

Small Communities Flood Risk Reduction Program Feasibility Study for City of Colusa

CITY OF COLUSA

DECEMBER 2019

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Acronyms

CDFW ..... California Department of Fish and Wildlife
CalTrans.....California Department of Transportation
DWR.....California Department of Water Resources
CEQA.....California Environmental Quality Act
CVFPB .....Central Valley Flood Protection Board
CVFPP .....Central Valley Flood Protection Plan
CVFED ..... Central Valley Floodplain Evaluation and Delineation Program
CVHS .....Central Valley Hydrology Study
CFR.....Code of Federal Regulations
CPT .....Cone Penetration Test
cfs.....Cubic Feet per Second
FEMA ..... Federal Emergency Management Agency
FIRM ..... Flood Insurance Rate Map
FIS.....Flood Insurance Study
GIS ..... Geospatial Information System
HEC-RAS ..... Hydrologic Engineering Center River Analysis System
LAMP ..... Levee Analysis and Mapping Plan
LiDAR..... Light Detection and Ranging
MA..... Maintenance Area
MUSR.....Mid-and Upper-Sacramento River
NEPA ..... National Environmental Protection Act
NFIP .....National Flood Insurance Program
NGO .....Non-Governmental Organization
NULE..... Non-Urban Levee Evaluation
NAVD .....North American Vertical Datum of 1988
O&M ..... Operations and Maintenance
RD .....Reclamation District
RFMP ..... Regional Flood Management Plan
SRWSLD.....Sacramento River West Side Levee District
SPFC..... State Plan of Flood Control
SCFRRP .....Small Communities Flood Risk Reduction Program
SuMY .....Sutter Maintenance Yard
USACE.....United States Army Corps of Engineers
USFWS .....United States Fish and Wildlife Service
USGS .....United States Geological Survey

Executive Summary

The report documents the flood risk reduction feasibility study (Study) that was conducted for the city of Colusa (Colusa). Colusa is an incorporated community located along the west bank of the Sacramento River in Colusa County. Previous California Department of Water Resources (DWR) Non-Urban Levee Evaluation (NULE) investigations determined that the section of the Sacramento River in the vicinity of and directly adjacent to Colusa suffers from through seepage deficiencies and erosion concerns. Currently Colusa is not mapped within a Federal Emergency Management Agency (FEMA) special flood hazard area, however FEMA has initiated a remapping process for Colusa County. Initial results indicate that without remediation of the Sacramento River levees, much of Colusa County, including Colusa, will be placed within a FEMA special flood hazard area.

This Study is being conducted under the first phase of the Small Community Flood Risk Reduction Program (SCFRRP). The goal of this Study is to identify a feasible alternative to provide 100-year level of flood protection for Colusa. This Study included geotechnical, hydrology and hydraulics, permitting, financial, and environmental evaluations for six alternatives that would achieve 100-year level of protection for Colusa and identified the most feasible alternative. The intent of this report is to assist decision makers in implementing the flood risk reduction measures which are consistent with the 2012 Central Valley Flood Protection Plan (CVFPP) and the 2017 update.

Jurisdictions with interest in this Study include the County of Colusa, the City of Colusa, Sacramento River West Side Levee District, Maintenance Area 1 (MA 1), Maintenance Area 12 (MA 12), DWR, and FEMA. Additional stakeholders include Colusa residents and property owners, and non-governmental organizations with interest in the potential multi-benefit aspects of the alternatives analyzed in this Study. See Section 7.1 for a discussion of the stakeholder involvement process.

Outlined in the Study are the various objectives developed which include technical, regulatory approval, funding, risk reduction, and alternatives evaluation objectives. Also considered are planning constraints, which influenced the formulation of the Study alternatives. These constraints include the level of flood protection, geotechnical conditions, existing infrastructure, land use impacts, environmental constraints, and regulatory conflicts.

A variety of flood risk management measures were considered during formulation of the Study alternatives. Both structural and non-structural actions were considered. Structural improvements considered include levee, floodwalls, and/or improvements that physically confine floodwaters to reduce risk of flooding. Non-structural measures considered raising structures to be above anticipated flood levels and flood-proofing structures to be unharmed by floodwaters. To provide a basis for developing the necessary measures and alternatives, geotechnical, hydrologic and hydraulics analyses

were performed. The geotechnical analysis examined the existing conditions of the State Plan of Flood Control (SPFC) levee along the Sacramento River and provided recommendations for remediation. The recommended remediation measures included a combination of shallow cutoff walls, deep mix cutoff walls, drained seepage berms, stability berms, geometry and freeboard repair, and new levees.

Given the potential for levee failure due to the geotechnical deficiencies identified, hydrologic and hydraulic analyses were conducted to delineate potential flood inundation scenarios resulting from SPFC levee breaches during a 100-year flood event. A total of seven breach locations were individually modeled, three upstream, three downstream of Colusa and one at Colusa, using FEMA guidelines. This analysis found the critical segment of levee in which a breach would impact Colusa, to be approximately from 20,000 feet upstream of Colusa to 25,000 feet downstream of Colusa. This critical levee segment framed the extent of SPFC levee that would need to be improved to a meet FEMA's 100-year levee criteria[1]. This analysis produced "Without Project" residual floodplain maps for each breach created, showing the impacted areas and anticipated depths. Inundation maps and the analysis are detailed in the Hydrology and Hydraulics Technical Memorandum in Appendix C. The resulting floodplain elevations were used during the development of alternatives.

In addition to the flood risk from the Sacramento River, the Colusa Basin Drain is also a potential danger to the city of Colusa. The existing Powell Slough levee provides some protection to Colusa, and the Powell Slough Feasibility Study prepared by Colusa County in 2016 examines additional options for addressing the flood threat from the Colusa Basin Drain. The existing Powell Slough levee is not part of the SPFC system, but improvements to this levee provides enhancements to the SPFC system by preventing flanking floodwaters originating from the Sacramento River and is necessary for providing 100-year flood protection to Colusa. The most feasible alternative identified in the Powell Slough Feasibility Study was included as part of this Study to encompass all the measures under evaluation for reducing flood risk in Colusa.

Six alternatives (as described in Chapter 4 and shown in Figures 4-2, 4-3, 4-4, 4-5, 4-6, and 4-7) were developed to provide a 100-year level of protection for Colusa and critical infrastructure and facilities within its defined Area of Protection (as shown in Figure 2-2), which include combinations of both structural and non-structural measures. Regional non-structural risk reduction strategies and multi-benefit opportunities which are common to all alternatives are also described. Structural measures include levee remediation such as cutoff walls, seepage berms, and rock slope protection to address existing SPFC levee deficiencies as well as new levee ring facilities surrounding the town to protect from flooding resulting from SPFC levee failures. Non-Structural measures include elevating residences, dry flood proofing non-residential structures,

[1] Title 44 of the Code of Federal Regulations, Section 65.10 – *Mapping of Areas Protected by Levee Systems.*

and regional non-structural strategies that include flood emergency preparedness and response, public outreach and education, and floodplain management.

Alternative 1 proposes to remediate existing SPFC levees, and complete a ring levee by connecting the existing Powell Slough Levee to the Sacramento River SPFC levee. This includes construction of a new levee on the north, west and south ends of Colusa.

Alternative 2 is similar to Alternative 1, as it also protects Colusa and critical infrastructure from both the Sacramento River and Colusa Basin Drain with a proposed ring levee and remediation of existing levees. Alternative 2, however, considers remediating a longer segment of SPFC levee and different alignment location in favor of protecting more land with a shorter segment of new levee in the south.

Alternative 3 is similar to the previous alternatives. This alternative protects Colusa and critical infrastructure from a 100-year breach from the Sacramento River on the north and east, and the Colusa Basin Drain on the west.

Alternative 4 is similar to the Alternative 1 with the exception of a different northern levee alignment. This alternative protects Colusa and critical infrastructure from a 100-year breach from the Sacramento River on the north and east, and the Colusa Basin Drain on the west.

Alternative 5 is also similar to the Alternative 2 with the exception of a different northern levee alignment. This alternative protects Colusa and critical infrastructure from a 100-year breach from the Sacramento River on the north and east, and the Colusa Basin Drain on the west.

Alternative 6 is also similar to Alternative 3 with the exception of a different northern levee alignment. This alternative protects Colusa and critical infrastructure from a 100-year breach from the Sacramento River on the north and east, and the Colusa Basin Drain on the west.

This Study also reviewed non-structural measures currently in place, and explored other measures that could further help to mitigate risk. The non-structural measures discussed help meet flood emergency preparedness goals listed in the 2012 CVFPP. All of the alternatives include the following non-structural strategies: regional flood emergency preparedness and response, public outreach and education, floodplain management, and participation in the National Flood Insurance Program (NFIP). The Study also explores multi-benefit opportunities including floodplain restoration and creation of recreational bike paths. These goals are in line with those outlined in the CVFPP Conservation Strategy.

In addition to all of the above, compliance with environmental regulations such as CEQA and/or NEPA was investigated. The selection process has examined each alternative's potential impact on the environment and the permits necessary for

implementation. The Study team performed a desktop analysis to determine potential environmental constraints for each of the four alternatives, which are outlined in detail in the Study and included appendices. Desktop biological and cultural resources analyses were also conducted and are outlined in detail. All six alternatives were determined to have potential impacts on the recourse areas below:

- Agriculture and Forestry Resources
- Air Quality and Greenhouse Gas Emissions
- Biological Resources
- Cultural and Tribal Cultural Resources
- Geology, Soils, and Mineral Resources
- Hazards and Hazardous Materials
- Hydrology and Water Quality
- Land Use and Planning
- Noise
- Public Services and Recreation
- Traffic and Transportation
- Utilities and Service Systems
- Energy

To determine the financial feasibility of the alternatives in this Study, a financial analysis was conducted. The Study evaluated the possible funding sources and the increase in property based special assessments for each alternative.

The financial analysis consisted of estimating likely assessment capacities for each alternatives' beneficiaries. This assessment capacity was limited to an assumed constraint of $200 for single family residential parcels. The assessment rates were based upon an Expected Benefit methodology. The assessments were assumed to be first utilized to pay for any incremental increases in operations and maintenance costs then used to service any debt incurred to raise local cost share capital requirements. Table ES-1 below presents the alternative construction costs (including all soft costs), the alternative's assessment capacity, incremental operations and maintenance costs, and likely bond amount. The project costs were escalated to 2025 for an assumed project construction date.

TABLE ES-1
SUMMARY OF FINANCIAL ANALYSES

Alternative	Total Project Cost (2025)	Annual Assessment Capacity[1]	Annual O&M Costs (Incremental)	High Bond Rate Funding Capacity (5% Bond, 30 year term)	Low Bond Rate Funding Capacity (3% Bond, 30 year term)
1	$188,031,802	$ 849,000	$ 69,751	$ 10,890,000	$ 13,880,000
2	$214,707,277	$ 850,000	$ 65,109	$ 10,970,000	$ 13,990,000
3	$204,123,042	$ 849,000	$ 45,880	$ 11,220,000	$ 14,310,000
4	$180,216,613	$ 850,000	$ 64,633	$ 10,980,000	$ 13,990,000
5	$206,892,088	$ 850,000	$ 60,595	$ 11,030,000	$ 14,070,000
6	$196,307,853	$ 850,000	$ 41,367	$ 11,300,000	$ 14,410,000

[1]Annual assessment capacities are rounded to the nearest thousand.

Following environmental constraint and financial analyses, the Study summarizes public outreach, agency consultation, and coordination with stakeholders and partner agencies. The evaluation criteria, rating system, and how the most feasible alternative was selected are also outlined in detail. Alternatives were evaluated for their ability to achieve a 100-year level of protection, and their alignment with the State's goals listed in the 2012 and 2017 Update CVFPP. More specifically, their ability to improve flood risk management, promote ecosystem functions and multi-benefit projects, improve institutional and public support, improve Operations and Maintenance activities, and the resulting capital costs and impacts to Operations and Maintenance costs. A rating matrix was used to identify the most suitable of the six alternatives.

TABLE ES -2
SUMMARY OF ALTERNATIVE SCORING

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Improve Flood Risk Management	4	4	4	4	4	4
Promote Multi-benefit Opportunities	1	1	1	1	1	1
Improve Institutional Support	2.9	2.2	3.6	3.2	2.5	3.9
Construction and O&M Costs	0.842	0.820	0.829	0.848	0.826	0.836
Total Rating	8.742	8.020	9.429	9.048	8.326	9.736

All evaluated alternatives provide a 100-year level of flood protection and scored similarly. In terms of promoting ecosystem functions and multi-benefit projects, all alternatives incorporate the same multi-benefit features that follow the 2016 CVFPP Conservation Strategy. Therefore, the scores across all the alternatives are the same

for both criteria. All the alternatives are consistent with current land use planning, scoring the same. All alternatives create additional O&M responsibility.

The Study identified Alternative 6 as the most feasible alternative. Alternative 6 provides the same benefits to the community as all the other alternatives, however based upon the public outreach response to the various alternatives, it faces less opposition from the public and causes the least impact to the Dolan Ranch Conservation Bank. Additionally it requires the minimum amount of permanent right-of-way acquisition and new levee miles.

To implement the chosen alternative, there are important constraints and next steps to consider. Applying for regulatory permits and consultations as listed in Section 9.2 will be one of the most time consuming processes that may cause schedule delays. The duration of construction activities were not estimated due to the possibility of phased implementation of the most feasible alternative. Commencement of construction activities on the length of the permitting process considering a more detailed constraints analysis to be performed in a future phase. Alternative 6 could potentially be phased by task (e.g. design, permitting) or by levee reaches (e.g. north wing levee, SPFC repairs), or a combination of task and levee reach; further discussions with stakeholders will be necessary to determine the final implementation plan.

The Study concludes with next steps and outlines a general path towards implementation of the most feasible alternative.

Chapter 1. Introduction

The report documents the flood risk reduction feasibility study (Study) that was conducted for the city of Colusa (Colusa). Colusa is an incorporated community located along the west bank of the Sacramento River in Colusa County. (See Figure 2-1).

Previous California (CA) Department of Water Resources (DWR) Non-Urban Levee Evaluation (NULE) investigations determined that the section of Sacramento River levee protecting Colusa has both under and through seepage deficiencies, areas of stability concerns, and erosion concerns. Figure 3-1 and Figure 3-2 present a summary of the geotechnical deficiencies of the levees protecting Colusa from the Sacramento River. Colusa also faces a flood threat from the Colusa Basin Drain to the west. The Powell Slough Levee (Phase 1) was constructed to remediate the western flood risk, and the previous Powell Slough Feasibility Study analyzed alternatives for Phase 2 of the levee project. The chosen alternative was not yet constructed, and there exists a gap between the Phase 1 levee and the Maintenance Area 12 (MA 12) levee that protects Colusa in the west. Currently Colusa is not mapped within a Federal Emergency Management Agency (FEMA) special flood hazard area, however FEMA has initiated a remapping process for Colusa County. Initial results indicate without remediation of the Sacramento River levees and construction of the Powell Slough most feasible alternative (See Section 2.5), much of Colusa County, including the city of Colusa will be placed within a FEMA special flood hazard area.

This Study is being conducted under the first phase of the Small Communities Flood Risk Reduction Program (SCFRRP). The feasibility of this feasibility study is to identify a feasible alternative to provide 100-year level of flood protection for Colusa. This study included geotechnical, hydrology and hydraulic, permitting, financial, and environmental evaluations for six alternatives that would achieve 100-year level of protection for Colusa. The intent of this report is to assist future decision makers in implementing the most feasible alternative.

Chapter 2. Project Setting

This section describes the Project authority and funding background, setting, participating stakeholders, and related studies.

2.1. Study Authority and Background

This Study is being conducted under the first phase of the SCFRRP. The SCFRRP is a local assistance program developed by DWR with the objective to reduce flood risk for small communities such as Colusa that are within the California Central Valley and protected by SPFC facilities. The SCFRRP was created to aid with implementation of the 2012 Central Valley Flood Protection Plan (2012 CVFPP), and the 2017 update to the 2012 CVFPP (2017 Update).

The 2012 CVFPP describes the State's strategy for modernizing the SPFC to address current flood management challenges. Known as the State System Investment Approach (SSIA), the strategy provides guidance for State participation in projects and programs, such as the SCFRRP, to improve integrated flood management in the Central Valley. One of the key elements of the SSIA is the goal to provide small communities within the Central Valley with a 100-year level of flood protection through implementation of structural and non-structural flood risk reduction options such as:

- Protecting small communities "in-place" using ring levees, training levees, or floodwalls;
- Reconstructing or remediating adjacent SPFC levees; and/or
- Implementing non-structural improvements, such as elevating structures, flood proofing, and/or relocating structures.

Funding for the SCFRRP was authorized under The Disaster Preparedness and Flood Prevention Bond Act of 2006[2] which authorized funding for DWR to repair, rehabilitate, reconstruct, or replace levees, weirs, bypasses and facilities of the SPFC.

Colusa County received a grant under the SCRRFP to undertake this Study, as well as flood risk reduction feasibility studies for the towns of Grimes and Princeton. Colusa County does not maintain the SPFC levees protecting these communities from Sacramento River flooding, however County Public Works does maintain the existing Powell Slough Levee (locally known as the "Tractor Levee.") Sacramento River west bank levees are maintained and operated by the Sacramento River West Side Levee District (SRWSLD) and by DWR. However SCFRRP guidelines required that an agency with land-use authority lead the feasibility studies. Therefore Colusa County entered into

[2] Proposition 1E; Pub. Resources Code, § 5096.800 et seq.

a Memorandum of Understanding (MOU) with SRWSLD and the City of Colusa to define roles and responsibilities in conducting the Study.

2.2. Study Setting

Colusa is located in Colusa County on the west bank of the Sacramento River approximately 65 miles upstream of Sacramento, California. Located at the junction of Highway 20 and 45, Colusa currently serves as the County seat. The 2010 United States Census reported a population of 5,971 people. Colusa County is primarily an agricultural county and is home to one of the top rice producing counties in the US with over 135,000 acres harvested in 2016[3]. While the lands surrounding Colusa are primarily agricultural, the Colusa National Wildlife Refuge stands to the southwest of the city. The refuge primarily consists of managed wetland impoundments, with some grassland and riparian habitats. The refuge provides habitats for migrant animals and supports several populations of endangered and sensitive species of plants. Colusa County is also home to the Cachil DeHe Band of Wintun Native Americans, whose community is located approximately four miles north of the city.

2.3. Area of Protection & Critical Infrastructure

In the Study initiation meeting with Colusa County, Colusa, SRWSLD, and DWR staff, the area which constitutes the limits of Colusa for the purposes of this Study (*area of protection*), and the facilities which are critical to the community were identified. The area of protection includes the existing City of Colusa Sphere of Influence (SOI) including those areas designated as industrial as identified in the County of Colusa's 2011 General Plan, in addition to the Colusa County Airport and its respective Safety Zone, and State Highways 20 and 45. For the purposes of this report, the area of protection will be collectively be referred to as Colusa.

Critical infrastructure identified during the same Study initiation meeting includes the Colusa Airport, Colusa Industrial Park, State Highways 20 and 45, and the City Wastewater Treatment Plant. The Colusa Airport serves as a critical regional supply staging area, provides helistops, and evacuation points for the region[4]. State Highways 20 and 45 provide primary evacuation routes for the region.

Colusa is subject to potential flooding from both the Sacramento River to the east, and the Colusa Basin Drain to the west. SPFC levees provide flood protection from the Sacramento River. To the west, the city is partially protected from flooding from the Colusa Basin Drain by non-project levees north of Highway 20 and SPFC levees south of Highway 20. Figure 2-2 presents a vicinity map of Colusa and identifies critical infrastructure.

[3] Colusa County. *2016 Colusa County Crop Report.*
[4] Identified in the *Colusa Basin Unified Flood Fight Command Map* and *City of Colusa Special Case Map*.

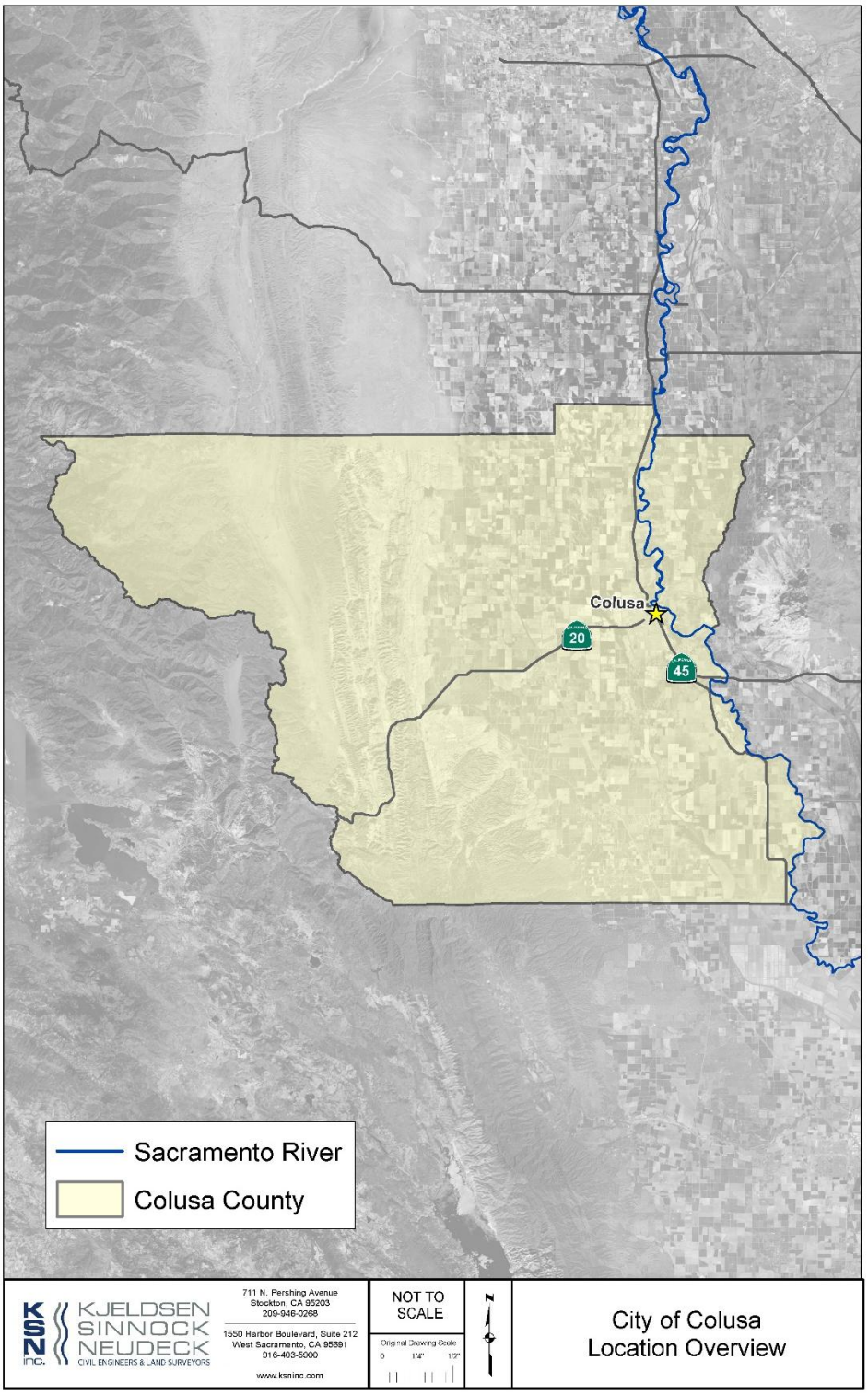


FIGURE 2-1
CITY OF COLUSA LOCATION

2.4. Study Stakeholders

Jurisdictions with an interest that participated in this feasibility study include the County of Colusa, Colusa, Sacramento River West Side Levee District (SRWSLD), CA DWR's MA 1 and MA 12, and FEMA. Additional stakeholders include property owners adjacent to alignments of identified alternatives, and non-governmental organizations with interest in the potential multi-benefit aspects of the alternatives developed in this Study, including American Rivers and Trout Unlimited.

2.5. Related Studies

The CVFPP planning process brought together many partners, stakeholders, and flood-management-related efforts in the Central Valley in an effort to develop a common, outcome-driven vision that guides State investments. Related and previous studies were reviewed to help inform development of alternatives, and are briefly summarized below.

Central Valley Flood Protection Plan (CVFPP)

The CVFPP is California's strategic blueprint to improve flood risk management in the Central Valley. The first plan was adopted in 2012 and was updated in 2017. The plan lays out strategies to:

- Prioritize the State's investment in flood management over the next 3 decades;
- Promote multi-benefit projects, and;
- Integrate and improve ecosystem functions associated with flood risk reduction projects.

The 2012 CVFPP details the State's strategy (SSIA) for modernizing the SPFC to address current flood management challenges, including those faced by small communities such as the city of Colusa.

Mid-Upper Sacramento River Regional Flood Management Plan (MUSR RFMP)

Following adoption of the 2012 CVFPP, DWR funded six regionally-led RFMPs that asked local experts to inform and help shape regional flood management priorities and challenges. Colusa is included in the MUSR RFMP[5]. The MUSR RFMP effort established a working relationship among participating counties, cities, reclamation district (RDs), levee districts (LDs), and other levee maintaining agencies (LMAs) within the region. Additionally, tribal groups, NGOs, agricultural interests, and landowners within the MUSR RFMP planning area were encouraged to be involved. The flood management challenges facing the MUSR that were identified in the RFMP include, but are not limited to:

- Levee Deficiencies;
- System Maintenance;

[5] *Mid-Upper Sacramento River Regional Flood Management Plan*. November 2014.

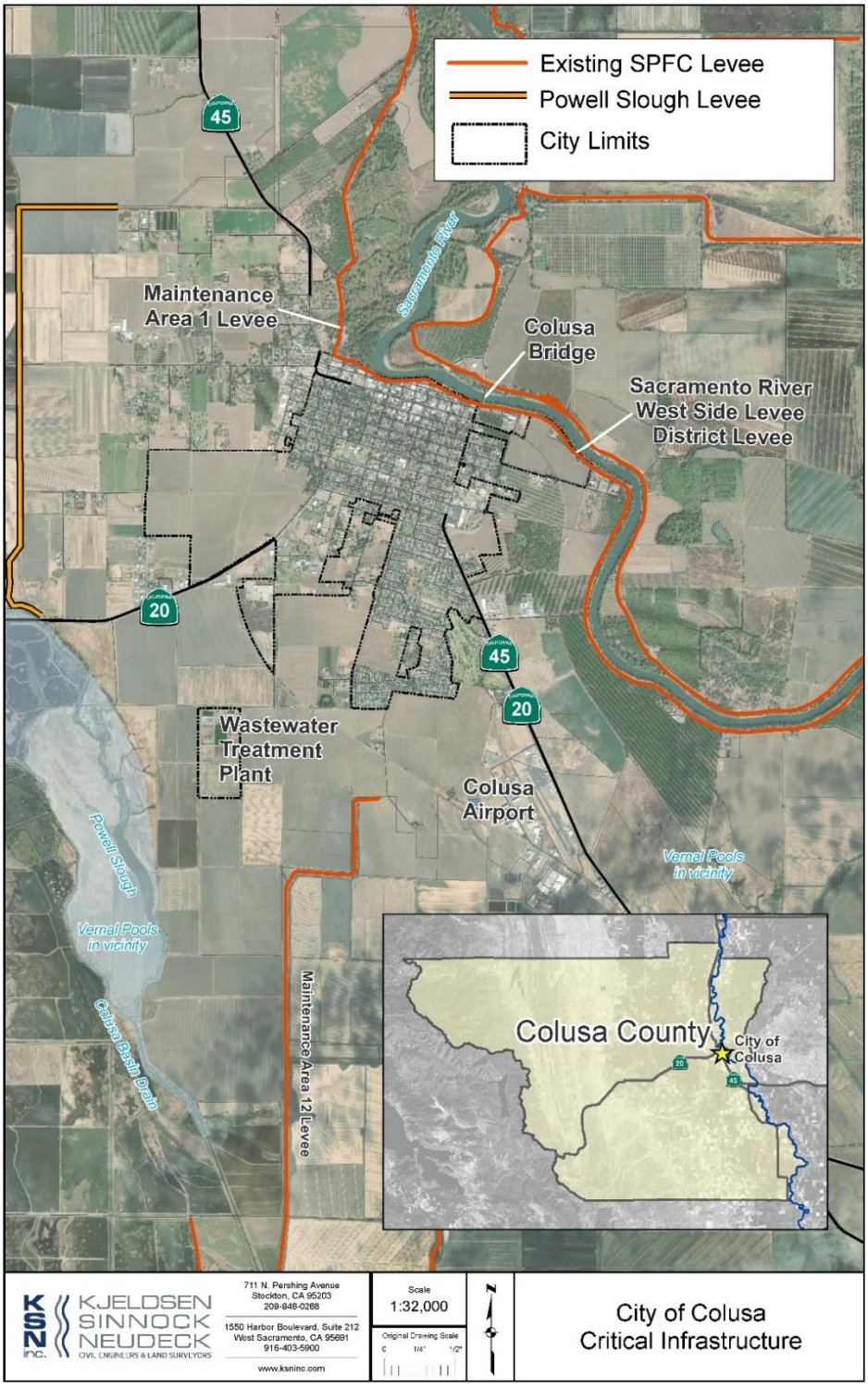


FIGURE 2-2
VICINITY MAP OF THE CITY OF COLUSA

- Balancing the need for Flood System Improvements with 2012 CVFPP Conservation Goals;
- System Expansion Concerns; and
- Protecting and Sustaining Small Communities.

Colusa is identified as a small community in the MUSR RFMP, and provided initial inventory of flood risks and potential alternatives. The alternatives identified in the MUSR RFMP were considered in this Study.

Feasibility Study for the Colusa Drain Flood Reduction Project[6]

The Powell Slough Feasibility Study, prepared by Colusa County in 2016, analyzed potential alternatives to reduce the flood risk to Colusa from the Colusa Basin Drain. The study analyzed alternative levee alignments for a new levee west of the city. A preferred alternative was identified as the Powell Slough Feasibility Study Preferred Alternative 7, and has been incorporated in the alternatives evaluated in this Study.

FEMA Flood Insurance Rate Map (FIRM) Update

FEMA has initiated a Levee Analysis and Mapping Plan (LAMP) project within Colusa County with the intent of revising its Flood Insurance Rate Maps for the County. As part of this work, FEMA has acquired the CVFED hydraulic model for the Sacramento River in Colusa County. Building upon the CVFED hydraulic model, FEMA is updating the hydraulic model to reflect current conditions. At the conclusion of the LAMP project it is anticipated that the levees along the Sacramento River west bank will be de-accredited and the areas behind those levees will be remapped into Special Flood Hazard Areas. The hydraulic model from the LAMP project was provided to the Study team by FEMA and served as the starting point for the hydraulic modeling in this Study.

Non-Urban Levee Evaluation (NULE) Program

The NULE Project was part of DWR's Levee Evaluation Program that completed geotechnical evaluations of 1,220 miles of SPFC levees and 280 miles of non-SPFC levees in the Central Valley in areas with populations of less than 10,000 people. Within this study area, geotechnical evaluations conducted in the SPFC levee along the Sacramento River were evaluated and incorporated in this study. No NULE data was found for levees protecting Colusa from the Colusa Basin Drain.

Drainage Master Plan

The city's Drainage Master Plan addresses interior hydrology and flooding concerns that affect the city. It presents a plan to size drainage facilities and mitigate impacts from local flooding.

Central Valley Hydrologic Study (CVHS)

The United States Army Corps of Engineers (USACE) completed the CVHS in 2015. The CVHS was a hydrologic study of the California Central Valley. It is an analysis of

[6] HDR. *Feasibility Study for the Colusa Drain Flood Reduction Project*. June 15, 2016. For the County of Colusa.

the hydrologic conditions at certain locations specific to the Federal-State levee system in the Central Valley watershed. The study was completed to update flood control system information about the Central Valley to assist with floodplain management decisions. The CVHS study was used for the hydrologic inputs to the hydraulic modeling for this study.

Central Valley Floodplain Evaluation and Delineation (CVFED)

The CVFED Project by DWR developed hydraulic models and floodplain maps for the Central Valley, including Colusa. Its main purpose was to provide detailed technical information and data about flood risk within the Central Valley. The LiDAR collected as a part of the CVFED Project was used as the source of topographic information for this study.

Chapter 3. Problems, Goals, Opportunities, and Constraints

This section outlines the problems, goals, opportunities, and constraints that defined the overall approach to the Study.

3.1. Summary of Problems

As stated in Chapter 2, Colusa has two potential flooding sources: the Sacramento River to the east, and the Colusa Basin Drain to the west. Colusa is protected by the following levees as illustrated in Figure 2-2:

Sacramento River

- SPFC levees, maintained by the Sacramento River West Side Levee District (SRWLD) and DWR's Maintenance Area 1,

Colusa Bain Drain

- Existing Powell Slough Levee (locally referred to as the "Tractor Levee") provides partial protection from the Colusa Basin Drain, north of State Highway 20.
- SPFC levee, maintained by DWR's Maintenance Area 12, provides partial protection from the Colusa Drain South of State Highway 20.

The approximate 2.1-mile gap between the existing Powell Slough Levee and the MA 12 levee leaves Colusa vulnerable to backwaters from the Colusa Basin Drain. Floodwaters through this gap have the ability to impact the City Wastewater Treatment Plant, the southwestern edge of Colusa and close State Highway 20, which serves as a critical evacuation and emergency supply transport route for the region.

The SPFC levees along the Sacramento River have geotechnical deficiencies and numerous levee encroachments which may hinder levee performance during high water events. Figure 3-1 and Figure 3-2 show that the levee has experienced erosion, seepage, and boils at numerous locations. These levees also have geometric and freeboard issues. Similarly, levees protecting Colusa from the Colusa Basin Drain have geometric issues and freeboard deficiencies.

The majority of Colusa is not currently mapped within a FEMA special flood hazard area, however FEMA has initiated a remapping process for Colusa County. Initial results from this remapping process indicate that without remediation of the Sacramento River levees, much of Colusa County, including Colusa, will be placed within a FEMA special flood hazard area. See Figure 3-3.

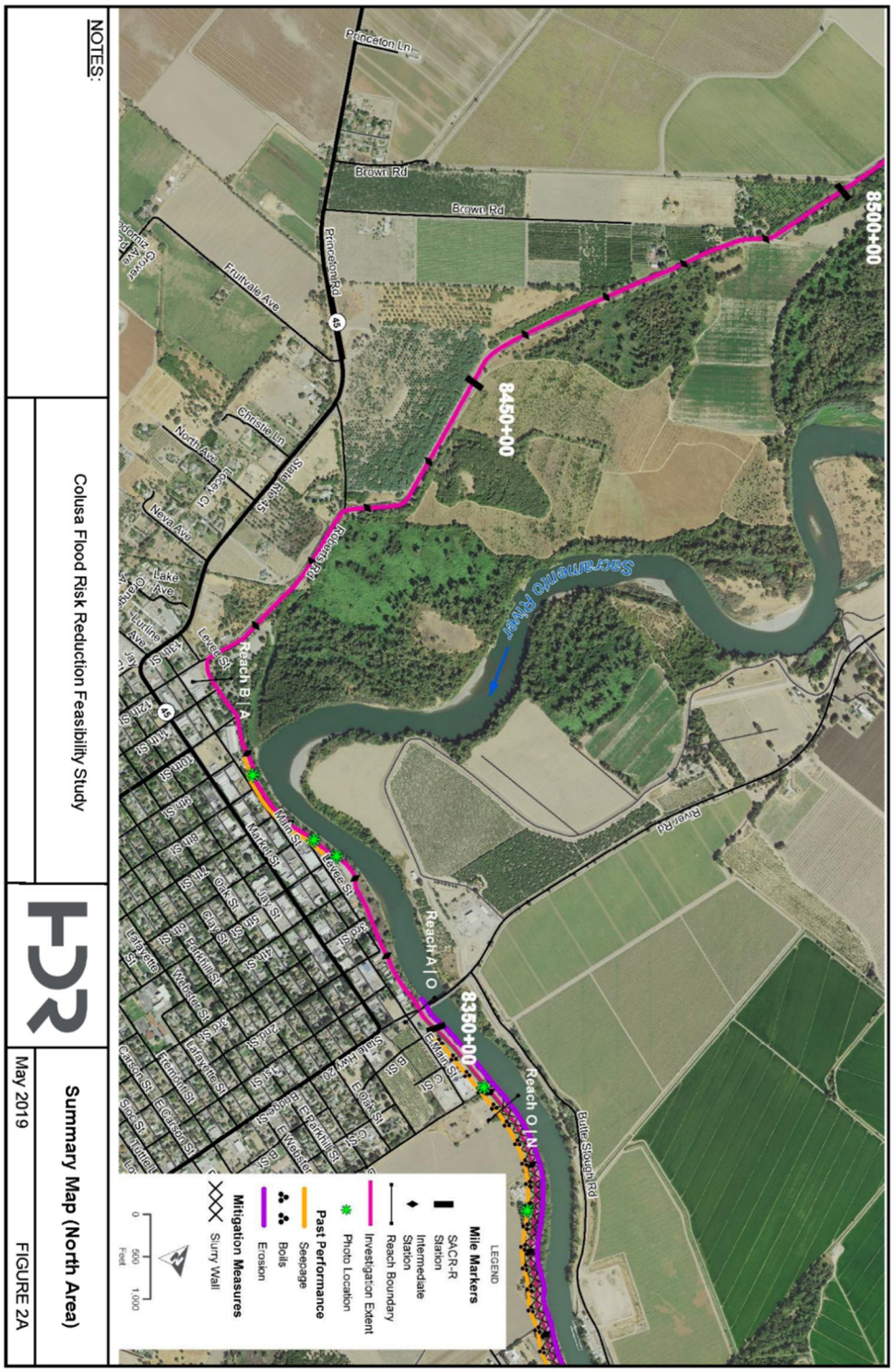


FIGURE 3-1
CITY OF COLUSA SUMMARY OF GEOTECHNICAL DEFICIENCIES (NORTH)

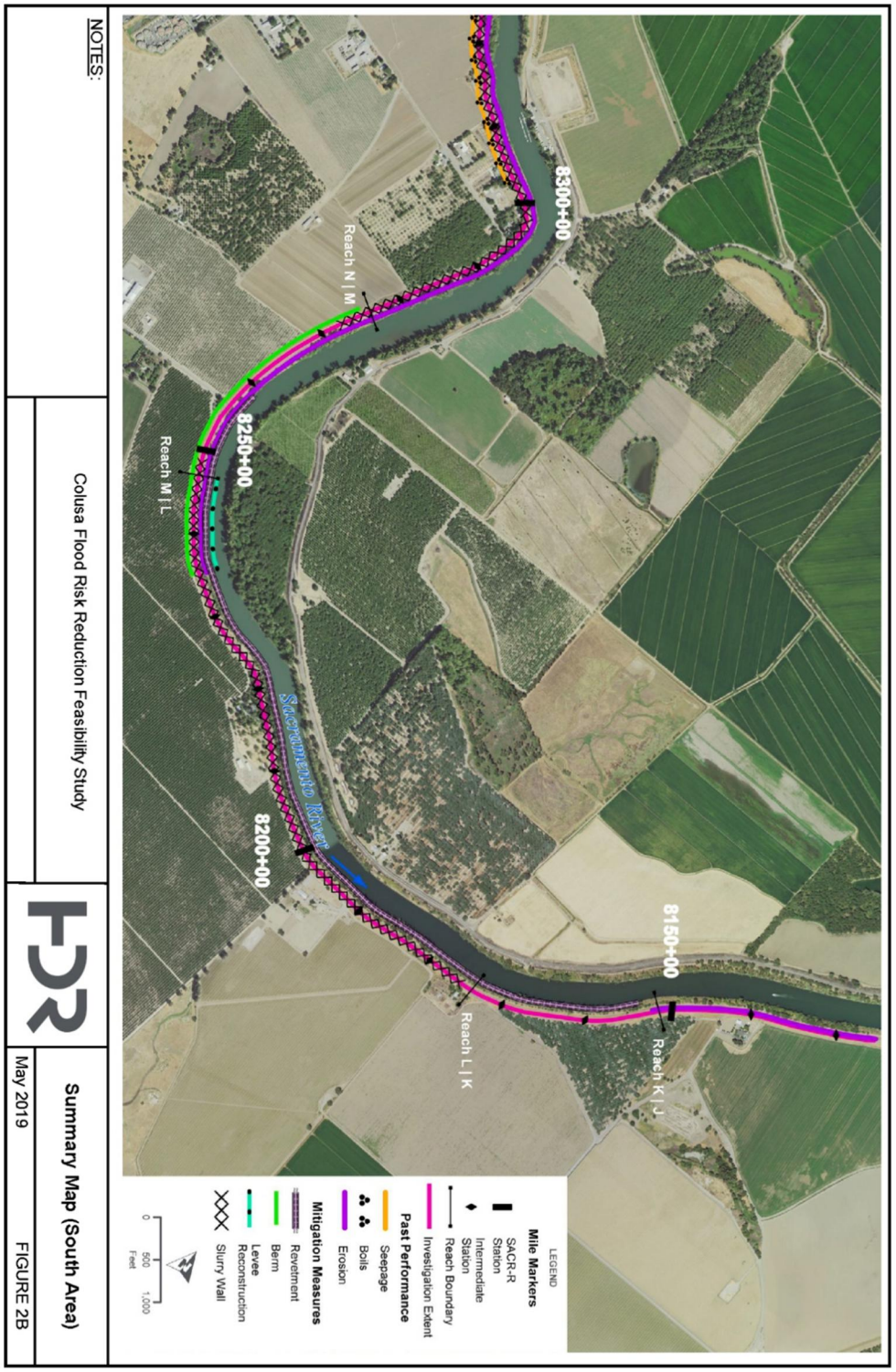


FIGURE 3-2
CITY OF COLUSA SUMMARY OF GEOTECHNICAL DEFICIENCIES (SOUTH)

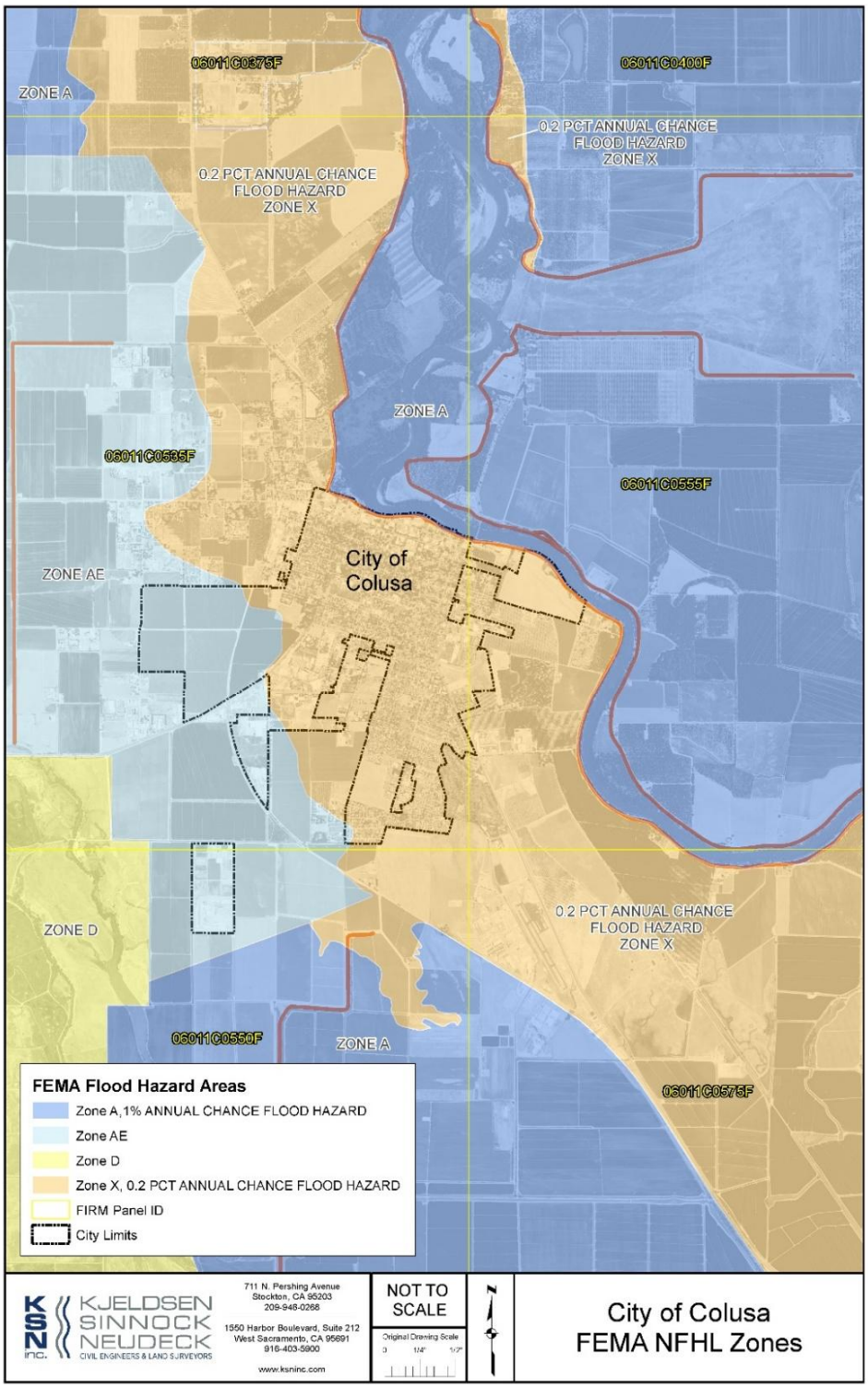


FIGURE 3-3
EFFECTIVE FEMA FLOOD HAZARDS NEAR THE CITY OF COLUSA

3.2. Goals and Objectives of this Feasibility Study

At the initiation of the Study, the study team developed and defined the Study's goals and objectives (See Appendix A). The goal of this feasibility study was defined as identifying a feasible alternative to provide 100-year level of flood protection for Colusa. In addition, the alternatives identified in this study have been developed to optimize meeting the multiple objectives identified in the 2012 CVFPP and the 2017 CVFPP Update. The potential contributions of this study to the advancement of the CVFPP's goals are summarized below:

1. Improve Flood Risk Management;
2. Improve Operations and Maintenance (O&M);
3. Promote Ecosystem Functions (in tandem with goals listed in the 2016 Conservation Plan, further discussed in 4.4.9 and Table 3-1);
4. Improve Institutional Support; and
5. Promote Multi-benefit Projects.

To achieve these goals, the following objectives were developed:

Objective 1: Technical Objectives

Technical objectives included gathering background information to identify existing system vulnerabilities and deficiencies. More specifically, geotechnical deficiencies in existing levees, possible inundation areas, and base flood elevations. In addition, real estate, environmental, civil, maintenance and operations, and multi-benefit constraints that would impact potential alternatives were considered. These results are further discussed in Chapter 4.

Objective 2: Regulatory Approval Objectives

The second objective was to develop alternatives that could obtain regulatory approval from appropriate agencies such as USACE, DWR, 100-year flood protection level as defined by FEMA, Central Valley Flood Protection Board (CVFPB) and local ordinances.

Objective 3: Funding Objectives

This objective sought to evaluate the financial feasibility of each alternative, by understanding the financial impacts to the residents, the City and County of Colusa, and respective levee maintaining agencies. Once alternatives were established, respective construction and anticipated O&M costs were developed. These cost estimates served as the basis for evaluating the financial feasibility of each alternative. This objective also aimed to identify potential funding sources (such as project beneficiaries) and estimate cost share programs (local, state, and federal). This objective also brought the multi-benefit elements to the foreground during the inception of alternatives, further discussed in Section 4.5.

Objective 4: Risk Reduction Objectives

The intent of this objective was to focus and provide specific flood risk reduction targets that helped guide the alternative development phase:

1. Improve the existing level of protection to a 100-year level for the Colusa area of protection; and
2. Minimize residual risk within the Colusa area of protection.

The USACE defines residual risk as "*the exposure to loss remaining after other known risks have been countered, factored in or eliminated.*" To meet the risk reduction targets, the Study team considered structural and non-structural strategies to reach a 100-year level of protection (see Section 4.2). The SCFRRP guidelines encouraged the consideration of a variety of strategies to mitigate residual risk such as wise floodplain management, land use designation, emergency preparedness and response, and dry flood-proofing of critical facilities.

Objective 5: Alternatives Evaluation Objective

This Study aimed to develop a suite (six) of structural and non-structural alternatives that can increase the level of flood protection while meeting criteria described in objectives 1 through 4. The intent of this objective is to develop evaluation criteria with stakeholders that guide prioritization, evaluation, and selection of the most feasible alternative. The ranking criteria also considers alignment with the 2012 CVFPP and 2017 CVFPP Update goals.

Table 3-1 summarizes how the objectives of this Study align with the goals listed in the 2012 CVFPP, 2017 CVFPP Update, and the 2016 Conservation Strategy.

3.3. Planning Constraints

Planning constraints which influenced the formulation of the study alternative are summarized below.

- **Level of Protection** – Provide 100-year level of flood protection in accordance with FEMA standards (44 CFR 65.10) for the Colusa area of protection;
- **Geotechnical Conditions** – Geotechnical characteristics of the existing levees determine the issues present in the system, and constrain the type of solution used in each alternative;
- **Existing Infrastructure** – The minimization of impacts, where possible, was sought on existing infrastructure, including irrigation canals and ditches, roads, highways, gas lines, and electrical transmission lines;
- **Land Use Impacts** – Alternatives were formulated to minimize impacts to private property. Ring levee alternatives were located along property lines; levee remediation alternatives were formulated to avoid structure impacts were possible, the increase in residual risk should be limited; and
- **Environmental Constraints** – Identification of environmental, cultural, and biological resources was pursued to first minimize impacts from alternatives, or where not possible, mitigate against impacts to these resources. These are discussed in more detail in Chapter 5.

- **Regulatory Conflicts** – Early resolution of potential conflicting regulatory frameworks and policies can reduce hindrances to the implementation, operations, and maintenance of study alternatives.

TABLE 3-1
SUMMARY OF COLUSA SCFRRFS GOALS AND 2012 AND 2017 CVFPP GOALS

Colusa SCFRRFS Goals and Objectives	2012 and 2017 CVFPP Update Goals
	PRIMARY GOAL
Technical and Risk Reduction Objective This Study identifies a most feasible alternative that achieves 100-year level of flood protection for the Colusa area of Protection, while also addressing residual risk.	**Improve Flood Risk Management**
	SUPPORTING GOALS
Funding Objective This Study evaluates and quantifies construction costs and long-term O&M cost impacts of the Alternatives considered.	**Improve Operations and Maintenance**
Regulatory Approval This study coordinated with FEMA to ensure that the approach taken for each alternative would result in the community being removed from the 100-year floodplain. Additionally an analysis for alternative was conducted to identify permits necessary for that alternative's implementation (e.g. Section 404/408).	**Improve Institutional Support**
Alternatives Evaluation This Study develops a suite of structural and non-structural flood control alternatives to achieve a 100-year level of flood protection for Colusa. This Study identifies and evaluates actions that could promote ecosystem functions consistent with the 2016 Conservation Strategies list of Targeted Processes, Habitats, Species, and Stressors.	**Improve Flood Risk Management** **Promote Ecosystem Functions** **Promote Multi-Benefit Projects**

Chapter 4. Alternatives Formulation

This chapter describes the alternatives formulation process.

4.1. Flood Risk Management Measures

A variety of flood risk management measures were considered when formulating the alternatives. Both structural and non-structural actions were considered. Structural improvements considered include levee, channel, and/or bypass improvements that physically confine floodwaters to reduce risk of flooding. Non-structural measures considered include: raising structures to be above anticipated flood levels, floodproofing structures to be unharmed by floodwaters, purchasing and relocating at-risk structures, limiting development in floodplains through the acquisition of agricultural conservation easements, open space easements, regulatory constraints, and incentive programs.

4.2. Measures and Alternatives Development

Structural and non-structural measures were developed using opportunities and constraints that arose through the analysis of land use, geotechnical, hydrologic, and hydraulic conditions in the area. Alternatives using a combination of different measures were then created to collectively reduce flood risk for the Area of Protection.

The alternatives were developed to a level of detail where the degree to which they met Study goals and objectives could be evaluated, and planning-level cost estimates for each alternative could be prepared. It is assumed that the design features, alignments, etc. of the most feasible alternative will be refined in subsequent phases.

4.3. Conceptual Design and Assumptions

To provide a basis for developing the necessary measures and alternatives, the geotechnical and hydrology and hydraulics analyses were performed.

4.3.1. Geotechnical Evaluation

The geotechnical analysis examined the existing conditions of the SPFC levee along the Sacramento River and provided recommendations for remediation. The evaluation was based on the CA DWR's NULE data. Review of the data found the SPFC levees along the Sacramento River to have through seepage and under-seepage deficiencies. The recommended remediation measures included a combination of shallow and deep cutoff walls for areas immediately behind Colusa where encroachments exist, as well as seepage and drainage berms for areas that could more easily accommodate a berm footprint. Geotechnical evaluation of the Powell Slough Levee found freeboard and geotechnical deficiencies, whole only geometric deficiencies were identified for MA 12 levees found geometric and potential freeboard deficiencies.

Limited boring and cone penetrations tests (CPTs) were also conducted along the north and south proposed alignments of new levees. Results from these analysis suggest that existing soil conditions are adequate to serve as foundation for a new levee with low potential toe seepage issues.

A detailed analysis of the geotechnical evaluation, exploration, and recommended remediation measures is included in the Existing Conditions Assessment – Geotechnical Report in Appendix B.

4.3.2. Hydrologic and Hydraulic Analysis

The hydrology and hydraulics analysis examined individual 100-year flood breach scenarios of the SPFC levee along the Sacramento River to establish flood depths before and after the preliminary design would be implemented. A total of seven breach locations were individually modeled, three upstream and downstream of Colusa, using FEMA guidelines. This analysis found the critical segment of levee in which a breach would impact Colusa, to be approximately from 20,000 feet upstream of Colusa to 25,000 feet downstream of Colusa. This critical levee segment framed the extent of SPFC levee that would need to be improved to a meet FEMA's 100-year levee criteria[7]. This analysis produced "Without Project" residual floodplain maps for each breach created, showing the impacted areas and anticipated depths. Inundation maps and the analysis is detailed in the Hydrology and Hydraulics Technical Memorandum in Appendix C.

Breach results from the previous Feasibility Study for the Colusa Drain Flood Reduction Project were reviewed to evaluate levees protecting Colusa from the Colusa Basin Drain. The 100-year water surface elevations produced by the Colusa Basin Drain were lower than those produced by the Sacramento River. Both water surface elevations were considered during the development of Alternatives.

4.3.3. Civil Considerations

Results of the geotechnical evaluation and "Without Project" inundation envelope served as the basis identifying the extents of remediation needed for existing levees, and for possible alignment locations and geometry of potential new levees. Additionally, aerial imagery, topographic conditions, and a site walk were conducted to evaluate preliminary locations for fatal flaws (such as encroaching structures) or document impacts such as roads and utilities. For this Study, a typical levee cross-section for new levees was designed in order to develop an understanding of impacted landowners, potential right-of-way issues, design criteria, and preliminary cost estimate.

The typical new levee cross section was designed with a 20-foot crown width, and set to meet the 100-year water elevation plus four feet of freeboard. The levee side slopes were set to 3:1 (horizontal: vertical) on the landward side and 2:1 (horizontal: vertical) on waterside.

For instances where the new levee was crossed by a paved road or state highway, causing the road to be elevated, side slopes set to 4H:1V to comply with the California Department of Transportation (Caltrans) requirements[8]. Easements and right-of-way

[7] Title 44 of the Code of Federal Regulations, Section 65.10 – *Mapping of Areas Protected by Levee Systems.*
[8] Caltrans. Chapter 300 – Geometric Cross Section. *Highway Design Manual.* December 30, 2015.

buffers of 20 feet were assumed on both the landward and waterside of the levee for maintenance and operations activities. This typical levee cross section is depicted in Figure 4-1.

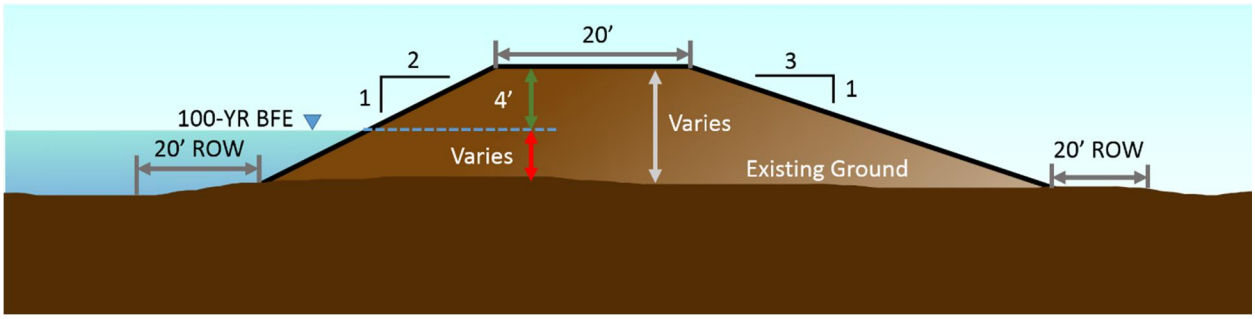


FIGURE 4-1
TYPICAL LEVEE CROSS-SECTION

For new levee alignments, it was assumed that levee penetrations are needed in order for agricultural operations in the vicinity of the levee to continue, however these penetrations were not designed. Only the likely need, a preliminary cost estimate, and a likely location were identified for this feasibility study.

For existing levees, the Study assumed that the only levee penetrations and encroachments to exist were those that had a permit which could be located on either the CVFPB or USACE websites. For these penetrations and encroachments, it was also assumed that continued maintenance or replacement will be needed during and after any work on the levees. If any non-permitted levee penetrations exist, these will adversely affect the cost and schedule of the developed alternatives. In all six alternatives, the proposed new alignments in the north will cross planned 115 kilovolt line routes for Sites Reservoir.

4.4. Array of Alternatives

Six alternatives were developed to achieve a 100-year level of protection for Colusa and critical infrastructure within its defined Area of Protection. This section will first briefly describe the individual structural and non-structural measures that form each alternative. Regional non-structural risk reduction strategies and multi-benefit opportunities which are common to all six alternatives are also described. Please refer to Sections 4.4.8 & 4.4.9 for more details on these common features to all alternatives.

4.4.1. Measures for Alternatives

A variety of measures were considered when developing alternatives aimed to reach a 100-year level of protection. These alternatives considered both structural and non-structural measures:

a. Structural

i. Cutoff wall, seepage and stability berms along the SPFC Levee to combat underseepage and through-seepage issues from the Sacramento River;
ii. Raising the existing Powell Slough levee to meet geometry and freeboard requirements;
iii. New Levee Facilities on the north (consistent with Figure 4-1), western, and south ends of the city to completed a ring levee that will protect from the Sacramento River and Colusa Basin Drain;

b. Non-Structural
   i. Regional non-structural strategies that include flood emergency preparedness and response, public outreach and education, and floodplain management.
      i. Elevating structures and floodproofing were considered for a non-structural alternative, but was screened out due to the high height of the 100-year flood elevation in the area and the volume of buildings that would need to be elevated/floodproofed.

The following alternatives are a combination of these measures that achieve 100-year level of protection, but result in differing economic, environmental, and societal impacts.

4.4.2. Alternative 1: Remediate SPFC Levee, Complete Ring Levee

Alternative 1 proposes to remediate existing SPFC levees, and complete a ring levee by connecting the Powell Slough Levee to the Sacramento River SPFC levee in the north, and the MA 12 levee to the Sacramento River in the south. This includes construction of a new levee on the north, west and south ends of Colusa and implementing non-structural strategies for properties on the fringe of the inundation envelope. Alternative 1 is presented in Figure 4-2, and proposes the following:

1. Remediate approximately 4.7 miles of existing Sacramento River SPFC Levee;
2. Construct a new, 2.1 mile levee from the existing Powell Slough Levee to connect with the SPFC Levee north of the city;
3. Remediate the existing Powell Slough Levee to meet freeboard criteria;
4. Construct the levee identified as the Powell Slough Feasibility Study Alternative 7 Levee, connecting the existing Powell Slough Levee to the MA 12 levee;
5. Remediate the MA 12 levee for geometry and freeboard deficiencies; and
6. Construct a new, 4.6 mile levee from the SPFC levee to the existing MA 12 levee along the south end of the city.

The remediation extent of the Sacramento River SPFC levee was based on analyses of the NULE geotechnical data, and CVFED-based hydraulics models (see Appendix B and Appendix C). These analyses delineated the critical levee segment that, in the

event of a breach, would introduce floodwaters into the city and critical facilities. To combat through seepage and under-seepage from the Sacramento River, remediation measures considered a combination of shallow and deep cutoff walls in areas immediately within the city where existing structures are prohibitively close to the levee. In areas less developed, where a berm footprint can more easily be accommodated, drained seepage and stability berms were proposed. Table 4-1 summarizes the type of remediation along each reach of the SPFC levee. The extents of the reaches are shown in Figure 3-1 and Figure 3-2.

TABLE 4-1
SUMMARY OF CITY OF COLUSA SPFC LEVEE REMEDIATION MEASURES

REACH (SEE FIGURE 3-1 AND 3-2)	REMEDIATION TYPE	CUTOFF WALL DEPTH (FT)	SEEPAGE BERM WIDTH (FT)
B	Drained Stability Berm	-	-
A	Shallow Cutoff Wall	20	-
O	Deep Cutoff Wall	102	-
N	Combination Drained Seepage Berm & Deep Cutoff Wall	76	70
M	Deep Cutoff Wall	85	-
L	Combination Drained Seepage Berm & Deep Cutoff Wall	76	70

The NULE analysis also identified erosion sites on the waterside of the levee as shown in Figures 3-1 and 3-2. Remediation measures for erosion include rock slope protection are included in this alterative.

The existing Powell Slough Levee will be extended approximately 2.1 miles to the east, along Tuttle Road on the north end of Colusa, and connect to the SPFC levee to prevent floodwaters resulting from an upstream breach from impacting Colusa. This new 2.1-mile levee will be approximately seven feet above existing ground to provide four feet of freeboard protection, consistent with the typical levee cross section presented in Figure 4-2.

To protect the city from impacts from the Colusa Basin Drain on the west, Alternative 1 proposes to extend the Powell Slough Levee three miles south to connect with the existing MA 12 levee. The alignment for the three mile extension to the south has been the identified in the previous study[9] as the Powell Slough Feasibility Study Alternative 7. For the purpose of this Study, the alignment is modified slightly to accommodate the

[9] HDR for the County of Colusa. *Feasibility Study for the Colusa Drain Flood Reduction Project*. June 15, 2016.

recent expansion of City owned property adjacent to the City's Wastewater Treatment Plant. This Preferred Alternative is based on flood impacts from the Colusa Drain and not the Sacramento River; therefore, the recommended geometry for the Powell Slough Feasibility Study Alternative 7 will be revised, as necessary, based on flood impacts from the Sacramento River.

Finally, to protect Colusa and the critical infrastructure from flooding from breaches on the Sacramento River levee or backwaters from the Colusa Basin Drain, a new levee would connect the existing MA 12 Levee to the Sacramento River levee.

This alternative would require the elevation of State Highway 20 entering Colusa from the West, and State Highway 45 on the south and north ends of Colusa.

The proposed multi-benefit component common to all alternatives involves lowering existing in-river floodplain areas. Section 4.4.9 below provides details on the development of this component. The material removed from the river to recreate the lowered floodplain could potentially be utilized in the construction of the drained seepage berms.

Regional non-structural strategies that are a component of this alternative include updating the region's Emergency Operations Plans, Flood Contingency Maps, and Unified Command Map. Also included are developing a Shelter-in-Place Map, conducting tabletop exercises, and replenishing flood fight supplies. Section 4.4.8 below provides more detail on this component.

Alternative 1 has a total cost of $188,031,802 (escalated to an assumed construction year of 2025). The additional annual O&M costs amount to $69,751. The total present worth in the year 2025 of Alternative 1 is $190,356,832. The breakdown in costs are presented below in Table 4-2. A detailed cost analysis and more detailed breakdown of costs is provided in Appendix D.

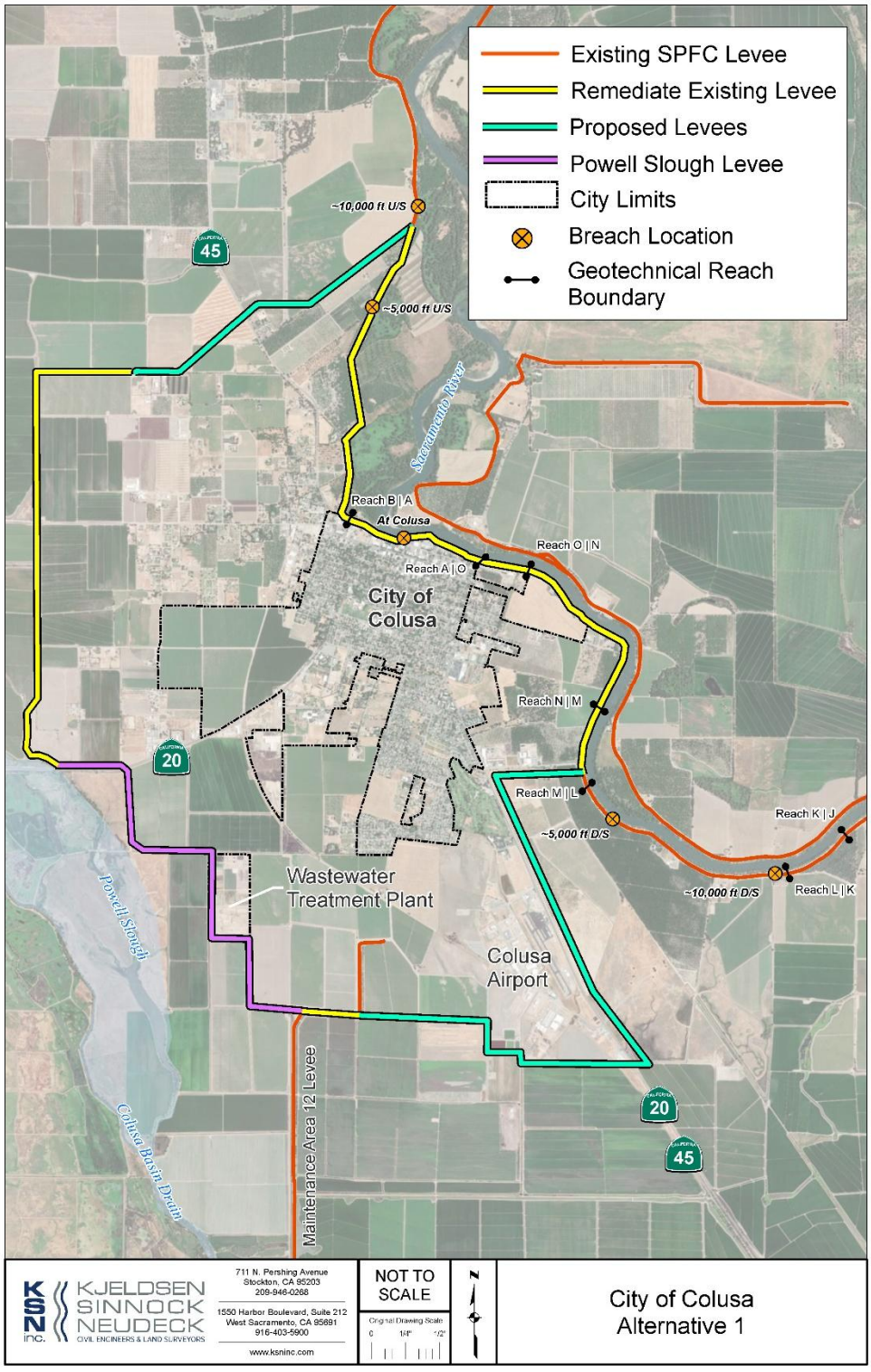


FIGURE 4-2
ALTERNATIVE 1: REMEDIATE SPFC LEVEE, CONSTRUCT NEW LEVEES

TABLE 4-2
ALTERNATIVE 1 COST BREAKDOWN

Item	Cost[1]
Remediate Reach B (Drained Stability Berm)	$ 9,527,048
Remediate Reach A (Soil-Bentonite Cutoff Wall)	$ 6,954,955
Remediate Reach O (Deep Soil Mix Cutoff Wall)	$ 9,776,514
Remediate Reach N (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$ 23,185,138
Remediate Reach M (Deep Soil Mix Cutoff Wall)	$ 16,504,065
Rock slope protection	$ 8,067,563
Powell Slough Alternative 7	$ 37,528,771
Repair Powell Slough	$ 16,418,565
Repair MA12	$ 1,707,111
New Levees	$ 53,455,273
Real estate management	$ 2,450,000
Multi-benefit	$ 2,356,799
Regional non-structural	$ 100,000
Total	$ 188,031,802
Real estate[2]	$ 2,512,809
Additional annual operations and maintenance cost	$ 69,751

[1]Soft costs, including escalation, contingency, design and engineering, permitting and legal, engineering during construction, and construction management are included in these costs per item.
[2]Included in the cost of all structural items (therefore not included in the total) and does not include management.

4.4.3. Alternative 2: Remediate SPFC Levee, Complete Ring Levee

Alternative 2 is similar to Alternative 1, as it also protects Colusa and critical infrastructure from both the Sacramento River and Colusa Basin Drain with a proposed ring levee and remediation of existing levees. Alternative 2, however, considers remediating a longer segment of SPFC levee and different alignment location in favor of protecting more land with a shorter segment of new levee in the south. Alternative 2 is presented in Figure 4-3 and proposes the following:

1. Remediate approximately six miles of the existing Sacramento River SPFC Levee;
2. Construct a new, 2.1 mile levee on the north end of Colusa, connecting the SPFC levee to the existing Powell Slough Levee;
3. Remediate the existing Powell Slough Levee to meet freeboard criteria;
4. Construct the Powell Slough Feasibility Study Alternative 7 Levee;

5. Remediate the MA 12 levee for geometry and freeboard deficiencies; and
6. Construct a new, four-mile levee alignment to connect the MA 12 levee to the SPFC levee south of the city.

Alternative 2 includes remediating approximately six miles of the Sacramento River SPFC Levee from a point approximately 10,000 feet upstream of Colusa to 10,000 feet downstream of Colusa. These remediation measures follow those presented in Table 4-1. Alternative 2 also proposes a ring levee and the same remediation measures to the existing Powell Slough and MA 12 Levees, as well as the Powell Slough Feasibility Study Alternative 7. However, the new levee on the south end of the city, connecting the MA 12 levee to the SPFC levee, will follow a different alignment than the one presented in Alternative 1.

Alternative 2 proposes extending the Powell Slough Levee at the north side of the city along the same alignment as Alternative 1. In Alterative 2, a new levee would further extend the south end of the Powell Slough Levee three miles to the east, from the MA 12 levee to the SPFC levee around vernal pools. This alternative would also require the elevation of State Highways 20 and 45 on the south and north ends of the city, respectively.

The proposed multi-benefit component common to all alternatives involves lowering existing in-river floodplain areas. Section 4.4.9 below provides details on the development of this component. The material removed from the river to recreate the lowered floodplain could potentially be utilized in the construction of the drained seepage berms.

Regional non-structural strategies that are a component of this alternative include updating the region's Emergency Operations Plans, Flood Contingency Maps, and Unified Command Map. Also included are developing a Shelter-in-Place Map, conducting tabletop exercises, and replenishing flood fight supplies. Section 4.4.8 below provides more detail on this component.

Alternative 2 has a total cost of $214,707,277 (escalated to an assumed construction year of 2025). The additional annual O&M costs amount to $65,109. The total present worth in the year 2025 of Alternative 2 is $216,877,562. The breakdown in costs are presented below in Table 4-3. A more detailed cost analysis is provided in Appendix D.

TABLE 4-3
ALTERNATIVE 2 COST BREAKDOWN

Item	Cost[1]
Remediate Reach B (Drained Stability Berm)	$ 9,527,048
Remediate Reach A (Soil-Bentonite Cutoff Wall)	$ 6,954,955
Remediate Reach O (Deep Soil Mix Cutoff Wall)	$ 9,776,514
Remediate Reach N (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$ 23,185,138
Remediate Reach M (Deep Soil Mix Cutoff Wall)	$ 22,909,844
Remediate Reach L (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$ 26,474,713
Rock slope protection	$ 8,067,563
Powell Slough Alternative 7	$ 37,528,771
Repair Powell Slough	$ 16,418,565
Repair MA12	$ 1,707,111
New Levees	$ 47,125,256
Real estate management	$ 2,575,000
Multi-benefit	$ 2,356,799
Regional non-structural	$ 100,000
Total	$ 214,707,277
Real estate[2]	$ 2,711,755
Operations and maintenance	$ 65,109

[1]Soft costs, including escalation, contingency, design and engineering, permitting and legal, engineering during construction, and construction management are included in these costs per item.
[2]Included in the cost of all structural items (therefore not included in the total) and does not include management.

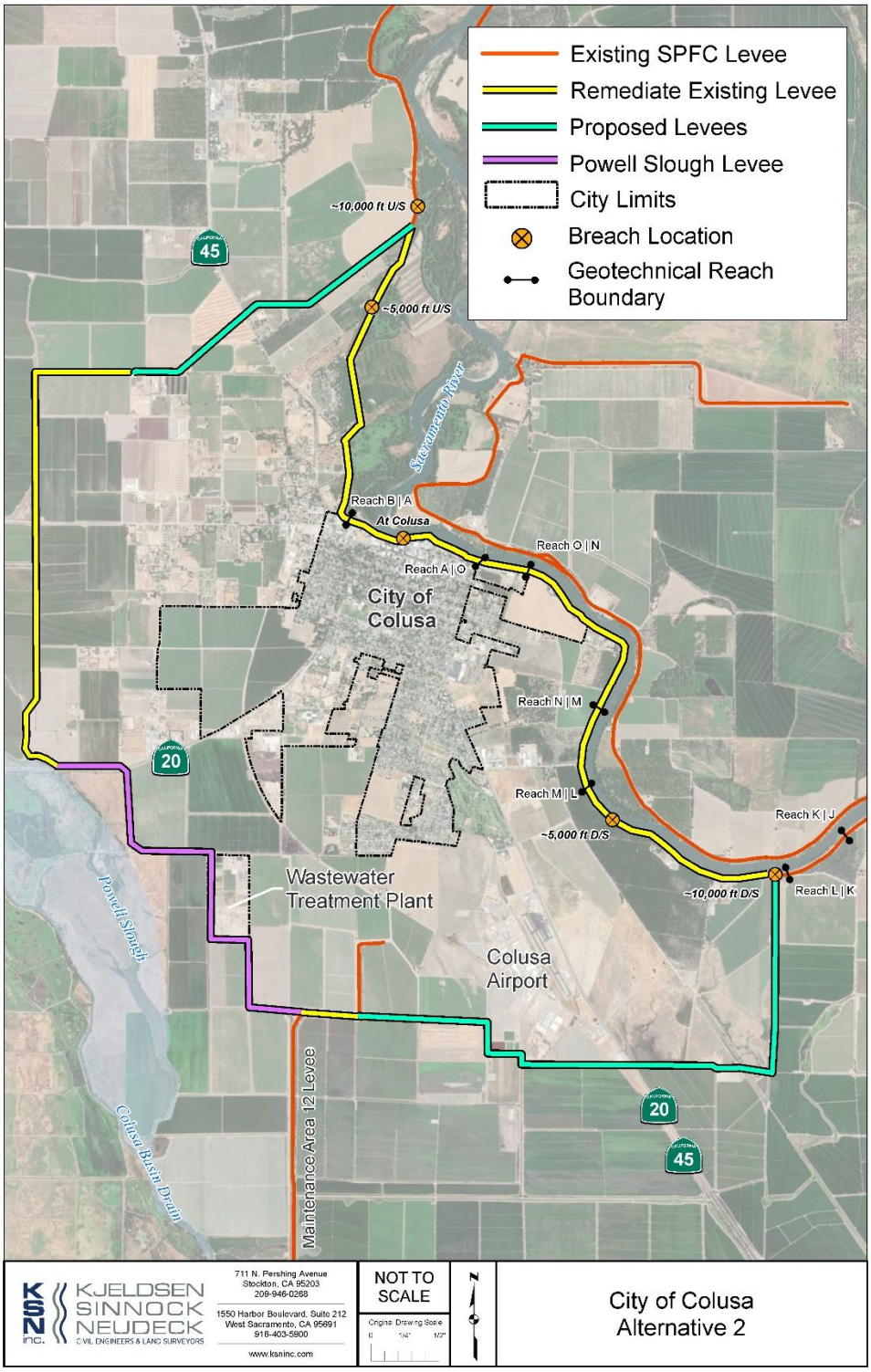


Figure 4-3
ALTERNATIVE 2: REMEDIATE SPFC LEVEE, COMPLETE ALTERNATIVE RING LEVEE

4.4.4. Alternative 3: Remediate SPFC levee, Construct North and South Levees

This alternative protects Colusa and critical infrastructure from a 100-year breach from the Sacramento River on the north and east, and the Colusa Basin Drain on the west similar to Alternatives 1 and 2. However, in the south, the new levee is shortened significantly to a wing levee. Alternative 3 is presented in Figure 4-4 and proposes the following:

1. Remediate approximately six miles of the Sacramento River SPFC levee;
2. Construct a new, 2.1 mile levee alignment from the existing Powell Slough Levee to connect with the SPFC Levee north of the city;
3. Remediate the existing Powell Slough Levee to meet freeboard criteria;
4. Construct the Powell Slough Feasibility Study Alternative 7 Levee;
5. Remediate the MA 12 levee for geometry and freeboard deficiencies; and
6. Construct a new, two-mile wing levee alignment south of the city.

Alternative 3 includes repairing approximately six miles of the SPFC levee from a point approximately 10,000 feet upstream and 10,000 feet downstream of Colusa similar to Alternative 2. Remediation measures also follow those presented in Table 4-1. Alternative 3 also proposes new levees that includes the same remediation measures to the existing Powell Slough and MA 12 levees, and incorporates the Powell Slough Feasibility Study Preferred Alternative 7. The new levee on the north end of the city, connecting the Powell Slough levee to the SPFC levee, will follow a similar alignment to the one presented in the previous alternatives. Alternative 3 proposes extending the Powell Slough Levee at the north side of the city along the same alignment as Alternative 1.

On the southern end of the city, the new wing levee proposed, which when combined with extended remediation to the SPFC levee to the south, is enough to protect the Colusa Airport from flooding, while reducing the cost and disturbance of a new levee significantly. Alternative 3 would also require the elevation of State Highways 20 and 45 on the south and north ends of the city, respectively.

The proposed multi-benefit component common to all alternatives involves lowering existing in-river floodplain areas. Section 4.4.9 below provides details on the development of this component. The material removed from the river to recreate the lowered floodplain could potentially be utilized in the construction of the drained seepage berms.

Regional non-structural strategies that are a component of this alternative include updating the region's Emergency Operations Plans, Flood Contingency Maps, and Unified Command Map. Also included are developing a Shelter-in-Place Map, conducting tabletop exercises, and replenishing flood fight supplies. Section 4.4.8 below provides more detail on this component.

Alternative 3 has a total cost of $204,123,042 (escalated to an assumed construction year of 2025). The additional annual O&M costs amount to $45,880. The total present worth in the year 2025 of Alternative 3 is $205,652,379. The breakdown in costs are presented below in Table 4-4. A more detailed cost analysis is provided in Appendix D.

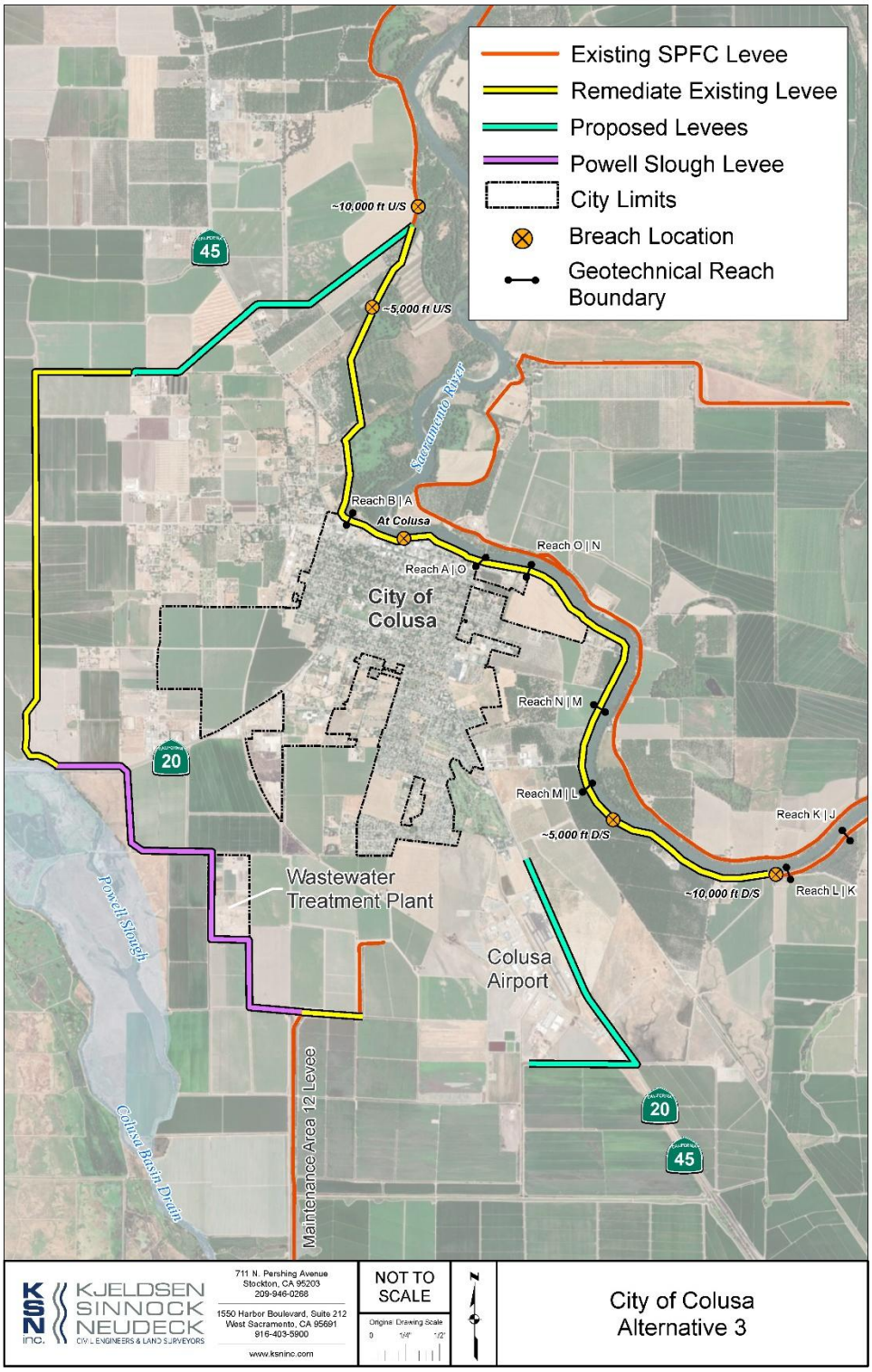


FIGURE 4-4
ALTERNATIVE 3: REMEDIATE SPFC LEVEE, CONSTRUCT NORTH AND SOUTH LEVEES

TABLE 4-4
ALTERNATIVE 3 COST BREAKDOWN

Item	Cost[1]	
Remediate Reach B (Drained Stability Berm)	$	9,527,048
Remediate Reach A (Soil-Bentonite Cutoff Wall)	$	6,954,955
Remediate Reach O (Deep Soil Mix Cutoff Wall)	$	9,776,514
Remediate Reach N (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$	23,185,138
Remediate Reach M (Deep Soil Mix Cutoff Wall)	$	22,909,844
Remediate Reach L (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$	26,474,713
Rock slope protection	$	8,067,563
Powell Slough Alternative 7	$	37,528,771
Repair Powell Slough	$	16,418,565
Repair MA12	$	1,707,111
New Levees	$	36,791,021
Real estate management	$	2,325,000
Multi-benefit	$	2,356,799
Regional non-structural	$	100,000
Total	$	204,123,042
Real estate[2]	$	2,252,900
Operations and maintenance	$	45,880

[1]Soft costs, including escalation, contingency, design and engineering, permitting and legal, engineering during construction, and construction management are included in these costs per item.
[2]Included in the cost of all structural items (therefore not included in the total) and does not include management.

4.4.5. Alternative 4: Remediate SPFC levee, Complete Ring Levee

Alternative 4 is similar to the Alternative 1 with the exception of the new northern levee alignment (described below.) This alternative protects Colusa and critical infrastructure from a 100-year breach from the Sacramento River on the north and east, and the Colusa Basin Drain on the west. Alternative 4 is presented in Figure 4-5 and proposes the same measures as Alternative 1 with the exception of the north alignment as follows:

1. Construct a new, 1.6 mile levee alignment from the existing Powell Slough Levee to connect with the SPFC Levee north of the city.

Alternative 4 proposes extending the Powell Slough Levee 1.6 miles to the east along a private farm road rather than Tuttle Road (as presented in the previous alternatives) to

minimize extent of improvements needed. This alternative would still require the elevation of State Highways 20 and 45 on the south and north ends of the city, respectively.

Alternative 4 has a total cost of $180,216,613 (escalated to an assumed construction year of 2025). The additional annual O&M costs amount to $64,633. The total present worth in the year 2025 of Alternative 4 is $182,371,036. The breakdown in costs are presented below in Table 4-5. A more detailed cost analysis is provided in Appendix D.

TABLE 4-5
ALTERNATIVE 4 COST BREAKDOWN

Item	Cost[1]	
Remediate Reach B (Drained Stability Berm))	$	6,655,028
Remediate Reach A (Soil-Bentonite Cutoff Wall)	$	6,954,955
Remediate Reach O (Deep Soil Mix Cutoff Wall)	$	9,776,514
Remediate Reach N (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$	23,185,138
Remediate Reach M (Deep Soil Mix Cutoff Wall)	$	16,504,065
Rock slope protection	$	8,067,563
Powell Slough Alternative 7	$	37,528,771
Repair Powell Slough	$	16,418,565
Repair MA12	$	1,707,111
New Levees	$	48,737,104
Real estate management	$	2,225,000
Multi-benefit	$	2,356,799
Regional non-structural	$	100,000
Total	$	180,216,613
Real estate[2]	$	2,371,139
Operations and maintenance	$	64,633

[1]Soft costs, including escalation, contingency, design and engineering, permitting and legal, engineering during construction, and construction management are included in these costs per item.
[2]Included in the cost of all structural items (therefore not included in the total) and does not include management.

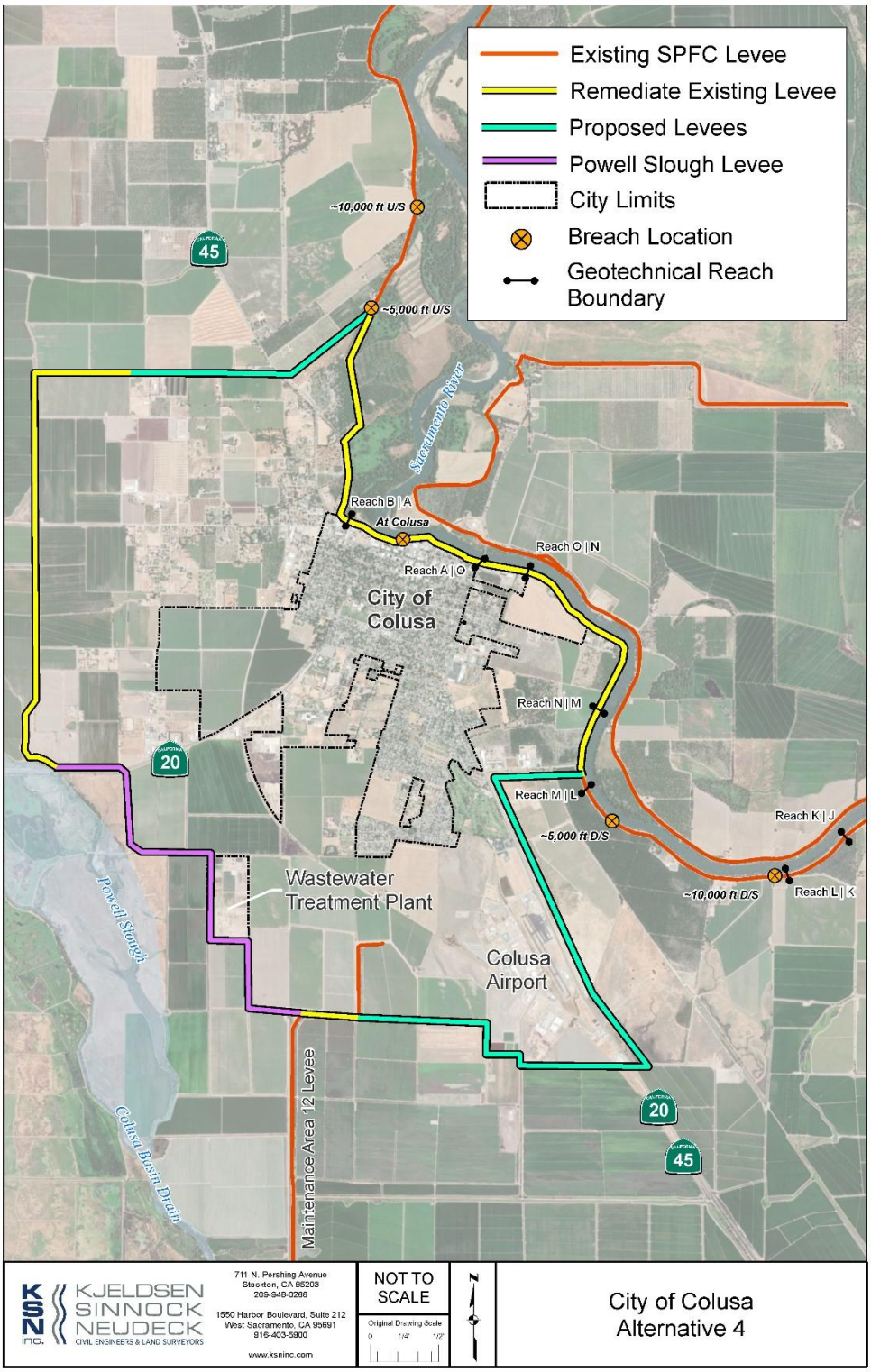


FIGURE 4-5
ALTERNATIVE 4: REMEDIATE SPFC LEVEE, COMPLETE ALTERNATIVE RING LEVEE

4.4.6. Alternative 5: Remediate SPFC levee, Complete Ring Levee

Alternative 5 is also similar to the Alternative 2 with the exception of the northern levee alignment, which is the same as Alternative 4. This alternative protects Colusa and critical infrastructure from a 100-year breach from the Sacramento River on the north and east, and the Colusa Basin Drain on the west. Alternative 5 is presented in Figure 4-4 and proposes the same measures as Alternative 2, except for the northern alignment, which follows Alternative 4.

Alternative 5 has a total cost of $206,892,088 (escalated to an assumed construction year of 2025). The additional annual O&M costs amount to $60,595. The total present worth in the year 2025 of Alternative 5 is $208,911,934. The breakdown in costs are presented below in Table 4-6. A more detailed cost analysis is provided in Appendix D.

TABLE 4-6
ALTERNATIVE 5 COST BREAKDOWN

Item	Cost[1]	
Remediate Reach B (Drained Stability Berm)	$	6,655,028
Remediate Reach A (Soil-Bentonite Cutoff Wall)	$	6,954,955
Remediate Reach O (Deep Soil Mix Cutoff Wall)	$	9,776,514
Remediate Reach N (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$	23,185,138
Remediate Reach M (Deep Soil Mix Cutoff Wall)	$	22,909,844
Remediate Reach L (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$	26,474,713
Rock slope protection	$	8,067,563
Powell Slough Alternative 7	$	37,528,771
Repair Powell Slough	$	16,418,565
Repair MA12	$	1,707,111
New Levees	$	42,407,087
Real estate management	$	2,350,000
Multi-benefit	$	2,356,799
Regional non-structural	$	100,000
Total	$	206,892,088
Real estate[2]	$	2,614,950
Operations and maintenance	$	60,595

[1]Soft costs, including escalation, contingency, design and engineering, permitting and legal, engineering during construction, and construction management are included in these costs per item.
[2]Included in the cost of all structural items (therefore not included in the total) and does not include management.

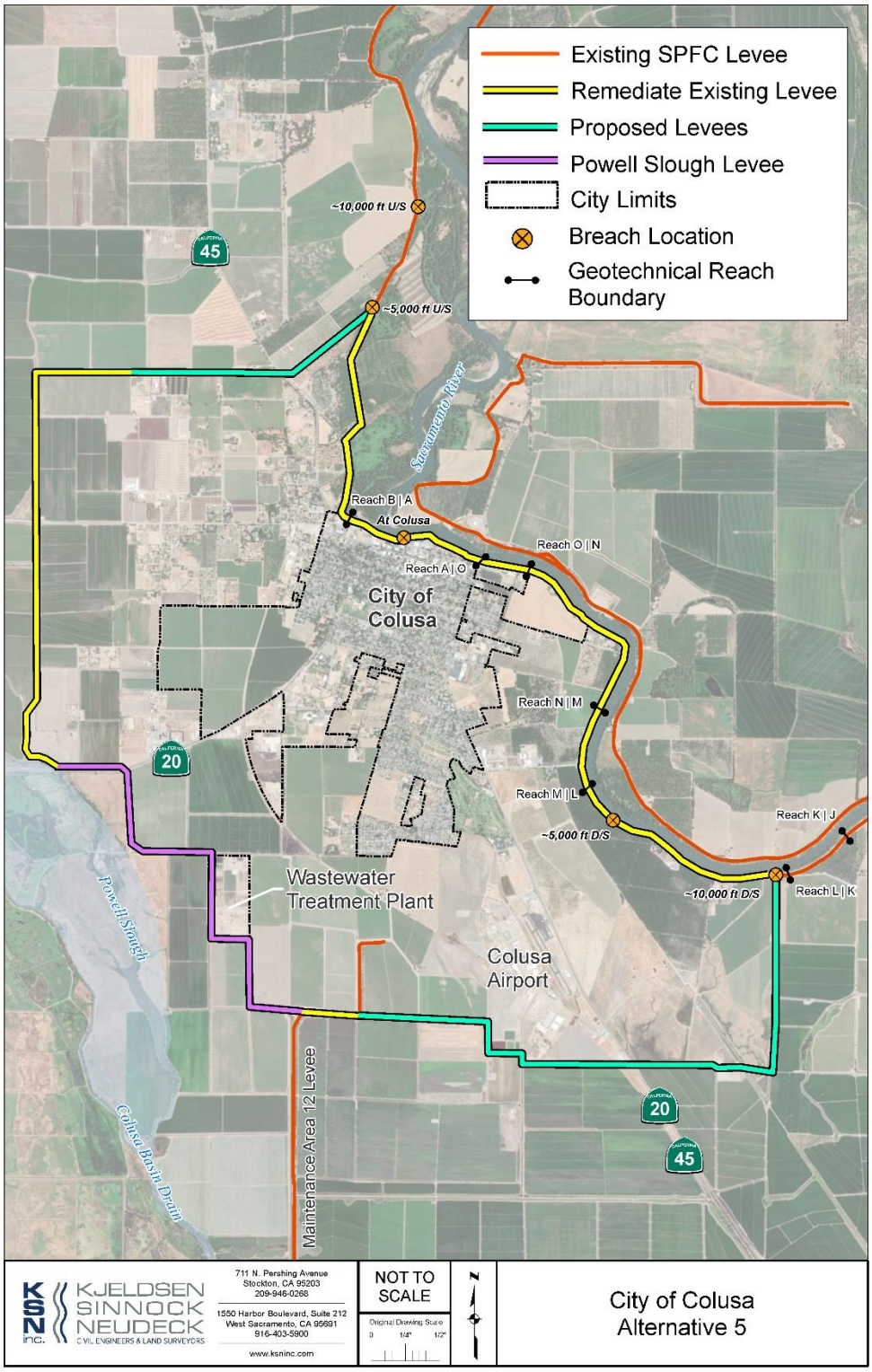


FIGURE 4-6
ALTERNATIVE 5: REMEDIATE SPFC LEVEE, ALTERNATIVE NORTH AND SOUTH ALIGNMENTS

4.4.7. Alternative 6: Remediate SPFC levee, Alternative North and South Levees

Alternative 6 is also similar to Alternative 3 with the exception of the northern levee alignment, which is the same as Alternative 4. This alternative protects Colusa and critical infrastructure from a 100-year breach from the Sacramento River on the north and east, and the Colusa Basin Drain on the west. Alternative 6 is presented in Figure 4-7 and proposes the same measures as Alternative 3, except for the northern alignment, which follows Alternative 4.

Alternative 6 has a total cost of $196,307,853 (escalated to an assumed construction year of 2025). The additional annual O&M costs amount to $41,367. The total present worth in the year 2025 of Alternative 6 is $197,686,751. The breakdown in costs are presented below in Table 4-7. A more detailed cost analysis is provided in Appendix D.

TABLE 4-7
ALTERNATIVE 6 COST BREAKDOWN

Item	Cost[1]	
Remediate Reach B (Drained Stability Berm)	$	6,655,028
Remediate Reach A (Soil-Bentonite Cutoff Wall)	$	6,954,955
Remediate Reach O (Deep Soil Mix Cutoff Wall)	$	9,776,514
Remediate Reach N (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$	23,185,138
Remediate Reach M (Deep Soil Mix Cutoff Wall)	$	22,909,844
Remediate Reach L (Combination Drained Seepage Berm & Deep Soil Cutoff Wall)	$	26,474,713
Rock slope protection	$	8,067,563
Powell Slough Alternative 7	$	37,528,771
Repair Powell Slough	$	16,418,565
Repair MA12	$	1,707,111
New Levees	$	32,072,852
Real estate management	$	2,100,000
Multi-benefit	$	2,356,799
Regional non-structural	$	100,000
Total	$	196,307,853
Real estate[2]	$	2,156,095
Operations and maintenance	$	41,367

[1]Soft costs, including escalation, contingency, design and engineering, permitting and legal, engineering during construction, and construction management are included in these costs per item.
[2]Included in the cost of all structural items (therefore not included in the total) and does not include management.

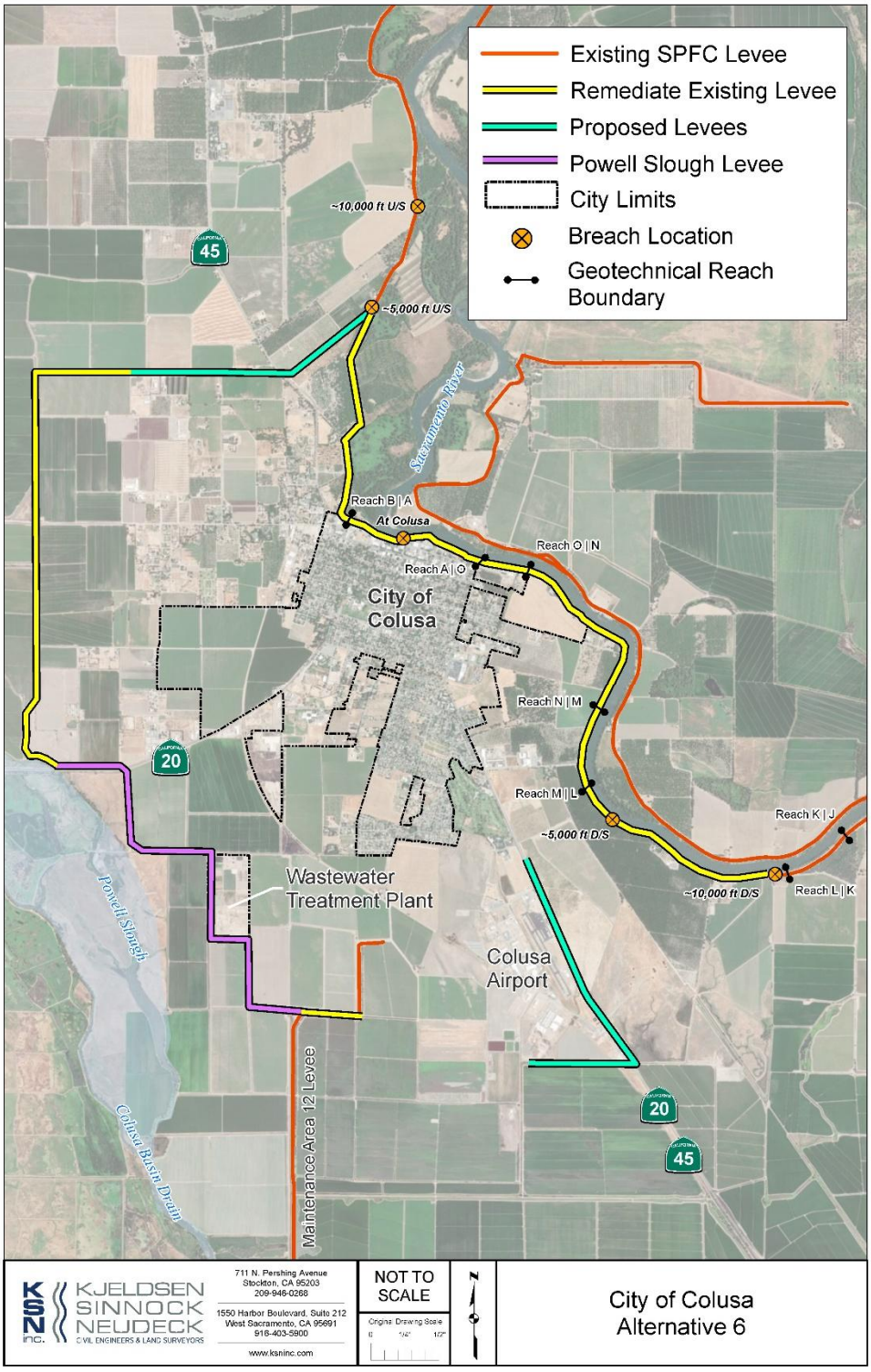


FIGURE 4-7
ALTERNATIVE 6: REMEDIATE SPFC LEVEE, ALTERNATIVE NORTH AND SOUTH ALIGNMENTS

4.4.8. Regional Non-Structural Measures

There are several regional non-structural strategies that are either currently being employed, or planned to be further explored to mitigate risk. Non-Structural measures help meet flood emergency preparedness goals in the 2012 CVFPP. This Project includes regional flood emergency preparedness and response, public outreach and education, floodplain management, and participation in the NFIP.

4.4.8.1. MUSR Flood Emergency Response Project (MUSR Flood ER Project) – Phases I, II, and III

Colusa, the County of Colusa, and its levee maintaining and public safety agencies have been active participants in the MUSR Region's series of three DWR grant-funded projects aimed to improve local emergency preparedness and response capabilities by focusing on planning, training, and flood fight supply acquisition and pre-staging.

The County of Colusa and the agencies responsible for levee maintenance (LMAs), flood emergency response, and public safety include: Sacramento River West Side Levee District (SRWSLD), DWR's MA 1 and MA 12, Colusa, the County of Colusa Fire, Colusa Police Department, County of Colusa Sheriff's Office, County of Colusa Office of Emergency Services, and the City and County Department of Public Works. Work completed through these projects include:

1. Emergency Operations Plans and Flood Contingency Maps for LMAs;
2. A Flood Fight, Levee Patrol, and Emergency Management Training Program;
3. Acquired and pre-staged ConEx containers fully stocked with flood fight materials for each LMA; and
4. Acquired and pre-staged regional rock stockpiles and additional flood fight supplies.

These projects and ongoing commitments have significantly helped manage flood risk for all areas of the County of Colusa including the areas in and around the city.

4.4.8.2. Public Outreach and Education

Strategies for effective public outreach and education have helped residents understand their flood risk, prompt them to take individual actions at home (i.e. have a go-bag ready, full tank of gas, have a family reuniting plan, etc.), and to prepare for and act on possible evacuation orders. Maps developed in the MUSR Flood ER Projects may be used as visuals to help communicate possible evacuation routes and methods through which the County will communicate emergency messages to residents of Princeton, Grimes, and Colusa. This may be accomplished through annual public meetings that can help build trust and strengthen the relationship between response agencies and the public.

4.4.8.3. Floodplain Management and the National Flood Insurance Program (NFIP)

The City and County of Colusa are currently participating agencies in the NFIP. As such, the County and City of Colusa currently have floodplain management ordinances

aimed to minimize flood hazards and promote public health, safety, and general welfare, and minimize public and private losses due to flooding[10,11]. To ensure the County and City's continued active status in the NFIP program, and therefore eligibility for NFIP claims within these jurisdictions, the County and City enforce existing ordinances that regulate new development or significant changes to existing residential, non-residential, and agricultural structures. These ordinances currently require that any new development or significant remodels be elevated to one foot above the BFE or incorporate approved dry flood-proofing measures (where allowed and applicable). Continued wise floodplain management is a means by which residual risk can be managed in the newly protected areas.

4.4.9. Regional Multi-Benefit Opportunities

Per the Small Communities Flood Risk Reduction Program Guidelines, and as discussed in Section 3.2, projects evaluated under the Program are expected to make significant progress towards "the advancement of flood protection for small communities while ***evaluating and considering multi-benefit projects that integrate other resources' needs (water supply, ecosystem, recreation, open space, effective flood emergency response, protection of State facilities, storage, etc.), as much as possible***". Per the Guidelines, Small Communities Flood Risk Reduction projects should also "Promote(s) ecosystem functions", a supporting goal of the CVFPP.

The 2017 CVFPP Update defines multi-benefit projects as "…projects (that) are designed to reduce flood risk and enhance fish and wildlife habitat, as well as create additional public benefits such as sustaining agricultural production, improving water quality and water supply reliability, increasing groundwater recharge, supporting commercial fisheries, and providing public recreation and educational opportunities, or any combination thereof." The 2016 Conservation Strategy discusses how multi-benefit projects that include ecosystem restoration or enhancements can help meet specific, measurable objectives and long-term approaches for improving riverine and floodplain ecosystem. The 2016 CVFPP Conservation Strategy is a non-regulatory support document to the 2017 CVFPP that includes specific metrics to measure contribution to conservation goals and non-regulatory numerical targets at regional and system-wide scales for the CVFPP to contribute to recovery of native species. The Conservation Strategy metrics and targets are meant to be iterative in nature and may be updated and reevaluated and revised as necessary, based on improvements to scientific understanding and further evaluation of opportunities for multi-benefit flood management projects. Other multi-benefit outcomes envisioned by the CVFPP (such as recreation and water supply) are not guided by numerical targets.

The CVFPP Conservation Strategy goals are:

- Improve dynamic hydrologic (flow) and geomorphic processes in the SPFC

[10] Article 39. – Floodplain Management. Appendix A. City of Colusa Code of Ordinances.
[11] Chapter 33 – Flood Damage Prevention. Colusa County Code.

- Increase and improve the quantity, diversity, and connectivity of riverine and floodplain habitats.
- Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.
- Reduce stressors related to the development and operation of the SPFC that negatively affect at-risk species.

The Conservation Strategy's approach to achieving its goals is to focus on the processes, habitats, and species in need of recovery with the greatest potential to benefit from conservation actions integrated with flood risk management actions. It also focuses on stressors to these processes, habitats, and species that could be addressed by flood risk management. Table 4-8 of the Conservation Strategy (reproduced below) lists the ecological goals and targeted ecosystem processes, habitats, species, and stressors that are the focus of the Conservation Strategy.

TABLE 4-8
ECOLOGICAL GOALS AND TARGETED ECOSYSTEM PROCESSES, HABITATS, SPECIES, AND STRESSORS

Ecological Goal	Targeted Ecosystem Process, Habitat, Species, or Stressor
Ecosystem processes. Improve dynamic hydrologic and geomorphic processes.	Floodplain inundation
	Riverine geomorphic processes
Habitats. Increase and improve quantity, diversity, and connectivity of riverine and floodplain habitats.	SRA cover
	Riparian
	Marshes and other wetlands
Species. Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.	Targeted species
Stressors. Reduce stressors related to the development and operation of the SPFC that negatively affect at-risk species.	Revetment
	Levees[1]
	Fish passage barriers
	Invasive plants

Key: SPFC = State Plan of Flood Control; SRA = shaded riverine aquatic.
[1] In particular, levees are a stressor where located within river meander zones or if their design does not provide sufficient capacity for riparian habitat throughout the floodway.

In addition to the Conservation Strategy, the MUSR RFMP evaluated potential multi-benefit projects that would advance the goals of the CVFPP. The goals and objectives of the CVFPP, Conservation Strategy and MUSR RFMP guided evaluation of the multi-benefit strategies investigated in the Colusa SCFRRFS.

The six alternatives presented in this section incorporate multi-benefit opportunities consistent with the 2016 CVFPP Conservation Strategy and the MUSR RFMP. After reviewing the Conservation Strategy's Floodplain Restoration Opportunity Analysis

geospatial data, several areas were identified in the vicinity of Colusa. One area along the Sacramento River on the north end of Colusa, provides approximately 374 acres of floodplain restoration opportunities. More specifically, these areas have been identified as having the potential for: lowering the floodway, enhancing riparian habitat, or enhancing perennial wetlands.

The northern-most area offers approximately 290 acres of opportunity to enhance riparian habitat or perennial wetland by allowing seasonal flooding. The area closest to Colusa is currently a dedicated floodway with opportunity to be lowered to increase seasonal inundation, resulting in riverine habitat enhancement.

After meeting with several NGOs, the two larger areas were determined to already have been "fully" restored and were thus ruled out, leaving the 33 acre area (see Figure 4-8) left as a restoration opportunity. An additional benefit of lowering this 33 acre area of the floodway would be the alleviation of erosion issues between 8th and 9th Street. As the Sacramento River approaches the easterly bend towards Colusa, the banks of the river are lined with revetments. These revetments are to prevent bank erosion and minimize river meander as the available floodplain is severely restricted between the levees downstream of this location. Due to hydraulics in this area, there is limited length of revetment that could be safely removed from the Sacramento River banks. Approximately 250 linear feet of revetment are proposed to be removed along the floodplain lowering area.

These areas were identified through a geospatial analysis of the Conservation Strategy's Floodplain Restoration Opportunity Analysis geospatial data provided by DWR.

The area identified as Potential Multi-Benefit Area in Figure 4-8, may be able to accommodate the following targeted species listed in the 2016 CVFPP Conservation Strategies: Grater Sandhill crane (*Grus Canadensis tabida*), Least Bell's vireo (*Vireo bellii pusillus*), Swainson's hawk (*Buteo swainsoni*), and Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*). While this area is directly across from CA State Parks property, increasing public access to the area was considered and deemed not practicable for pedestrian or automotive access. It should be noted that the Colusa Bridge does not currently support pedestrian traffic. The relative proximity to other restored areas will likely increase the benefits gained in both this area and the larger, already restored area across the river through connectivity with the river and adjoining floodplains.

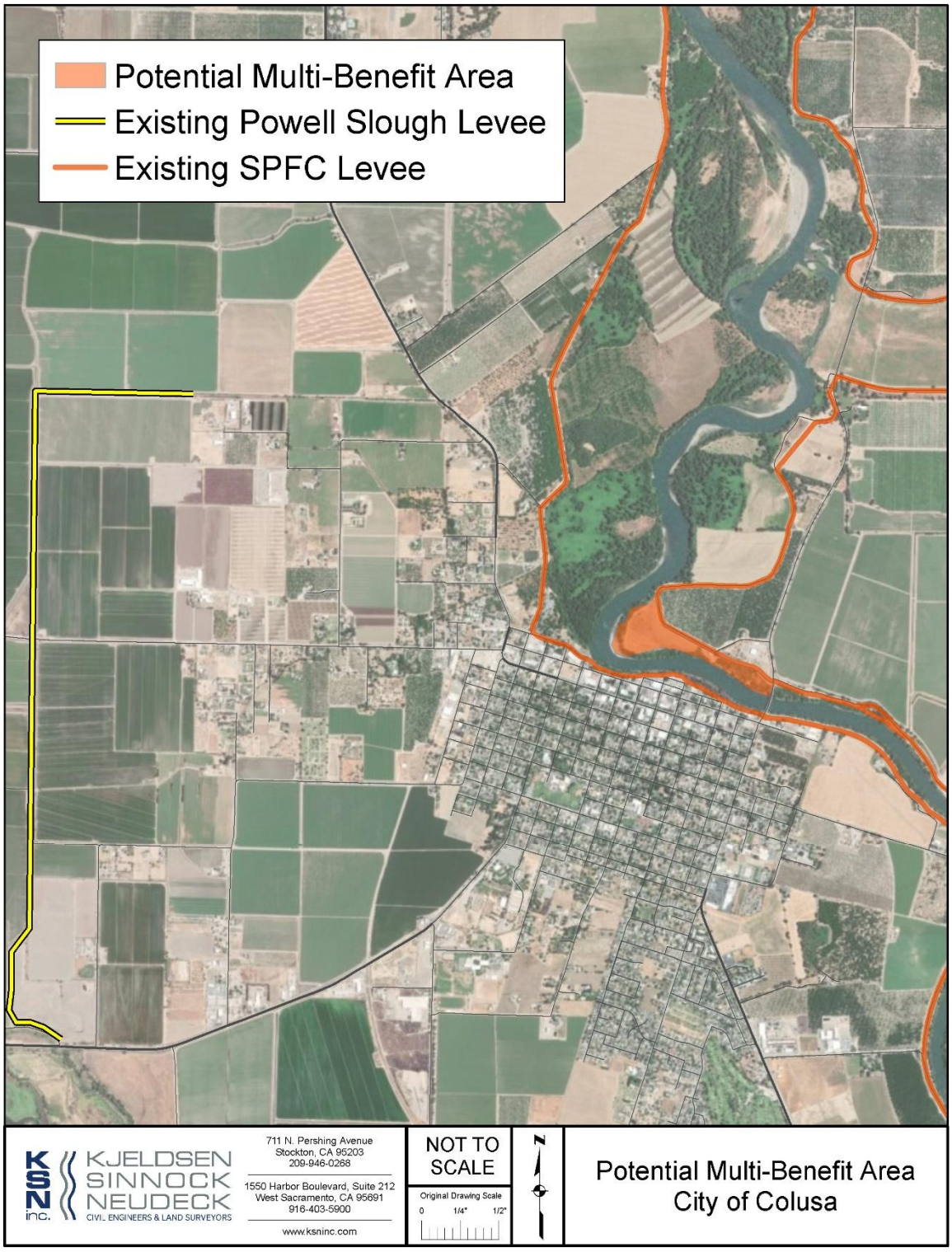


FIGURE 4-8
CITY OF COLUSA POTENTIAL MULTI-BENEFIT AREA

Chapter 5. Environmental Constraints Analysis

This chapter summarizes the analysis process used to analyze environmental constraints of each project alternative. A full report on the analysis process is contained in Appendix E.

5.1. Introduction

Compliance with environmental regulations such as CEQA and/or NEPA is an integrated part of each alternative. The selection process has examined each alternative's potential impact on the environment and the necessary permits obtained prior to implementation.

5.2. Scope of Environmental Analysis

The Study team performed a desktop analysis to determine potential environmental constraints for each of the six alternatives. Appendix G of the CEQA Guidelines was referenced to determine potentially significant impacts on different resource areas and was used to determine if CEQA documentation would be necessary for any of the alternatives. Specific areas evaluated include the following:

- Agriculture and Forestry Resources
- Air Quality and Greenhouse Gas Emissions
- Biological Resources
- Cultural and Tribal Cultural Resources
- Geology, Soils, and Mineral Resources
- Hazards and Hazardous Materials
- Hydrology and Water Quality
- Land Use and Planning
- Noise
- Public Services and Recreation
- Traffic and Transportation
- Utilities and Service Systems
- Energy

For further details regarding the Environmental Constraints Analysis scope and methodologies refer to Appendix E.

5.3. Biological Resource Analysis

The biological resources analysis included a desktop review that assessed potential biological constraints in the city of Colusa project area. There were two general phases to this review: a database search and a review of recent aerial imagery. The databases queried as a part of this review are listed below:

- U.S. Fish and Wildlife Service's (USFWS) Information Planning and Consultation (IPaC) System

- USFWS Critical Habitat Portal
- California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB)
- California Native Plant Society (CNPS) Inventory of Rare, Threatened, and Endangered Plants of California)
- USFWS National Wetland Inventory
- United State Geological Survey (USGS) topographical map.

Additionally a field reconnaissance was conducted by project team biologists on December 17, 2018. For more details and discussion regarding the biological resources analysis, see Appendix E.

5.4. Scope of Environmental Analysis

The cultural resources analysis consisted of a records search, historic map review, and a field reconnaissance by project team archeologists on January 22, 2019. The data referenced in this analysis includes:

- Northwest Information Center (NWIC) Resource Database
- NWIC Report Database, Office of Historic Preservation (OHP) Historic Properties Directory for Colusa County
- OHP Archaeological Determinations of Eligibility for Colusa County
- California Inventory of Historical Resources
- General Land Office (GLO) and/or Rancho Plat Maps

For more details regarding the data sources referenced and the methodologies undertaken in this analysis refer to Appendix E.

5.5. Environmental Constraints Analysis

All alternatives were determined to have potential impacts on the resource areas below:

- Biological Resources
- Cultural Resources
- Air Quality, Green House Gas Emissions, and Noise

The last bulleted resource area would only have a potential impact during project construction. Environmental constraints would not occur for the following resources: aesthetics, energy, land use and planning, minerals, and public services and recreation.

The relative impact of each alternative upon the CEQA resources areas are presented below in summary. Two check marks indicate a greater potential for impacts based upon the location or proposed project activities. In summary, the analysis did not identify any environmental constraints which would preclude any of the alternatives from potential implementation.

TABLE 5-1
RESOURCE AREA IMPACTS

Potential Environmental Constraints	Alternative					
	1	2	3	4	5	6
Agriculture and Forestry Resources	✓	✓✓	✓	✓	✓✓	✓
Air Quality and GHG Emissions	✓	✓	✓	✓	✓	✓
Biological Resources	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Cultural Resources	✓✓✓	✓	✓✓✓	✓✓✓	✓	✓✓✓
Geology and Soils	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Hazards and Hazardous Materials	✓✓	✓	✓✓	✓✓	✓	✓✓
Hydrology and Water Quality	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Noise	✓	✓	✓	✓	✓	✓
Traffic and Transportation	✓✓	✓	✓✓	✓✓	✓	✓✓
Utilities and Service Systems	✓	✓	✓	✓	✓	✓

Chapter 6. Financial Analyses

This chapter summarizes the anticipated construction and O&M costs for each alternative. Additionally, a summary of the financial analyses is presented below. A more detailed review of the construction and O&M cost development may be found in Appendix D, while the full details on the financial analyses may be found in Appendix F.

6.1. Project Costs

In order to quantify both the costs associated with each alternative's construction and the incremental increase in O&M, the Study developed construction costs and annual O&M costs. These costs were escalated to an assumed construction start of January 2025 and the present worth (cost) of the annualized O&M were calculated for January 2025.

6.1.1. Development of Preliminary Construction Costs

In order to develop preliminary cost estimates for the construction of each alternative, the project team first developed quantity estimates using AutoCAD Civil 3D, ArcGIS, and typical cross sections of average levee heights and geometries. These quantities were then entered into a cost estimating tool provided by DWR called the Preliminary Cost Estimating Tool (PCET). PCET unit costs were updated based upon recent bid results from similar projects in the region. Unit costs were adjusted for inflation from 2017 to 2019 using Engineering News Record Construction Cost Indexes (ENR CCI). Costs were escalated to the January 2025 start date using a 28.5% escalation factor. All alternatives include a 30% contingency factor to account for the preliminary nature of the designs being estimated.

6.1.2. Development of Operations & Maintenance Costs

New levee alignments and new berms along existing alignments would result in increased O&M costs. Assuming that these new levees would be maintained by DWR, the Study utilized DWR's annual maintenance costs on a per mile basis. This assumption was made only for estimating purposes and it should not be assumed that DWR will be the LMA at the end of the project. The annual O&M unit cost used was $10,000 per new levee mile. This unit cost was provided by DWR's Sutter Maintenance Yard and was corroborated by SRWSLD.

The additional O&M costs for new berms was determined to be approximately $1,000 per linear levee mile. This unit cost was based upon recent seepage repair projects within the Mid-Upper Sacramento River Region.

These O&M costs were calculated for each alternative and their present (2025) value was calculated.

6.1.3. Summary of Other Costs

The cost estimation for each alternative included anticipated costs related to the below items. Details on the development of these costs can be found in Appendix D. It should be noted that Environmental mitigation and permit fees were included in the PCET.

- Non-structural Flood Protection Measures
- Multi-benefit Costs
- Regional Non-structural Costs

6.1.4. Preliminary Alternative Costs Summary

The preliminary cost estimates for the four alternatives are presented below in Table 6-1.

TABLE 6-1
PRELIMINARY ALTERNATIVE COSTS

Alternative	Existing Levee Repair	New Levee Construction	Real Estate Management[1]	Total Construction Cost (2025)	Annual O&M	Total Present Worth (2025)
1	$ 92,140,959	$ 90,984,044	$ 2,450,000	$188,031,802	$69,751	$190,356,835
2	$ 125,021,451	$ 84,654,027	$ 2,575,000	$214,707,277	$65,109	$216,877,577
3	$ 125,021,451	$ 74,319,792	$ 2,325,000	$204,123,042	$45,880	$205,652,375
4	$ 89,268,939	$ 86,265,875	$ 2,225,000	$180,216,613	$64,633	$182,371,046
5	$ 122,149,431	$ 79,935,858	$ 2,350,000	$206,892,088	$60,595	$208,911,921
6	$ 122,149,431	$ 69,601,623	$ 2,100,000	$196,307,853	$41,367	$197,686,753

[1]Does not include real estate acquisition. Real estate acquisition is contained within existing levee repair and new levee construction costs estimates.

All three alternatives $2,356,799 in multi-benefit construction, and $100,000 in regional non-structural costs. These costs are included in the total construction costs and total present worth tabulations in Table 6-1.

6.2. Financial Analyses

As part of this Study, a financial analysis was conducted. This study was comprised of three parts which are summarized below and can be found in their entirety within Appendix F.

6.2.1. Financial Feasibility

The first analysis for analyzing financial feasibility starts with the assumption a property based special assessment will utilized to raise the local funding required for a flood risk reduction project. The general approach utilized are summarized below:

1) Estimate the assessment rates required to generate, on an aggregates basis, $100,000 of annual revenue and review the resulting rates;

2) Establish criteria based on an assumed maximum single-family residence assessment rate ($200) developed by the project team; and
3) Estimate the maximum amount of annual revenue that could be generated from project beneficiaries in the local community.

The methodologies utilized to determine the project beneficiaries and the relative benefits received are documented in Appendix F and are based upon the assumption that a Proposition 218 Assessment will be needed to provide any funding needed for a local cost-share.

The estimated total assessment capacity of each alternative is presented below in Table 6-2. These revenues are based upon the methodologies and assumptions documented in Appendix F. It is assumed that the local funding will be utilized first for any increase in operations and maintenance costs and then used to service any debt that may be incurred in funding the alternative. The assessment capacity was estimated based upon a constraint of a $200 annual assessment limit for single family residential parcels. These assessments have been rounded to the nearest $1,000.

Table 6-2
Revenue Estimate

Alternative	Total Assessment Capacity
1	$ 849,000
2	$ 850,000
3	$ 849,000
4	$ 850,000
5	$ 850,000
6	$ 850,000

6.2.2. Funding Sources Analyses

This Study also evaluated potential funding sources beyond a Proposition 218 Assessment. These include partners for the multi-benefit portions, structural and non-structural projects. A summary of these findings may be found in Appendix F: Funding Sources Analyses.

6.2.3. Conceptual Financial Plan

The final portion of the financial analysis conducted during this Study was the development of a conceptual financial plan. The conceptual plan is summarized below and a more detailed description can be located in Appendix F.

Using the above revenue estimates, the incremental increase in annual operations and maintenance costs, and assumed bond rates and durations, potential local funding capacities were estimated below in Table 0-3.

Table 0-3
Local Funding Analysis

Alternative	Remaining Assessment Capacity[1]	Low Rate Bond Capital Capacity (3%, 30 years)	High Rate Bond Capital Capacity (5%, 30 years)	Local Cost Share (Low Rate Bond)	Local Cost Share (High Rate Bond)
1	$ 778,400	$ 13,880,000	$ 10,890,000	7.39%	5.79%
2	$ 783,500	$ 13,990,000	$ 10,970,000	6.51%	5.11%
3	$ 801,700	$ 14,310,000	$ 11,220,000	7.01%	5.50%
4	$ 784,600	$ 13,990,000	$ 10,980,000	7.77%	6.09%
5	$ 788,000	$ 14,070,000	$ 11,030,000	6.80%	5.33%
6	$ 807,200	$ 14,410,000	$ 11,300,000	7.34%	5.76%

[1]Remaining Assessment Capacity is the Total Assessment Capacity less the annual operations and maintenance costs.

For further details regarding this analysis please refer to Appendix F: Financial Conceptual Plan.

Chapter 7. Public Outreach, Consultation, and Coordination

This chapter will summarize the public outreach, agency consultation, and coordination with stakeholders and partner agencies.

7.1. Public Involvement

The Project actively invited participation from the Public throughout key points of the feasibility study, including initial evaluation results, development of alternatives, and alternative selection.

7.1.1. Stakeholder Meetings

This Study was led by the County of Colusa, and also invited stakeholders with critical functions within the city of Colusa. More specifically, this included the levee maintaining agency (LMA) protecting this area that would be directly impacted by the implementation of a selected alternative. These LMAs included the Sacramento River West Side Levee District (SRWSLD) and CA DWR's MA 12 and MA 1. Copies of meeting sign-in sheets are provided in Appendix G.

The Study team met monthly via phone conference, and quarterly in person at the County of Colusa's Public Works office. Meetings with Study stakeholders were to review progress of the Study and obtain feedback and input from the LMAs. Stakeholders provided feedback as to whether presented remediation measures were feasible, what O&M implications could be expected, and assisted by facilitating conversations with local property owners who may be impacted by proposed alternatives. The Study team closely considered this feedback, and subsequently made adjustment to alignment location and recommended remediation measures. Finally, stakeholders provided input and ultimately approved on the selection criteria for the alternative evaluations, as well as the recommended most feasible alternative.

7.1.2. Community Meetings

Two community meeting were held: the first community meeting was held on Tuesday November 14, 2018 at the Colusa Industrial Park. This first meeting presented preliminary draft alternative alignments in order to more clearly communicate how flood risks would be reduced with implementation of one of the alternatives, and allow landowners who could be impacted with these alignments to ask questions or provide feedback. Meetings were announced via direct mail postcards in partnership with the Sacramento River Westside Levee District, the Mid & Upper Sacramento River Regional Flood Management website, an email blast to the Mid & Upper Sacramento River Regional Flood Management contact list, and a media release sent to local print publications. The County of Colusa also discussed potential impacts to flood insurance rates in the absence of levee improvement to meet FEMA accreditation. Generally, the public that attended was supportive of the Study.

The second community meeting focused on presenting the most feasible alternative and was held on December 12, 2019 at Egling Middle School in Colusa. This meeting presented the most feasible alternative to the public and discussed potential paths towards project implementation. Generally the public was supportive of the results and elected officials were in attendance to respond to the numerous questions about next steps.

7.1.3. Small Group Meetings

Small group meetings were held with landowners that could expect more significant impacts to their property during the implementation phase of the alternatives. These meetings reviewed alternatives considered, how the Study team arrived to the current alternative, and considered landowner input. These small group meetings helped cultivate local support for this Study. Additionally two non-governmental organizations (NGOs) were consulted to discuss multi-benefit opportunities within the project area: American Rivers and The Nature Conservancy.

7.2. Agency Consultation and Coordination

Similarly, meetings were held with the County of Colusa's Board of Supervisors and regulatory agencies, the CA DWR and FEMA. These meetings aimed to update and inform agencies on the planning process and solicit feedback.

7.2.1. Updates to Governing Agencies

Several meetings were held with Colusa Board of Supervisors to provide a study overview and periodic study status updates. These meetings were also used to coordinate public outreach and identify potential concerns within their districts.

7.2.2. Alternatives Workshop

A workshop meeting was held with DWR and FEMA to review the progress and process of how three alternatives were developed for Colusa. The workshop provided an opportunity for both agencies to provide input, ask for clarification, and provide guidance on the evaluation criteria that was used to select the most feasible alternative. After subsequent meetings, the number of alternatives was increased from three to six.

7.2.3. Mid & Upper Sacramento River Flood Management Plan Website Updates

Meeting notices and the final study were posted to the program website. See Appendix G for further details.

7.2.4. Email Notifications (if necessary)

Meeting notices and the availability of the final study were distributed via email to the Mid & Upper Sacramento River Flood Management Plan contact list. See Appendix G for further details.

7.2.5. Media Releases

Meeting notifications and the availability of the final study were distributed to local print media via media advisories. See Appendix G for further details.

Chapter 8. Development of a Most-Feasible Alternative

This Section will describe how selection criteria was developed, and the process by which the most feasible alternative was determined.

8.1. Evaluation of Alternatives

This most important criteria was whether the alternative improved flood risk management by providing a 100-year level of flood protection. The Study also considered the fraction of existing and future population it would protect, the alternative's resiliency toward future climate change, and the ability to facilitate the wise use of floodplain management practices.

8.1.1. Criteria 1 – Improve Flood Risk Management

This most important criteria was whether the alternative improved flood risk management by providing a 100-year level of flood protection. The Study also considered the fraction of existing and future population it would protect, the alternative's resiliency toward future climate change, and the ability to facilitate the wise use of floodplain management practices.

8.1.2. Criteria 2 – Promote Multi-benefit Opportunities

Promoting multi-benefit projects included reviewing the alternative's potential to effectively utilize open space to provide recreational, resource, or environmental benefits beyond flood protection. Multi-benefit opportunities in the project area were identified in the 2016 CVFPP Conservation Strategy and MUSR RFMP.

8.1.3. Criteria 3 – Improve Institutional Support

Improving institutional support included consistency with local maintaining agency and community goals and objectives. Each alternative was additionally evaluated to determine if the creation of additional O&M responsibilities would result from its implementation.

8.1.4. Criteria 4 – Construction and O&M Costs

Preliminary construction and incremental increases in operations and maintenance costs were prepared as part of the evaluation process. The process of developing the costs are detailed in Appendix D. Alternatives that have the least expenditures necessary to complete the project, as well as requiring the least yearly maintenance and repair were rated more favorably than the converse.

8.2. Comparison of Alternatives

A detailed scoring and ranking of each alternative based on the criteria listed above is provided in Appendix H. A summary of the scoring for each alternative is shown in Table 8-1 below. The basis for this numbering system is also contained within Appendix H. The highest scoring alternative is the recommended or most feasible alternative.

TABLE 8-1
SUMMARY OF ALTERNATIVE SCORING

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Improve Flood Risk Management	4	4	4	4	4	4
Promote Multi-Benefit Opportunities	1	1	1	1	1	1
Improve Institutional Support	2.9	2.2	3.6	3.2	2.5	3.9
Construction and O&M Costs	0.842	0.820	0.829	0.848	0.826	0.836
Total Rating	**8.742**	**8.02**	**9.429**	**9.048**	**8.326**	**9.736**

All evaluated alternatives provide a 100-year level of flood protection and scored similarly.

In terms of promoting ecosystem functions and multi-benefit projects, all alternatives incorporate the same multi-benefit features that follow the 2016 CVFPP Conservation Strategy. Therefore, the scores across all the alternatives are the same for both criteria.

All the alternatives are consistent with current land use planning, scoring the same.

All alternatives create additional O&M responsibility.

8.3. Most Feasible Alternative

From Table 8-1, the Study identified Alternative 6 as the most feasible alternative. Alternative 6 provides the same benefits to the community as all the other alternatives, however based upon the public outreach response to the various alternatives, it faces less opposition from the public and causes the least impact to the Dolan Ranch Conservation Bank. It also requires the least permanent right-of-way acquisition and least amount of new levee miles

Chapter 9. Next Steps & Implementation

This chapter lays out potential next steps and identifies a general path towards project implementation.

9.1. Preliminary Design

Currently all alternatives have a conceptual level of design. In order to proceed past the feasibility study, the most feasible alternative will need preliminary design work completed. This level of design is characterized by more detailed existing conditions information such as geotechnical explorations to confirm subsurface geotechnical conditions and detailed easement and boundary surveys.

9.2. Regulatory Permits

While the project is proceeding through preliminary design, permits from regulatory agencies will need to be applied for and depending upon the permit's particular process, obtained. Based upon the work done in the environmental constraints analysis (see Chapter 5 and Appendix E), these permits and consultations include, but are not necessarily limited to:

- Clean Water Act, Section 404 Permit
- National Historic Preservation Act, Section 106 Consultation
- Endangered Species Act, Section 7 Consultation
- California Endangered Species Act, Section 2081 Consultation
- California Fish and Game Code, Section 1602
- Native American Heritage Commission Consultation
- Clean Water Act, Section 402 Permit
- Clean Water Act, Section 401 Permit
- Air Pollution Control District, Authority to Construct/Permit to Operate

9.3. Coordination with FEMA

During the preliminary design of the most feasible alternative, FEMA Region IX should be closely coordinated with in order to ensure that compliance with Title 44 of the Code of Federal Regulations (CFR), Chapter 65, Subchapter 10 (44 CFR 65.10) is maintained as well as developing a Levee Analysis and Mapping Plan (LAMP) which would permit the most feasible alternative to be analyzed as a Sound Reach.

The Sound Reach approach in a LAMP analysis is predicated upon the concept that while the levee system as a whole does not meet 44 CFR 65.10, certain portions of the levee system (the Sound Reach) may meet all criteria identified in 44 CFR 65.10. This allows the areas protected by the Sound Reach to receive protection from the 100-year flood on the Flood Insurance Rate Maps (FIRMs). In the case of Colusa, the levee system is the entirety of the Colusa Basin levees. The Sound reach for the city of Colusa is the critical section of levee identified during the hydrologic and hydraulic analyses (see Chapter 3, Section 4.3.2 and Appendix C). While this approach will not

remove Colusa from the special flood hazard area, it will remove the town from the 100-year floodplain and the requirement for mandatory purchase of flood insurance for any federally backed mortgaged properties.

Prior to the implementation of the most feasible alternative, a Conditional Letter of Map Revision (CLOMR) should be obtained from FEMA. While a CLOMR is not strictly necessary to obtain prior to project construction, it does remove a sizeable amount of risk from the project by ascertaining that the completed project will result in Colusa being removed from the 100-year floodplain. As part of this CLOMR, documentation that the project will result in a Sound Reach will be necessary. In order for the Sound Reach to be recognized, the alternative will need to demonstrate compliance with 44 CFR 65.10.

9.4. Formation of a Regional Assessment District

Due the capital costs of the most feasible alternative and the potential funding capacity of the project beneficiaries, the County should explore the establishment of a regional assessment district to fund a regional capital improvement program (CIP). The formation of a regional assessment district and a regional CIP would allow the leveraging of a larger benefit assessment area to generate local funds to match State and Federal funding. The regional assessment district could initially be used to fund the SCFRR projects within Colusa County and then other critical projects overtime. The regional assessment district could be formed to be exclusively within the County or potentially a multi-county jurisdiction with the Colusa Basin forming the limits of the district.

Appendix A
Goals and Objectives Memorandum

KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

Stephen K. Sinnock, P.E.
Christopher H. Neudeck, P.E.
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2302-0010
02-0800

FILE MEMORANDUM

March 30, 2018

To: Scott Lanphier, Director of Public Works

Subject: Confirmation of Goals and Objectives

Project: Colusa County Flood Risk Reduction Feasibility Studies

From: Joseph Thomas, Project Manager

1.0 Purpose

The Small Communities Flood Risk Reduction (SCFRR) Program's ultimate goal is to support small communities like Colusa, Grimes, and Princeton, to achieve protection from a 1-in-100 year flood. To achieve this goal, the SCFRR Program was divided into two phases: 1) Feasibility Study, and 2) Design and Implementation as shown in Figure 1. The Colusa County Flood Risk Reduction Feasibility Studies (FRRFS) are currently in the first phase of the SCFRR Program. The purpose of this memorandum is to present the goal and supporting objectives for Phase I of the Colusa County FRRFS Project.

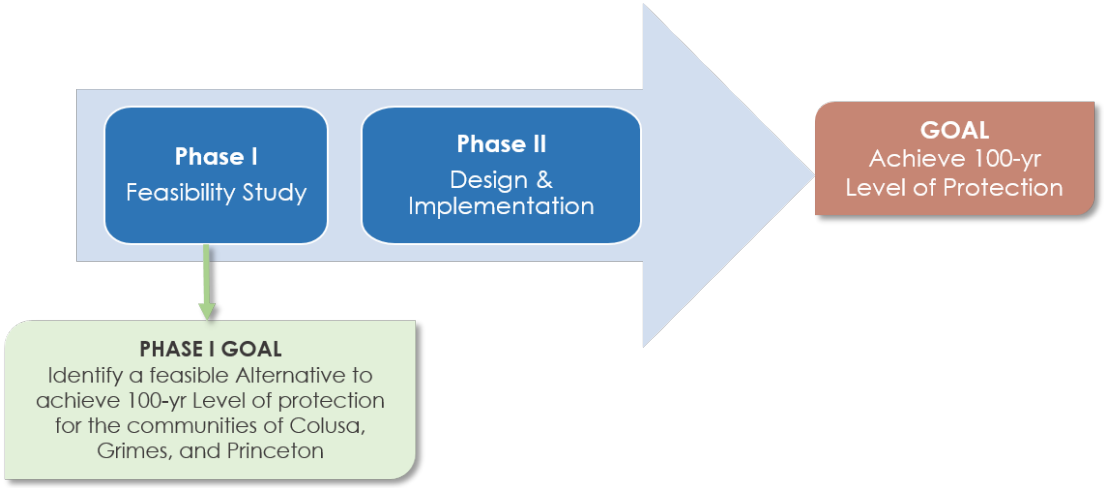


Figure 1 SCFRR Program Overview of Goals

2.0 Goals and Objectives of Phase 1

To achieve the final goal of reaching 100-yr level of protection for the three communities, an evaluation of feasible alternatives to improve flood protection must be completed. Therefore, the goal of Phase 1 is to identify a feasible Alternative to provide 100-yr level of protection in the City of Colusa, and communities of Grimes and Princeton. Figure 2 on the following page summarizes the five objectives that will help guide the selection of a preferred, feasible alternative to reach 100-yr. level of protection.

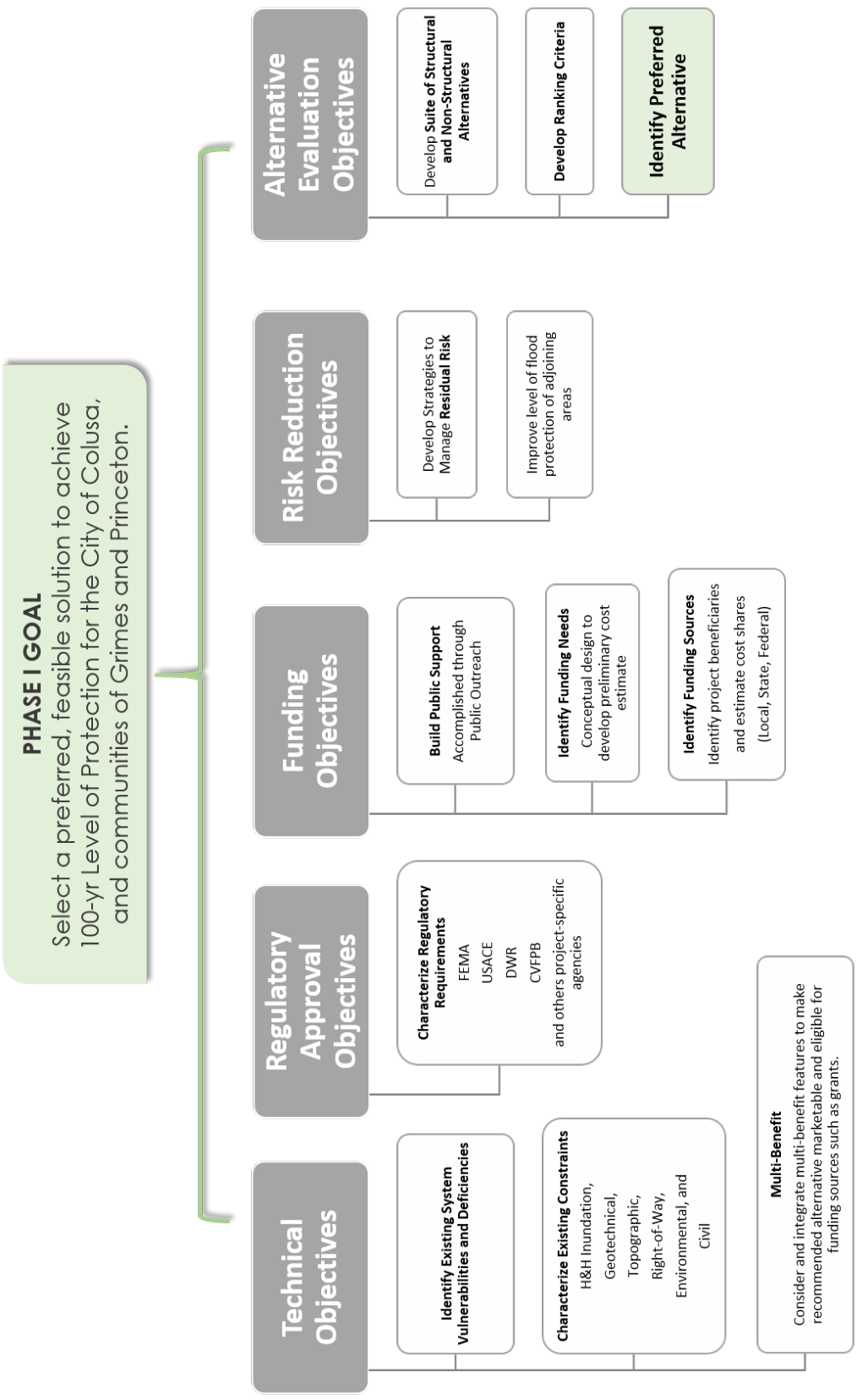


Figure 2 Summary of Objectives in Order to Achieve the Phase I Goal

Objective 1: Technical Objectives

Technical objectives will include gathering background information to identify existing system vulnerabilities and deficiencies. In addition, our objective will be to understand how inundation areas, base flood elevations, geotechnical deficiencies in levees, real estate, environmental, civil, maintenance and operations, and multi-benefit constraints impact potential alternatives.

Objective 2: Regulatory Approval Objectives

The second group of objectives is to develop alternatives that can obtain regulatory approval from appropriate agencies such as US Army Corp of Engineers (USACE), Department of Water Resources (DWR), 100-yr flood protection level as defined by the Federal Emergency Management Agency (FEMA), Central Valley Flood Protection Board (CVFPB) and local ordinances, in addition to gaining the public's support for selected alternative.

Objective 3: Funding Objectives

The funding objectives will be to understand the financial needs of a project (cost estimate), identify potential funding sources and opportunities (such as project beneficiaries), and estimate cost share programs (local, state, and federal). This will also include tailoring alternatives to be attractive candidates for funding opportunities.

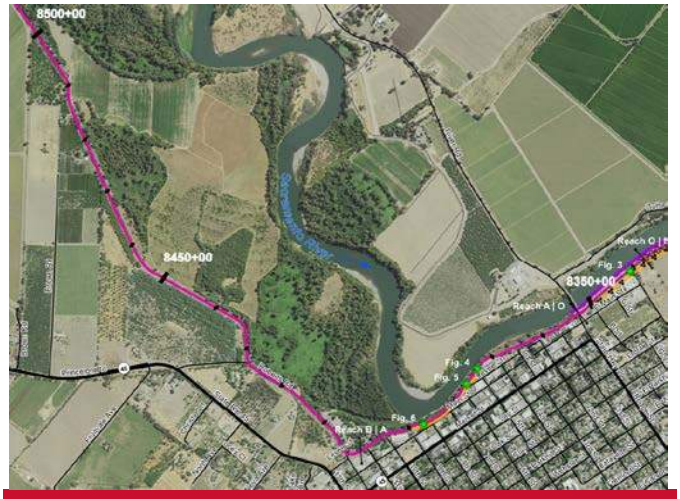
Objective 4: Risk Reduction Objectives

The reduction of flood risk in these communities is the primary driver of these studies. Along with the reduction of flood risk to a goal level of less than a 1 in 100 year flood, these studies must also seek to minimize increasing residual risk within these communities. USACE defines residual risk as "*the exposure to loss remaining after other known risks have been countered, factored in or eliminated.*" Since improvements of the level of flood protection are being planned, the objective of managing residual risk is to identify strategies to minimize residual risk through such tools as land use designations or developer fees.

Objective 5: Alternatives Evaluation Objective

Develop a suite (three) of structural and non-structural alternatives that can would increase the level of flood protection while meeting criteria described in objectives 1 through 4. Once three alternatives are created, the project team, along with stakeholders, will develop ranking criteria to guide the selection of the preferred alternative.

Appendix B
Preliminary Geotechnical Evaluation



Existing Conditions Assessment – Geotechnical

Flood Risk Reduction Feasibility Study

City of Colusa

Colusa County, CA

June 7, 2019

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Attachment B – Seepage Analysis
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1 Introduction

1.1 Background

As part of the State of California Department of Water Resources (DWR) Small Community Flood Risk Reduction Program (SCFRRP), Colusa County is preparing a Flood Risk Reduction Feasibility Study (project) for the City of Colusa (Colusa). The County has assembled a team of consultants to assist in the execution of the Project. Kjeldsen, Sinnock, Neudeck, Inc. (KSN) is the prime consultant and will lead the team. HDR, Inc. (HDR) will provide geotechnical engineering expertise. The project team has been tasked with performing a feasibility level assessment of the levees surrounding Colusa and proposed ancillary flood control features for a 100-year flood event.

Colusa is located in Colusa County about 20 miles northwest of Yuba City on the west side of the Sacramento River as shown in Figure 1 – Location Map. Colusa is protected by the levees on the right bank (west) of Sacramento River and left bank levees of Powell Slough and Hopkins Slough. The Sacramento River levee is maintained by the Sacramento River West Side Levee District (SRWSLD) and Reclamation District (RD) 2047. Powell and Hopkins Slough levees are maintained by Colusa County Department of Public Works.

1.2 Purpose and Scope

The purpose of the Project is to perform a flood risk reduction feasibility level study for Colusa, develop a set of remediation alternatives, and select one preferred remediation alternative to address the existing flood risks to Colusa for a 100-year flood event. This report focuses on the 7.3 miles of levee protecting Colusa and documents the feasibility level geotechnical evaluation performed by HDR. HDR undertook the following:

- Reviewed existing geotechnical exploration data and analysis performed by others for DWR's Non-Urban Levee Evaluation (NULE) program.
- Performed slope stability and seepage analyses on select levee cross-sections using the 100-year water surface elevation. Select levee cross-sections were adapted from existing analyses shown in NULE program documents.
- Performed a supplemental geotechnical exploration program consisting of five cone penetration tests (CPTs) and three mud-rotary borings.
- Performed slope stability and seepage analyses of select cross-sections for the proposed wing levees north and south of Colusa.
- Evaluated potential seismic hazards.
- Evaluated potential remediation alternatives to address deficient levee segments.
- Evaluated potential borrow area locations near Colusa.
- Prepared this technical memorandum documenting the assessment.

1.3 Datum and Stations

The vertical datum used for the project is the North American Vertical Datum of 1988 (NAVD88). The horizontal datum is the North American Datum of 1983 (NAD83). All coordinates and elevations are presented in feet.

2 Levee Past Performance

The past performance of the levees included in this geotechnical assessment for Colusa is documented in the NULE Geotechnical Assessment Report (GAR) (URS, 2011) and NULE Geotechnical Overview Report (GOR) (URS, 2014a; 2014b). Past performance events documented by NULE include underseepage, through seepage, erosion, and slope instability.

The Colusa levee is located along the west bank of the Sacramento River adjacent to Colusa. The Colusa levee is approximately between DWR Station 8125+00 and 8510+00 in NULE segments 100, 287, 380, which includes Reaches J through O of the Colusa South Study Area and Reaches A and B of the Colusa North Study Area. The boundary of the two study areas is located at DWR Station 8352+75, which is the boundary between SRWSLD and RD 2087 (Bridge Street). The Powell levee, approximately between Station PWLS-L 1000+00 and 1010+73, and the Hopkins levee, between HPKS-L 1000+00 and 1174+45 in NULE segments 1024 and 1025, protect the town in the east side from the backwater.

There are no documented reports of underseepage, through seepage, slope instability, erosion, overtopping, or breaches along Segment 1024, and 1025 of the Colusa North Study Area. However, the levees have not experienced a flood event after their construction in 2000.

Several past performance events have been documented in the Colusa levee study area. A summary of past performance events from north to south within the Colusa levee study area is shown on Figures 2A and 2B – Summary Map. Detailed descriptions of levee segments past performance, based on NULE documents, are provided below.

2.1 Erosion

Erosion was reported in all of the reaches within the Colusa levee study area with the exception of Reach J.

- Station 8434+55 to 8435+29 (Reach B) experienced erosion bank caving during the 1936 flood season. No documented mitigation was reported.
- Station 8374+56 to 8389+93 (Reach A) experienced recurring events of erosion of the riverbank, however the dates are unknown (USACE, 1993).
- Station 8337+64 to 8352+84 (Reach O) experienced erosion on the waterside in 1936, 1957, and 1997.
- Station 8276+00 to 8337+64 (Reach N) experienced erosion on the waterside in 1936, 1957, and 1997.
- Stations 8249+35 and 8255+36 (Reach M) experienced erosion on the waterside in 1997.
- Stations 8246+93 to 8276+00 (Reach M) experienced erosion on the waterside in 1936, 1957, and 1997.
- Station 8224+95 (Reach L) experienced erosion on the waterside in 1997.

- Station 8240+21 (Reach L) experienced embankment failures in an unknown year.
- Stations 8174+07 to 8246+93 (Reach L) experienced erosion on the waterside in 1936, 1957, 1997.
- Station 8168+82 (Reach K) experienced erosion on the waterside in 1997.
- Station 8151+33 to 8174+07 (Reach K) experienced erosion on the waterside in 1936, 1957, 1997.

2.2 Seepage

Seepage was reported in all of the reaches within the Colusa levee study area with the exception of Reach B.

- Underseepage from Station 8374+56 to 8389+93 (Reach A) was reported during high water stage (USACE, 1997a).
- Seepage and boils on the landside from Station 8337+64 to 8352+84 (Reach O) in 1986, 1993, and 1997.
- Seepage and boils on the landside from Station 8276+00 to 8337+64 (Reach N) in 1986, 1993, and 1997.
- Seepage on the landside at Station 8250+77 (Reach M) in an unknown year.
- Seepage and boils on the landside from Station 8246+93 to 8276+00 (Reach M) in 1986, 1993, and 1997.
- Seepage on the landside at Stations 8197+97 and 8224+37 (Reach L) in an unknown year.
- Seepage and boils on the landside from Station 8174+07 to 8246+93 (Reach L) in 1986, 1993, and 1997.
- Seepage on the landside at Station 8171+57 (Reach K) in an unknown year.
- Seepage and boils on the landside from Station 8151+33 to 8174+07 (Reach K) in 1986, 1993, and 1997.
- Seepage on the landside at Stations 8124+05 (Reach J) in an unknown year.
- Seepage and boils on the landside from Station 8071+68 to 8151+33 (Reach J) in 1986, 1993, and 1997.

2.3 Stability

There are no past reports of stability issues within any of the reaches in the Colusa levee study area.

2.4 Animal Persistence

Animal persistence is assessed using a relative scale indicating how persistent observations of burrows and burrowing animals have been through time, as recorded in levee inspection reports. DWR animal persistence data for the southern end of Reach B

indicates an “infestation” level of animal activity south of approximately Station 8426+00, and a “low” level of animal activity from approximately Station 8426+00 to 8486+75.

At the northern end of Reach B, the animal persistence data indicates a “high” to “infestation” level from approximately Station 8486+75 to 8544+90. The data indicates a “low” level of animal activity from approximately Station 8426+00 to 8486+75. South of approximately Station 8426+00, animal activity is categorized at “infestation” level. Within Reach A, south of Station 8400+00, DWR animal persistence data indicates a “low” level of animal activity. For the rest of the study area levee, Reaches J through O of section 287, DWR data indicate “medium” levels of animal persistence.

2.5 Construction History

According to the GAR, the Colusa levee was originally constructed in the early 1880’s by local interests. The construction methods used to build the levees are unknown. In approximately 1940, sections of the levee were setback, enlarged, strengthened or raised to meet Project standards by the U.S. Army Corps of Engineers (USACE). In addition, the following modifications have been made to the Colusa levee:

- Reach L – 30 to 33 foot deep Soil-Cement-Bentonite Cutoff Wall
- Reach N – 30 foot deep Soil-Cement-Bentonite Cutoff Wall
- Reach M – Landside Seepage Berm
- Reach A – Reinforced concrete retaining walls near full height of the levee installed in 1992 by the City of Colusa. Rock revetment installed along waterside toe.

The Powell and Hopkins levees were constructed in 2000 after the area flooded in 1998. The levees were constructed to protect the west side of the town of Colusa in the area north of Highway 20. Local borrow material was used to construct the levees.

3 Geology

3.1 Area Geology

The Colusa study area levees are located in the northern Great Valley geomorphic province, within the Sacramento Valley. The Great Valley geomorphic province is a large, elongated structural trough that contains a thick sequence of predominantly sedimentary formations that range in age from Jurassic (206 to 144 million years old) to Recent. From the late Triassic Period until the late Jurassic, this area was part of the continental shelf and ocean floor on which the marine Great Valley sequence was deposited. By the early Pleistocene Epoch (about 1.8 million years ago), after uplift of the Coast Ranges, the present boundaries of the Great Valley were well developed and deposition changed from marine to mostly continental. Surficial units within the project area are predominantly Pleistocene and Holocene alluvial deposits.

Materials underlying the northern portion of the Sacramento Valley, including the Colusa levee, consist primarily of Holocene alluvial deposits from the Sacramento River and its east-flowing tributaries that drain the Coast Ranges located west of the project area.

3.2 Study Area Surficial Geology and Geomorphology

The Colusa levee study area lies within the Sacramento River floodplain geomorphic domains (URS, 2011). The Sacramento River is located between natural levees formed during Holocene high-water events. When flood waters overtop the river banks, the coarser fraction of the entrained material is deposited near the river and finer grained material is transported farther from the river. Most of the areas adjacent to the river have experienced flooding during historical high-water events. Geomorphic analyses for NULE consisted of mapping of geomorphology/surficial geology in corridors along Project and non-Project NULE levees. The mapping was carried out at two levels. Level 2-I mapping was based primarily on the compilation and analysis of existing regional geologic and geomorphic information at a final scale of 1:62,000. Level 2-II mapping was original mapping at a scale of 1:24,000. More details regarding the DWR geomorphic assessment are provided in URS (2011) and summarized below.

3.2.1 Levee Alignment

The Level 2-II geomorphic mapping (URS, 2011) shows that the study area is underlain by Historical overbank deposits, meander scroll, distributary channel, and undifferentiated alluvium. A thin veneer of Historical overbank deposits overlies Holocene meander scroll deposits.

The floodplain sediments consist of mixtures of sand, silt, and clay (Holmes et al., 1913). Levees constructed along the Sacramento River within the study area are likely to overlie young, unconsolidated, relatively coarse-grained alluvium with a high underseepage potential (Helley and Harwood, 1985; Water Engineering and Technology, 1990).

3.2.2 Landward Variations

The geomorphic study found that near surface conditions consist of young, unconsolidated, relatively coarse-grained alluvium (Holocene Overbank Deposits) extending to 1,800 feet from the levee near the downstream end of the project limits which increases to 5,000 feet or greater through Colusa. North of Colusa the width of these deposits approaches 7,000 feet north of the Colusa overlain by Holocene Crevasse Splay deposits at the intersection of Roberts Road and Highway 45. Distributary channels are mapped along the levee but are obscured by urban development within the city limits. One distributary channel is mapped as intersecting the levee northwest of the intersection of Roberts Road and Highway 45. Two channels downstream of the city connect to a small pond located between the levee at Commerce Avenue and Highway 45. A number of smaller channels are mapped downstream of this channel, beginning near Moon Bend Road as shown on Figure 3A through 3C – Geomorphology Map.

3.3 Area Seismicity

The project area has a relatively low seismic hazard when compared to other parts of California. The most active faults, such as the San Andreas, Hayward, Calaveras, and others, are at least 100 miles away. The California Department of Conservation, Earthquakes of California (magnitude 5+), 1769 to 2015 database showed that significant historical seismicity (i.e., Magnitude (Mw) > 5.0) near Colusa is non-existent, with the closest notable earthquakes being the 1975 Mw 5.8 Palermo earthquake, located 30 miles northwest and the 1892 Mw 6.4 Vacaville-Winters earthquake, located approximately 50 miles southwest (Eaton, 1986).

The closest seismically capable structure to Colusa is the Great Valley Subsection 3 fault (Mysterious Ridge), which is located approximately 15 miles to the west. The fault is Quaternary in age with slip rate estimates less than 0.2 mm/year. A fault map showing the project location relative to nearby faults is included as Figure 4 – Fault Map.

4 Geotechnical Data Summary

4.1 Site Condition

4.1.1 Levee Geometry

Embankment height and geometry (side slopes in Horizontal to Vertical inclinations, H:V) for levees in the study area is included in the NULE program (URS, 2011). Levee height, crown width, and side slopes are summarized in Table 1.

Table 1. Levee Geometry

Segment	Reach	Height (feet)	Crown Width (feet)	Waterside Slope	Landside Slope
288/287	J	17 to 22	20	1.9H:1V to 3.3H:1V	2.4H:1V to 4.0H:1V
287	K	14 to 20	16 to 60	2.3H:1V to 2.9H:1V	3H:1V
287	L	15 to 20	16 to 30	2.3H:1V to 2.9H:1V	3H:1V
287	M	16	20	2.3H:1V to 2.9H:1V	3H:1V
287	N	11 to 21	18 to 30	2.3H:1V to 2.9H:1V	3.0H:1V to 4.0H:1V
287	O	13 to 17	20	2.3H:1V to 2.9H:1V	4H:1V
100	A	6 to 14	15 to 20	1.7H:1V to 2.5H:1V	2.5:H1V to 3.3:H:V
100/380	B	11 to 16	15 to 25	1.7H:1V to 2.5H:1V	2.5H:1V to 4H:1V
1024/1025	N	2 to 9	10 to 30	2.5H:1V to 3.0H:1V	1.5H:1V to 2.0H:1V
1025	O	2 to 9	10 to 20	2.5H:1V to 3.0H:1V	1.5H:1V to 2.0H:1V

Source: URS, 2011

4.1.2 Encroachments and Penetrations

Utilities penetrate the study area levees and largely consist of conduits that convey fluids or contain either electric or communication lines. An inventory table of known penetrations is included in URS (2011). Known penetrations are summarized in Table 2. Some encroachments on the Sacramento River Levee photographed during the site visits are shown in Figure 5A through 5E – Encroachments.

Table 2. Summary of Penetrations

Segment	Reach	Number of Penetrations	Diameter Range (inches)	Depth Range (feet)	Common Conduit Type
288/287	J	1	24	5.7	Steel Pipe
287	K	1	4	2	Steel Pipe
287	L	5	8 to 24	3 to 25.5	Steel Pipe
287	M	3	14 to 16	17 to 18	Steel Pipe
287	N	8	0.5 to 24	2.1 to 15.5	Steel Pipe
287	O	6	2 to 36	18.5 to 23.7	Steel Pipe
100	A	3	2.5 to 3	2 to 22	Steel Pipe
100/380	B	3	30 to 60	15	Steel Pipe
1024/1025	N	7	24 to 30	-	Concrete Pipe
1025	O	1	30	-	Concrete Pipe

Source: URS, 2011

4.2 Existing Explorations

Existing exploration data includes work performed for and summarized by the NULE program. The existing data is summarized by reaches for the study area levees in Table 3. Plan and profile of subsurface investigation locations are shown in Attachment A (URS, 2014a; 2014b).

Table 3. Summary of Existing Explorations for NULE (URS, 2014a; 2014b)

Segment	Reach	Exploratory Borings		Cone Penetration Test (CPT)	
		Total Number	Maximum Depth (feet)	Total Number	Maximum Depth (feet)
288/287	J	13	112	38	98
287	K	1	75	4	83
287	L	4	96	10	112
287	M	-	-	3	92
287	N	3	97	9	100
287	O	1	101	1	78
100	A	2	98	6	65
100/380	B	4	77	12	70
1024/1025	N	7	40	17	60
1025	O	-	-	1	26

Source: URS, 2014a and 2014b

4.3 Subsurface Conditions

Plan and profile plates with subsurface explorations prepared as part of the NULE Geotechnical Overview Reports (GOR) (URS, 2014a; 2014b) are presented in Attachment A.

Geomorphology Level 2-II mapping indicates Segment 287 overlies overbank deposits consisting of materials like sand, silt and clay. Distributary channel deposits are also present beneath the levee and are likely to contain more sand than the overbank deposits. The boring logs show that the levee and foundation material include clean sand, clayey sand, silt, and clay.

According to the geomorphology Level 2-II mapping, Segment 100 overlies overbank deposits typically consisting of coarse-grained materials like sand and silt, with the potential for coarser-grained (sand and gravel) distributary channel deposits directly beneath the levee or deeper in the subsurface. Boring logs indicate the presence of clay, silt, and sand in the levee foundation materials. Two of the three boring logs indicate three to five feet of silty sand is present at the base of a clayey/silty levee, while the third boring indicates a levee composed of lean clay with minor sand. The foundation materials logged in these borings are highly variable horizontally and/or vertically, ranging from lean clay to poorly-graded sand. Soil borings in borrow pit locations related to the Segment 100 levee enlargement and widening indicate that silty soil was used. Soil borings in the segment indicate that the levee is made of clay, silt, and some sand. Borrow pit information related to repair work indicates that repairs to Segment 100 levee were made using silty materials.

Based on geomorphology Level 2-II mapping, Segment 380 soils are predominantly overbank deposits that are likely to consist of sand, silt and clay. In addition to the overbank deposits, multiple channels cross under the levee which may contain a coarser-grained matrix. Exploration logs show Segment 380 consist of silty and clayey materials, with a few localized sandy layers.

Geomorphology level 2-II mapping indicates Segment 1024 primarily overlie Holocene basin deposits comprised of fine-grained soils consisting mostly of clay and silts with fine sand. Available explorations along the levee footprint, through native soils show the levee embankment consists of lean to sandy clay.

In Segment 1025, the levee foundation and embankment are assumed to consist of lean to sandy clay, based on available boring information and level 2-II geomorphology. Organic soils (peat) and trace gravel were found below the subsurface in places. Geomorphology level 2-II mapping indicates Segment 1025 primarily overlies Holocene basin deposits. These basin deposits are described as fine-grained soils consisting mostly clay and silts with fine sand. The segment overlies Holocene alluvium and Holocene distributary channel deposits beyond Station 1150+00. The alluvium and distributary channel deposits are described as mostly clay, silt, sand with trace gravel.

5 Reach Summary

As part of the NULE program, the Project levee segments were divided into reaches. A separate reach or sub-reach was identified when a major change in conditions potentially affecting levee performance was noted. Reach selection and characterization was generally an iterative process of successive refinement. Reasons for identifying a separate reach included significant changes in levee geometry, including presence of a landside ditch, subsurface conditions, or levee performance during high water events. These conditions within each reach were then characterized by a single transverse analysis cross section. A summary of the reaches is provided in Table 4, reaches are shown in Figures 6A and 6B – Reach Summary. Details regarding the reach selection are discussed in the GOR (URS, 2014a; 2014b).

Table 4. Reach Summary

Maintained By	Segment	Reach	Station	Levee Miles
NA 16	288/287	J	SACR-R 7794+86 to 8151+33	NA 16, Unit 1 LM 39.54 to 46.35
NA 16	287	K	SACR-R 8151+33 to 8174+07	NA 16, Unit 1 LM 46.35 to 46.78
NA 16	287	L	SACR-R 8174+07 to 8246+93	NA 16, Unit 1 LM 46.35 to 48.17
NA 16	287	M	SACR-R 8246+93 to 8276+00	NA 16, Unit 1 LM 48.17 to 48.73
NA 16	287	N	SACR-R 8276+00 to 8337+64	NA 16, Unit 1 LM 48.73 to 49.90
NA 16	287	O	SACR-R 8337+64 to 8352+84	NA 16, Unit 1 LM 49.90 to 50.19
DWR MA 1	100	A	SACR-R 8352+84 to 8400+00	MA 01-Unit 1 LM 0.00 to 0.90
DWR MA 1	100/380	B	SACR-R 8400+00 to 8544+90	MA 01-Unit 1 LM 0.90 to 3.70
Colusa County Department of Public Works	1024/1025	N	PWLS-L 1000+00 to 1010+73 and HPKS-L 1000+00 to 1154+20	-
Colusa County Department of Public Works	1025	O	HPKS-L 1154+20 to 1174+45	-

Source: URS, 2014a and 2014b

As part of this geotechnical feasibility level study, HDR used the same segment and reach limits and designations developed by the NULE program. Additional analysis was not carried out for Segments 1024 and 1025.

6 Engineering Analyses

6.1 NULE Program Analyses

The NULE program analyzed the existing conditions of the Colusa area levees by dividing the levee alignments into reaches, selecting analysis cross-section locations, and performing seepage and slope stability analyses. The delineation of reaches, selection of critical cross sections, and selection geotechnical analysis parameters are more fully described in the Geotechnical Overview Report (GOR, URS, 2014a; 2014b). The NULE program used the 1955/57 design water surface elevation (WSE) for analyses which is the design flood event for the Project levees. The NULE analysis results for each Reach, including the identified levee deficiency and remedial alternatives, are summarized in Table 5.

Table 5. Summary of NULE Program Analyses (URS, 2014a; 2014b; 2014c; 2014d)

Segment	Reach	Assessment Type				Remedial Alternative 1	Remedial Alternative 2	Selected Remedial Alternatives
		Under Seepage	Through Seepage	Stability	Erosion[1] (%)			
288/287	J	**Does Not Meet Criteria**	**Does Not Meet Criteria**	**Does Not Meet Criteria**	**13**	**Seepage Berm and Ditch Fill**	**Cutoff Wall**	**Seepage Berm and Ditch Fill**
287	K	**Does Not Meet Criteria**	Meets Criteria	Meets Criteria	0	**Seepage Berm**	**Cutoff Wall**	**Seepage Berm**
287	L	**Does Not Meet Criteria**	Meets Criteria	Meets Criteria	0	**Seepage Berm**	**Cutoff Wall**	**Seepage Berm**
287	M	**Does Not Meet Criteria**	Meets Criteria	Meets Criteria	0	**Cutoff Wall**	None	**Cutoff Wall**
287	N	**Does Not Meet Criteria**	Meets Criteria	Meets Criteria	0	**Seepage Berm**	**Cutoff Wall**	**Seepage Berm**
287	O	**Does Not Meet Criteria**	**Does Not Meet Criteria**	**Does Not Meet Criteria**	0	**Seepage Berm**	**Cutoff Wall**	**Seepage Berm**
100	A	**Does Not Meet Criteria**	**Does Not Meet Criteria**	Meets Criteria	0	**Cutoff Wall**	None	**Cutoff Wall**
100/380	B	Meets Criteria	**Does Not Meet Criteria**	Meets Criteria	0	**Drained Stability Berm**	**Cutoff Wall**	**Drained Stability Berm**
1024/1025	N	Meets Criteria	Meets Criteria	Meets Criteria	0	None	None	None
1025	O	Meets Criteria	Meets Criteria	Meets Criteria	0	None	None	None

Note: [1] Portion of total reach length identified to be deficient

6.2 Updated NULE Analyses

HDR's geotechnical assessment is focused on identifying feasibility level remediation alternatives for a 100-year level of protection which has a lower water surface elevation than the 1955/57 WSE. Therefore, the NULE analytical results were reviewed with respect to the lower flood level. Re-analysis of the NULE sections was performed as necessary using the 100-year WSE. HDR's analyses are based on existing data assembled for and described by the GOR (URS, 2014a; 2014b).

HDR performed geotechnical analyses for select reaches to evaluate levee underseepage, through seepage, and slope stability using the 100-year WSE. Analyses were performed in general accordance with FEMA 44CRF65.10 and the following agency and industry standards:

- Engineering Manual (EM) 1110-2-1913 - Design and Construction of Levees (USACE, 2000).
- Engineering Technical Letter (ETL) 1110-2-569 - Design Guidance for Levee Underseepage (USACE, 2005).
- Engineer Regulation (ER) 1110-2-1806 - Earthquake Design and Evaluation for Civil Works Projects (USACE, 2016).
- Engineering Circular (EC) 1110-2-6067 - USACE Process for the National Flood Insurance Program (NFIP) Levee Systems Evaluation (USACE, 2010).
- Idriss and Boulanger (2008), Soil Liquefaction During Earthquakes.

6.2.1 Water Surface Elevation

The 100-year WSEs for the Sacramento River were developed by KSN and provided for HDR's use in the feasibility level geotechnical assessment. A comparison of the 1955/57 and 100-year WSEs for the NULE cross-sections along Sacramento River levee is presented in the table below.

Table 6. Summary of Water Surface Elevations for Sacramento River

Segment	Reach	DWR Stationing[1]	100 year WSE (feet)[2]	1955/57 WSE (feet)[2]
287	K	SACR-R 8173+57	65.8	67.6
287	L[3]	-	-	-
287	M	SACR-R 8275+00	66.7	68.5
287	N	SACR-R 8326+82	68.2	69.0
287	O[4]	SACR-R 8345+00	68.4	69.5
100	A	SACR-R 8385+00	68.7	69.6
100/380	B	SACR-R 8436+00	68.9	70.0

Note: [1] Stationing from URS 2014a; 2014b
[2] Elevation (NAVD 88)
[3] Cross-section not analyzed for the reach in NULE
[4] Cross-section analyzed by HDR, cross-section geometry not available in NULE
Source: KSN, 2018

6.2.2 Cross-Section Selection

Three cross-sections were selected for seepage and stability analyses using the 100-year WSE for the Sacramento River Levee. Additionally, one cross-section was selected to assess liquefaction triggering and seismically induced settlement because of the thick, loose, coarse-grained cohesionless soil (sand and gravel) identified by the NULE explorations. The cross-sections and associated analyses are summarized in Table 7. The cross-section for Reach O was not developed for the NULE report. The nearest available cross-section geometry from Reach A (Segment 100) was used to analyze Reach O.

Table 7. Re-analyzed NULE Reach Cross-sections for Sacramento River Levee

Segment	Reach	DWR Stationing	Analyses Performed		
			Seepage	Stability	Liquefaction
287	M	SACR-R 8275+00	x	x	
287	O*	SACR-R 8345+00	x	x	
100/380	B	SACR-R 8436+00	x	x	x

Note: * Cross-section not available in NULE

6.2.3 Seepage Analyses

HDR performed a steady-state seepage analysis on the NULE program cross-sections identified in Table 7. Results from the NULE program were used to interpolate underseepage results for additional cross-sections that were not re-analyzed as part of this feasibility level geotechnical assessment.

There are two modes of seepage that are of concern with regards to levee performance: underseepage and through seepage.

Underseepage problems commonly occur when a surficial layer of fine-grained, relatively impervious soils, also known as a blanket layer, overlays a layer of coarse-grained, more pervious soil. At times of flood stage, pressure builds up in the confined coarse-grained sublayers and can cause subsurface erosion or piping at or beyond the landside toe of the levee. This occurs when water is pushed through the discontinuities within the blanket layer and carries soil particles as it travels to the surface, potentially forming seeps that could lead to internal erosion and sand boils. Over a period of time, this could lead to failure of the levee foundation as increasing amounts of soil are internally eroded away.

Through seepage occurs when water enters the waterside slope of the levee and exits through the landside slope. Through seepage can cause surficial erosion at the landside face and possibly internal erosion of the levee as soil particles are carried through the slope. Through seepage also impacts the stability of the levee slope by increasing internal pore pressures, which can decrease the shear strength of the soil and make the slope more susceptible to failure. Levees constructed of silt material are most susceptible to through seepage erosion.

Seepage Criteria

Based on USACE's ETL 1110-2-569 (USACE, 2005), the seepage criteria shown in Table 8 were used to evaluate the subject levee.

Table 8. Seepage Criteria

Location	Allowable Exit Gradient
Underseepage: Average Vertical Exit Gradient at Landside Levee Toe (i_{ave})	≤ 0.5
Through Seepage	Phreatic surface should not exit the landside levee face if levee consists of erodible material.
Underseepage at Drainage Ditch or Low Point	Exit gradient in the bottom of the ditch should not exceed 0.5 at the landside levee toe and should not exceed 0.8 at a distance 150 feet landward of the landside levee toe and beyond. Between the landside levee toe and 150 feet landward of the landside levee toe, the maximum allowable exit gradient in the bottom of the ditch should increase linearly from 0.5 to 0.8.

Hydraulic Conductivity

Material permeability characteristics for HDR analyses were reviewed and adopted from the NULE analyses (URS, 2014a; 2014b). Permeability characteristics include saturated hydraulic conductivity (k) and the ratio of vertical to horizontal permeability (anisotropy ratio). The hydraulic conductivity values used for each cross-section are shown on the seepage model figures presented in Attachment B.

Seepage Model Development

The finite element computer program SEEP/W, part of Geostudio 2016 version 8.16 software package, was used to model the selected levee sections. The same topography, stratigraphy, and hydraulic conductivities developed for as part of the NULE program were used for HDR's analyses. The models extend to the river channel centerline and landward 2,000 feet from the centerline of the levee.

Guidance Document for Geotechnical Analyses (URS, 2015) was used to determine the boundary condition. Generally, the boundary conditions for the SEEP/W models are:

- Nodes along the channel bottom and waterside embankment slope were set to the 100-year WSE.
- Nodes along the waterside vertical edge were generally set to 100-year WSE.
- Nodes along the bottom of the model were set to have a no flow condition.
- Nodes on the landside vertical edge were set to the landside ground surface elevation.
- Nodes on the landside levee slope and the landside ground surface were modeled as potential seepage faces.

Steady-State Seepage Results

The average vertical exit gradient (i_{ave}) is calculated as the total head drop in the vertical direction at the landside levee toe or low spot divided by the blanket thickness. In addition, phreatic breakout above the levee landside toe was evaluated. The results of the seepage analyses are presented in Table 9 and graphically in Attachment B. Reach M does not meet the i_{ave} underseepage criteria (≤0.5) but meets through seepage criteria (breakout point below toe and/or non-erodible levee embankment material). Reach B and O meet the underseepage criteria but not through seepage criteria.

Table 9. 100-year WSE Seepage Analysis Results

Segment	Reach	DWR Stationing	WSE (feet)	i_{ave} (toe)	i_{ave} (low spot)	Through Seepage Breakout Point (feet above toe)	Erodible Levee Material
287	M	SACR-R 8275+00	66.7	**1.04**	-	-	Meets criteria
287	O	SACR-R 8345+00	68.4	0.39	0.36	**2.6**	**Does not meet criteria**
100/380	B	SACR-R 8436+00	68.9	0.02	-	**1.0**	**Does not meet criteria**

Note: Bold values do not meet USACE criteria

Steady-state seepage analysis results for a 100-year WSE were estimated for additional reaches by interpolating the results from URS (2014a; 2014b). Interpolated results were obtained by plotting the 100-year WSE on existing WSE versus Average Vertical Gradient through Blanket figures in the NULE reports. The plots used to interpolate values are included in Attachment C, results are shown in Table 10.

Table 10. Interpolated 100-year WSE Seepage Results

Segment	Reach	DWR Stationing	100 year WSE SEEP/W Analysis Result		Interpolated 100 year WSE Results	
			i_{ave} (toe)	i_{ave} (low spot)	i_{ave} (toe)	i_{ave} (low spot)
287	K	SACR-R 8173+57	Not Analyzed		0.10	0.64
287	M	SACR-R 8275+00	**1.04**	-	**1.04**	-
287	N	SACR-R 8326+82	Not Analyzed		0.38	**0.64**
287	O	SACR-R 8345+00	0.39	0.36	Not Analyzed	
100	A	SACR-R 8385+00	Not Analyzed		**0.56**	-
100/380	B	SACR-R 8436+00	0.02	-	0.02	-

Note: Bold values do not meet USACE maximum gradient criteria of 0.5 or less.

6.2.4 Settlement

FEMA 44CFR65.10 states that the minimum freeboard must be maintained if levee settlement occurs. Typical causes of settlement are the compressibility of the levee embankment or foundation soils and liquefaction induced settlement.

The Colusa area Sacramento River levee embankment and foundation materials are comprised of both granular and cohesive soils. Settlement in granular soils is normally small and occurs quickly with little additional long-term settlement, static settlement is expected to have occurred during or shortly after levee construction. For the levee embankment or foundation materials comprised of fine-grained soils like silt and clay, consolidation settlement can occur over a longer timeframe. However, due to the age of the Colusa area levees, primary consolidation settlement is no longer expected to be occurring.

For this feasibility level geotechnical assessment, the liquefaction potential of levee embankment foundation materials was estimated. The Sacramento River levee Reach B cross-section was used to evaluate liquefaction potential. Liquefaction potential was evaluated in general accordance with the standard penetration test (SPT) procedures described in Idriss and Boulanger (2008). The depth of water table was assumed at the elevation of the levee toe for the analysis. Ground motion data were necessary to evaluate liquefaction potential. Necessary ground motion data includes the PGA, earthquake magnitude (Mw), and distance to the seismic source (r). Colusa study area corresponds to seismic site class D. Ground motion data were determined using the USGS Unified Hazard Tool and are shown in Table 11. The liquefaction evaluation indicated that there is a low likelihood that significant liquefaction would occur at the levee based on a 100-year event. Further analyses of liquefaction induced settlement and post-earthquake slope stability were not performed as part of this feasibility level geotechnical assessment.

Table 11. Ground Motion Data

Latitude (deg)	Longitude (deg)	Site Class	Return Period (year)	PGA (g)	Mw	r (km)
39.213	-122.010	D	100	0.12	6.71	62.5.

Source: USGS Unified Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/)

6.2.5 Seismic Hazards

The levees in the study area are not located in the vicinity of any faults and therefore are not subject to fault surface rupture hazard or fault displacements. The main seismic hazard to the study area levees is ground shaking associated with earthquakes. The closest seismically capable structure is the Midland fault; however, this fault has a relatively low slip rate and hazard. Several other faults associated with the Great Valley fault zone are located approximately 30 miles from the study area and also are has low slip rates and hazards.

6.2.6 Stability Analysis

Embankment and foundation stability analyses were performed using the same stratigraphy and models used for the seepage analyses. Stability analyses performed evaluated the landside slope under steady-state conditions using the 100-year WSE and the waterside slope under rapid drawdown (RDD) conditions. Rapid drawdown conditions considered the staged drawdown from the 100-year WSE (before drawdown) to the elevation of the landside levee toe (after drawdown).

Stability Criteria

EM 1110-2-1913 (USACE, 2000) identifies four types (cases) of loading conditions for slope stability analysis as described below. The minimum slope stability factor of safety (FS) against failure for each case is presented in the Table 12.

Case 1 – End of construction

This case addresses slope stability at the end of construction of the levee. According to EM 1110-2-1913, this case represents undrained conditions for impervious levee embankments and foundation soils (i.e. excess pore pressure is present because the soil has not had time to drain since being loaded). Due to the elapsed time since construction was completed on the levees, this case was not analyzed.

Case 2 – Rapid Drawdown

This case represents a condition where the flood stage fully saturates a majority of the levee embankment then the water falls faster than the soil can drain. The FS varies with persistence of pool level. A FS of 1.0 applies when the water level is unlikely to persist for long periods preceding drawdown and a FS of 1.2 applies when the water level is likely to persist for long periods prior to drawdown.

Case 3 – Steady-State

This case occurs when the water remains at or near flood stage levels, thus fully saturating the embankment soils.

Case 4 – Earthquake (Seismic) Loading

Earthquake loading is not typically considered in analyzing the stability of levees due to the low probably of an earthquake coinciding with periods of high water. However, it is recommended that seismic stability be considered if:

- The peak ground acceleration (PGA) for a 100-year earthquake is greater than 0.10 g for the site.
- If liquefaction is indicated based on the site PGA.

EC 1110-2-6067 recommends a minimum FS of 1.2 for post-earthquake stability of levees.

Table 12. Slope Stability Criteria

Condition	Allowable FS
End of Construction	Not Analyzed
Rapid Drawdown	≥ 1.0 to 1.2
Steady-State	≥1.4
Post-earthquake	Not Analyzed Based on Evaluation of Liquefaction Potential

Material Properties for slope Stability Analyses

The effective shear strength, total shear strength, and unit weight values used for each cross-section analyzed were obtained from the respective NULE analyses (URS, 2014a; 2014b). The strength values used for each cross-section are shown on the stability model figures in Attachment D.

Slope Stability Analysis Method

The limit equilibrium computer program SLOPE/W, part of Geostudio 2016 version 8.16 software package, was used for the slope stability analysis of the select cross-sections identified in Table 7. Results from the NULE program were used to interpolate slope stability results for additional cross-sections that were not re-analyzed as part of this feasibility level geotechnical assessment.

Spencer's Method of Slices was used for calculating factors of safety (FS). Pore pressures computed by SEEP/W were imported into SLOPE/W for use in the analyses. The entry and exit search method was used. For the steady-state slope stability analysis, the entry point range extended from the waterside to landside crown hinge points and the exit point range extended form approximately 1/3 of the levee height from the landside toe up the landside slope to a distance approximately equal to twice the embankment height on the landside. For the rapid drawdown stability analysis, the entry point range extended from the landside to waterside crown hinge points and the exit range extended form the distance approximately equal to twice the embankment height from the waterside toe of the model to approximately 1/3 up the waterside slope.

SLOPE/W performs analysis on each of the potential entry/exit combinations to find the critical slip surface. If the critical slip surface was located at the extremes of either the entry or exit range, the entry or exit range was extended to capture the critical slip surface. In order to eliminate identifying surficial failures, a minimum slip surface depth of five feet was used.

Results of Slope Stability Analysis

The results of the stability analyses using the 100-year WSE are presented in Table 13 and graphically in Attachment D. Reach M, O, and B meet the minimum recommended FS's for both landside steady-state and waterside rapid drawdown.

Table 13. 100-year WSE Slope Stability Analysis Results

Segment	Reach	DWR Stationing	WSE (feet)	Landside Steady State FS	Waterside Rapid Drawdown FS
287	M	SACR-R 8275+00	66.7	1.67	1.79
287	O	SACR-R 8345+00	68.4	1.86	2.63
100/380	B	SACR-R 8436+00	68.9	1.81	1.42

Note: Bold values do not meet USACE criteria; FS of 1.4 or higher for Landside Steady State and 1.0 to 1.2 or higher for Waterside Rapid Drawdown.
For Rapid Drawdown Analysis, water drawn down to the elevation of toe.

The 100-year WSE was plotted on existing NULE Stability Analysis Results Summary pages from URS (2014a; 2014b) to estimate slope stability factors of safety using the 100-year WSE for sections not reanalyzed using SLOPE/W. URS (2014a; 2014b) only plotted results for landside steady-state slope stability analysis so the interpolation procedure does not include waterside rapid drawdown FS estimates. The plots are included in Attachment E and results are summarized in the Table 14.

Table 14. Interpolated 100-year WSE Landside Steady-State Slope Stability Results

Segment	Reach	DWR Stationing	100 year WSE SLOPE/W Analysis Result	Interpolated 100 year WSE Results
287	K	SACR-R 8173+57	Not Analyzed	2.47
287	M	SACR-R 8275+00	1.67	1.70
287	N	SACR-R 8326+82	Not Analyzed	2.10
287	O	SACR-R 8345+00	1.86	Not Analyzed
100	A	SACR-R 8385+00	Not Analyzed	1.55
100/380	B	SACR-R 8436+00	1.81	1.80

Note: Bold values do not meet USACE criteria; FS of 1.4 or higher for Landside Steady State and 1.0 to 1.2 or higher for Waterside Rapid Drawdown.

6.3 Wing Levee Evaluation

As part of identifying feasibility level remediation alternatives for Colusa flood protection, wing levees were proposed north and south of Colusa. These proposed wing levees along with the Sacramento River Levee, Powell Slough Levee, and a 2000 feet alignment of Colusa Basin Drain Levee constitute a ring levee around the City of Colusa. The alternative alignments for the wing levees were obtained from KSN. Three alternative alignments were proposed for the wing levees. The proposed wing levee alternative alignments are shown in Attachment F.

For feasibility level analysis of the proposed wing levee alignments, a geotechnical exploration program involving six CPTs and three mud-rotary borings was carried out. One CPT location was inaccessible due to rain and soft unpaved road and only five CPTs and three mud-rotary borings were carried out. The plan view of the exploration locations is shown in Figure 7 – Exploration Plan for Wing Levee Alignment. The exploration program was focused on Alignment 2 as per the instruction from KSN. The bore logs and CPT logs from the exploration program are presented in Attachment G. Laboratory testing was carried out for the soil samples obtained from the borings. The laboratory test results are presented in Attachment H.

The explorations near the north wing levee alignments indicate layers of clay and silts overlain by coarse grained material like sand and gravel. The depth to the sand and gravel layer decreases further east from the Sacramento River. The presence of low permeability blanket layers indicate low potential for underseepage issues. The south

wing levee alignments overlie layers of clay and silt that overlies coarse grained sand and gravel layers. Due to the presence of a 15 to 20-foot thick layer of fine grained blanket materials on the surface overlying coarse grained materials along both the north and south wing levee alignments, the potential for underseepage issue is low.

Seepage and slope stability analyses were carried out for the wing levee alignments using four analysis cross-sections. Two cross-sections were analyzed for the north wing levee alignment and two for the south wing levee alignment as shown in Figure 8 – Wing Levee Analysis Cross-sections. For the feasibility level analysis of the proposed wing levees, the standard levee prism geometry was used. The standard levee prism defined by the 1954 USACE MOU is a minimum 20-foot crown width, 3H:1V waterside slopes, and 2H:1V landside slopes. The levee height was governed by the 100 year WSE on the waterside of the wing levees. Minimum freeboard of three feet above the 100 year WSE along the wing levee alignments was maintained. The 100 year WSE data for the wing levee alignments were obtained from KSN and are shown in Attachment I.

The analysis cross-sections were selected based on the sub-surface conditions and depth of inundation indicated by 100 year WSE for the wing levees. The majority portion of the proposed south wing levee alternative alignment between the Colusa Drain Basin Levee (Wescott Road) and Highway 20 is situated higher than the 100 year WSE and the rest is loaded with 2 to 3 feet of water. Since the hydraulic loading and the required height of the wing levee is low for this portion, additional analysis was not carried out. The four analysis cross-sections are located along Alignment 2. The general subsurface condition are assumed to be similar for Alignments 1 and 3 for this study.

Hydraulic conductivity and strength properties for the sub-surface soil strata were estimated using the Guidance Document for Geotechnical Analyses (URS, 2015). For the analysis of the wing levee, the levee prism was assumed to overlie the existing ground without any modifications. The levee prism was assumed to be composed of compacted lean clay without any organic matter, which is a typical specification for levee fill material. The existing ground surface geometry was obtained using the LiDAR data collected by DWR as part of the Central Valley Floodplain Evaluation and Delineation (CVFED) effort.

Seepage and stability analysis for the wing levees were carried out using the same approach outlined previously for the updated NULE analysis. The results from the seepage analysis along the wing levee alignment are shown in Table 15. The seepage results indicate low average vertical exit gradients suggesting low potential for underseepage. South Wing Levee Section 2 (SWL-2) seepage analysis shows the phreatic surface daylighting one foot above the levee toe. Since the levee fill material is considered non-erodible (lean clay), the section meets the through seepage criteria.

Table 15. Wing Levee Alignments 100-year WSE Seepage Analysis Results

Wing Levee Alignment	Alternative	Section	Station (Alt. 2 Stationing)	WSE (feet)	i_{ave} (toe)	i_{ave} (low spot)	Through Seepage Breakout Point (feet above toe)	Erodible Levee Material
North Wing Levee	Alternative 2	NWL-1	26+78	61.2	0.05	-	-	Meets criteria
North Wing Levee	Alternative 2	NWL-2	57+93	58	0.06	-	-	Meets criteria
South Wing Levee	Alternative 2	SWL-1	194+33	56.2	0.02	0.06	-	Meets criteria
South Wing Levee	Alternative 2	SWL-2	123+41	52.2	0.13	0.23	1	Meets criteria

Note: Bold values do not meet USACE criteria

The results from the stability analysis along the wing levee alignment are shown in Table 16. The results indicate the standard levee prism is stable and meets both the landside and waterside steady-state criteria for all four analysis cross-sections. The seepage and stability model figures are shown in Attachment J.

Table 16. Wing Levee Alignments 100-year WSE Slope Stability Analysis Results

Wing Levee Alignment	Alternative	Section	Station (Alt. 2 Stationing)	WSE (feet)	Landside Steady State FS	Waterside Rapid Drawdown FS
North Wing Levee	Alternative 2	NWL-1	26+78	61.2	1.85	2.51
North Wing Levee	Alternative 2	NWL-2	57+93	58	2.35	2.84
South Wing Levee	Alternative 2	SWL-1	194+33	56.2	2.11	2.1
South Wing Levee	Alternative 2	SWL-2	123+41	52.2	1.68	2.26

Note: Bold values do not meet USACE criteria; FS of 1.4 or higher for Landside Steady State and 1.0 to 1.2 or higher for Waterside Rapid Drawdown.
For Rapid Drawdown Analysis, water drawn down to the elevation of waterside toe.

The liquefaction evaluation for the wing levee alignments indicated a low likelihood of significant liquefaction based on a 100-year event. Further analysis of liquefaction induced settlement and post-earthquake slope stability was not performed. Due to the presence of fine grained materials underneath the wing levee alignments, consolidation settlement can occur during the construction of the wing levee embankment. The settlement due to primary consolidation was evaluated for the wing levee alignment with highest required embankment along the proposed wing levee alignments at Station 189+00 South Wing Levee Alignment – Alternative 2. The analysis indicated low values of primary consolidation settlement with expected settlements of approximately 2 inches. Additional settlement analysis was not carried out for this study.

No remediation alternatives were analyzed for the wing levee alignments.

6.4 Erosion, Freeboard, and Geometry

Erosion, freeboard, and geometry remediation recommendations were reviewed and adopted from URS (2014a; 2014b). HDR is adopting NULE Program recommendations

largely due to the evaluations being qualitative and no new data were collected as part of this feasibility level geotechnical assessment.

7 Feasibility Level Levee Evaluation

7.1 Levee Deficiencies

Seepage and slope stability analyses were performed for select NULE cross-sections using the 100-year WSE. The 100-year WSE was provided by KSN and is lower than the 1955/57 WSE for the Sacramento River. Analysis were performed using the Geostudio computer program. Additionally, existing data from the NULE program were used to interpolate results for cross sections not analyzed using Geostudio. The performance of the Colusa area levee reaches for 100-year WSE are summarized in Table 17.

Table 17. 100 year WSE Deficiencies

Segment	Reach	Assessment Type				Notes
		Under Seepage	Through Seepage	Stability	Erosion[1] (%)	
288/287	J	**Does Not Meet Criteria**	**Does Not Meet Criteria**	**Does Not Meet Criteria**	**13**	Not Analyzed but several past erosions and seepage events noted.
287	K	Meets Criteria	Meets Criteria	Meets Criteria	0	Checked against NULE results plot. Underseepage analysis met criteria using 100 year WSE, but several seepage events noted.
287	L	**Does Not Meet Criteria**	Meets Criteria	Meets Criteria	0	Not Analyzed but several past erosions and seepage events noted.
287	M	**Does Not Meet Criteria**	Meets Criteria	Meets Criteria	0	Reanalyzed using 100 year WSE. Underseepage criteria not met.
287	N	**Does Not Meet Criteria**	Meets Criteria	Meets Criteria	0	Checked against NULE results plot. Underseepage criteria not met.
287	O	Meets Criteria	**Does Not Meet Criteria**	Meets Criteria	0	Reanalyzed using nearest cross-section geometry and explorations. Not analyzed in NULE. Gravel at the base of levee noted. Additional evaluation using updated cross-section and sub-surface explorations recommended. Through seepage criteria not met. Erosions on waterside and seepage and boils on landside noted.
100	A	**Does Not Meet Criteria**	**Does Not Meet Criteria**	Meets Criteria	0	Checked against NULE results plot. Underseepage and through seepage criteria not met.
100/380	B	Meets Criteria	**Does Not Meet Criteria**	Meets Criteria	0	Reanalyzed using 100 year WSE. Through seepage criteria not met.

Note: [1] Portion of total reach length identified to be deficient

7.2 Potential Remediation Alternatives

The Segments and Reaches that did not meet the criteria for a 100-year flood were evaluated for one or more remediation alternatives. In general, the remediation alternatives considered consist of cutoff wall, drained stability berm, undrained seepage berm, drained seepage berm, combined drained stability and seepage berm, and landside ditch fill. Remediation alternatives for the 100-year WSE are shown in Table 18. In general, Remediation Alternative 1 should be considered as the preferred alternative. Remediation Alternative 2 may be considered if land acquisition, stakeholder interests, environmental or cultural resource conflicts, cost, or other pertinent limitations apply. See URS (2014c; 2014d) for analyses supporting remediation alternatives.

Table 18. 100 year WSE Remediation Alternatives

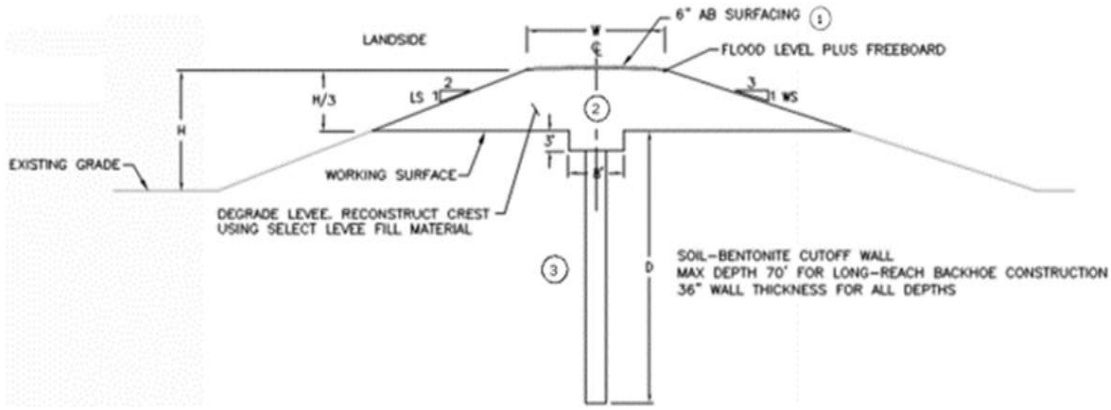
Segment	Reach	Station	Levee Miles	Remediation Alternative 1	Remediation Alternative 2
288/287	J	SACR-R 7794+86 to 8151+33	NA 16, Unit 1 LM 39.54 to 46.35	Drained seepage berm - 105 feet wide and backfilling the landside depression with locally available materials	Cutoff Wall – 102 feet below the half-levee degrade
287	K	SACR-R 8151+33 to 8174+07	NA 16, Unit 1 LM 46.35 to 46.78	Drained seepage berm - 97 feet wide extension to the existing drained stability berm	Cutoff Wall – 30 feet below the half-levee degrade
287	L	SACR-R 8174+07 to 8246+93	NA 16, Unit 1 LM 46.35 to 48.17	Drained seepage berm - 70 feet wide	Cutoff Wall – 76 feet below the half-levee degrade
287	M	SACR-R 8246+93 to 8276+00	NA 16, Unit 1 LM 48.17 to 48.73	Cutoff Wall – 85 feet below the half-levee degrade	Drained seepage berm - with additional explorations for aquifer and blanket layers on landside
287	N	SACR-R 8276+00 to 8337+64	NA 16, Unit 1 LM 48.73 to 49.90	Drained seepage berm - 70 feet wide	Cutoff Wall – 76 feet below the half-levee degrade
287	O	SACR-R 8337+64 to 8352+84	NA 16, Unit 1 LM 49.90 to 50.19	Drained seepage berm - 105 feet wide	Cutoff Wall – 102 feet below the half-levee degrade
100	A	SACR-R 8352+84 to 8400+00	MA 01-Unit 1 LM 0.00 to 0.90	Cutoff Wall – 20 feet below the half-levee degrade	No remediation
100/380	B	SACR-R 8400+00 to 8544+90	MA 01-Unit 1 LM 0.90 to 3.70	Drained stability berm - 15 feet wide	Cutoff Wall – 11 feet below the half-levee degrade

7.2.1 Cutoff Wall

Cutoff walls will mitigate underseepage by providing a seepage barrier within the levee and its foundation. Proposed cutoff walls should extend at least 5 feet into lower permeability strata. Cutoff walls could consist of conventional soil-bentonite (SB) material or if desired, interlocking sheetpiles. Penetrations through the levee would require special consideration if found to be in conflict with the cutoff wall.

For cutoff wall construction, the existing levee crown is degraded 1/3 to 1/2 of the current levee height to create a working platform that provides sufficient space for construction equipment. SB cutoff walls are constructed using an excavator with a long-stick boom capable of digging a trench to a maximum depth of approximately 75 to 85-feet deep. The trench width is typically 3 feet. Bentonite or cement-bentonite slurry is placed in the trench as it is excavated to prevent caving while the backfill material is mixed. The excavated soil is then mixed with the appropriate soil-bentonite (SB) slurry to achieve the required cutoff wall permeability, and then backfilled into the trench. Deep Soil Mixing (DSM) walls are used if the depth of the cutoff wall is greater than 85 feet. After installation of the cutoff wall, the levee is rebuilt to the pre-construction geometry using degraded levee material or imported fine-grained soils that meet requirements for levee fill. A typical SB cutoff wall cross-section is shown as Exhibit 1.

Exhibit 1. Typical SB Cutoff Wall (from URS, 2014c; 2014d)



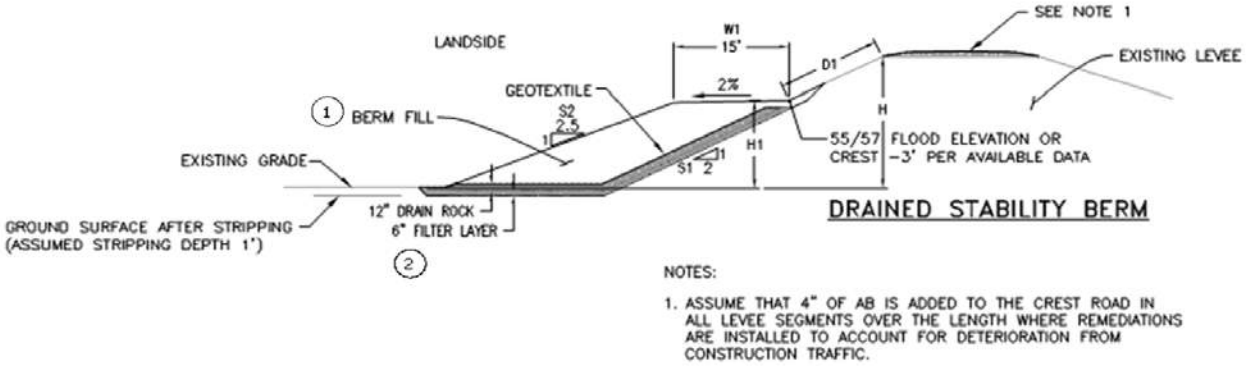
An interlocking sheetpile system could be used in lieu of a SB cutoff wall. The interlocking sheetpile system would be installed through the levee crown with minimal levee degrade. The wall alignment along the levee crown could be trenched 2 to 3 feet to allow driving the top of the sheetpiles below the levee crown and below the all-weather road surface.

7.2.2 Drained Stability Berm

Drained stability berms will mitigate landside slope stability and/or through seepage. In the case of mitigating landside stability, the drained stability berm will provide additional weight at the toe to resist forces that develop along a slip surface. In the case of mitigating through seepage, filter material will retain existing embankment material in

place and allow seepage to safely flow from the embankment. Drained stability berms are constructed by stripping approximately 1 foot of soil from the existing ground surface, placing filter material, placing drain material, and then placing a protected layer of embankment soil. A typical drained stability berm is shown as Exhibit 2. For the purposes of assessing project feasibility, assume that drained stability berms extend a minimum of 40 feet (two times the levee height) beyond the ends of the levee segment needing improvement. The extended improvement area is intended to address end-around effects. The drained seepage berm will discharge captured water at the berm toe and grading to provide positive drainage away from the levee will be required.

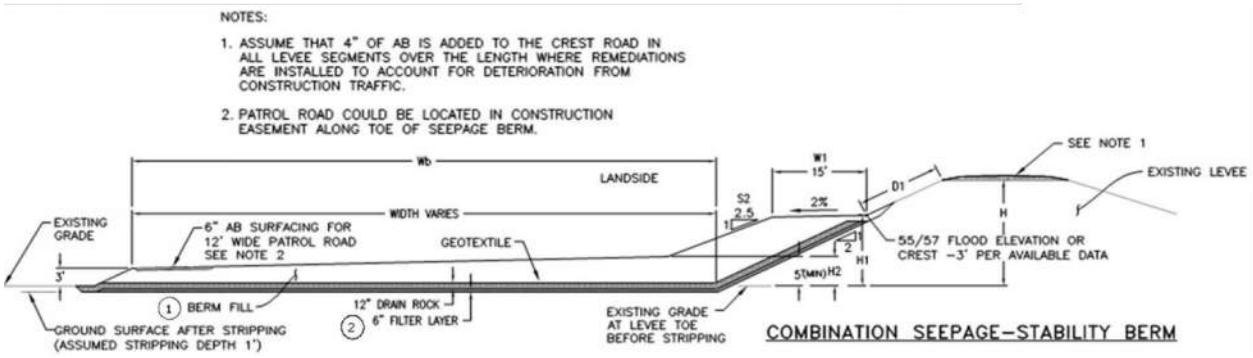
Exhibit 2. Typical Drained Stability Berm (from URS, 2014c; 2014d)



7.2.3 Combined Drained Stability and Seepage Berm

Combined drained stability and seepage berms can be used to remediate underseepage, through seepage, and landside levee embankment slope instability. The berm includes a drainage layer on the foundation and levee landside slope that is comprised of drain rock over a sand filter layer placed on the foundation. A geotextile fabric separates the drain rock from the overlying berm fill. Berms are constructed by stripping approximately 1 foot of soil from the existing ground surface, placing geotextile filter material, placing drain material, and then placing a protected layer of embankment soil. The berm fill should be more pervious than the existing levee and shallow foundation layer. A typical combined drained stability and seepage berm is shown as Exhibit 3. For the purposes of assessing project feasibility, assume that combined drained stability and seepage berms extend a minimum of 40 feet (two times the levee height) beyond the ends of the levee segment needing improvement. The extended improvement area is intended to address end-around effects. The drained seepage berm will discharge captured water at the berm toe and grading to provide positive drainage away from the levee will be required.

Exhibit 3. Typical Combined Drained Stability and Seepage Berm (from URS, 2014c; 2014d)



7.2.4 Erosion Remediation – Rock Slope Revetment

Rock slope revetment can be used to remediate erosion and generally consists of 6 inches of sand bedding overlain by 2 feet of rip-rap. Earthwork should be performed before placing sand bedding to backfill eroded areas and reshape the surface. Rock slope revetment generally extends from the waterside toe to the design WSE.

8 Borrow Area Recommendations

Potential borrow areas for the project were located using the USDA Web Soil Survey (WSS) tool (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx). The WSS tool was used to draw areas of interest adjacent to and near the levee reaches. A soil map was obtained from the WSS tool which delineated various soil types identified within the area of interest. Along with the soil map, a range of engineering properties for each soil unit used for classification was also obtained from the web tool. Comparing the typical engineering properties of each soil unit with the typical engineering properties of levee fill materials, potential borrow areas were identified and marked. Typical specifications of materials that are suitable for use as levee fill are shown in Table 19. Special construction details (e.g., 4:1 slopes) may be substituted where materials meeting the typical levee fill specifications are not readily attainable, but all levee fill materials must be free of organics and materials that cannot be properly compacted (e.g., saturated soils must be dried).

Table 19. Typical levee fill specifications

Specification	Levee Fill	ASTM Test
Percent Passing - 3 inch	100	D6913
Percent Passing - No. 200	≥ 20	D6913
Liquid Limit	≤ 50	D4318
Plasticity Index	≥ 8	D4318

In general, soil units identified as majority lean clay (CL) were selected as potential borrow areas. From these potential borrow areas, the locations closest to the levees were selected and marked. These potential borrow areas are shown in Figure 9 – Potential Borrow Area.

Additional screening for preliminary engineering design will need to evaluate actual soil engineering properties, depth to groundwater, landowner agreement(s), potential haul routes, and permitting requirements (e.g., erosion and sediment control, United States Army Corps of Engineers 404/401, environmental and cultural resources surveys, mining, others).

9 Geotechnical Design-Level Scope Recommendations

This document describes the feasibility level geotechnical assessment of the Colusa study area levees. The following items are recommended to be included in the design level scope:

- Supplemental explorations
  - In the Sacramento River Levee
  - As necessary based on the selected remediation alternative(s) to reduce the flood risk for Colusa
  - In proposed wing levees for design level exploration
- Steady-State Seepage and Stability Analysis
  - Supplemental analyses as necessary based on the selected remediation alternative(s) to reduce the flood risk for Colusa
  - Updated analysis for existing conditions using the additional investigations for Sacramento River Levee
  - Supplemental analyses for proposed wing levees
- Perform detailed design analyses in accordance with regulatory and industry standards for the selected remediation alternatives.
- Update seismic hazard assessment and evaluate liquefaction potential for additional cross sections.
- Evaluate end around seepage if a combination of cutoff wall and drained berm are considered due to site constraints.
- Develop an inventory of encroachments and penetrations.
- Identification and evaluation of the penetrations (majority pipelines) through the study area levees. Each penetration must be relocated above the 100 year WSE or evaluated by a qualified engineer.
- Update erosion site locations for all levees to be improved as part of the Colusa flood risk reduction project.
- Further investigate potential borrow areas for material compliance as embankment fill.

10 Limitations

This report has been prepared for the use of KSN and its consultants for specific application to Flood Risk Reduction Feasibility Study for the City of Colusa in accordance with generally accepted geotechnical engineering practice. No warranty, express or implied, is made. The analyses and recommendations submitted are based on the data available to HDR at the time of this geotechnical investigation. This report does not reflect subsurface soil variations that may occur between the locations of the explorations or variations in groundwater conditions which may occur over a period of time. Variations in conditions may become evident during subsequent studies and construction, at which time re-evaluation of the conclusions may become necessary. Potential remedial measures for the Colusa Flood Risk Reduction Feasibility Study are presented in this report based upon review of investigations and analyses prepared by URS consultants for DWR as part of the NULE program and our professional interpretation of the geotechnical data. Six CPTs and three mud-rotary borings were authorized as part of the grant funding for the feasibility level analyses. Five CPTs and three mud-rotary borings were carried out. Remedial measures have been identified including the preferred measure identified by DWR. Additional evaluations will be required to support the feasibility studies and development of the preliminary remedial design. The evaluations included herein are not suitable for work beyond this feasibility study.

In the event of design changes in the project after the final report is submitted, the recommendations should be reviewed and possibly modified with HDR's participation.

Historical explorations and testing were not performed by HDR and HDR cannot vouch for the accuracy of data and information obtained by others. Data by others should not be relied upon unless the originator of that data is available to confirm its accuracy.

This geotechnical study did not include an investigation regarding the existence, location, or type of possible hazardous materials. If any hazardous materials are encountered during construction of the project, the proper regulatory officials should be notified immediately.

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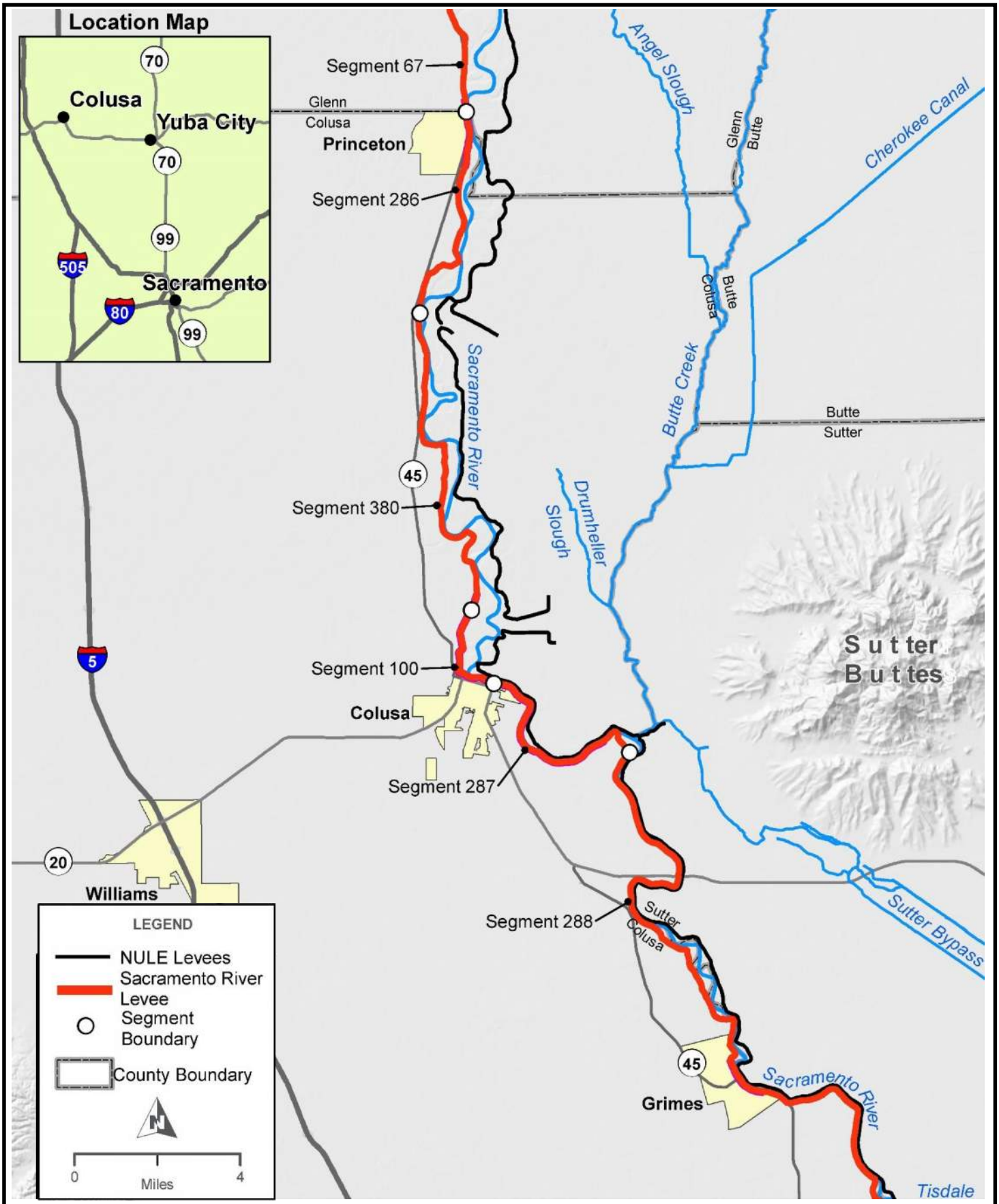
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Figures

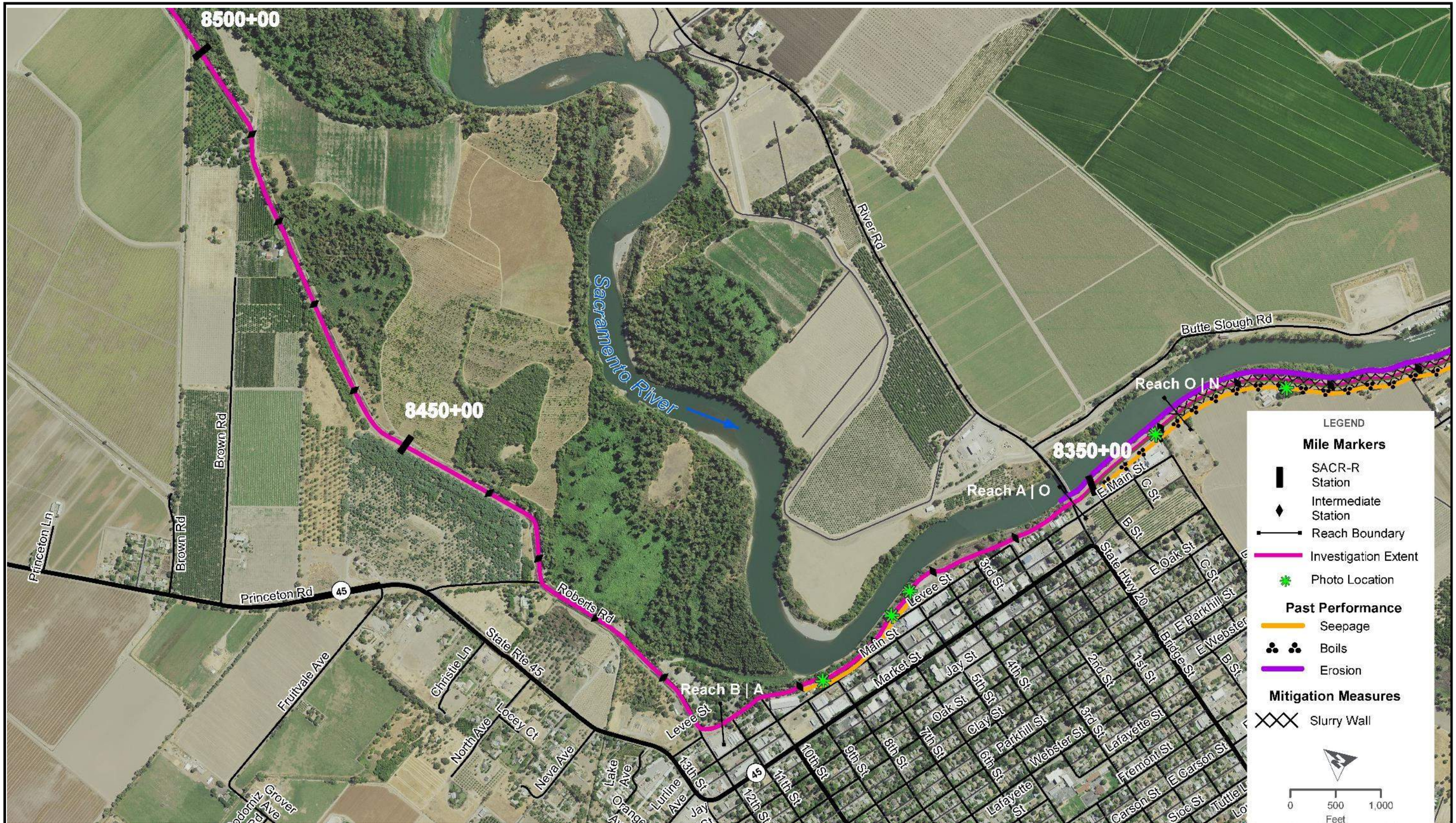


NOTES:

Colusa Flood Risk Reduction Feasibility Study

Location Map

May 2019 FIGURE 1



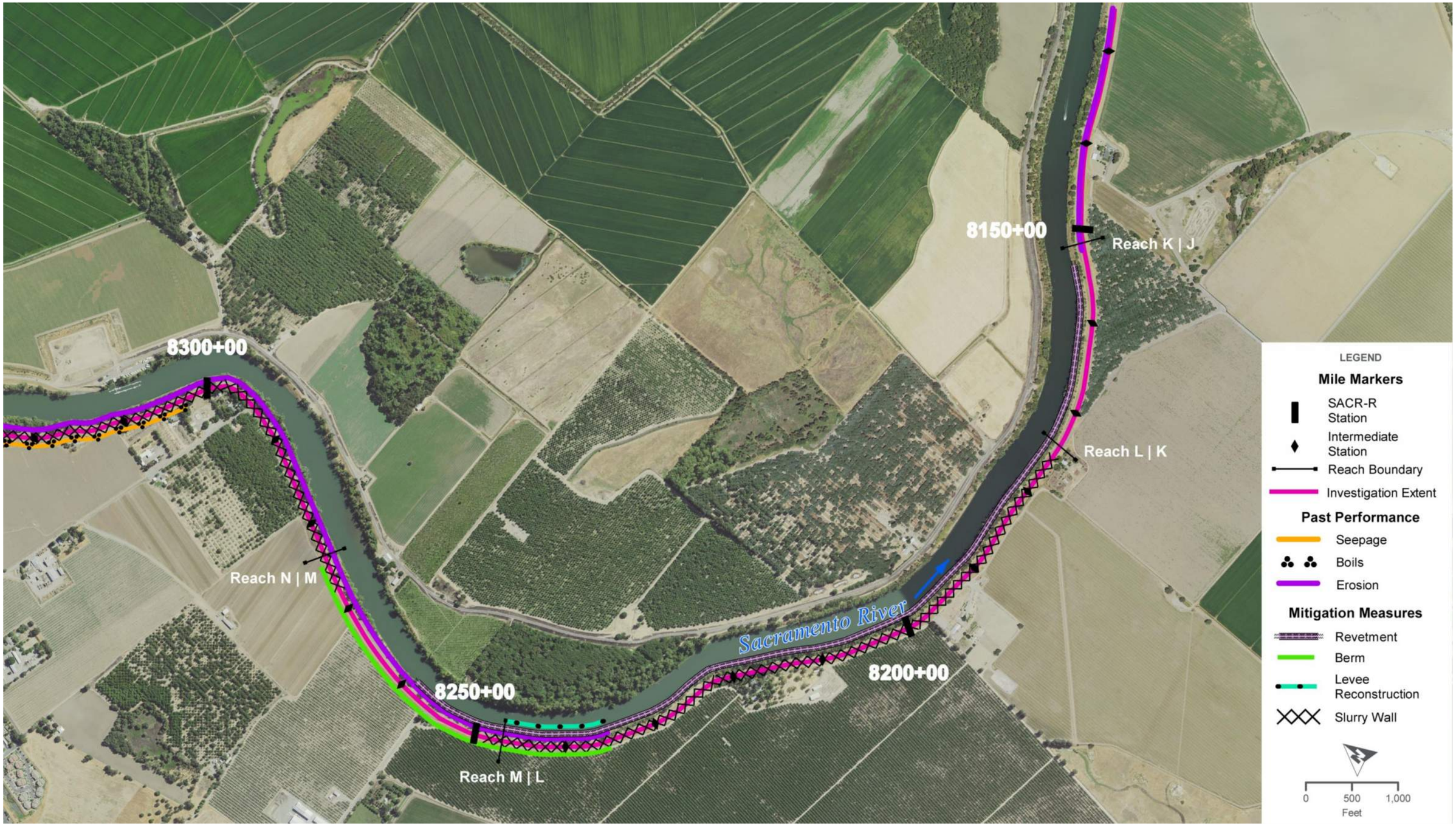
NOTES:

Colusa Flood Risk Reduction Feasibility Study

Summary Map (North Area)

May 2019

FIGURE 2A



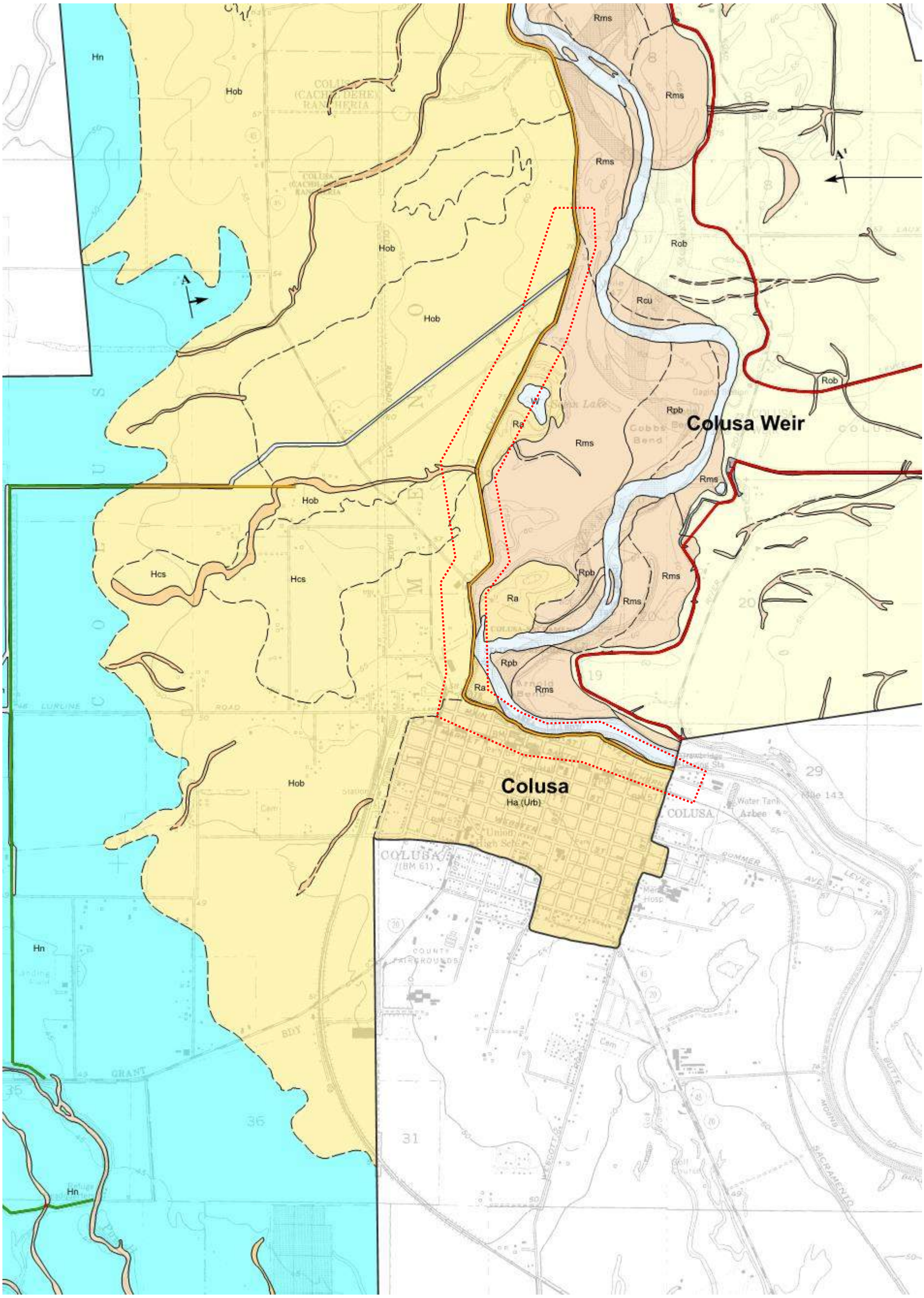
NOTES:

Colusa Flood Risk Reduction Feasibility Study

Summary Map (South Area)

May 2019

FIGURE 2B



Study Area Location

N

NOTES: Source: Non-Urban Levee Evaluation (NULE) (URS, 2012)

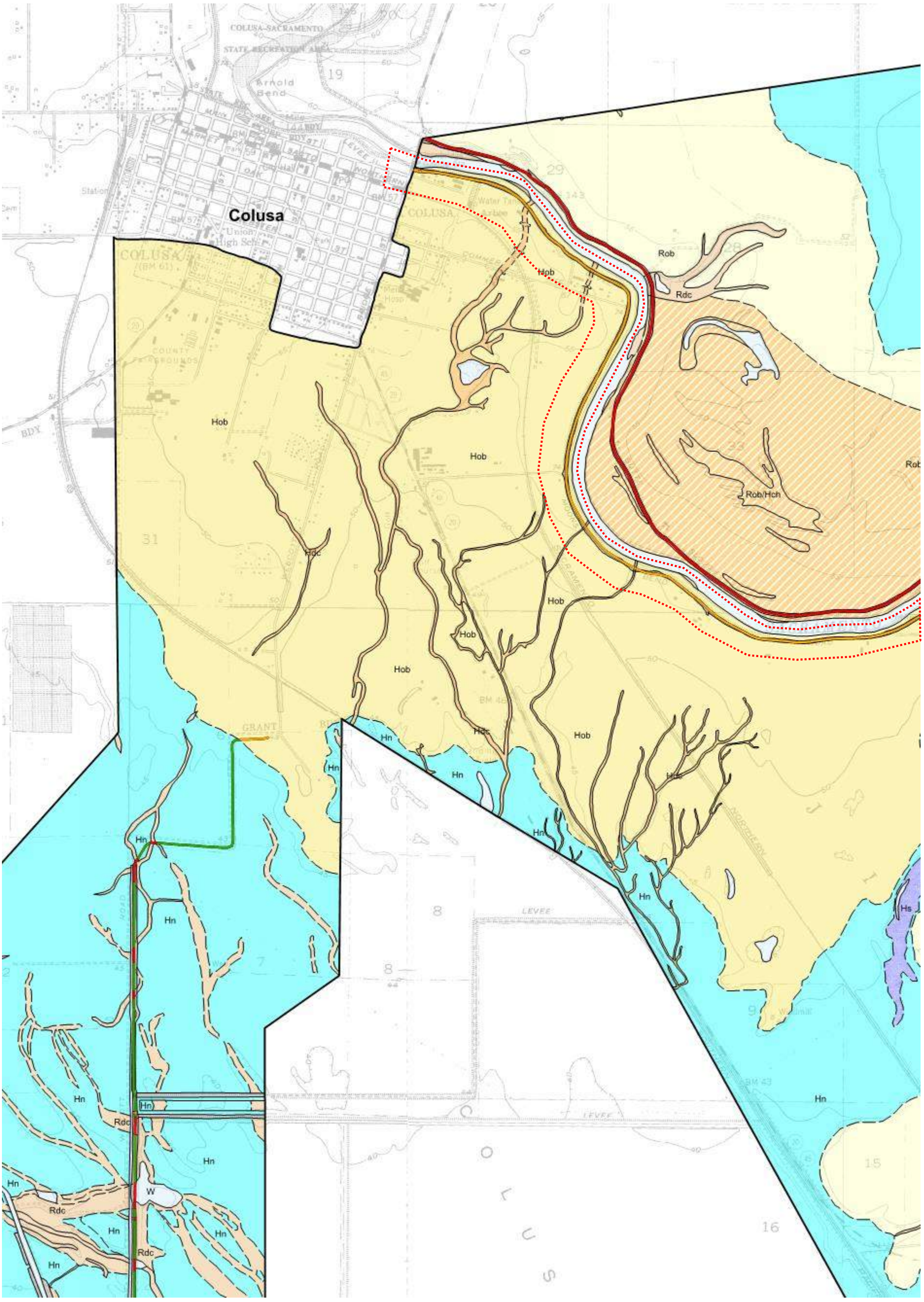
Colusa Flood Risk Reduction Feasibility Study

Scale 1:24,000

Geomorphology Map (North)

May 2019

FIGURE 3A



Study Area Location

N

NOTES: Source: Non-Urban Levee Evaluation (NULE) (URS, 2012)

Colusa Flood Risk Reduction Feasibility Study

Scale 1:24,000

Geomorphology Map (South)

May 2019

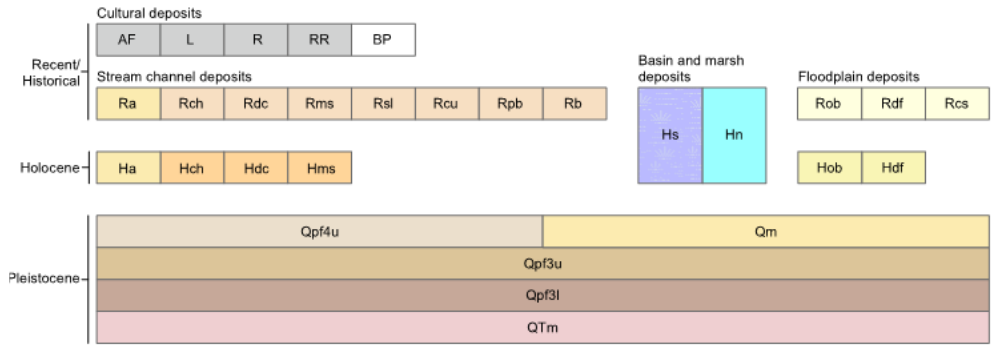
FIGURE 3B

Explanation

Underseepage Susceptibility Along Non-Urban Levee Alignment

Very High | High | Moderate | Low

Stratigraphic Correlation Chart



W	Water, as mapped from 1937 aerial photographs.
W(1904)	Water, as mapped from 1904 topographic map.
C	Canal, as mapped from 1937 aerial photographs and historical topographic maps.
BP	Borrow Pit, as mapped from 1937 aerial photographs.

Geologic Units

HISTORICAL	
L	Levee (made of artificial fill); as mapped from 1937 aerial photographs and historical topographic maps.
R	Road embankment (made of artificial fill); as mapped from 1937 aerial photographs and historical topographic maps.
RR	Railroad embankment (made of artificial fill); as mapped from 1937 aerial photographs and historical topographic maps.
AF	Artificial fill; as mapped from 1937 aerial photographs and historical topographic maps.
Rob	Historical overbank deposits; sand, silt, and clay with trace fine gravel, deposited during high-stage water flow that overtopped channel banks.
Rob/Hob	Veneer of historical overbank deposits (probably less than 5-feet thick), overlying Holocene overbank deposits.
Rob/Hch	Veneer of historical overbank deposits (probably less than 5-feet thick), overlying Holocene channel deposits.
Rob/Hms	Veneer of historical overbank deposits (probably less than 5-feet thick), overlying Holocene meander scroll deposits.
Rob/Hn	Veneer of historical overbank deposits (probably less than 5-feet thick), overlying Holocene basin deposits.
Rcs	Historical crevasse splay deposits; fine to coarse sand, with lenses of gravel; deposited after breaching of natural levees.
Rdf	Historical distributary alluvial fan deposits; sand, silt, and clay.
Rch	Historical channel deposits; well sorted sand and fine gravel.
Rms	Historical channel meander scroll deposits; sand, silt, and clay; from lateral channel migration.
Rb	Historical channel bar deposits; fine gravel, sand, or silt deposited in or along channel margins.
Rpb	Historical point bar deposits; well sorted sand with silt and fine gravel.
Rcu	Historical cut off channel (chute) deposits; occurs on insides of meander bends within the river channel; on flood plain - entrenchment of overflow channels into hydraulic mining debris.
Rdc	Historical distributary channel deposits; sand, silt, clay, and trace gravel; deposited in areas of channelized flow conducting sediment to floodplain.
Rsl	Historical slough deposits; sand, silt, and clay, fining upward; low energy channel deposits.
Ra	Historical alluvial deposits, undifferentiated; sand, silt, and clay with lenses of fine gravel.
Ra/Qpf3u	Veneer of historical alluvial deposits (probably less than 5-feet thick), overlying late Pleistocene alluvial fan deposits.
HOLOCENE	
Hob	Holocene overbank deposits; sand, silt, and clay with trace fine gravel, deposited during high-stage water flow that overtopped channel banks.
Hob/Hn	Veneer of Holocene overbank deposits (probably less than 5-feet thick), overlying Holocene basin deposits.
Hdf	Holocene distributary fan deposits; sand, silt, and clay.
Hch	Holocene channel deposits; sorted sands and silts with trace gravel; fining upward.
Hms	Holocene meander scroll deposits; sand, silt, and clay from lateral channel migration.
Hdc	Holocene distributary channel deposits; sand, silt and clay with trace gravel.
Ha	Holocene aluvial deposits, undifferentiated; sand, silt, and lenses of gravel.
Hn	Holocene basin deposits; silt, clay, and fine sand.
Hn/Qp4fu	Veneer of Holocene basin deposits (probably less than 5-feet thick), overlying late Pleistocene alluvial fan deposits.
Hn/Qm	Veneer of Holocene basin deposits (probably less than 5-feet thick), overlying late Pleistocene Modesto Formation.
Hs	Holocene marsh deposits; silt, clay, sand, and lenses of gravel.
PLEISTOCENE	
Qpf4u	Late Pleistocene alluvial fan deposits; unconsolidated gravel, sand, silt, and clay; generally mapped by Helley and Harwood (1985) as upper Modesto Formation.
Qpf3u	Late Pleistocene alluvial fan deposits; semi-consolidated to consolidated gravel, sand, and silt and minor clay; generally mapped by Helley and Harwood (1985) as upper Riverbank Formation.
Qpf3l	Late Pleistocene alluvial fan deposits; consolidated gravel, sand, silt, and clay, generally capped with a soil with strong duripan horizon; generally mapped by Helley and Harwood (1985) as lower Riverbank Formation.
QTm	Early Pleistocene Tuff Breccia; andesitic and rhyolitic tuffs and breccias, generally mapped by Williams and Curtis (1977) as the middle unit of the Rampart Beds.

NOTES: Source: Non-Urban Levee Evaluation (NULE) (URS, 2012)

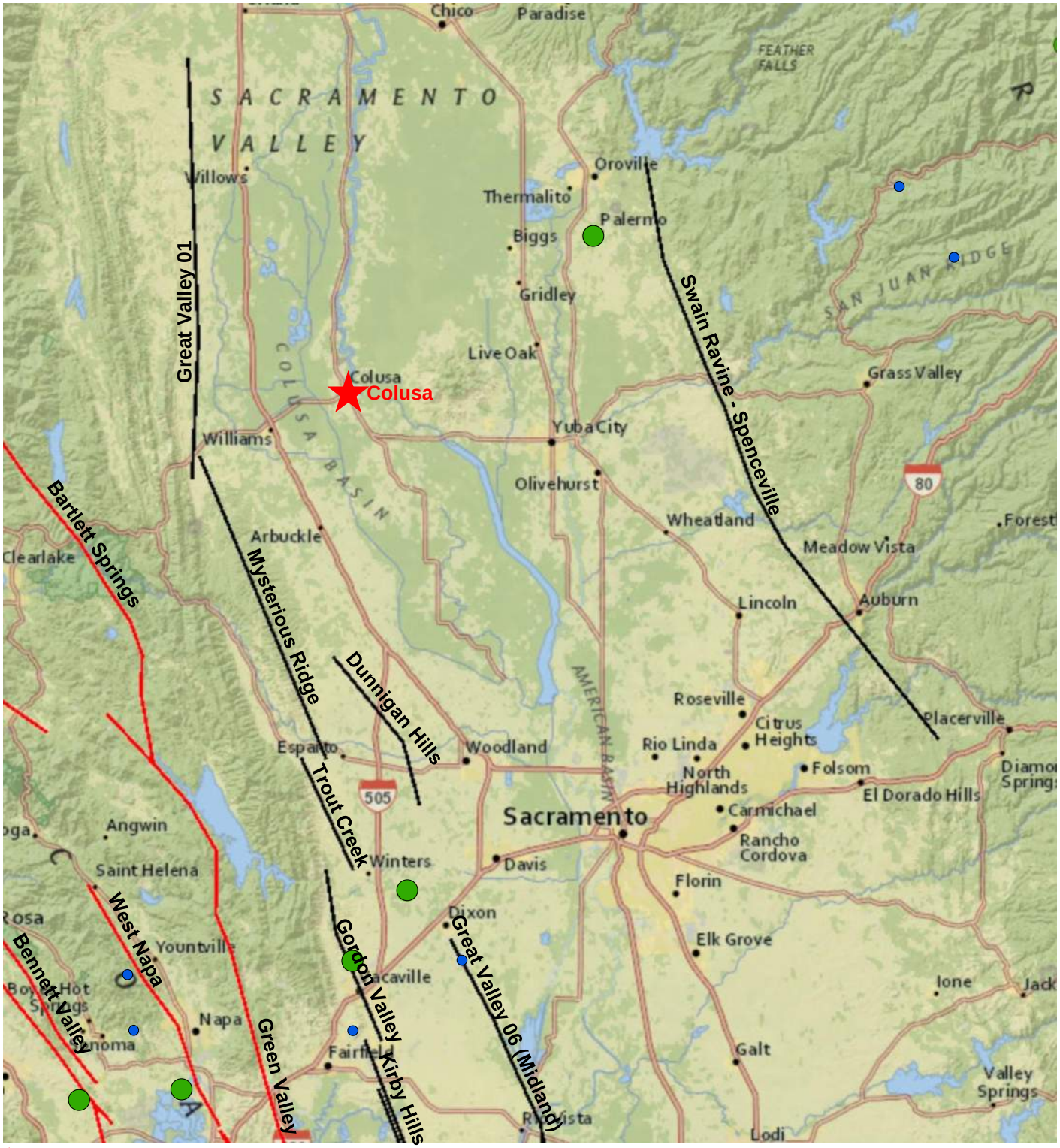
Colusa Flood Risk Reduction Feasibility Study

Scale 1:24,000

Geomorphology Map Units and Symbols

May 2019

FIGURE 3C



Project Location

Historic Earthquake Magnitude 5-6

Historic Earthquake Magnitude 6-7

Thrust Fault

Strike Slip Fault

N

Not to Scale

NOTES:

Colusa Flood Risk Reduction Feasibility Study

Fault Map

May 2019 FIGURE 4



NOTES:

Colusa Flood Risk Reduction Feasibility Study

Encroachment on levee toe at Station 8340+00

May 2019 FIGURE 5A



NOTES:

Colusa Flood Risk Reduction Feasibility Study

Permitted building encroaching on levee embankment Station 8372+00

May 2019 FIGURE 5B



NOTES:

Colusa Flood Risk Reduction Feasibility Study

Retaining wall within levee embankment Station 8375+00

May 2019 FIGURE 5C



NOTES:

Colusa Flood Risk Reduction Feasibility Study

Municipal structures and retaining wall within levee embankment Station 8388+00

May 2019 FIGURE 5D

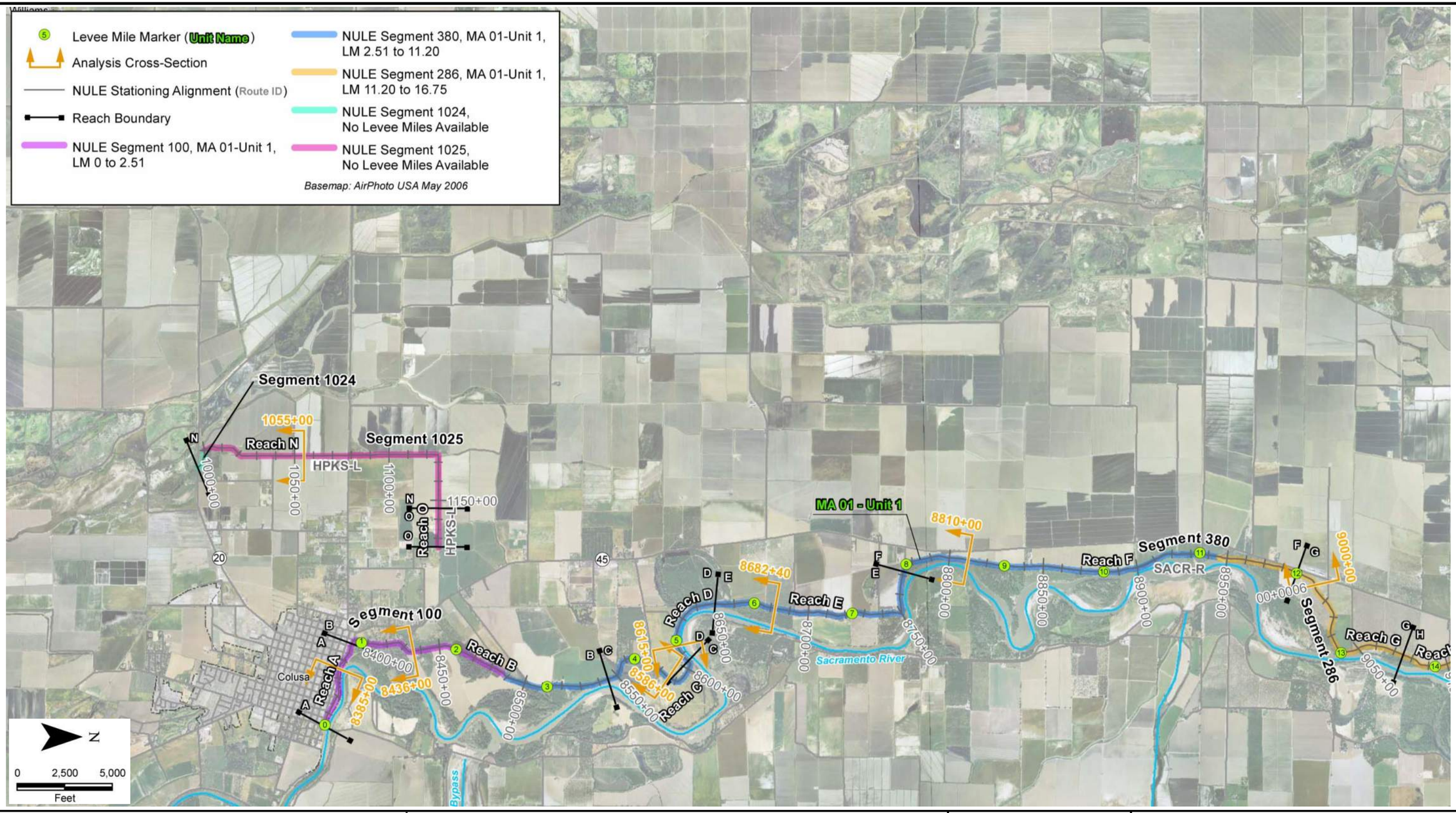


NOTES:

Colusa Flood Risk Reduction Feasibility Study

Evidence of seepage adjacent to levee toe Station 8325+00

May 2019 FIGURE 5E

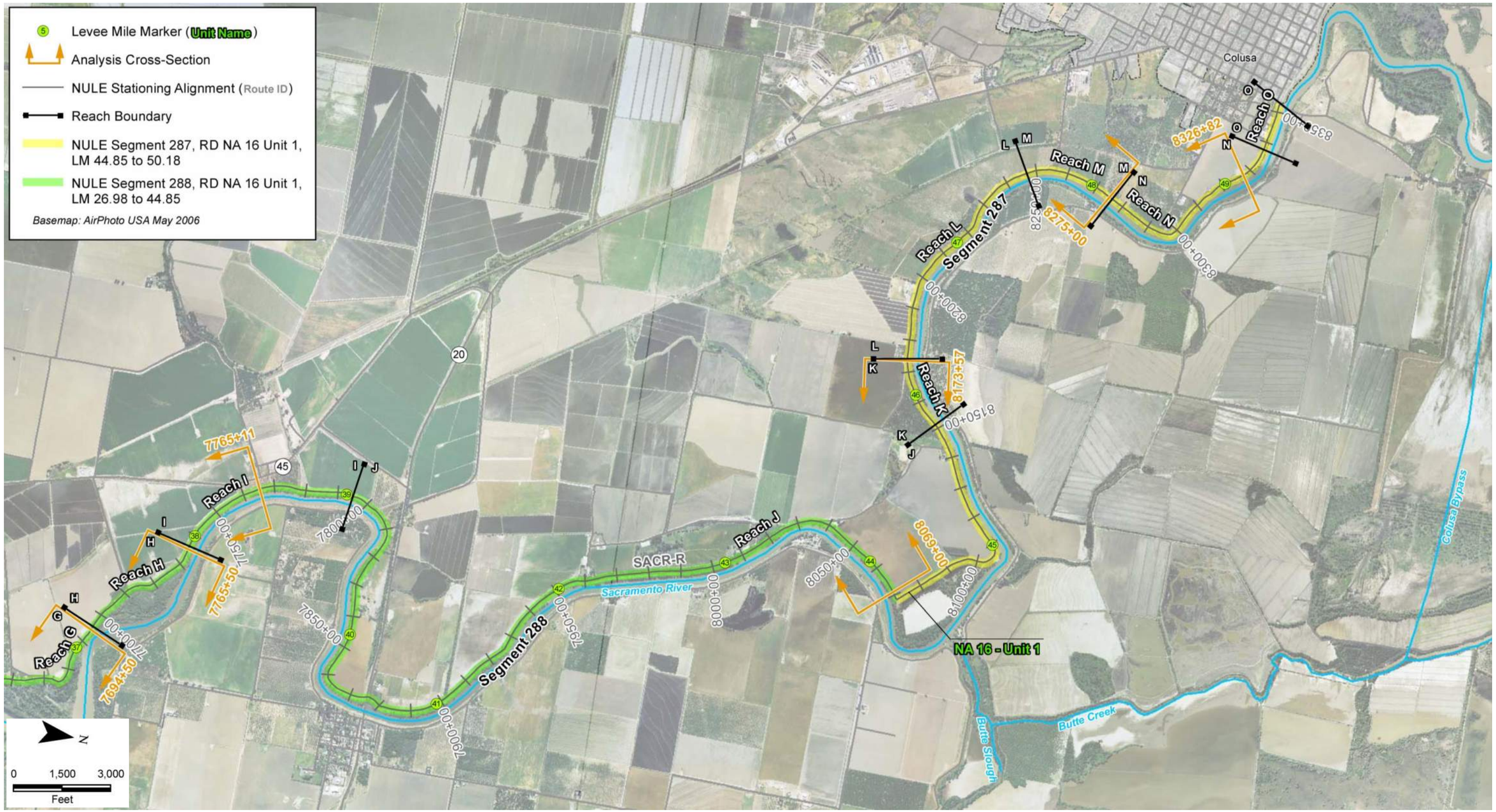


NOTES: Source: Non Urban Levee Evaluation (NULE) (URS, 2014)

Colusa Flood Risk Reduction Feasibility Study

Reach Summary
Colusa North

May 2019 FIGURE 6A

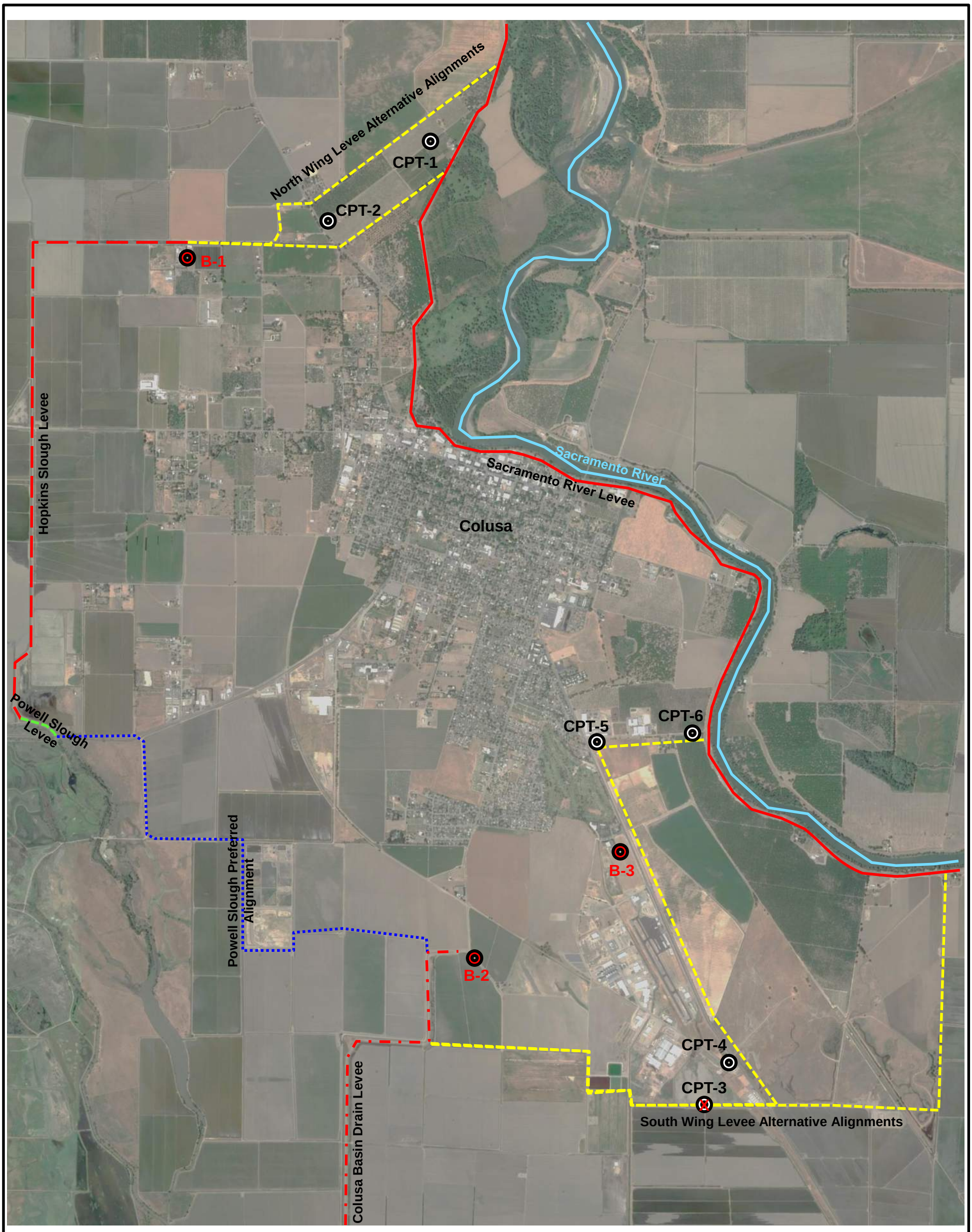


NOTES: Source: Non Urban Levee Evaluation (NULE) (URS, 2014)

Colusa Flood Risk Reduction Feasibility Study

Reach Summary
Colusa South

May 2019 FIGURE 6B



Boring Location

CPT Location

Proposed CPT not carried out

Sacramento River Levee

Wing Levee Alternative Alignment

Hopkins Slough Levee

Powell Slough Levee

Powell Slough Preferred Levee Alignment

Colusa Basin Drain Levee

N

0 2500 Feet

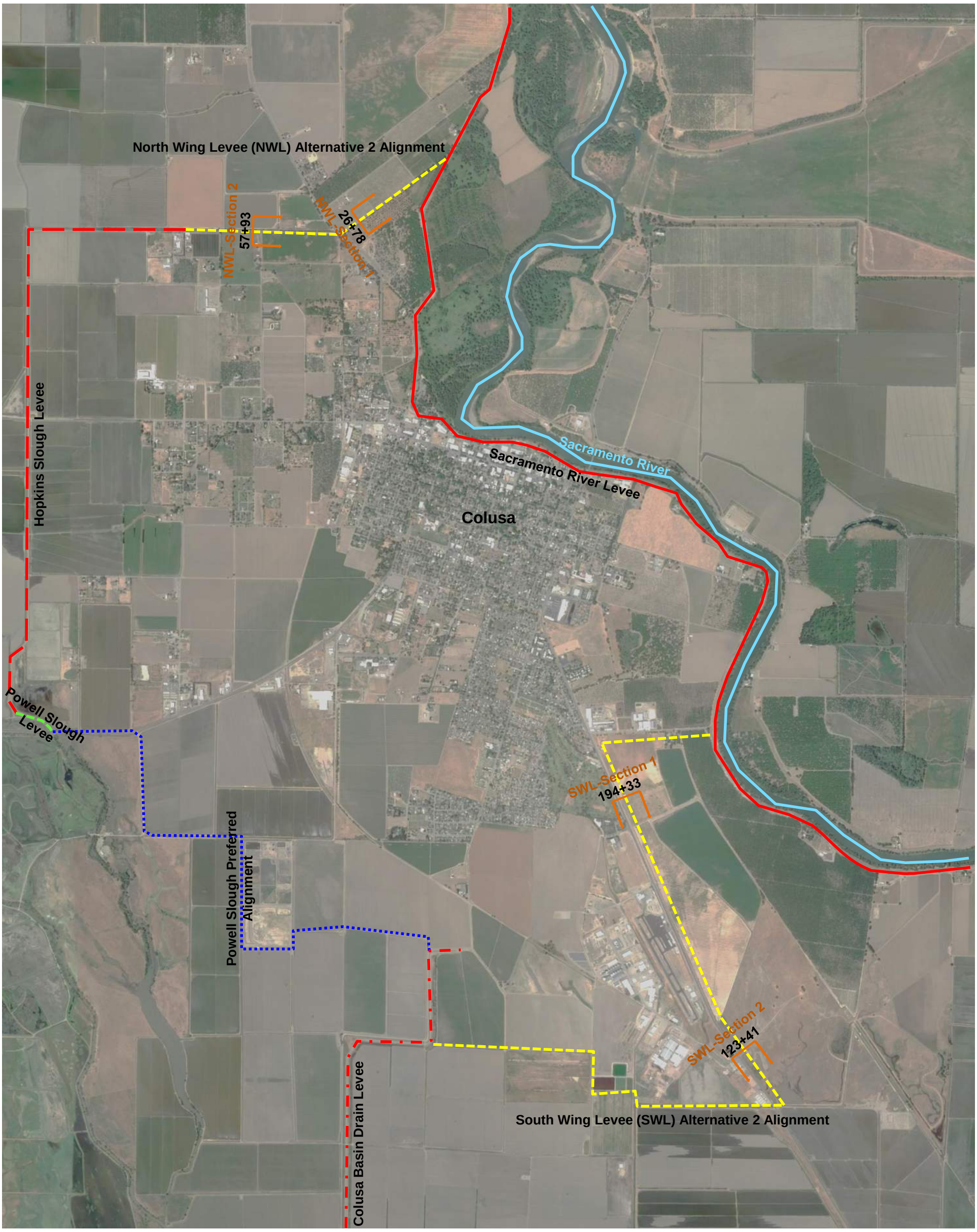
NOTES:

Image Source: Google Earth Pro 2019

Colusa Flood Risk Reduction Feasibility Study

Exploration Plan for Wing Levee Alignment

May 2019 FIGURE 7



0+00 Analysis Cross-section (Stationing)

Sacramento River Levee

Hopkins Slough Levee

Powell Slough Levee

Powell Slough Preferred Levee Alignment

Colusa Basin Drain Levee

Wing Levee Alternative Alignment

N

0 2500 Feet

NOTES:

Image Source: Google Earth Pro 2019

Colusa Flood Risk Reduction Feasibility Study

Wing Levee Analysis Cross-section – Alignment 2

May 2019 FIGURE 8

Map Unit Legend	
Map Unit Symbol	**Map Unit Name**
104	Willows silty clay, 0 to 1 percent slopes, frequently flooded
106	Willows silty clay, 0 to 1 percent slopes
107	Scribner silt loam, 0 to 1 percent slopes, occasionally flooded
108	Scribner silt loam, 0 to 1 percent slopes
109	Scribner silt loam, 0 to 1 percent slopes, frequently flooded
124	Moonbend silt loam, 0 to 2 percent slopes, occasionally flooded
125	Moonbend silt loam, 0 to 2 percent slopes
126	Moonbend silt loam, 0 to 2 percent slopes, frequently flooded
130	Corbiere silt loam, 0 to 1 percent slopes
131	Corbiere silt loam, 0 to 2 percent slopes, frequently flooded
136	Colusa loam, 0 to 2 percent slopes
160	Grandbend loam, 0 to 2 percent slopes
170	Vina loam, 0 to 2 percent slopes, frequently flooded
171	Vina loam, silt loam substratum, 0 to 2 percent slopes, MLRA 17
175	Tujunga loam, overwash, 0 to 2 percent slopes, frequently flooded
185	Riverwash
652	Water

Map Units selected for borrow are highlighted in table

Legend

- Recommended Potential Borrow Area
- Sacramento River Levee
- Proposed Wing Levee Alignment
- Hopkins Slough Levee
- Powell Slough Levee
- Powell Slough Preferred Alignment
- Colusa Basin Drain Levee

0 2000 4000 8000 12000 Feet

N

NOTES: Source: USDA Web Soil Survey

Colusa Flood Risk Reduction Feasibility Study

Potential Borrow Area

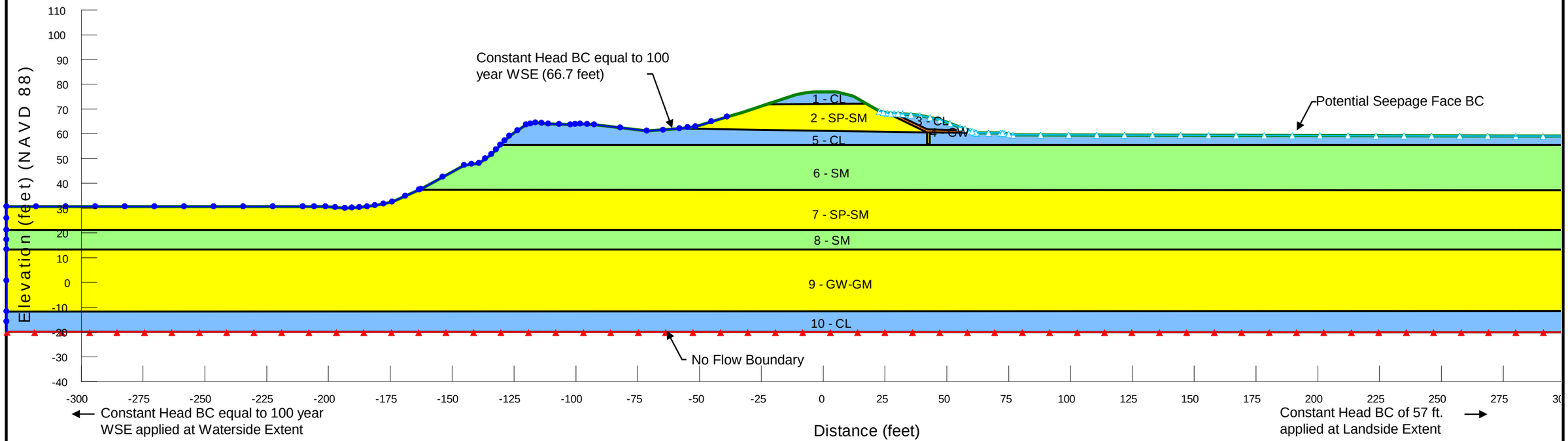
May 2019

FIGURE 9

Attachment B – Seepage Analysis

Reach M Station SACR-R 8275+00

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**CL**	0.034	1.0E-5	0.25
2	**SP-SM**	22.680	8.0E-3	0.25
3	**CL**	0.034	1.0E-5	0.25
4	**GW**	230.000	8.0E-2	1
5	**CL**	0.011	4.0E-6	0.25
6	**SM**	5.670	2.0E-3	0.25
7	**SP-SM**	22.680	8.0E-3	0.25
8	**SM**	5.670	2.0E-3	0.25
9	**GW-GM**	113.390	4.0E-2	0.25
10	**CL**	0.011	4.0E-6	0.25



NOTES:

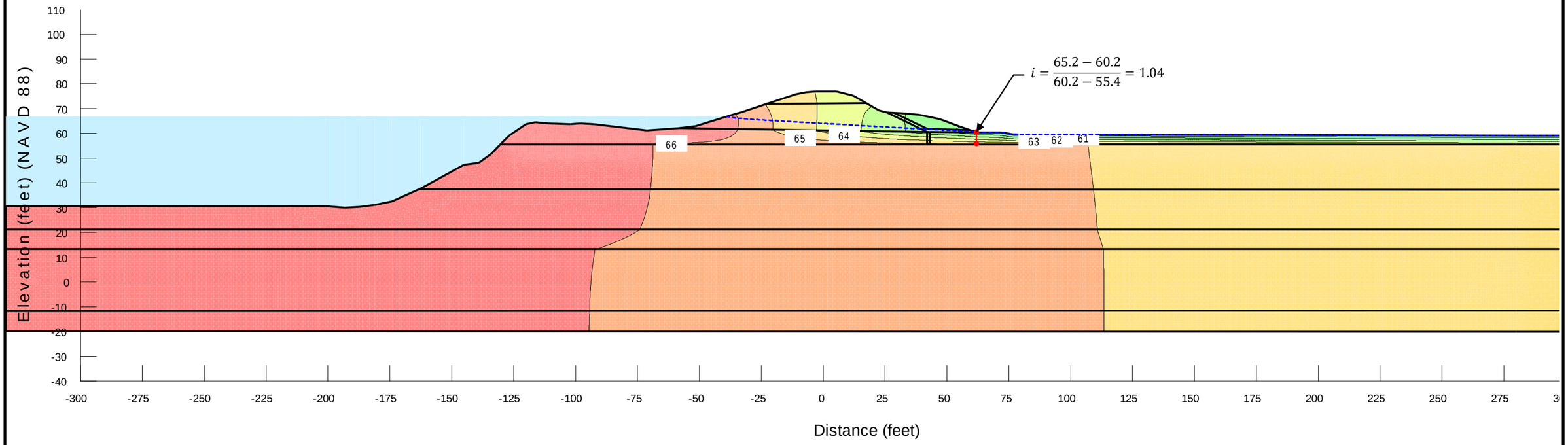
Colusa Flood Risk Reduction Feasibility Study

Reach M Seepage Model
100 year WSE

May 2019 FIGURE B1

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

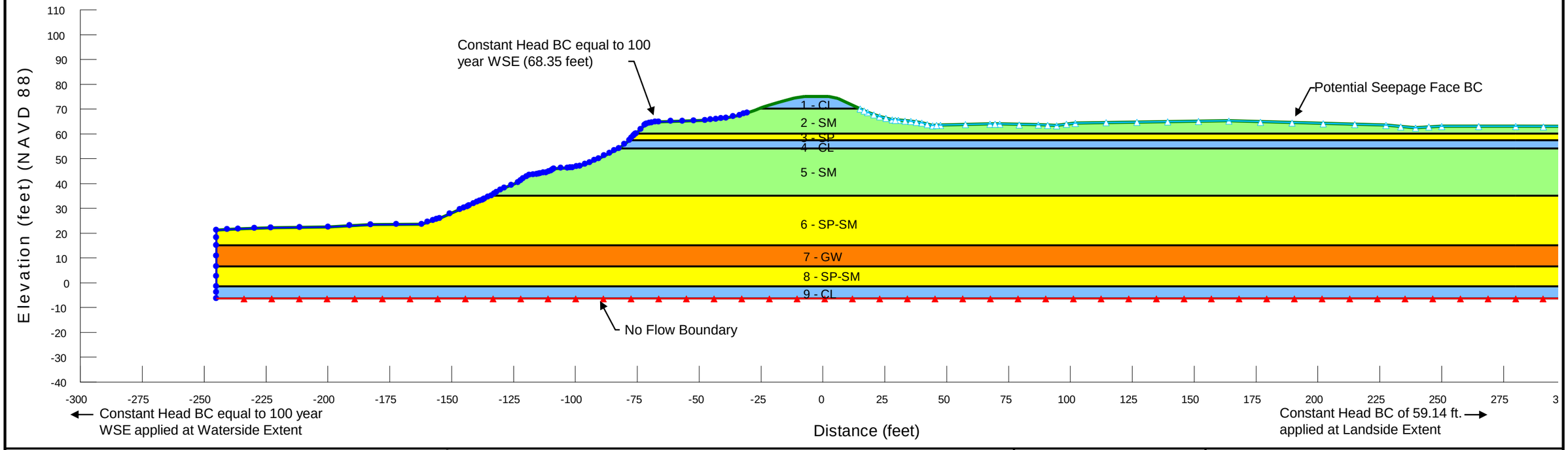
Reach M Seepage Result
100 year WSE

May 2019

FIGURE B2

Reach O Station SACR-R 8345+00

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**CL**	0.034	1.0E-5	0.25
2	**SM**	0.340	1.0E-4	0.25
3	**SP**	28.350	1.0E-2	1
4	**CL**	0.011	4.0E-6	0.25
5	**SM**	0.340	1.0E-4	0.25
6	**SP-SM**	22.680	8.0E-3	0.25
7	**GW**	113.390	4.0E-2	1
8	**SP-SM**	22.680	8.0E-3	0.25
9	**CL**	0.011	4.0E-6	0.25



NOTES:

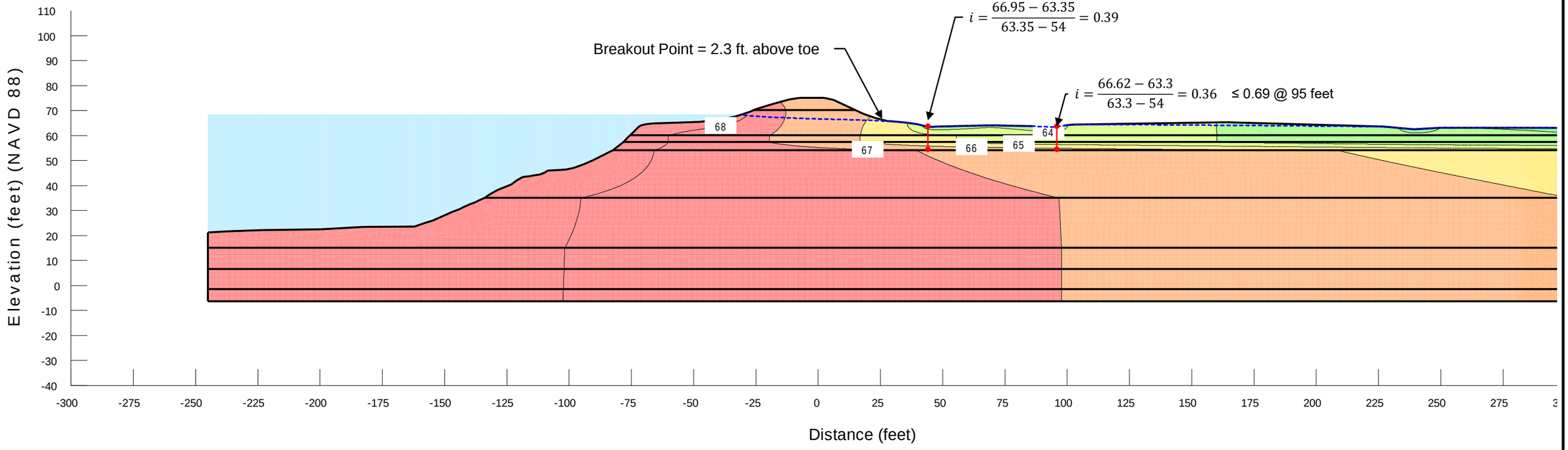
Colusa Flood Risk Reduction Feasibility Study

Reach O Seepage Model
100 year WSE

May 2019 FIGURE B3

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

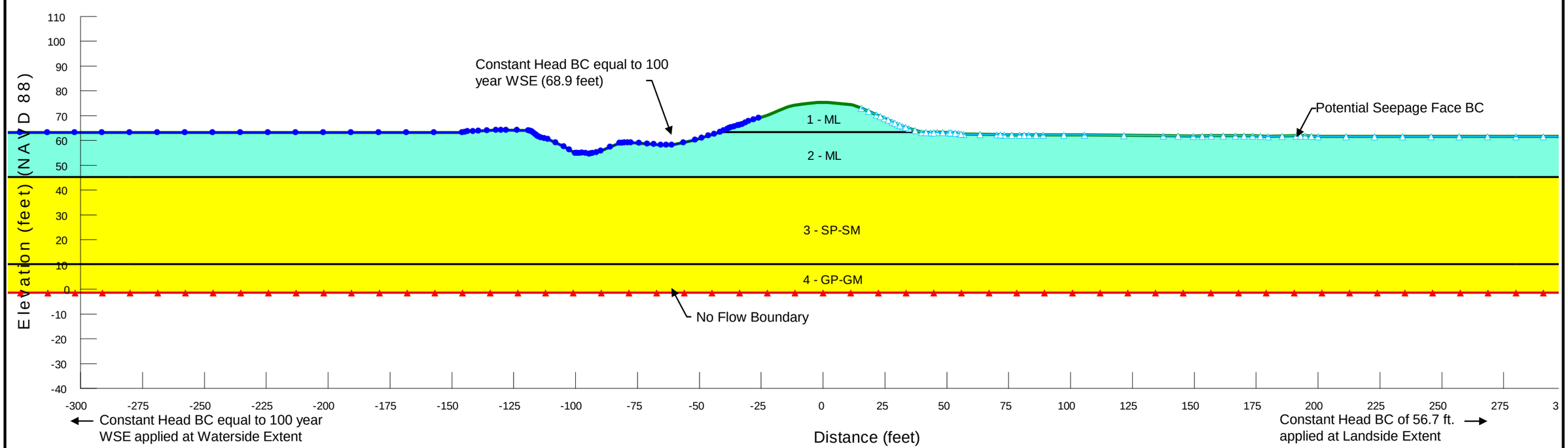
Reach O Seepage Result
100 year WSE

May 2019

FIGURE B4

Reach B Station SACR-R 8436+00

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**ML**	0.085	3.0E-5	0.25
2	**ML**	0.028	1.0E-5	0.25
3	**SP-SM**	28.350	1.0E-2	0.25
4	**GP-GM**	56.690	2.0E-2	0.25



NOTES:

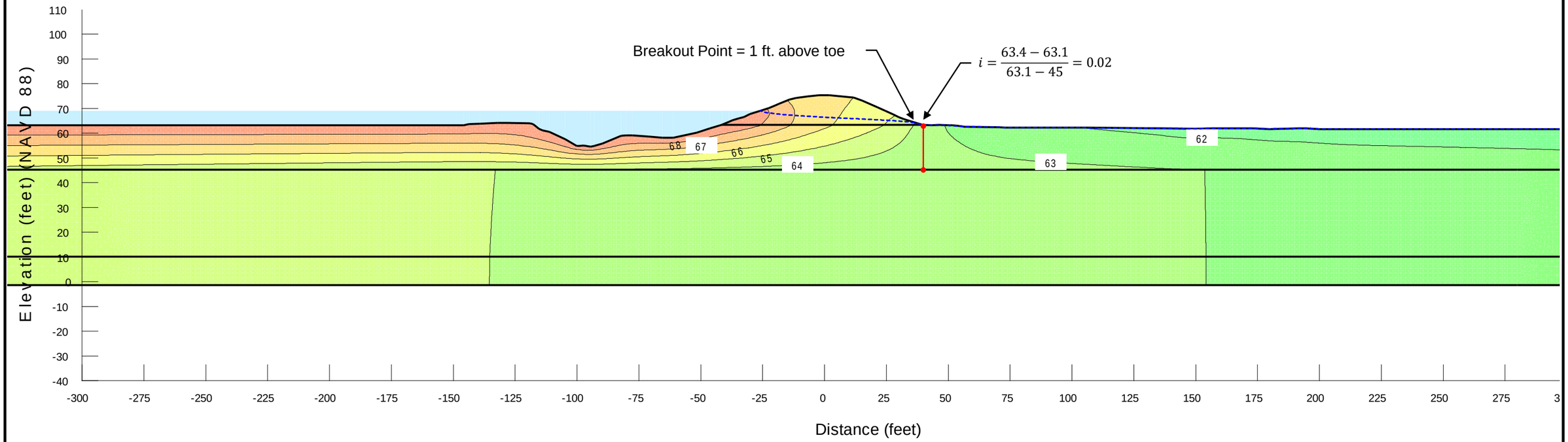
Colusa Flood Risk Reduction Feasibility Study

Reach B Seepage Model
100 year WSE

May 2019 FIGURE B5

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

Reach B Seepage Result
100 year WSE

May 2019

FIGURE B6

Attachment C – Seepage Interpolation

Figures used for interpolation for Reaches K, M, N from: URS (2014b). Geotechnical Overview Report, Volume 1, Existing Conditions, Colusa South Study Area, Levee Segments 158, 287, and 288. August 2014.

Figures used for interpolation for Reaches A and B from: URS (2014a). Geotechnical Overview Report, Volume 1, Existing Conditions, Colusa North Study Area, Levee Segments 65, 67, 100, 286, 380, 1024, and 1025. July 2014.

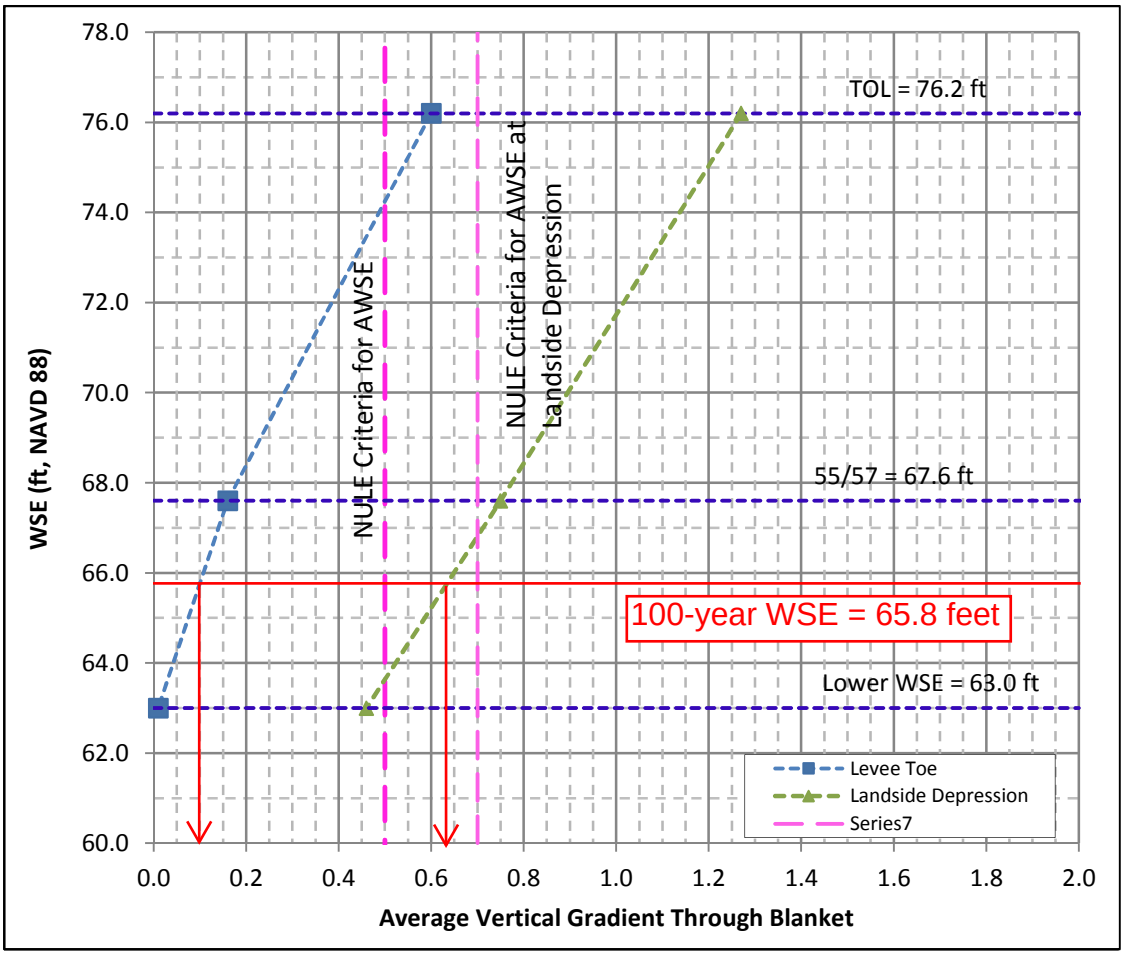


Figure D-K-1: *Reach K Seepage Analysis Results Summary*

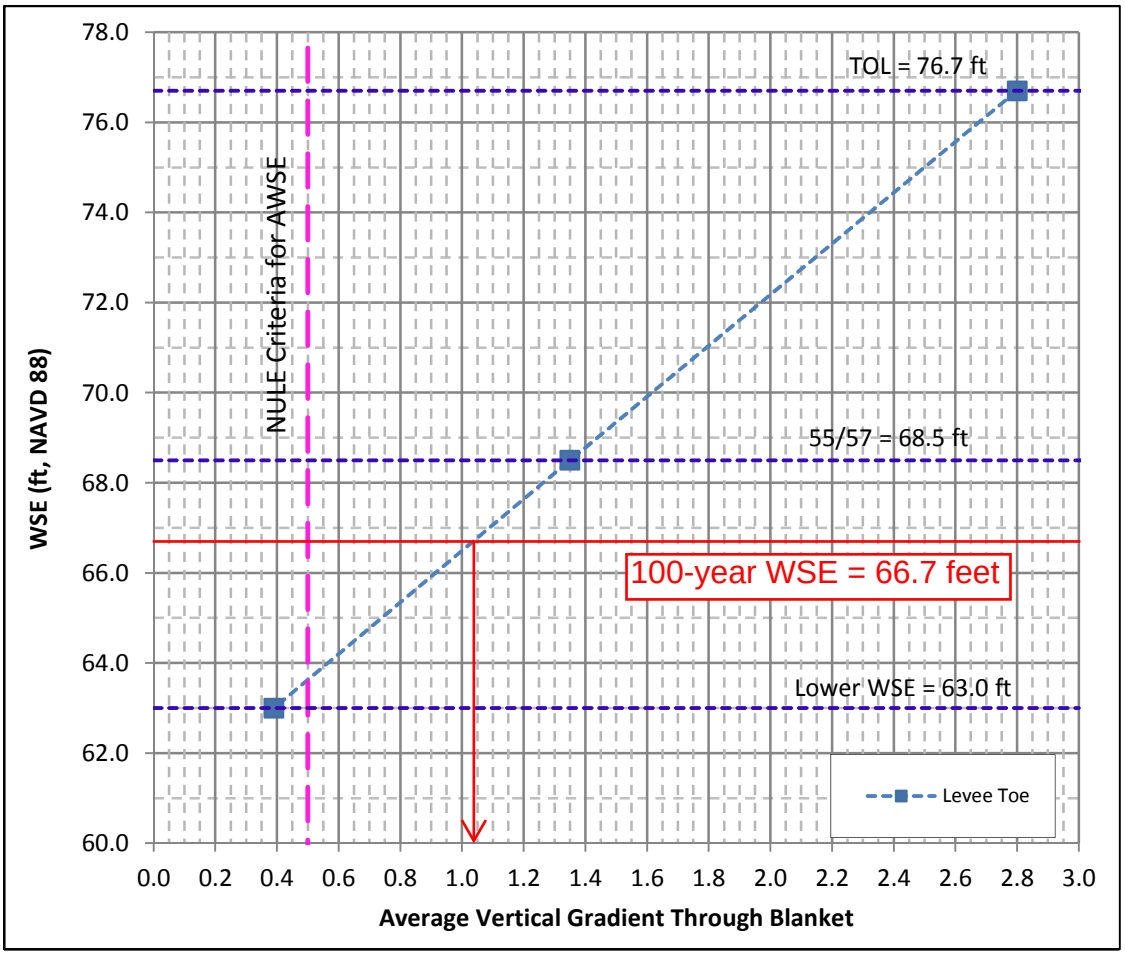


Figure D-M-1: *Reach M Seepage Analysis Results Summary*

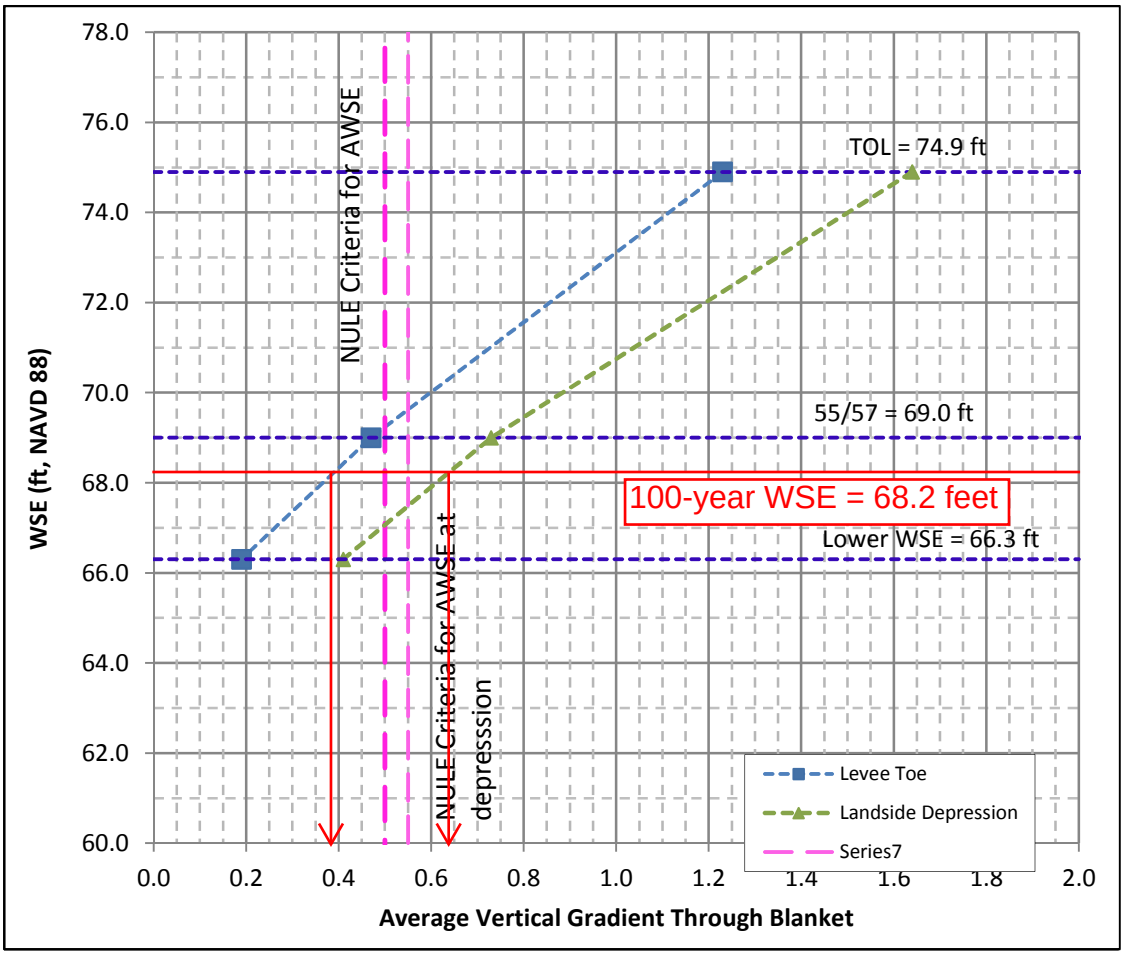


Figure D-N-1: *Reach N Seepage Analysis Results Summary*

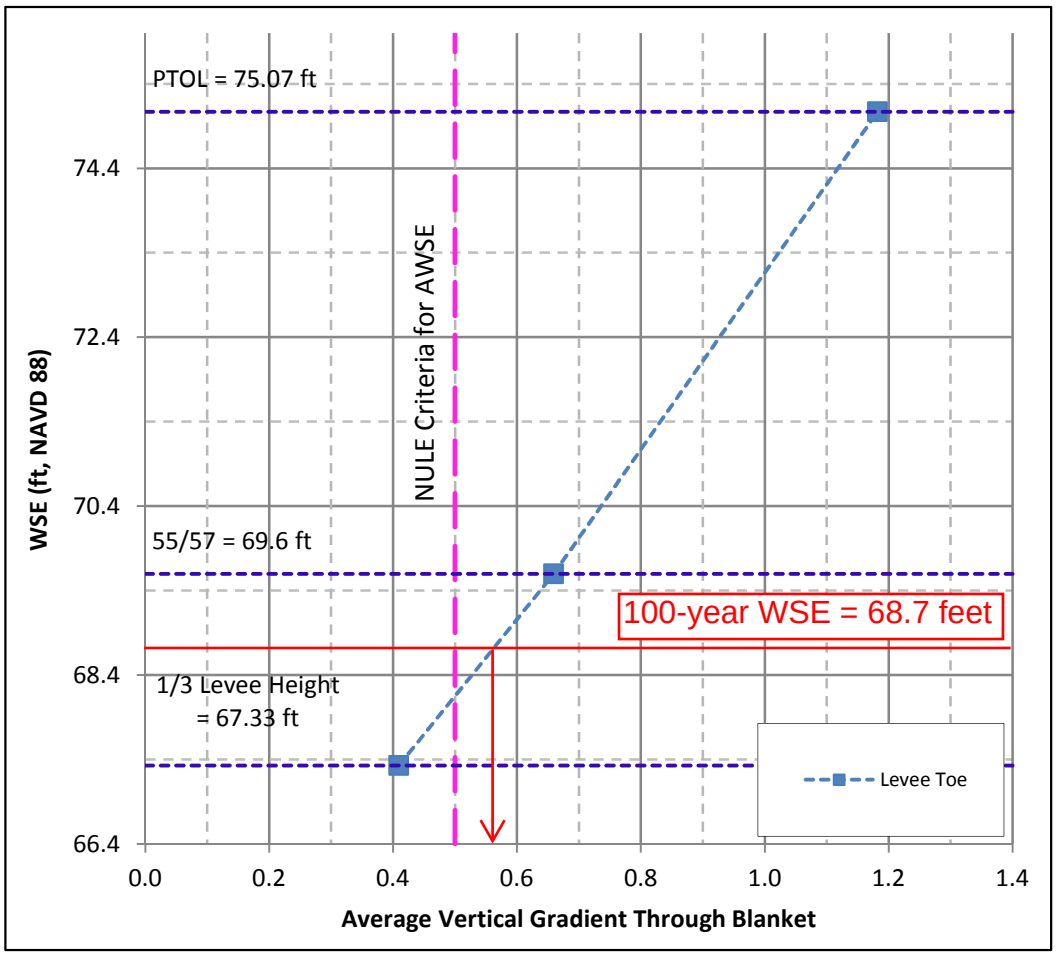


Figure D-A-1: *Reach A Seepage Analysis Results Summary*

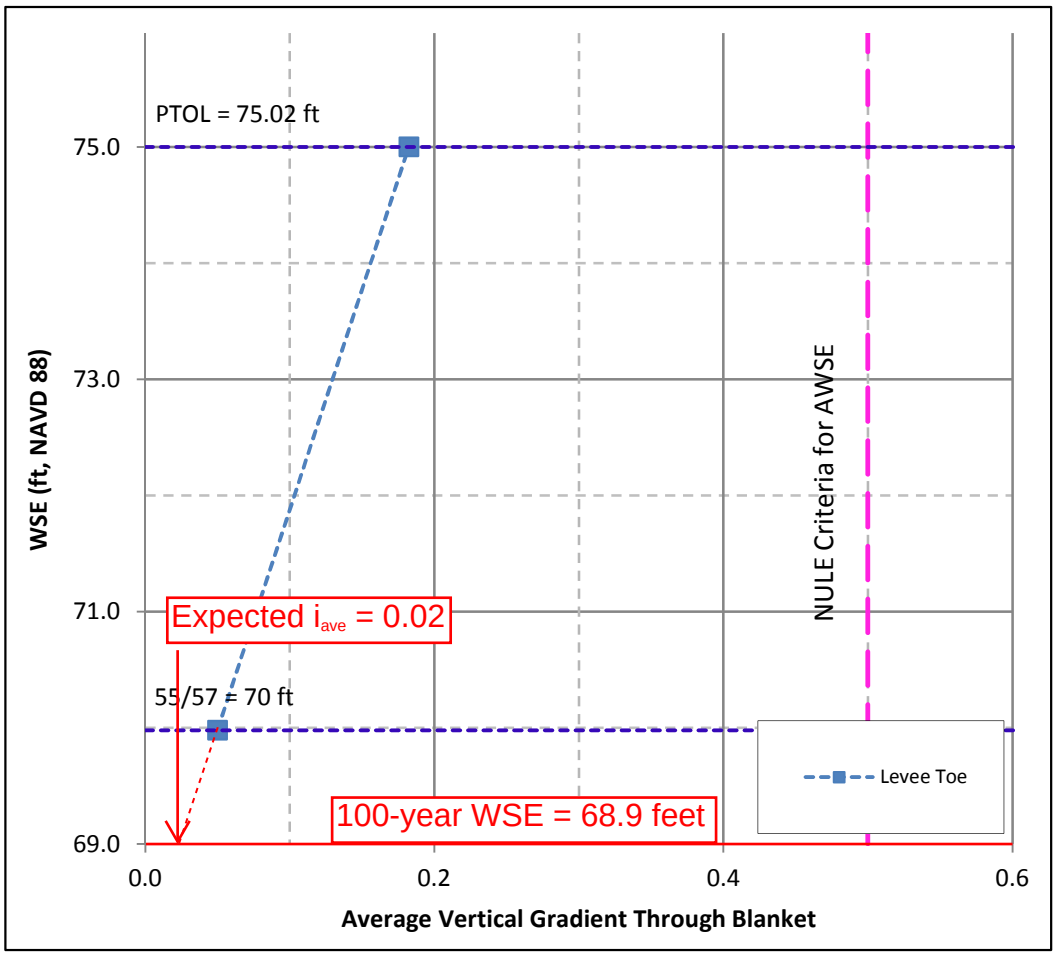


Figure D-B-1: *Reach B Seepage Analysis Results Summary*

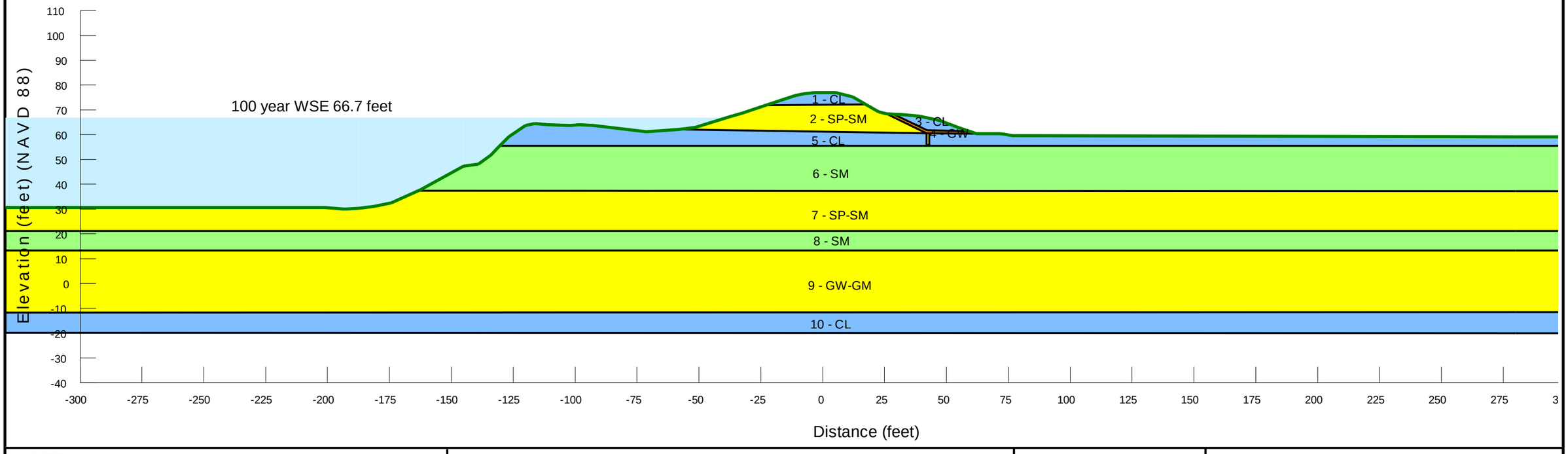
Attachment D – Stability Analysis

Reach M Station SACR-R 8275+00

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**CL**	120	75	29	90	1
2	**SP-SM**	130	0	32	-	-
3	**CL**	120	75	29	90	1
4	**GW**	130	0	35	-	-
5	**CL**	120	75	29	360	4
6	**SM**	130	0	32	-	-
7	**SP-SM**	130	0	33	-	-
8	**SM**	130	0	32	-	-
9	**GW-GM**	130	0	33	-	-
10	**CL**	120	100	30	360	4

Waterside

Landside



NOTES:

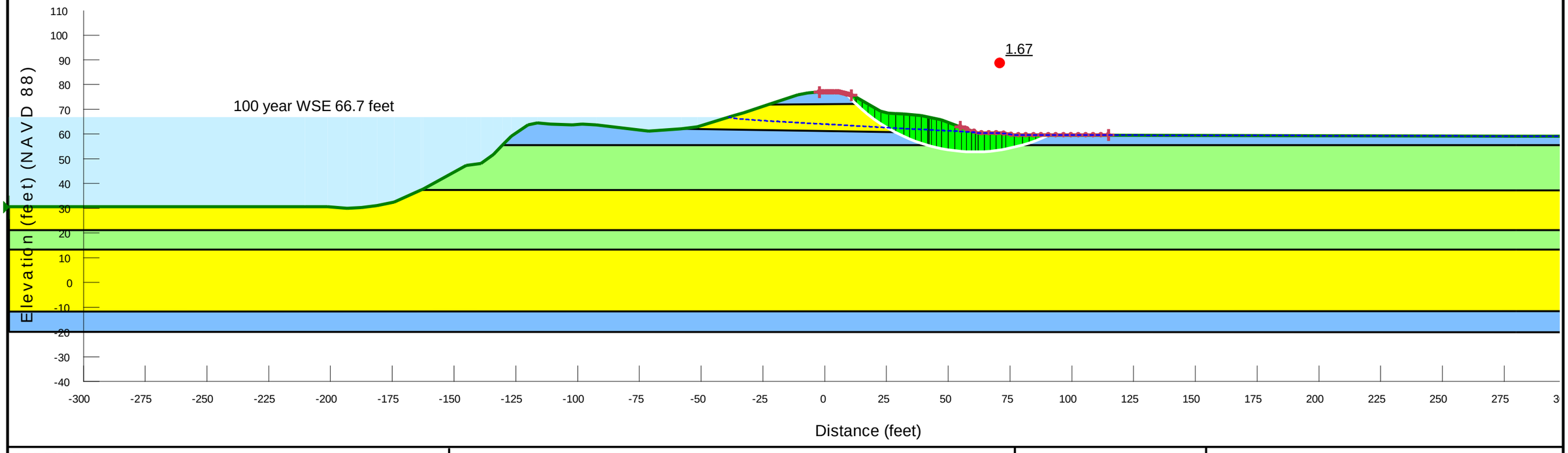
Colusa Flood Risk Reduction Feasibility Study

Reach M Slope Stability Model

May 2019 FIGURE D1

Waterside

Landside

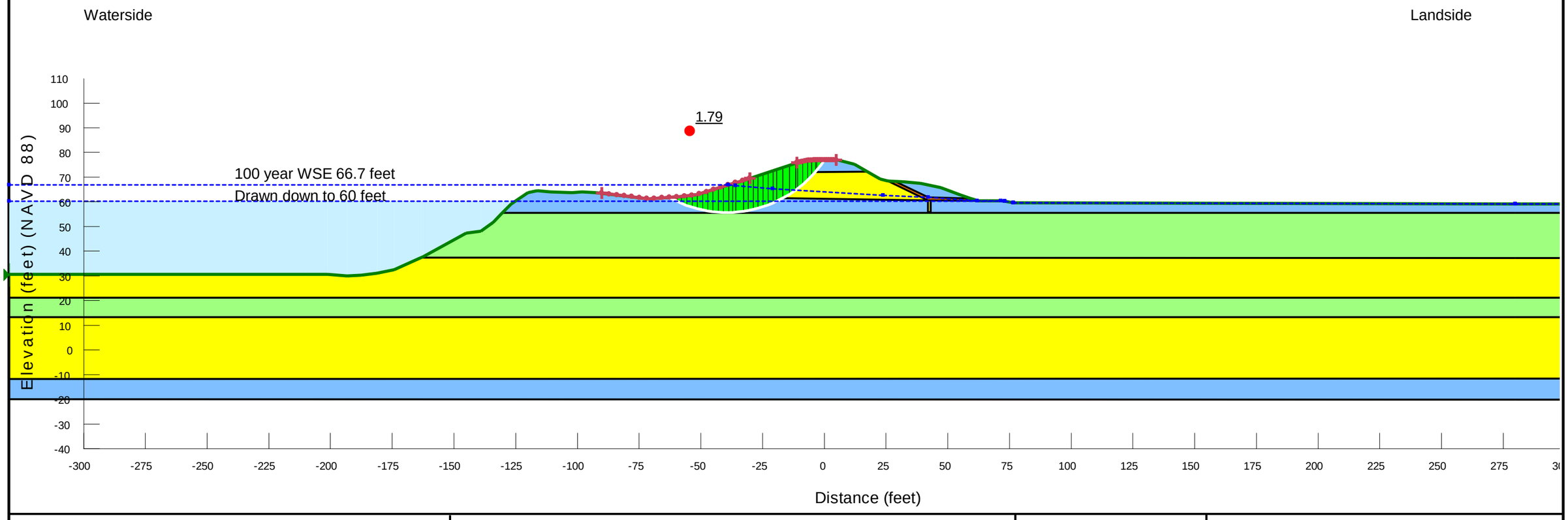


NOTES:

Colusa Flood Risk Reduction Feasibility Study

Reach M Slope Stability Result
Steady State Landside
100 year WSE

May 2019 FIGURE D2



NOTES:

Colusa Flood Risk Reduction Feasibility Study

Reach M Slope Stability Result
Waterside RDD 100 year WSE

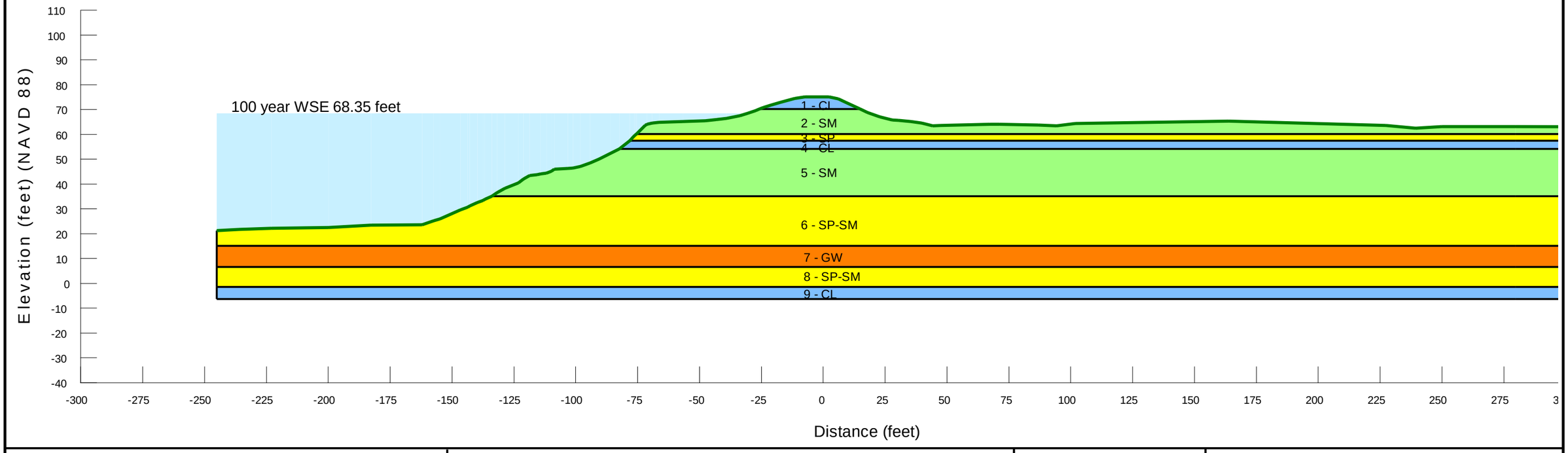
May 2019 FIGURE D3

Reach O Station SACR-R 8345+00

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**CL**	120	75	29	530	5
2	**SM**	130	0	33	-	-
3	**SP**	130	0	35	-	-
4	**CL**	120	100	30	960	7
5	**SM**	130	0	33	-	-
6	**SP-SM**	130	0	32	-	-
7	**GW**	135	0	35	-	-
8	**SP-SM**	130	0	32	-	-
9	**CL**	120	100	30	960	7

Waterside

Landside



NOTES:

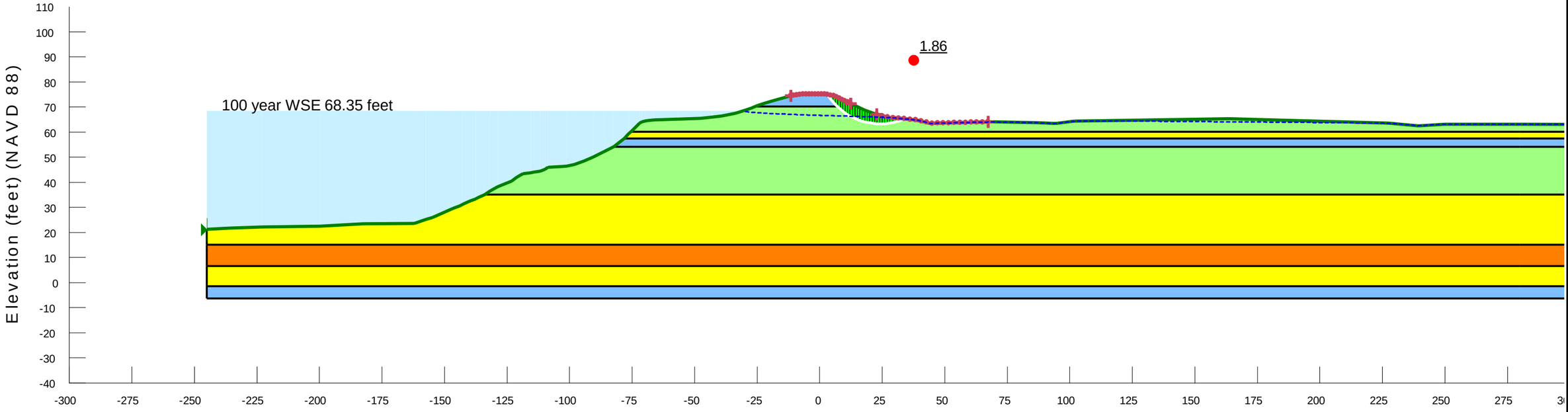
Colusa Flood Risk Reduction Feasibility Study

Reach O Slope Stability Model

May 2019 FIGURE D4

Waterside

Landside



NOTES:

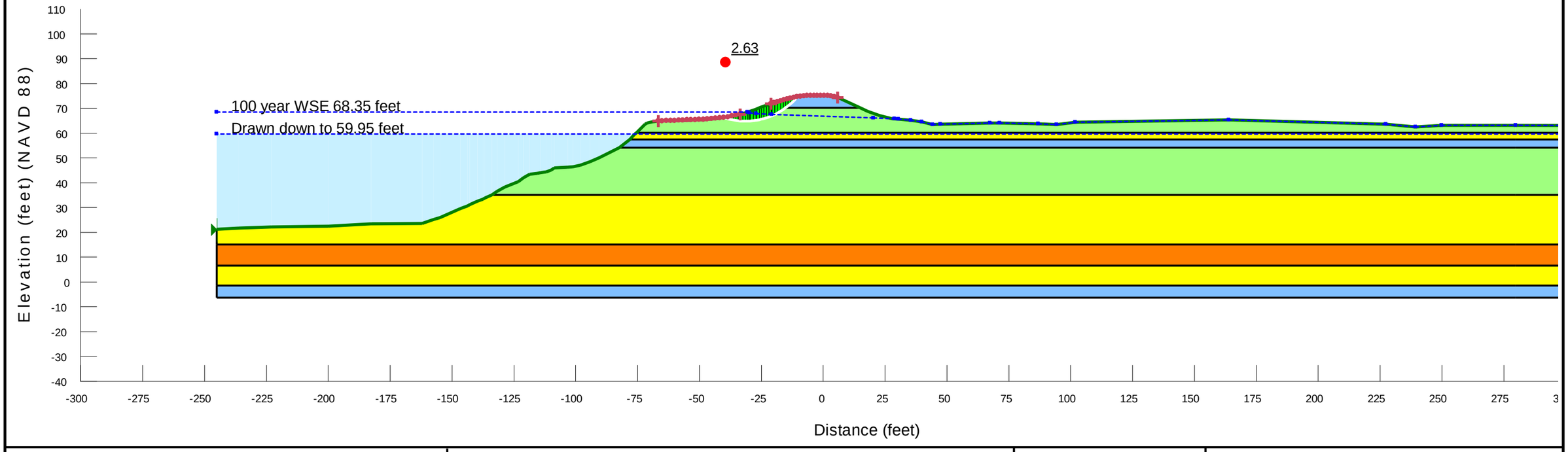
Colusa Flood Risk Reduction Feasibility Study

Reach O Slope Stability Result
Steady State Landside
100 year WSE

May 2019 FIGURE D5

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

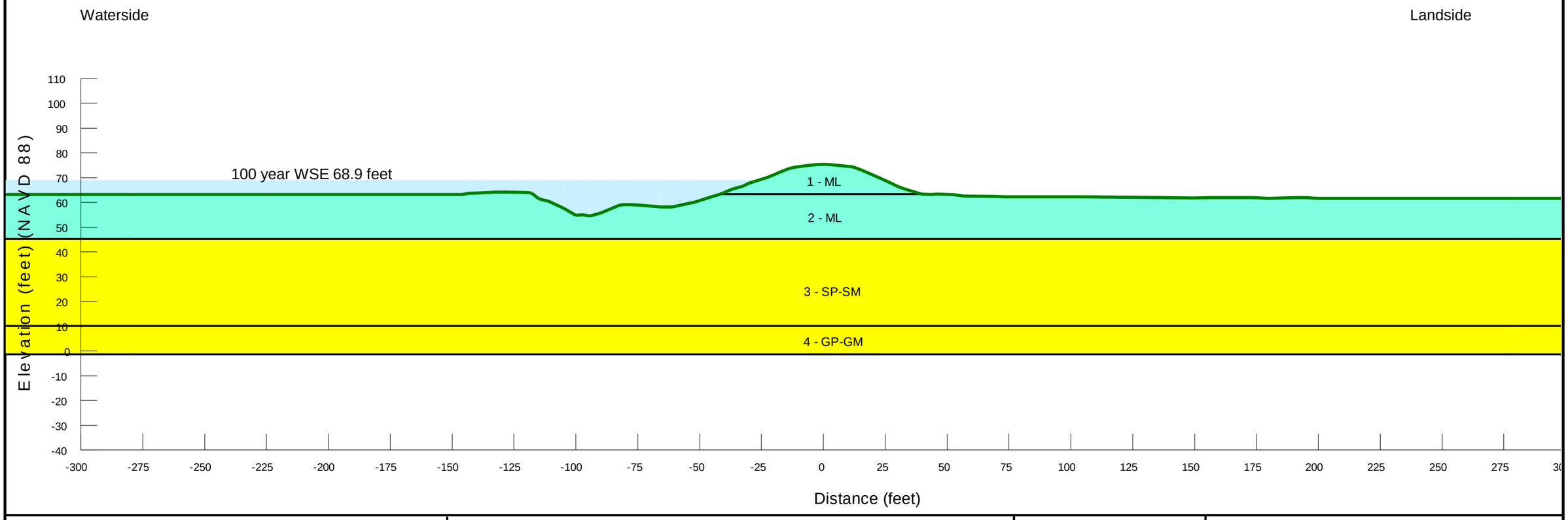
Reach O Slope Stability Result
Waterside RDD 100 year WSE

May 2019

FIGURE D6

Reach B Station SACR-R 8436+00

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**ML**	120	50	31	360	4
2	**ML**	120	50	31	360	4
3	**SP-SM**	125	0	34	-	-
4	**GP-GM**	130	0	35	-	-



NOTES:

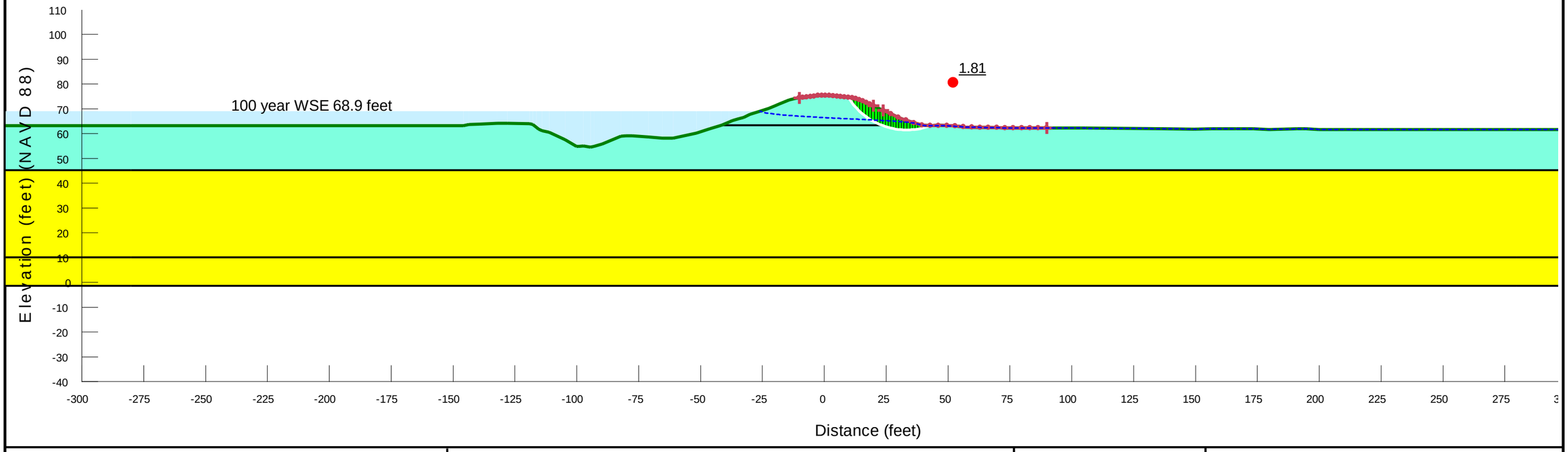
Colusa Flood Risk Reduction Feasibility Study

Reach B Slope Stability Model

May 2019 FIGURE D7

Waterside

Landside



NOTES:

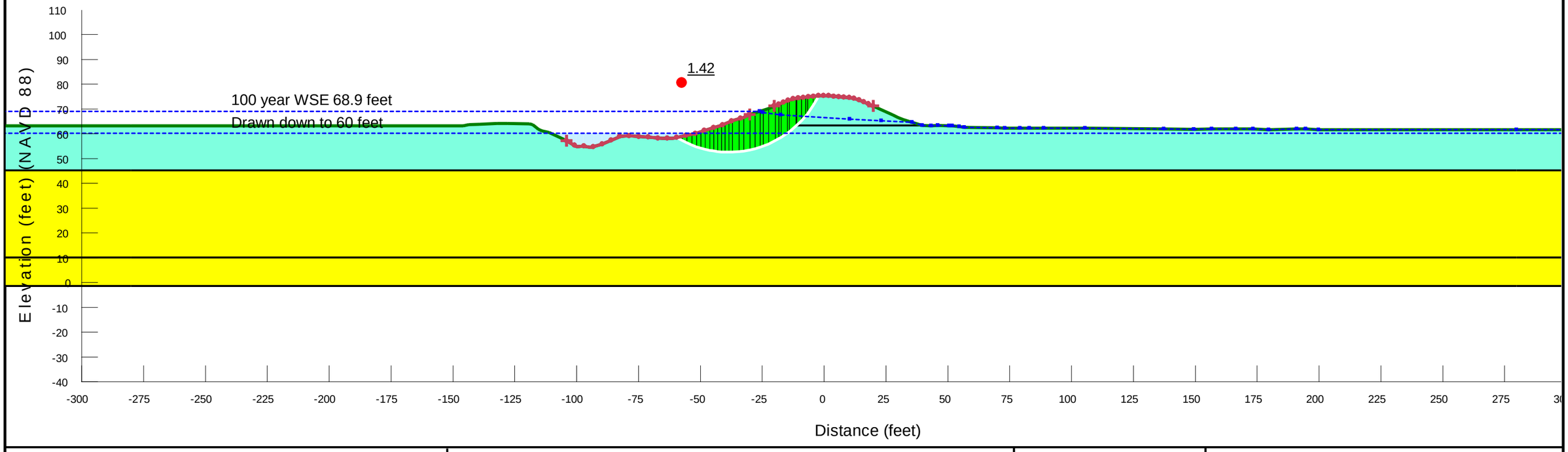
Colusa Flood Risk Reduction Feasibility Study

Reach B Slope Stability Result
Steady State Landside
100 year WSE

May 2019 FIGURE D8

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

Reach B Slope Stability Result
Waterside RDD 100 year WSE

May 2019

FIGURE D9

Attachment E – Stability Interpolation

Figures used for interpolation for Reaches K, M, N from: URS (2014b). Geotechnical Overview Report, Volume 1, Existing Conditions, Colusa South Study Area, Levee Segments 158, 287, and 288. August 2014.

Figures used for interpolation for Reaches A and B from: URS (2014a). Geotechnical Overview Report, Volume 1, Existing Conditions, Colusa North Study Area, Levee Segments 65, 67, 100, 286, 380, 1024, and 1025. July 2014.

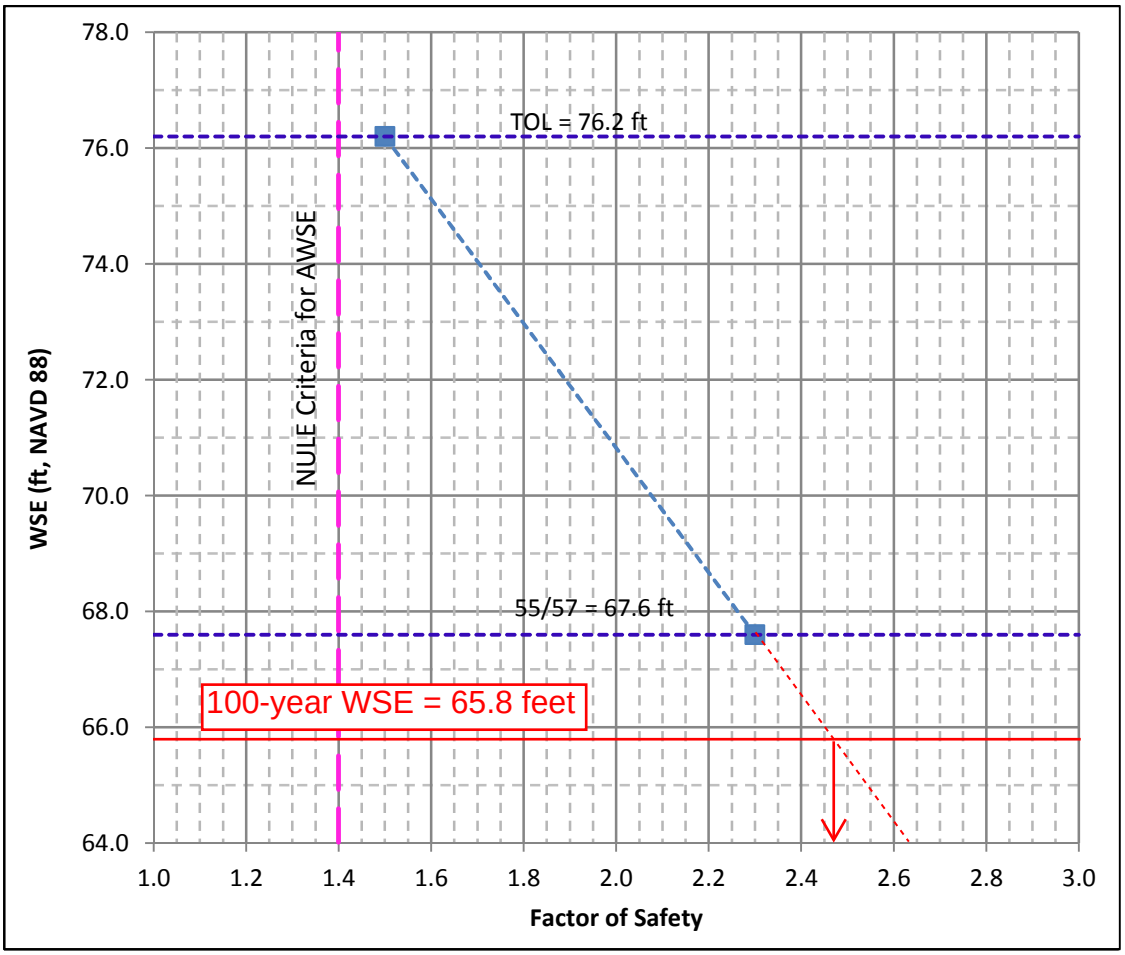


Figure D-K-2: *Reach K Stability Analysis Results*

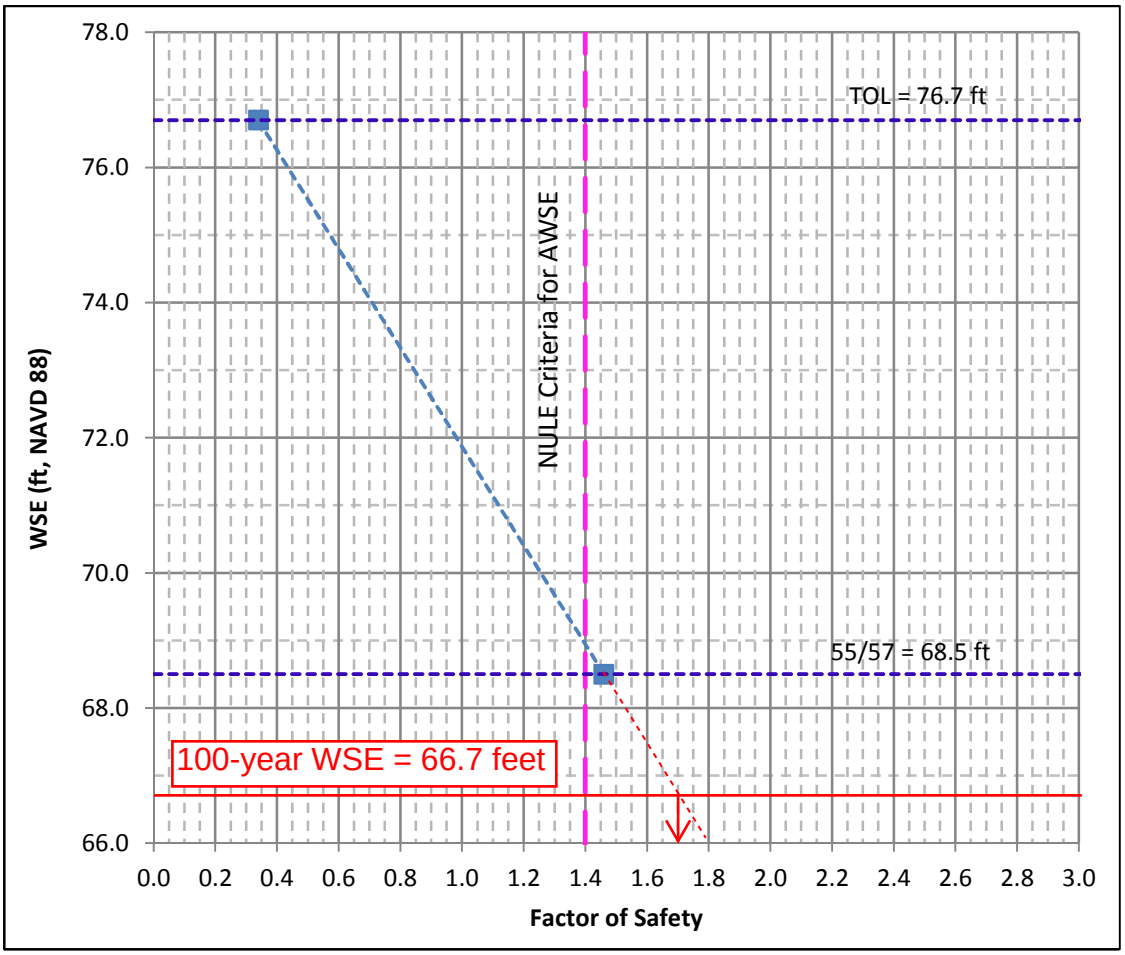


Figure D-M-2: *Reach M Stability Analysis Results*

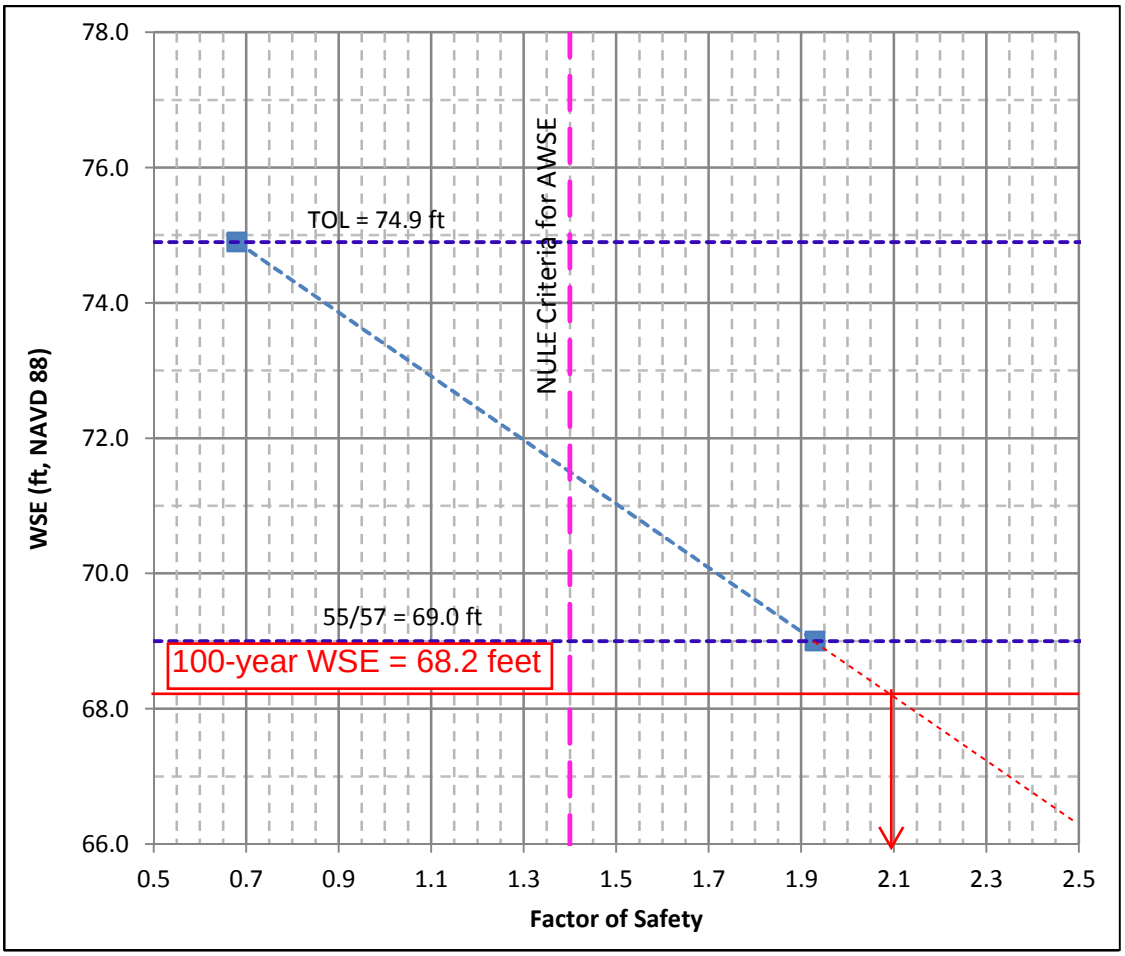


Figure D-N-2: *Reach N Stability Analysis Results*

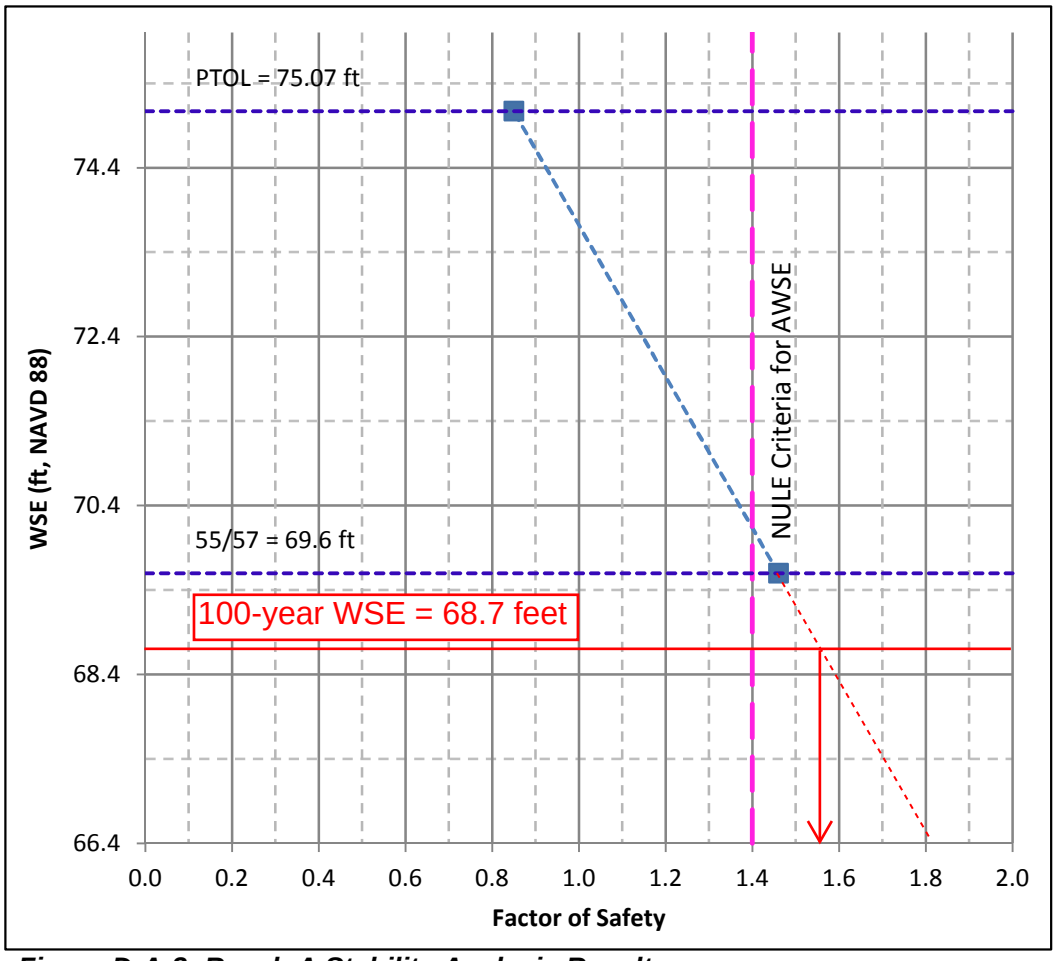


Figure D-A-2: Reach A Stability Analysis Results

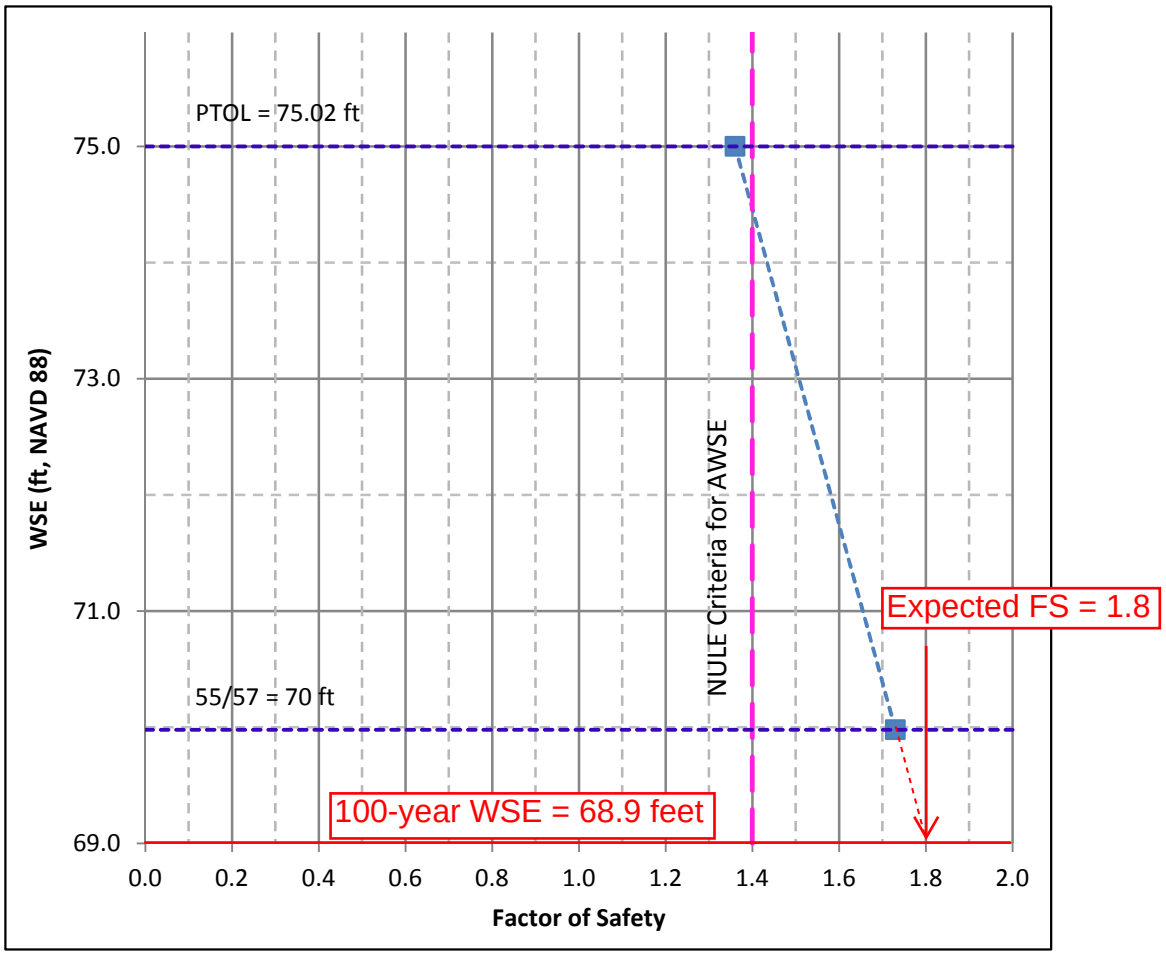
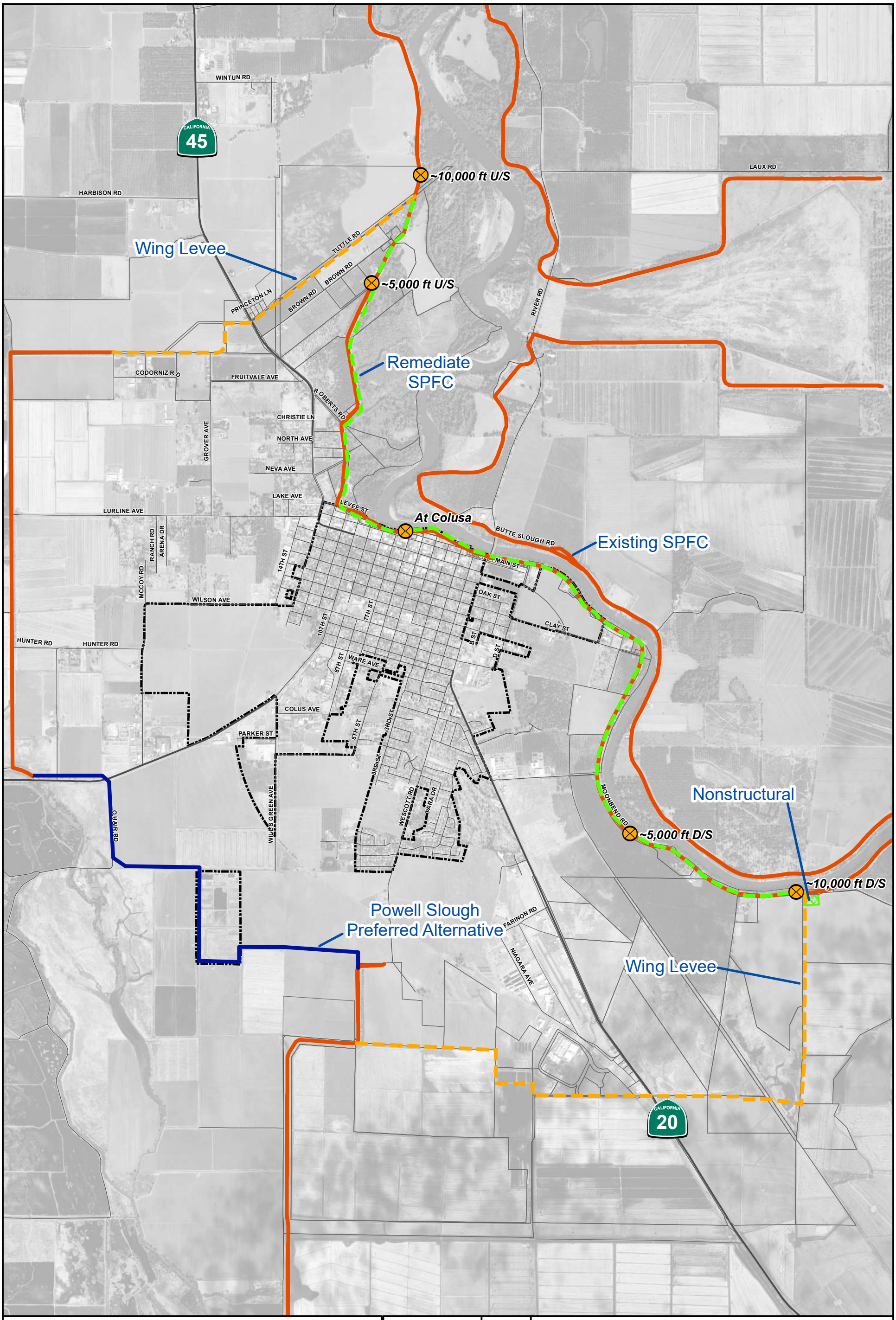


Figure D-B-2: Reach B Stability Analysis Results

Attachment F – Wing Levee Alternative Alignments



KSN inc. KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

711 N. Pershing Avenue
Stockton, CA 95203
209-946-0268

1550 Harbor Boulevard, Suite 212
West Sacramento, CA 95691
916-403-5900

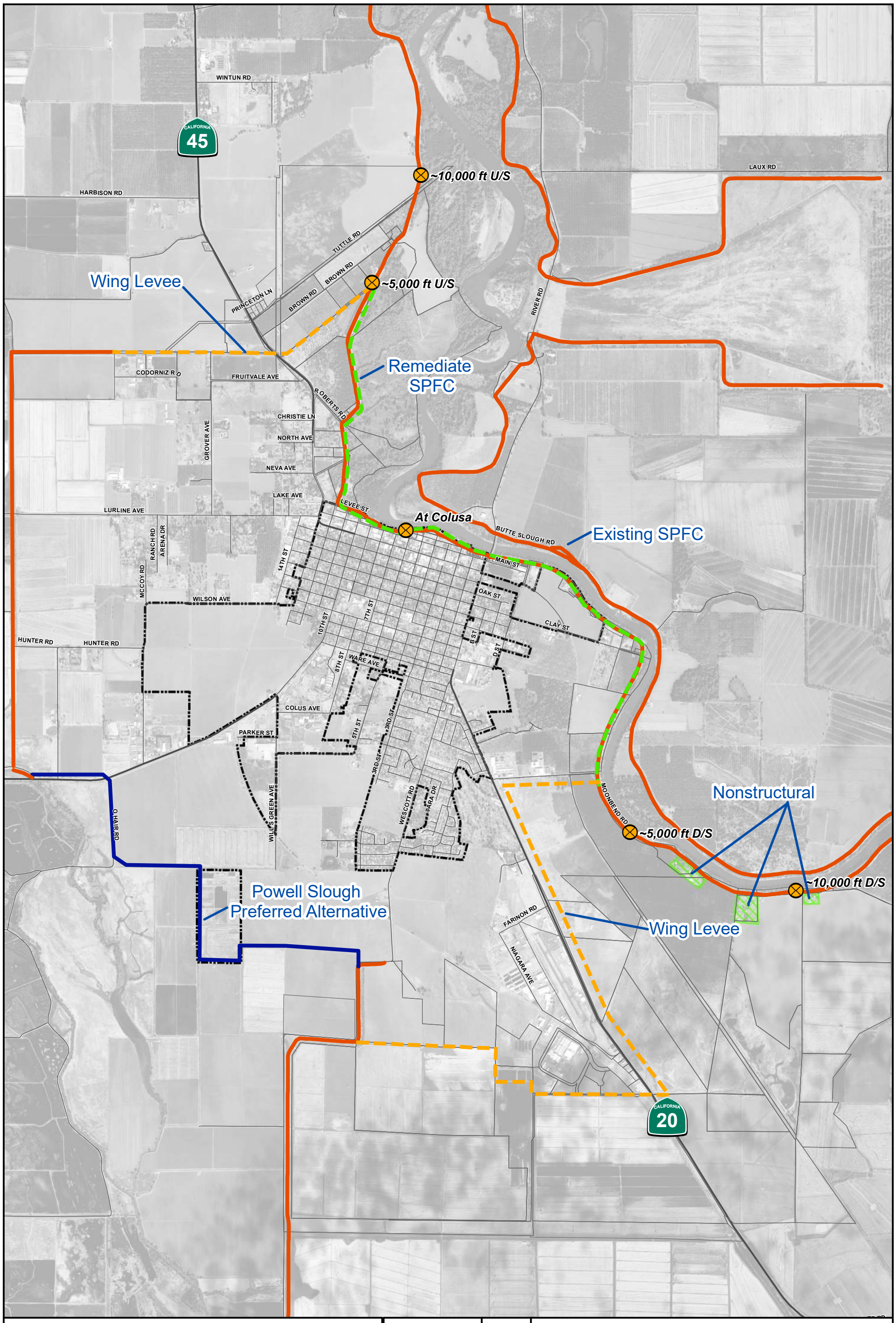
www.ksninc.com

Scale
1:32,000

Original Drawing Scale
0 1/4" 1/2"

N

City of Colusa
Proposed Alternative 1



KSN inc. KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

711 N. Pershing Avenue
Stockton, CA 95203
209-946-0268

1550 Harbor Boulevard, Suite 212
West Sacramento, CA 95691
916-403-5900

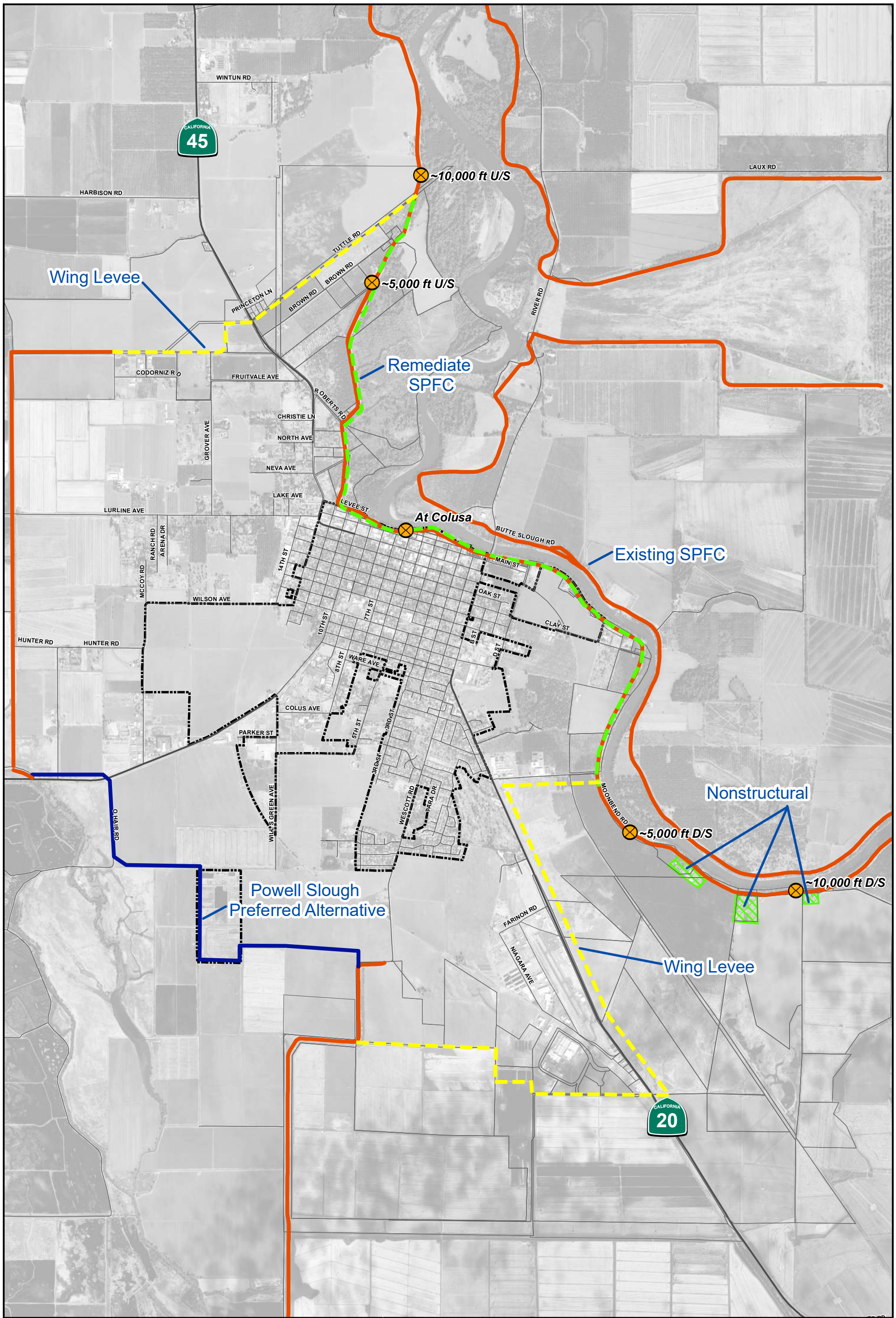
www.ksninc.com

Scale
1:32,000

Original Drawing Scale
0 1/4" 1/2"

N

City of Colusa
Proposed Alternative 2



KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS
KSN inc.

711 N. Pershing Avenue
Stockton, CA 95203
209-946-0268

1550 Harbor Boulevard, Suite 212
West Sacramento, CA 95691
916-403-5900

www.ksninc.com

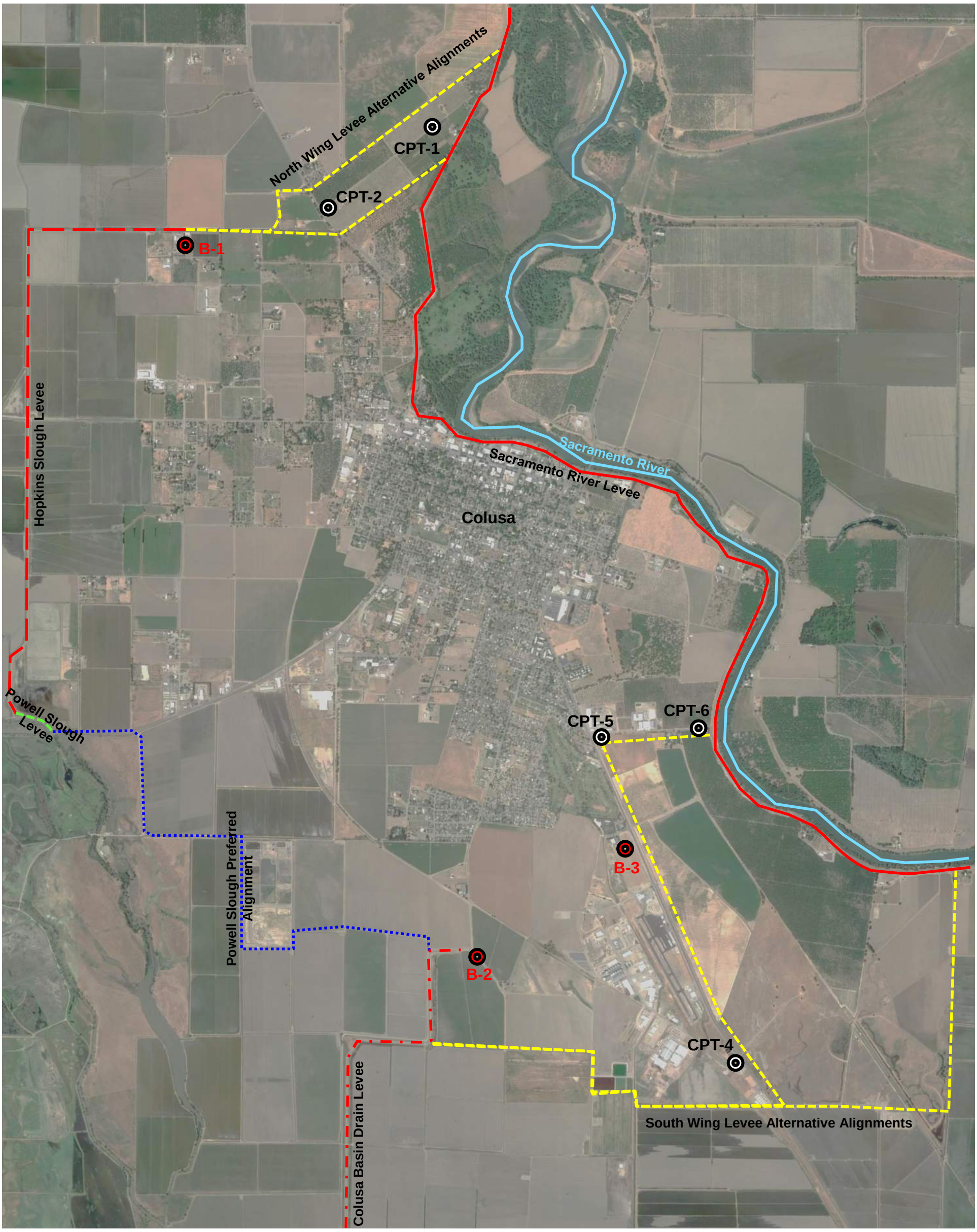
Scale
1:32,000

Original Drawing Scale
0 1/4" 1/2"

N

City of Colusa
Proposed Alternative 3

Attachment G – Boring and CPT Logs for Wing Levee Exploration



Boring Location

CPT Location

Sacramento River Levee

Wing Levee Alternative Alignment

Hopkins Slough Levee

Powell Slough Levee

Powell Slough Preferred Levee Alignment

Colusa Basin Drain Levee

N

0 2500 Feet

NOTES:

Image Source: Google Earth Pro 2019

Colusa Flood Risk Reduction Feasibility Study

Exploration Plan for Wing Levee Alignment

June 2019

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	$C_u \geq 4$ AND $1 \leq C_c \leq 3$	GW	WELL-GRADED GRAVEL
			$C_u < 4$ AND/OR $1 > C_c > 3$	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS >50% OF COARSE FRACTION PASSES NO 4. SIEVE	CLEAN SANDS <5% FINES	$C_u \geq 6$ AND $1 \leq C_c \leq 3$	SW	WELL-GRADED SAND
			$C_u < 6$ AND/OR $1 > C_c > 3$	SP	POORLY-GRADED SAND
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY
			PI<4 OR PLOTS<"A" LINE	ML	SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY
			PI PLOTS <"A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT

OTHER SYMBOLS

MATERIALS

- Asphalt
- Aggregate Base
- Topsoil
- Bedrock

PIEZOMETER

- Grout Seal or Fill
- Bentonite Seal or Fill
- Sand Pack + Solid Pipe
- Sand Pack + Slotted Pipe

SAMPLERS

- SPT (2" OD)
- Modified California (3" OD)
- California (2.5" OD)
- Shelby Tube
- Pitcher Barrel
- HQ Core
- Grab/Bulk

- INITIAL WATER LEVEL MEASUREMENT(WITH DATE)
- STABILIZED WATER LEVEL MEASUREMENT(WITH DATE)

GRAIN SIZES

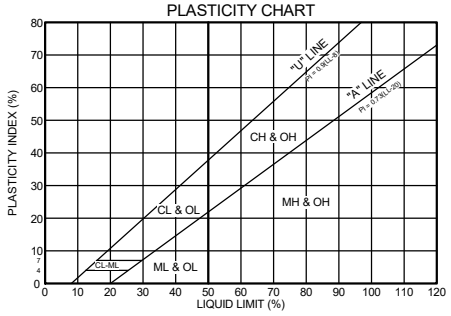
U.S. STANDARD SIEVE	200	40	10	4	3/4"	3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

PENETRATION RESISTANCE

SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	UNC. COMP. STRENGTH (KSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 1	0 - 1/2
LOOSE	5 - 10	SOFT	2 - 4	1/2 - 1
MEDIUM DENSE	11 - 30	MEDIUM STIFF	5 - 8	1 - 2
DENSE	31 - 50	STIFF	9 - 15	2 - 4
VERY DENSE	OVER 50	VERY STIFF	16 - 30	4 - 8
		HARD	OVER 30	OVER 8

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

PLASTICITY CHART



LABORATORY TESTS

AT	ATTERBERG LIMITS
CD	CONSOLIDATED DRAINED TRIAXIAL
CN	CONSOLIDATION
CR	CORROSIVITY
CU	CONSOLIDATED UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
HY	HYDROMETER
PR	PERMEABILITY
RV	R-VALUE
SA	SIEVE ANALYSIS
TC	CYCLIC TRIAXIAL
UC	UNCONFINED COMPRESSION
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL
-200	% PASSING NO. 200 SIEVE

PROPERTIES

c	COHESION
DD	DRY DENSITY
EI	EXPANSION INDEX
LL	LIQUID LIMIT
MC	MOISTURE CONTENT
N_f	FIELD BLOW COUNT
PI	PLASTICITY INDEX
Su	UNDRAINED STRENGTH

UNDRAINED SHEAR STRENGTH

V	FIELD VANE
P	POCKET PENETROMETER
T	TORVANE
Q	UNCONFINED COMPRESSION
U	UNCONSOLIDATED UNDRAINED TRIAXIAL

INCREASING VISUAL MOISTURE CONTENT

WET
MOIST
DRY

Boring and Test Pit Legend

Flood Risk Reduction Feasibility Study - City of Colusa
Colusa, CA

Date
June 2019

Figure
LEGEND

LEGEND_JULY 2016; 10085452 - SMALL COMMUNITIES - COLUSA.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 5/20/19

Project: Flood Risk Reduction Feasibility Study - City of Colusa		Boring ID: B-1	Sheet 1 of 2 Sheets
Project Location: Colusa, CA			
Project Number: 10085452			
Start Date: 3/4/2019	End Date: 3/5/2019	Logged By: Hamed Mousavi	Checked By: / Date Checked:
Drilling Company (Rig Type): Taber Drilling (Track CME 55)	Inspector:	Weather Conditions: Cloudy - Rainy	
Drill Method: Mud / Hand	Drilled By: Toby	Elevation Top of Boring: 55.0 ft. Vertical Datum: NAVD88	
Drill Bit (Type/Size): Spade / 4 inches	Total Depth Drilled: 61.5 ft.	Latitude: 39.229870° Longitude: -122.036384° Horizontal Datum: WGS84	
Hammer Type: Automatic	Hole Backfill: Neat Cement Grout	Northing: Easting: Coordinate System:	
Hammer Efficiency:	Rod Type: 94 mm	Total Number of Samples: 15 Disturbed: 15 Undisturbed: 0	Initial Groundwater Depth: 5 ft (;) Static Groundwater Depth:

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N_f	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory: Fines	LL	PI	DD	MC	Su (ksf)	REMARKS
								HA							Hand Auger to 5 ft
50	5		3 5 6	11		FAT CLAY (CH): soft, brown, moist. Stiff.	100	S-1	92	58	25			0.50 P	Begin with 4" spade, driller reported ground water
			3 7 10	17		LEAN CLAY with Sand (CL): very stiff, brown, moist, fine sand.	72	S-2						2.50 P	Switch to mud rotary
45	10		5 6 9	15		Stiff.	100	S-3						3.50 P	
			5 5 5	10			100	S-4	80	39	16	97	27		
40	15		3 1 3	4		SANDY SILT (SM): loose, brown, wet, fine sand.	100	S-5	62	26	5				
			3 5 7	12		SILTY SAND (SM): medium dense, brown, wet.	83	S-6	40				31		
35	20		21 21 18	39		Poorly Graded SAND with Silt and Gravel (SP-SM): dense, dark grayish brown, wet, fine to medium sand, fine subangular to rounded gravel up to 3/4".	61	S-7	8				10		used sample catcher
30	25		10 8 8	16		Well-Graded GRAVEL with Silt and Sand (GW-GM): medium dense, black and gray, with fine to coarse subangular to rounded up to 1", medium to coarse sand.	55	S-8	7				14		casing was leaking, and driller reported loosing bentonite grout

HDR SOIL BORING LOG_2017_MARCH_R1; 10085452 - SMALL COMMUNITIES - COLUSA.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 5/23/19

Project: Flood Risk Reduction Feasibility Study - City of Colusa	Boring ID: B-1	Sheet 2 of 2 Sheets
Project Location: Colusa, CA		
Project Number: 10085452		

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N_f	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory: Fines	LL	PI	DD	MC	Su (ksf)	REMARKS
			21 35 30	65		Poorly Graded SAND with Silt and Gravel (SP-SM): very dense, dark grayish brown, with fine subangular to rounded black/ white gravel up to 1".	61	S-9	9				9		
20	35		22 22 18	40		Dense, with fine subangular to rounded black/ white gravel up to 3/4".	50	S-10	8				11		
15	40		3 6 8	14		LEAN CLAY (CL): stiff, brown, moist.	89	S-11	93	44	20			2.50 P	
10	45		2 3 3	6		Medium stiff, brown.	100	S-12	71	35	16		23		removed sample catcher
5	50		8 10 12	22		Very stiff.	0	S-13							No recovery in MC sampler.
0	55		6 8 10	18		FAT CLAY (CH): very stiff, yellowish brown, moist.	100	S-14	87	50	25			1.50 P	second day of drilling
-5	60		14 18 21	39		Hard, yellowish brown slightly mottled gray.	100	S-15						4.50 P	
						Boring terminated at 61.5 feet depth.									

HDR SOIL BORING LOG_2017_MARCH_R1; 10085452 - SMALL COMMUNITIES - COLUSA.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 5/23/19

HDR Engineering, Inc.

Project: Flood Risk Reduction Feasibility Study - City of Colusa		Boring ID: B-2	Sheet 1 of 2 Sheets
Project Location: Colusa, CA			
Project Number: 10085452			
Start Date: 3/5/2019	End Date: 3/5/2019	Logged By: Hamed Mousavi	Checked By: / Date Checked:
Drilling Company (Rig Type): Taber Drilling (Track CME 55)	Inspector:	Weather Conditions: Rainy	
Drill Method: Mud / Hand	Drilled By: Toby	Elevation Top of Boring: 50.0 ft. Vertical Datum: NAVD88	
Drill Bit (Type/Size): Spade / 4 icnhes	Total Depth Drilled: 61.5 ft.	Latitude: 39.180283° Longitude: -122.010487° Horizontal Datum: WGS84	
Hammer Type: Automatic	Hole Backfill: Neat Cement Grout	Northing: Easting: Coordinate System:	
Hammer Efficiency:	Rod Type: 94 mm	Total Number of Samples: 19 Disturbed: 19 Undisturbed: 0	Initial Groundwater Depth: 12.5 ft (;) Static Groundwater Depth:

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N_f	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory: Fines	LL	PI	DD	MC	Su (ksf)	REMARKS
						Fill (af) 12" Aggregate Base.		HA							Hand Auger to 5 ft
						LEAN CLAY (CL): soft, dark grayish brown, moist.									
45	5		2 1 2	3			89	S-1	86	34	10				Begin with 4" spade Drill Bit
			2 3 3	6		Medium stiff.	100	S-2							
40	10		3 3 5	8		FAT CLAY (CH): medium stiff, dark grayish brown, moist.	100	S-3						0.50 P	
			5 8 11	19		Very stiff.	61	S-4	95	53	25	104	24	2.50 P	Driller reported ground water, switched to mud rotary
35	15		4 5 6	11		Stiff.	100	S-5						2.50 P	
			5 5 5	10		LEAN CLAY (CL): stiff, dark brown, moist.	100	S-6	90	32	9			0.50 P	
30	20		7 8 9	17		SILT (ML): very stiff, brown, moist.	72	S-7	89	34	5	85	37		
			5 8 10	18		LEAN CLAY (CL): stiff, dark brown, moist.	100	S-8						3.00 P	
25	25		3 3 6	9			100	S-9							
			3 3 4	7		Medium stiff.	100	S-10						0.75 P	

HDR SOIL BORING LOG_2017_MARCH_R1; 10085452 - SMALL COMMUNITIES - COLUSA.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 5/23/19

Project: Flood Risk Reduction Feasibility Study - City of Colusa	Boring ID: B-2	Sheet 2 of 2 Sheets
Project Location: Colusa, CA		
Project Number: 10085452		

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N_f	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory: Fines	LL	PI	DD	MC	Su (ksf)	REMARKS
			7 11 14	25		Very stiff.	72	S-11						3.00 P	
			3 3 3	6		Medium stiff.	100	S-12	91	47	25		32	1.75 P	
15	35		3 3 3	6		SILT with Sand (ML): medium stiff, brown mottled gray, moist, fine sand.	100	S-13	85	35	10		31		
			4 5 4	9		Loose, brown.	100	S-14	85	31	6		35		
10	40		3 4 6	10		SANDY SILT (ML): medium dense, brown.	100	S-15	56				33		
5	45		36 40 36	76		Well-Graded SAND with Silt and Gravel (SW): very dense, dark gray, wet, fine to medium sand, fine to coarse subangular to rounded black and white gravel up to 3/4".	72	S-16	9				10		
0	50		6 5 8	13		SILT with Sand (ML): medium dense, brown, wet.	55	S-17	72				45		used sample catcher
-5	55		20 18 24	42		SANDY SILT with Gravel (SM): very dense, black, moist, fine to medium sand, fine to coarse subangular to rounded black and white gravel up to 0.5".	0	S-18							No recovery in MC sampler.
-10	60		20 37 42	79			55	S-19	30				18		

Boring terminated at 61.5 feet depth.

HDR SOIL BORING LOG_2017_MARCH_R1; 10085452 - SMALL COMMUNITIES - COLUSA.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 5/23/19

Project: Flood Risk Reduction Feasibility Study - City of Colusa		Boring ID: B-3	Sheet 1 of 2 Sheets
Project Location: Colusa, CA			
Project Number: 10085452			
Start Date: 3/4/2019	End Date: 3/4/2019	Logged By: Hamed Mousavi	Checked By: / Date Checked:
Drilling Company (Rig Type): Taber Drilling (Track CME 55)	Inspector:	Weather Conditions: Cloudy	
Drill Method: Mud / Hand	Drilled By: Toby	Elevation Top of Boring: 47.0 ft. Vertical Datum: NAVD88	
Drill Bit (Type/Size): Spade / 4 inches	Total Depth Drilled: 61.5 ft.	Latitude: 39.187475° Longitude: -121.996920° Horizontal Datum: WGS84	
Hammer Type: Automatic	Hole Backfill: Neat Cement Grout	Northing: Easting: Coordinate System:	
Hammer Efficiency:	Rod Type: 94 mm	Total Number of Samples: 20 Disturbed: 20 Undisturbed: 0	Initial Groundwater Depth: 20 ft (;) Static Groundwater Depth:

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N_f	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory Fines	LL	PI	DD	MC	Su (ksf)	REMARKS
						Fill (af)		HA							Hand Auger to 5 ft
						6" Aggregate Base.									
45						LEAN CLAY (CL): soft, dark gray, moist.										
	5		3 3 4	7		Medium stiff, dark grayish brown.	100	S-1						2.50 P	Begin with 4" spade Drill Bit
40			3 7 11	18		Very stiff.	77	S-2							
	10		2 4 7	11		Stiff.	100	S-3						3.50 P	
35			4 6 10	16		Very stiff.	89	S-4	95	31	11		21	4.00 P	
	15		6 17 22	39			77	S-5						4.50 P	
30			8 16 18	34		SILT (ML): hard, dark gray.	72	S-6	86	48	16	91	31	4.00 P	
	20		7 9 20	29		SILTY CLAY with Sand (CL-ML): very stiff, dark gray, moist.	100	S-7	76	23	5		26		Driller reported ground water
25			4 7 10	17		SILT with Sand (ML): very stiff, dark brown, moist.	100	S-8	82	30	6		26	4.00 P	switched to mud rotary
	25		6 8 10	18			89	S-9							
20			8 10 11	21			100	S-10						4.50 P	
						SANDY SILT (ML): stiff, dark gary, moist.									

HDR SOIL BORING LOG_2017_MARCH_R1; 10085452 - SMALL COMMUNITIES - COLUSA.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 5/23/19

Project: Flood Risk Reduction Feasibility Study - City of Colusa
Project Location: Colusa, CA
Project Number: 10085452

Boring ID: B-3

Sheet 2 of 2 Sheets

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N_f	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory Fines	LL	PI	DD	MC	Su (ksf)	REMARKS
			4 6 7	13			100	S-11	70	26	3		32		
15			5 8 16	24		LEAN CLAY (CL): very stiff, brown, moist.	100	S-12	92	28	11	100	26		
	35		5 7 9	16			100	S-13	88	36	17				
10			4 6 7	13		Stiff.	100	S-14						4.00 P	
	40		5 5 6	11		Medium dense, gray.	100	S-15	73	31	9				
5			3 2 5	7		SILT with Sand (ML): loose, gray, moist, with fine to medium subangular to rounded gravel up to 3/4".	100	S-16	85	31	7				
	45		3 6 7	13		LEAN CLAY (CL): stiff, gray, moist.	97	S-17	91	33	10				
0															
	50		4 5 7	12			100	S-18	94	34	12				
-5															
	55		4 8 8	16		Very stiff, bluish gray.	77	S-19							
-10															
	60		5 6 9	15		SILT (ML): stiff, bluish gray, moist.	100	S-20	98	47	18				

Boring terminated at 61.5 feet depth.

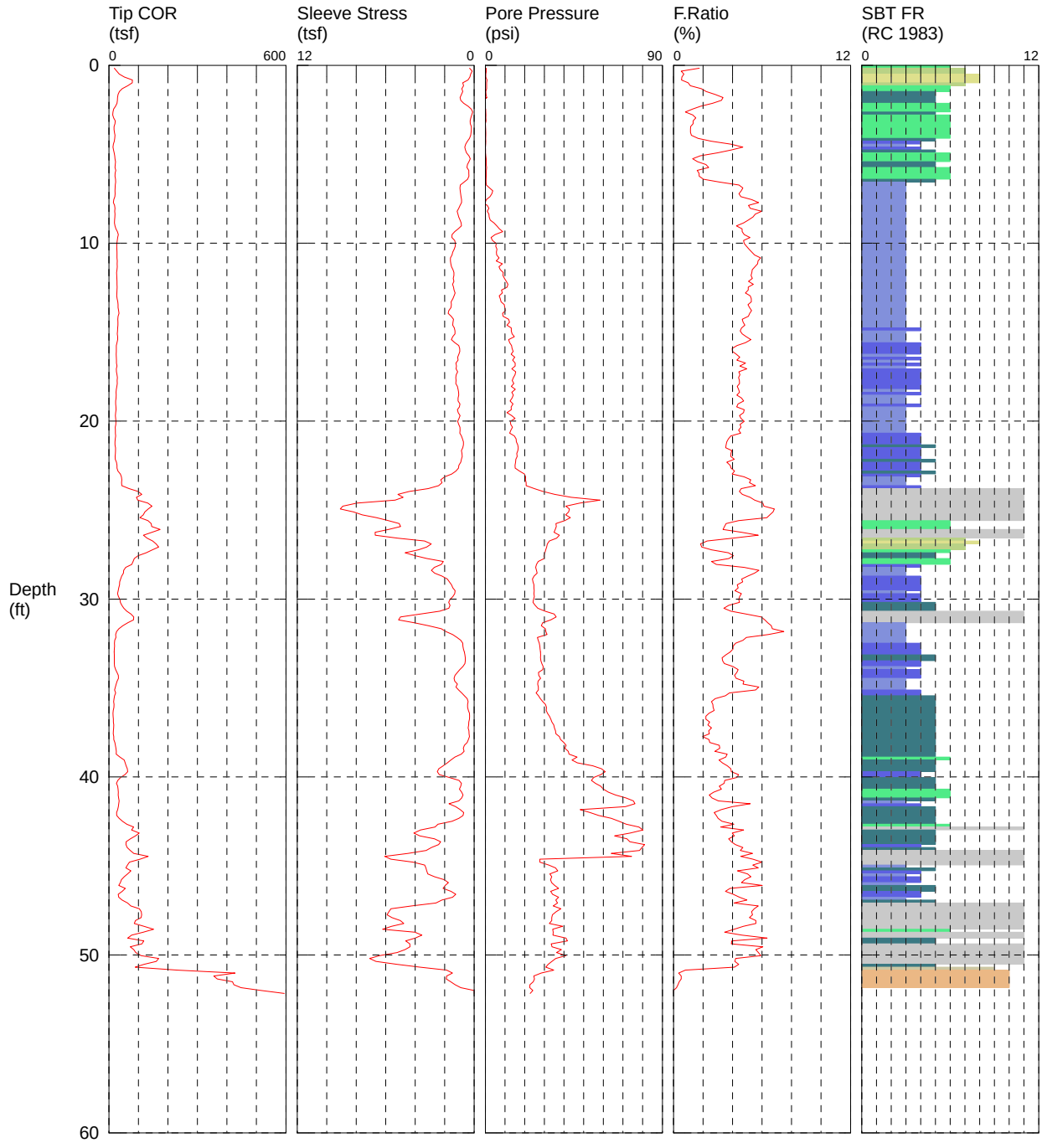
HDR SOIL BORING LOG_2017_MARCH_R1; 10085452 - SMALL COMMUNITIES - COLUSA.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 5/23/19

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION:

JOB NUMBER:
HOLE NUMBER: **CPT-1**
TEST DATE: 12/18/2018 9:04:03 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

ELEVATION: 62 feet (NAVD 88)
GPS (LAT,LON): (39.237563,-122.014731)
LOCATION: 3590 Brown Rd
LOCATION: Colusa, CA 95932
LOCATION:



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

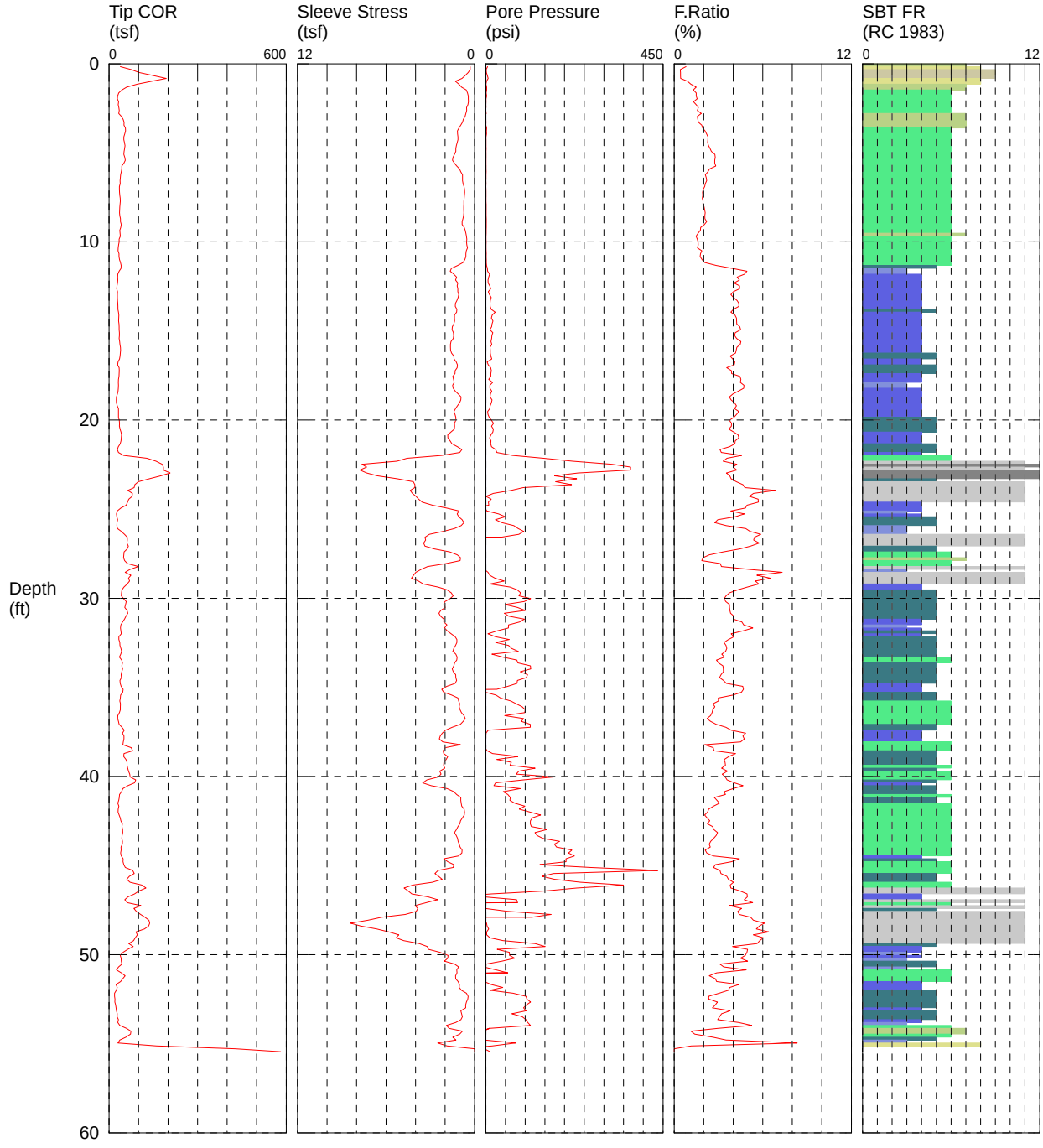
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION:

JOB NUMBER:
HOLE NUMBER: **CPT-2**
TEST DATE: 12/18/2018 10:56:44 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

ELEVATION: 59 feet (NAVD 88)
GPS (LAT,LON): (39.23184,-122.024549)
LOCATION: Intersection of HWY 45
LOCATION: and Brown Road
LOCATION: Colusa, CA 95932



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

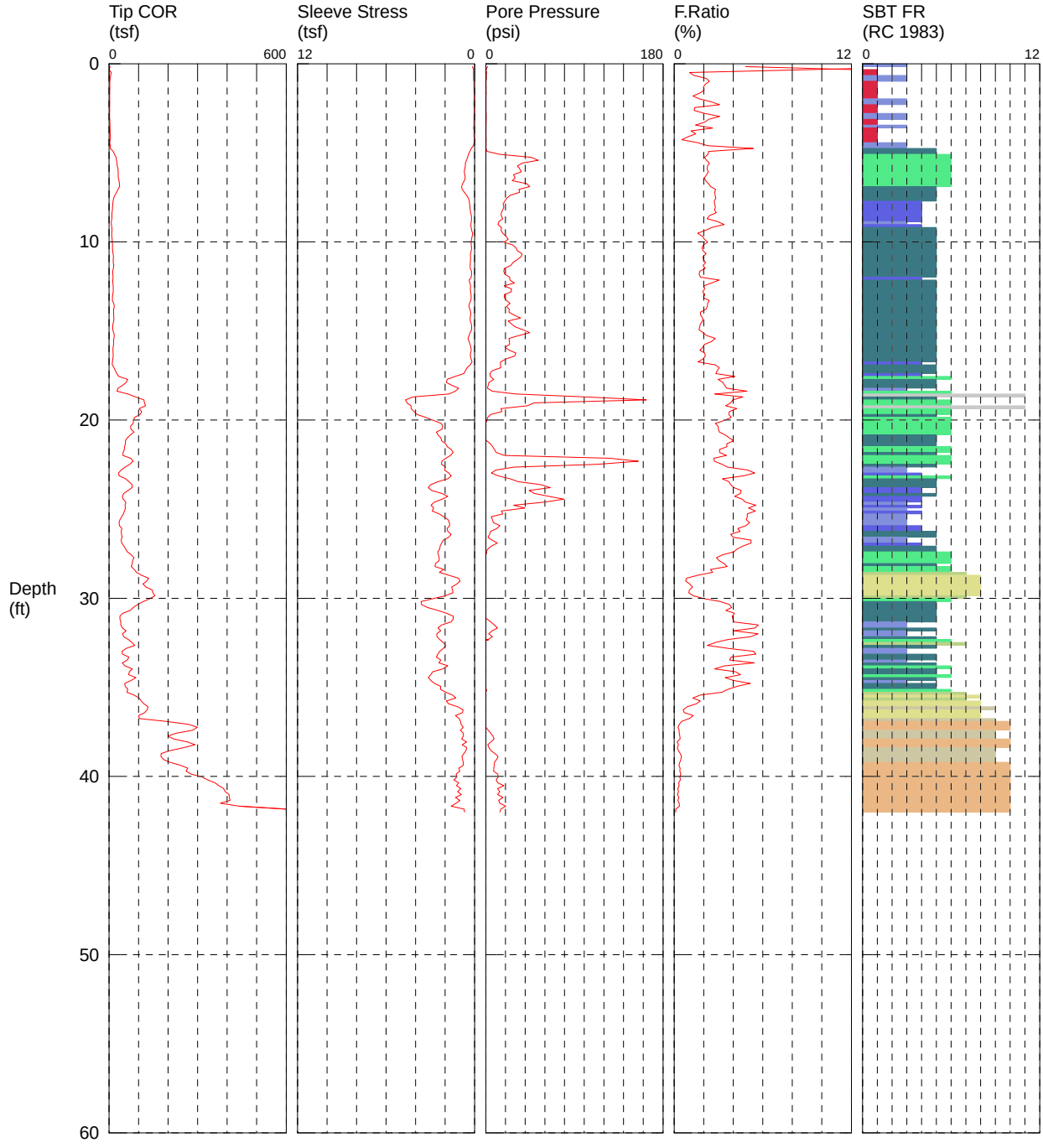
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION:

JOB NUMBER:
HOLE NUMBER: **CPT-4**
TEST DATE: 12/19/2018 9:28:46 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

ELEVATION: 44 feet (NAVD 88)
GPS (LAT,LON): (39.172837,-121.986921)
LOCATION: Intersection of HWY 20 and
LOCATION: Niagara Ave
LOCATION: Colusa, CA 95932



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

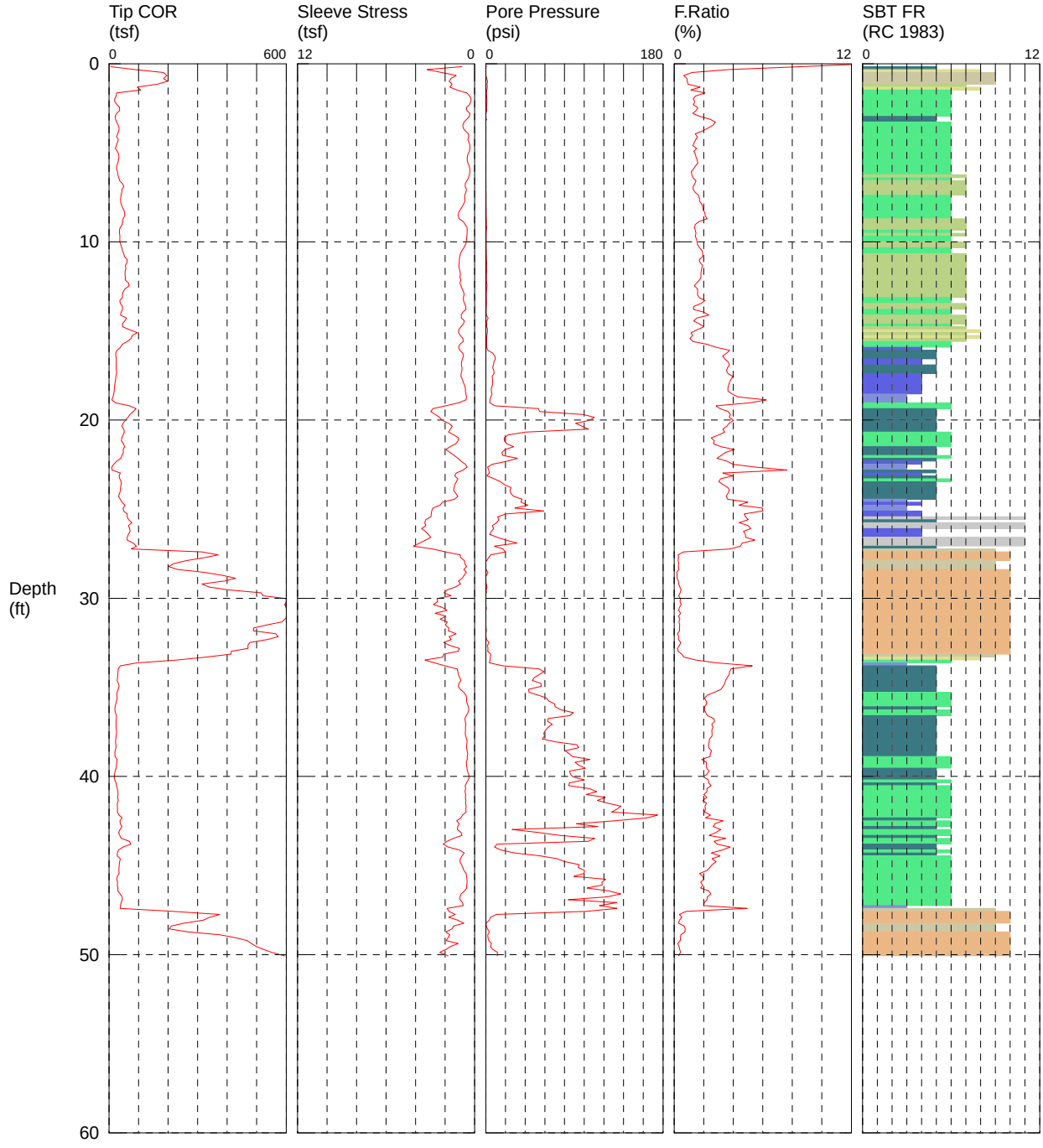
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION:

JOB NUMBER:
HOLE NUMBER: **CPT-5**
TEST DATE: 12/19/2018 10:51:59 AM
COMMENT: Auto Enhance On
COMMENT: Filter On

ELEVATION: 51 feet (NAVD 88)
GPS (LAT,LON): (39.195392,-121.999698)
LOCATION: 7207 Moon Bend Rd
LOCATION: Colusa, CA 95932
LOCATION:



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

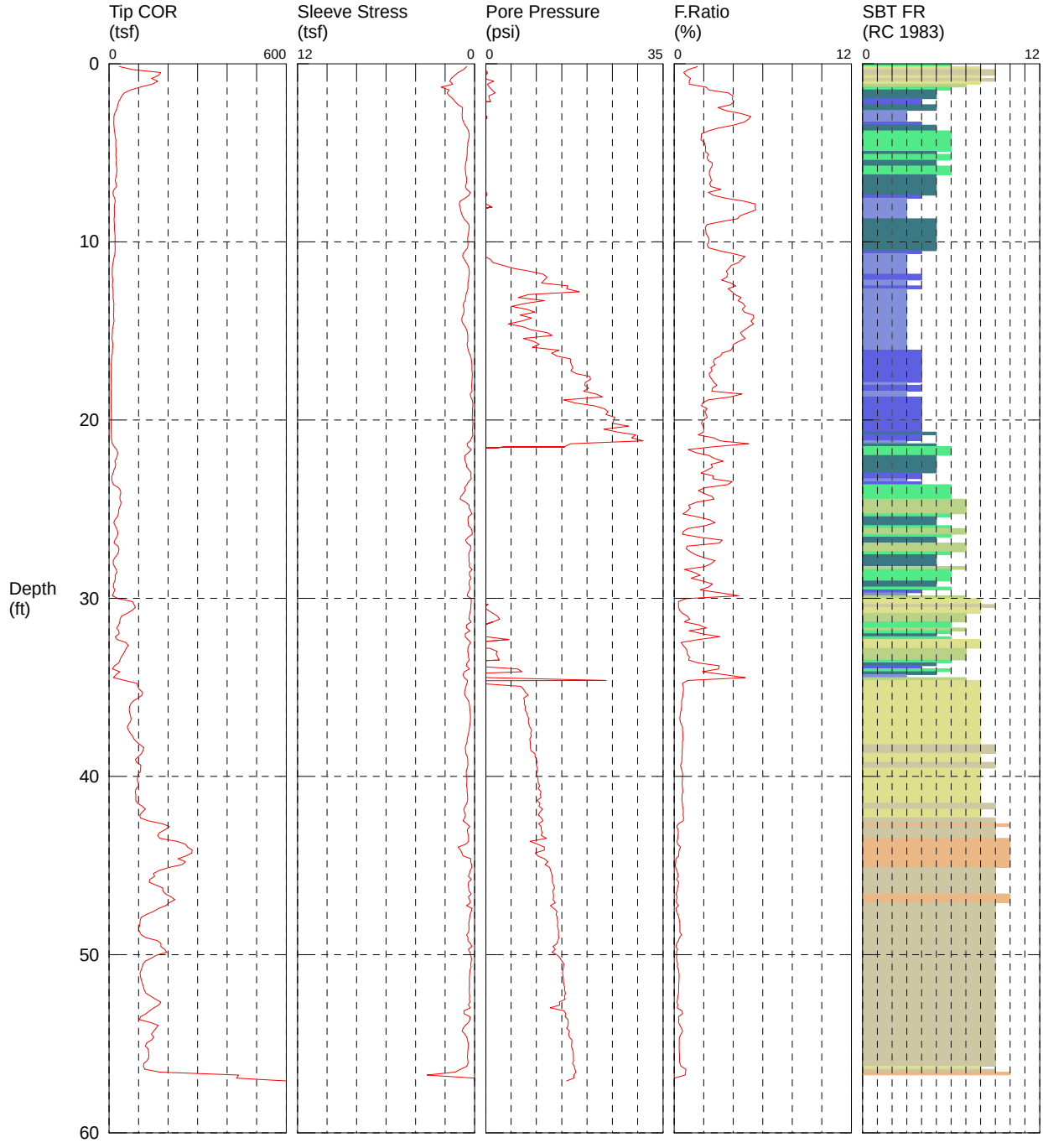
*SBT/SPT CORRELATION: UBC-1983

SOUNDING

SOUNDING
CUSTOMER: Taber Drilling
OPERATOR: Tim
CONE ID: DDG1361
LOCATION:

JOB NUMBER:
HOLE NUMBER: **CPT-6**
TEST DATE: 12/18/2018 1:02:23 PM
COMMENT: Auto Enhance On
COMMENT: Filter On

ELEVATION: 56 feet (NAVD 88)
GPS (LAT,LON): (39.195854,-121.989716)
LOCATION: 7308 Moon Bend Rd
LOCATION: Colusa, CA 95932
LOCATION:

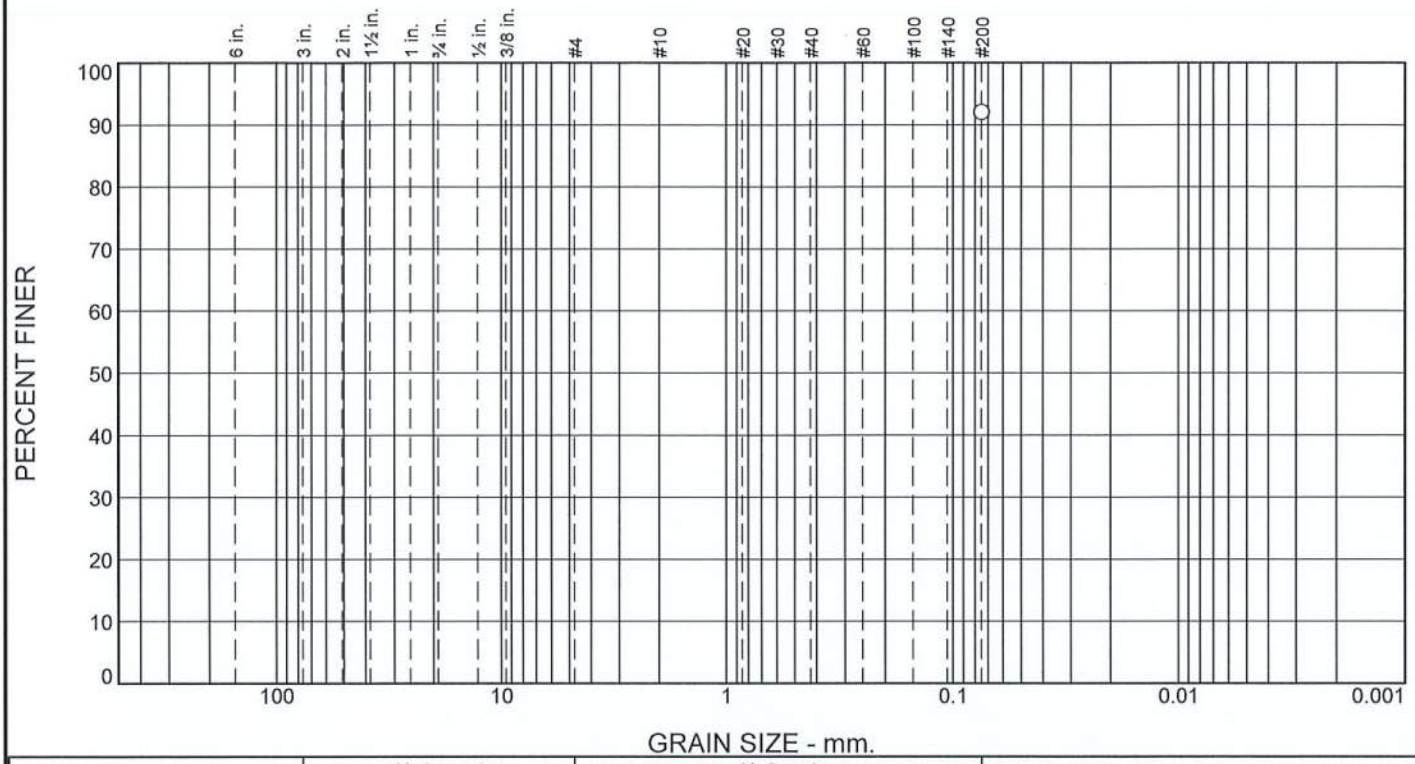


1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

Attachment H – Laboratory Test Results for Wing Levees Exploration

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						92

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	92		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 33 LL= 58 PI= 25

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/8/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42718 **Depth:** 5.5'-6.5'

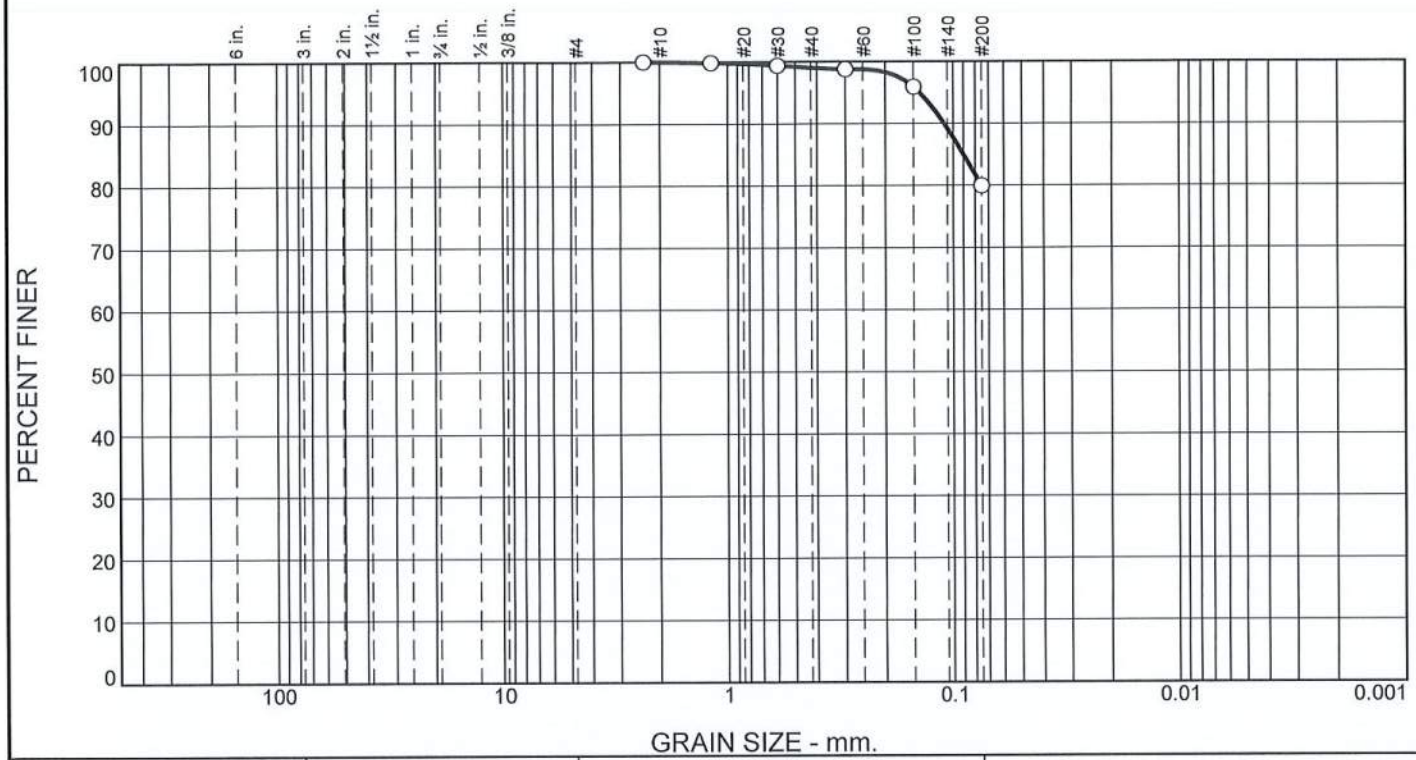
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	1	19	80

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#8	100		
#16	100		
#30	99		
#50	99		
#100	96		
#200	80		

* (no specification provided)

Material Description

Brown lean clay with sand

Atterberg Limits (ASTM D 4318)

PL= 23 LL= 39 PI= 16

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-6(13)

Coefficients

D_{90}= 0.1098 D_{85}= 0.0901 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.06

Date Received: 4/19/19 **Date Tested:** 4/24/19

Tested By: AF

Checked By: JML

Title: PM

Location: MOD CAL: B-1 **Date Sampled:** -

Sample Number: 42747 **Depth:** 13.0'-14.0'

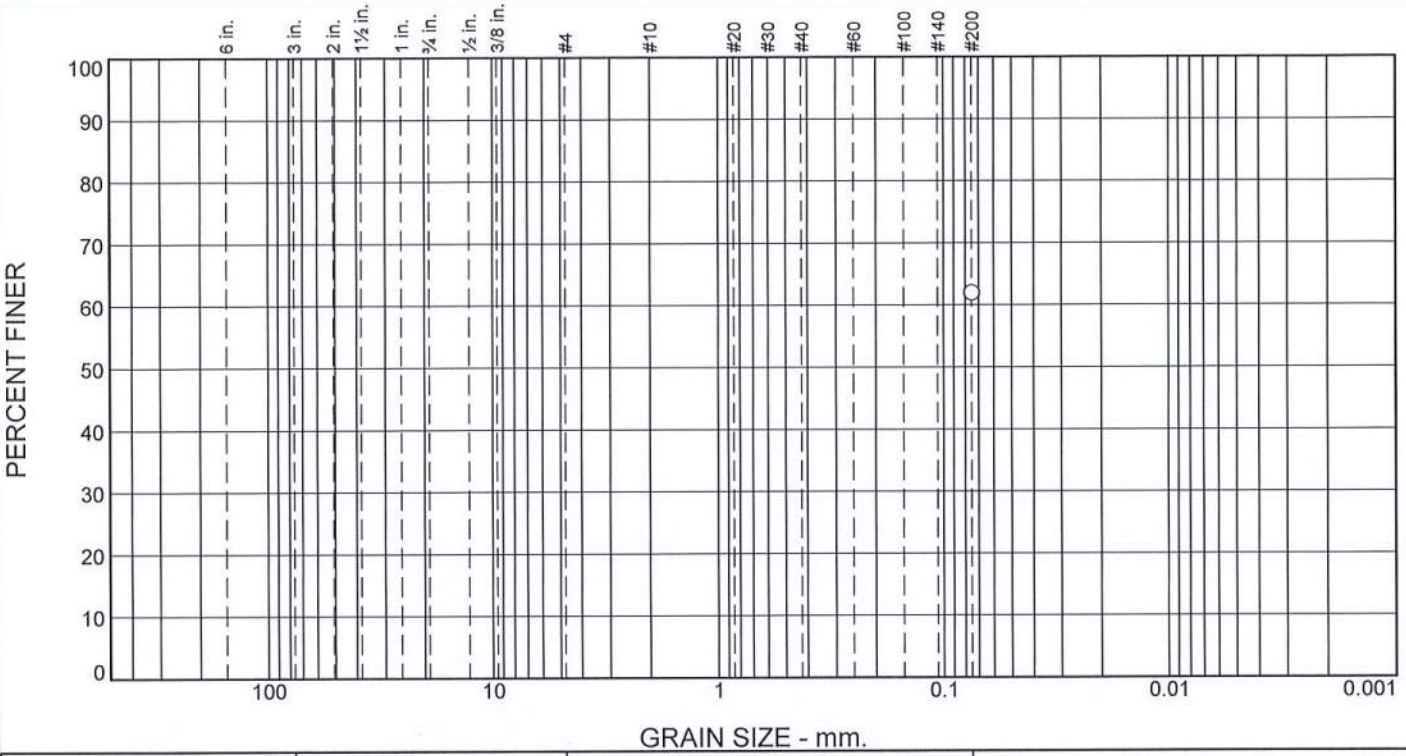
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						62

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	62		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 21 LL= 26 PI= 5

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/8/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42722 **Depth:** 15.5'-16.5'

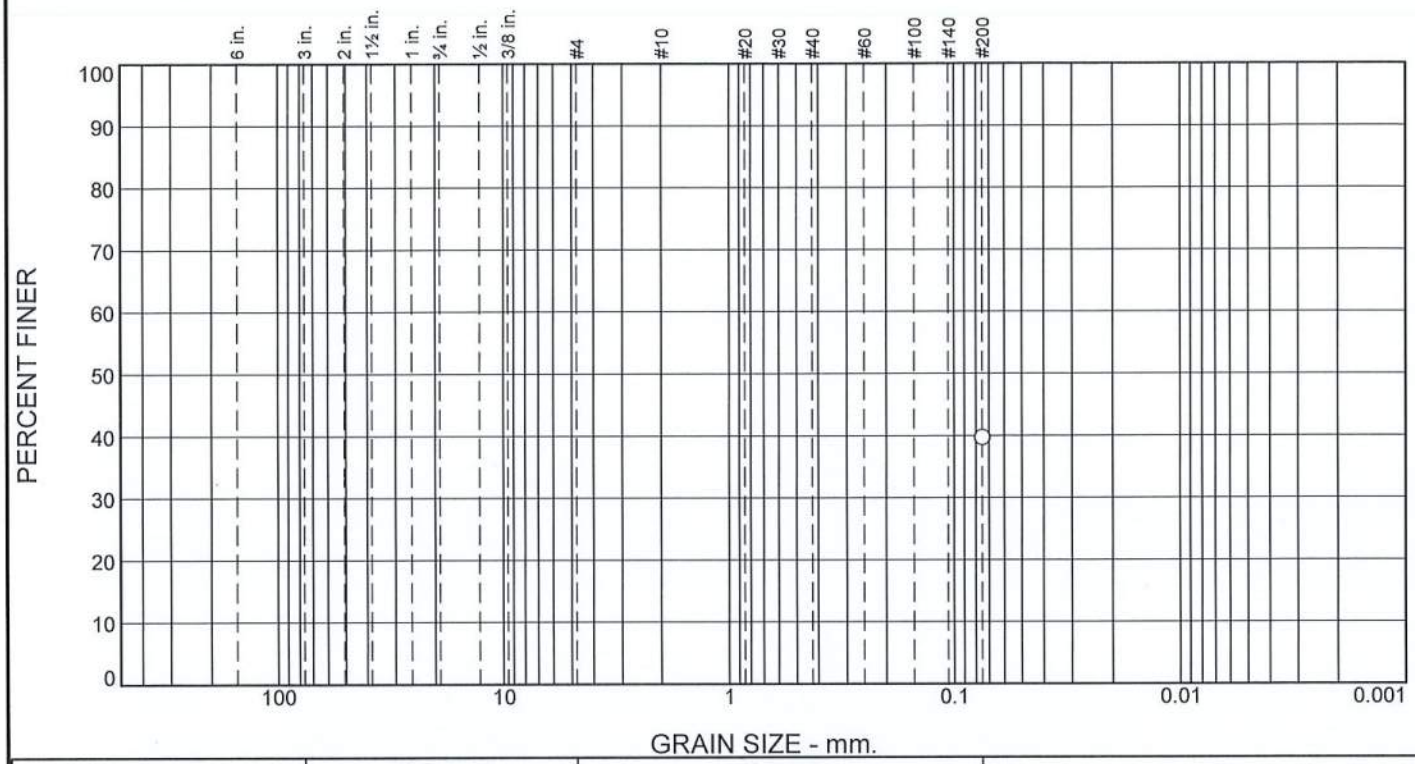
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						40

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	40		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/7/19

Tested By: RC

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42726 **Depth:** 18.0'-19.0'

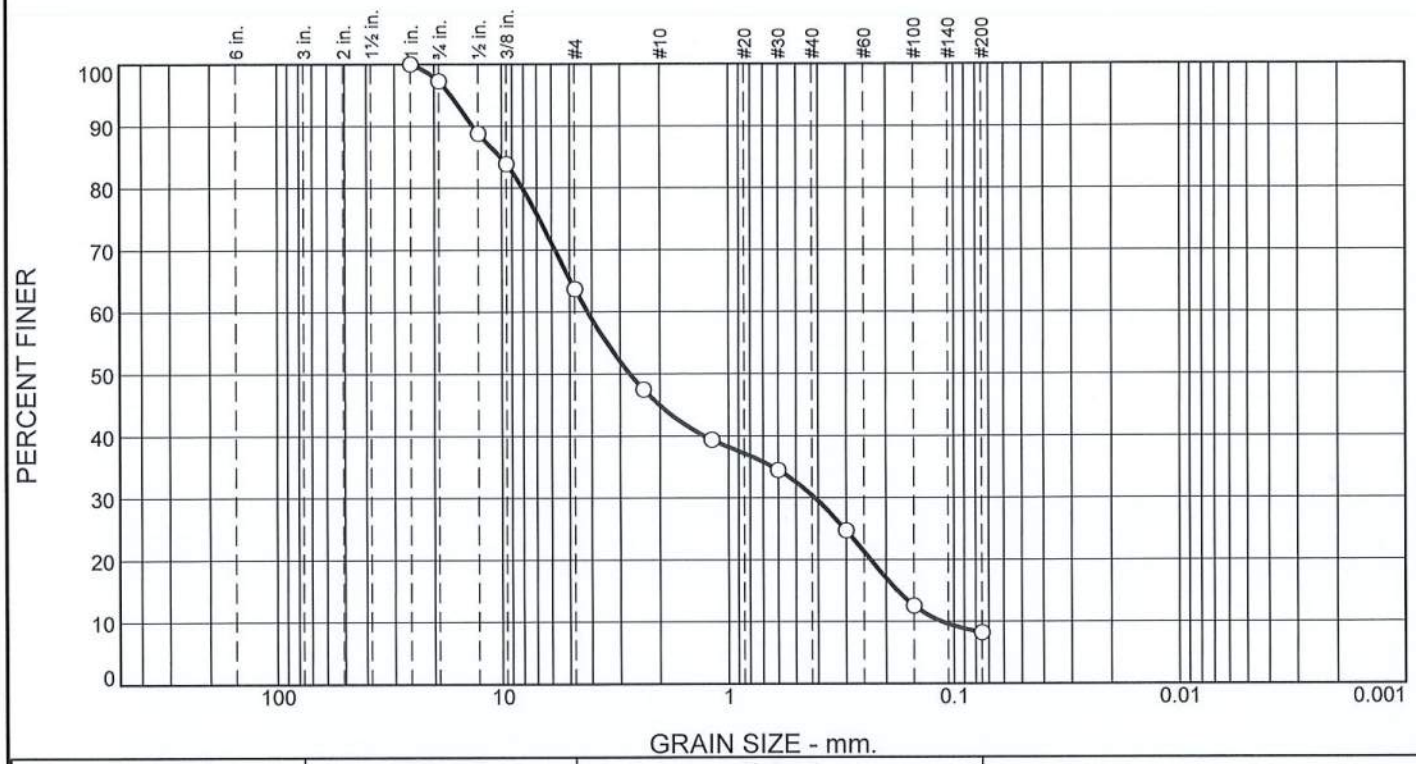
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	3	33	19	15	22	8

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1 Inch	100		
3/4 Inch	97		
1/2 Inch	89		
3/8 Inch	84		
#4	64		
#8	47		
#16	39		
#30	34		
#50	25		
#100	13		
#200	8.2		

* (no specification provided)

Material Description

Brown poorly graded sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-a

Coefficients

D_{90}= 13.4667 D_{85}= 10.1253 D_{60}= 4.1748
D_{50}= 2.7169 D_{30}= 0.4150 D_{15}= 0.1776
D_{10}= 0.1138 C_u= 36.70 C_c= 0.36

Remarks

F.M.=3.97

Date Received: 4/19/19 **Date Tested:** 5/6/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42723 **Depth:** 20.5'-21.5'

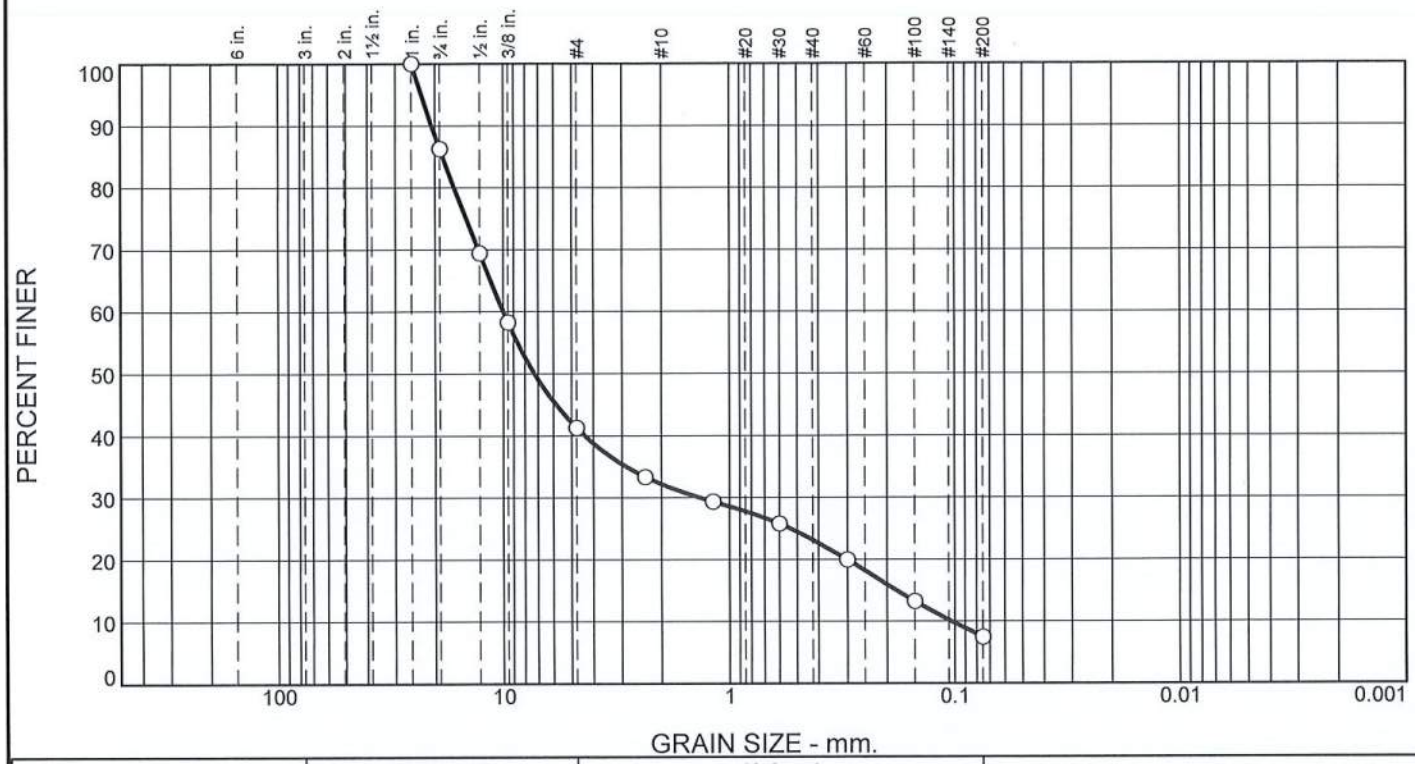
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	14	45	9	9	16	7

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1 Inch	100		
3/4 Inch	86		
1/2 Inch	69		
3/8 Inch	58		
#4	41		
#8	33		
#16	29		
#30	26		
#50	20		
#100	13		
#200	7.4		

* (no specification provided)

Material Description

Brown well-graded gravel with silt and sand

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= GW-GM AASHTO (M 145)= A-1-a

Coefficients

D_{90}= 20.6504 D_{85}= 18.5102 D_{60}= 9.9987
D_{50}= 7.2648 D_{30}= 1.3587 D_{15}= 0.1815
D_{10}= 0.1034 C_u= 96.69 C_c= 1.79

Remarks

F.M.=4.93

Date Received: 4/19/19 **Date Tested:** 5/6/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42724 **Depth:** 25.5'-26.5'

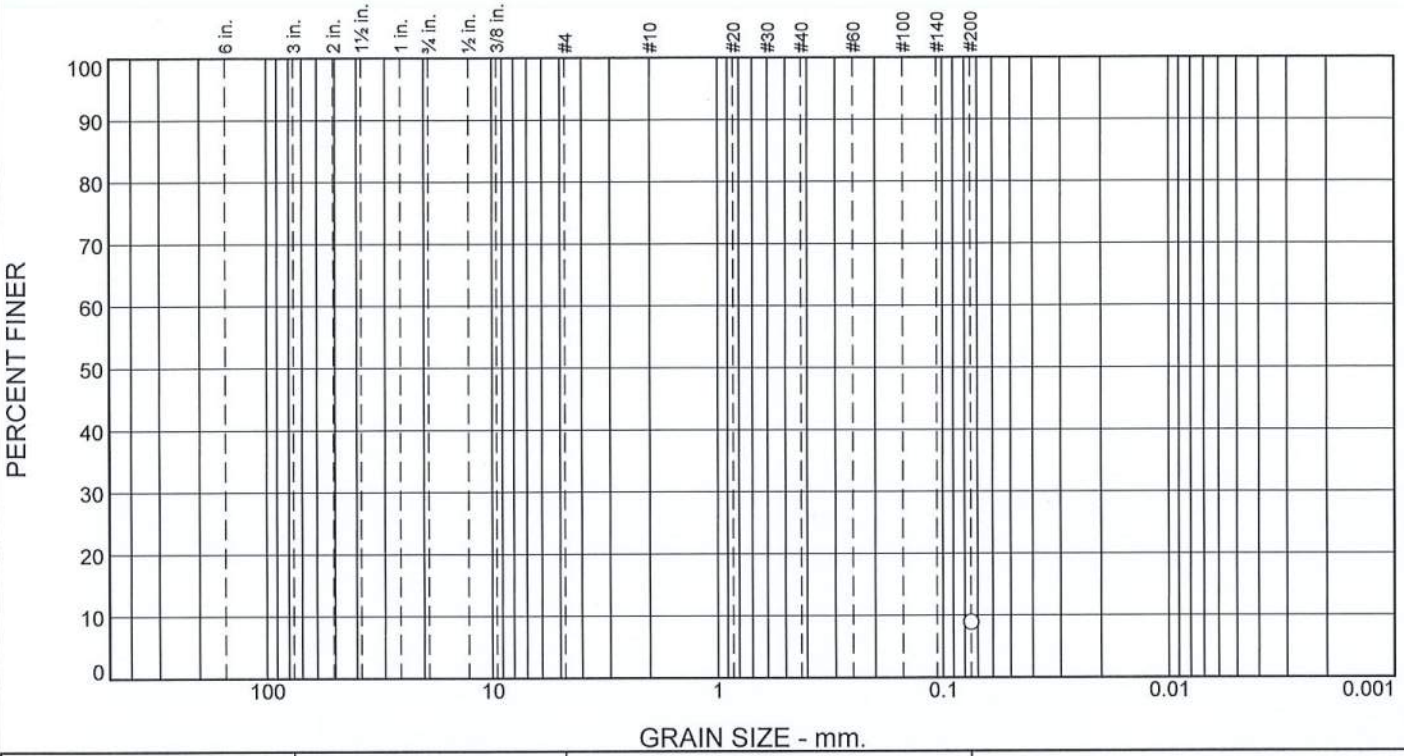
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						9

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	8.9		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/7/19

Tested By: RC

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42727 **Depth:** 30.5'-31.5'

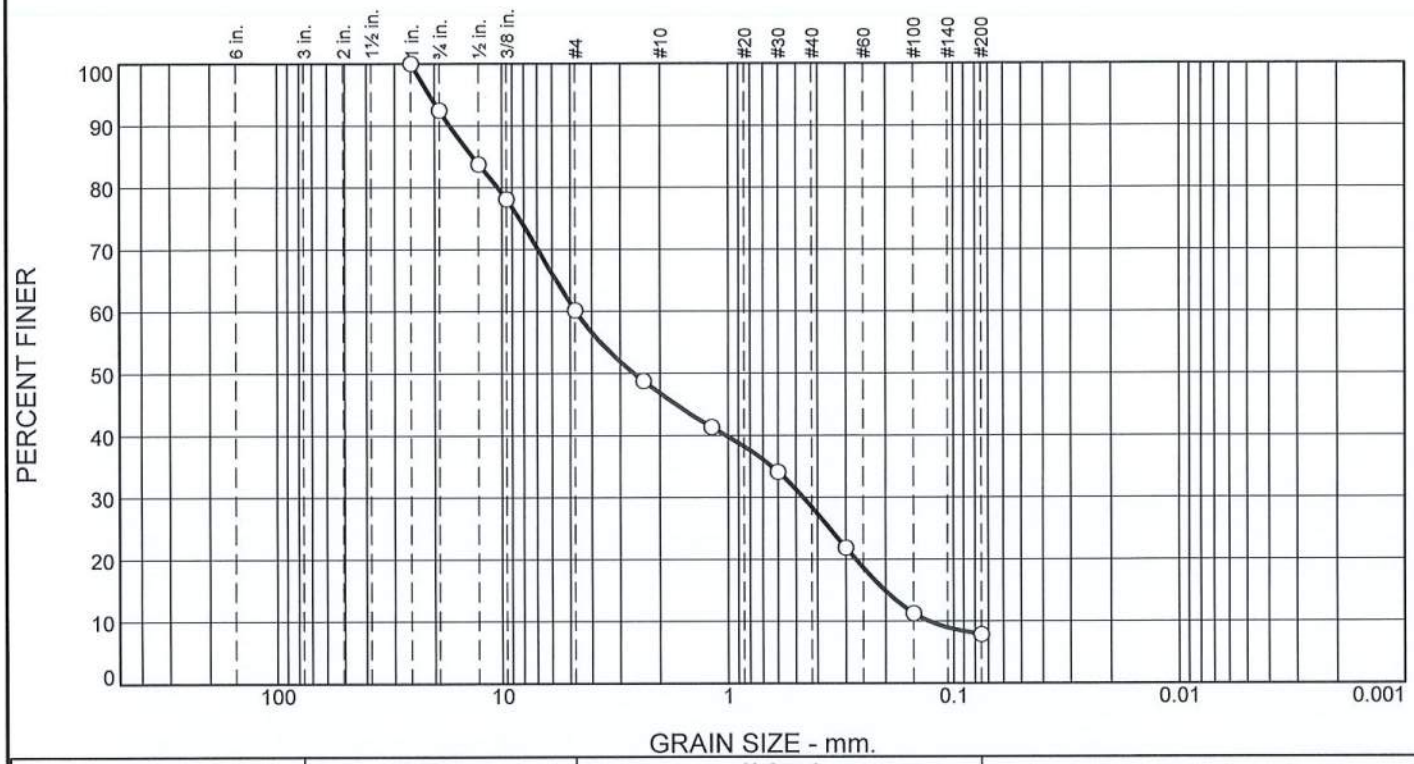
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	8	32	13	19	20	8

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1 Inch	100		
3/4 Inch	92		
1/2 Inch	84		
3/8 Inch	78		
#4	60		
#8	49		
#16	41		
#30	34		
#50	22		
#100	11		
#200	7.9		

* (no specification provided)

Material Description

Brown poorly graded sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-a

Coefficients

D_{90}= 17.1632 D_{85}= 13.5428 D_{60}= 4.7151
D_{50}= 2.6037 D_{30}= 0.4642 D_{15}= 0.2013
D_{10}= 0.1286 C_u= 36.66 C_c= 0.36

Remarks

F.M.=4.12

Date Received: 4/19/19 **Date Tested:** 5/6/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42725 **Depth:** 35.5'-36.5'

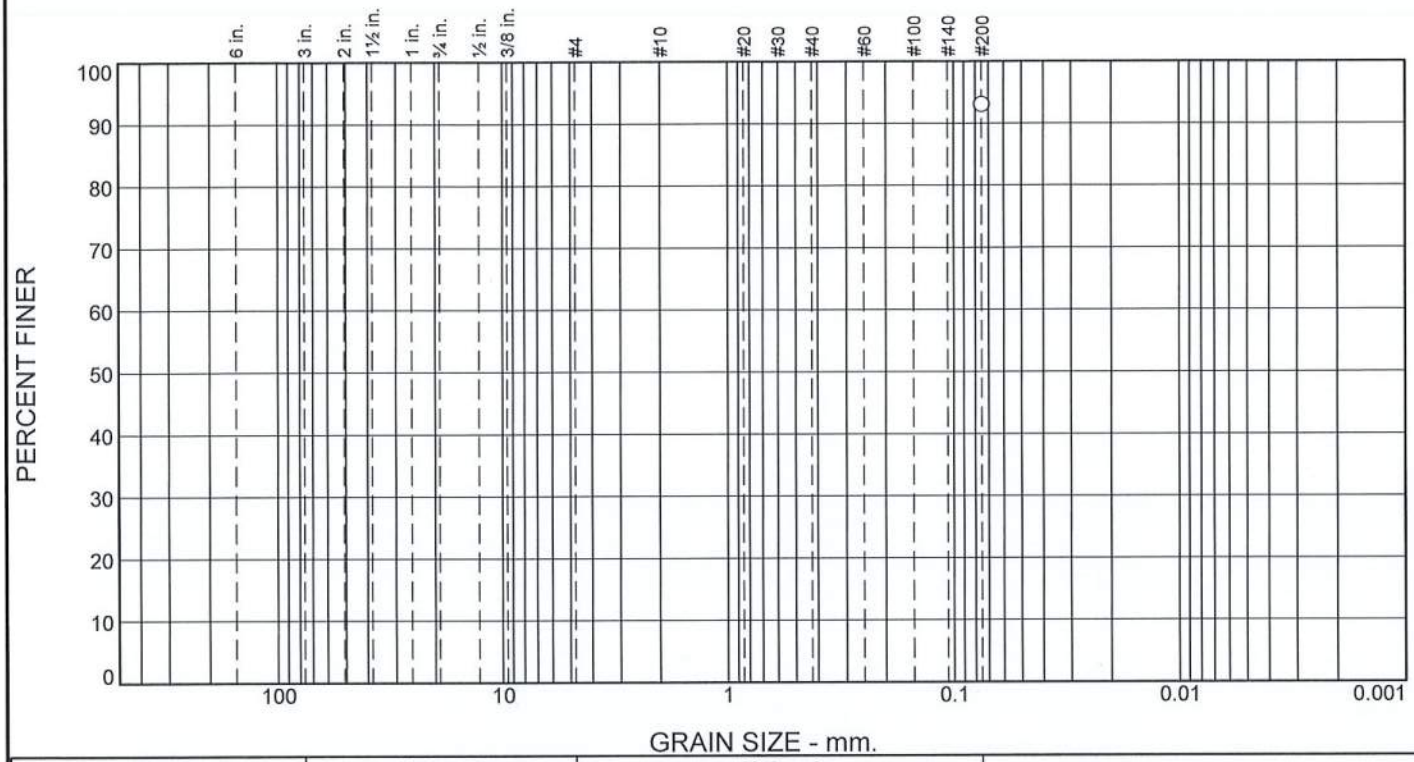
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						93

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	93		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 24 LL= 44 PI= 20

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/8/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42719 **Depth:** 40.5'-41.5'

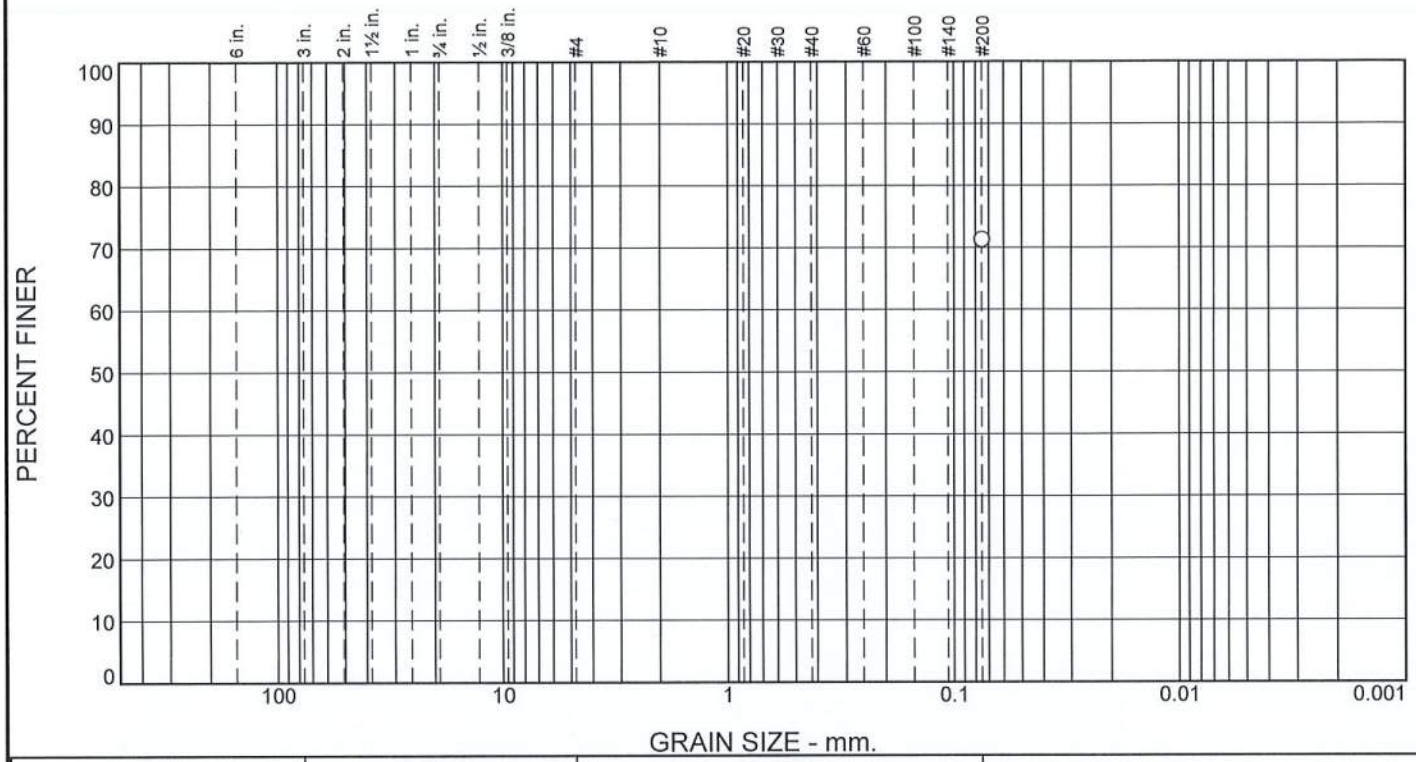
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						71

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	71		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 19 LL= 35 PI= 16

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/7/19

Tested By: RC

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42720 **Depth:** 45.5'-46.5'

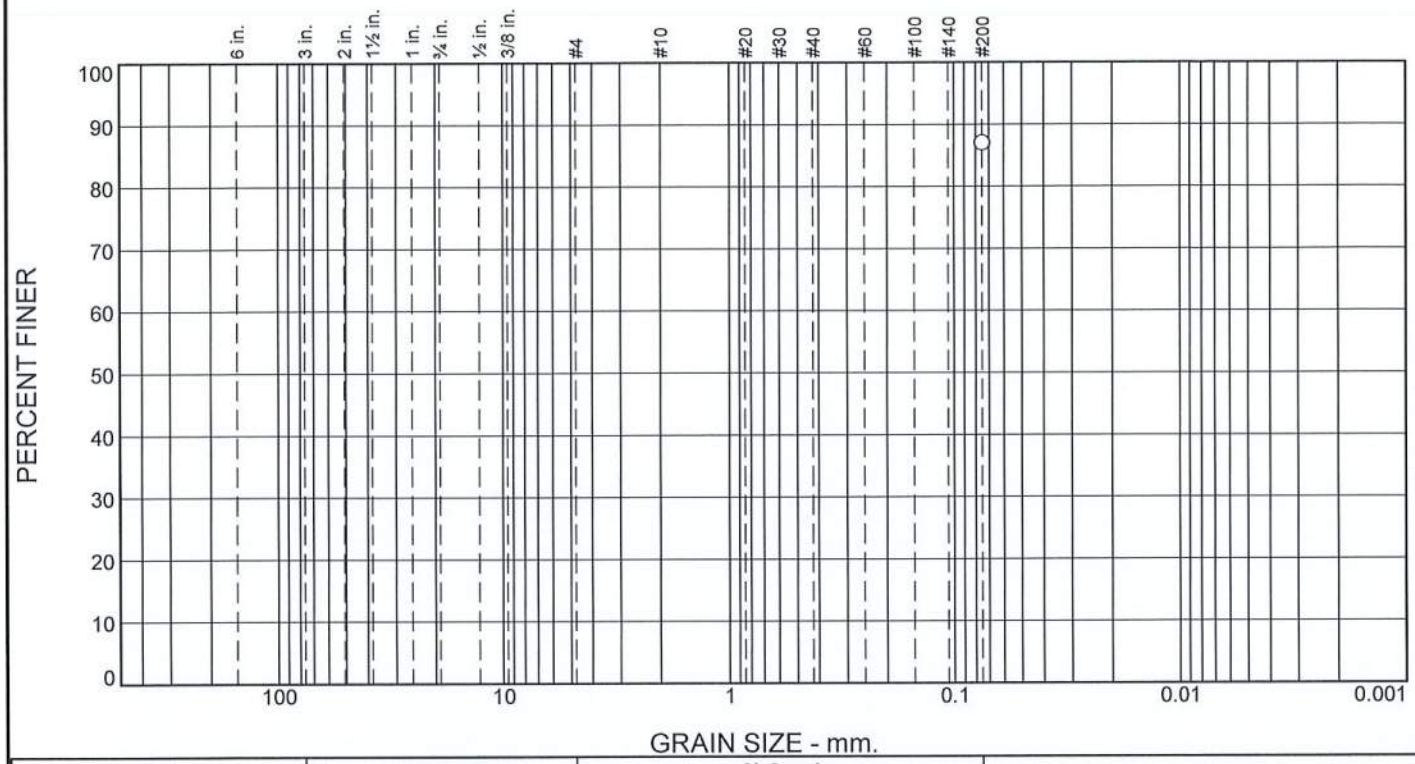
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						87

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	87		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 25 LL= 50 PI= 25

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/8/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-1 **Date Sampled:** -

Sample Number: 42721 **Depth:** 55.5'-56.5'

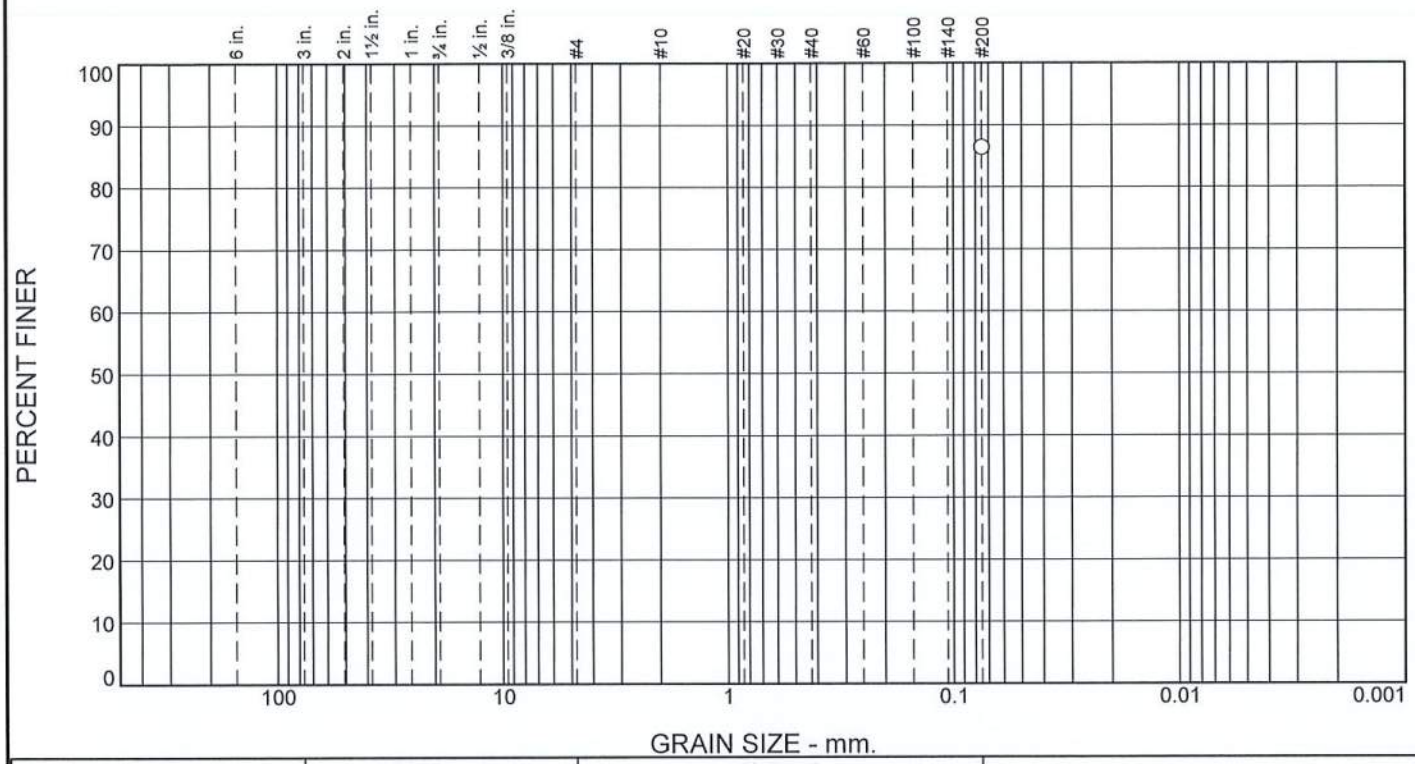
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						86

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	86		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 24 LL= 34 PI= 10

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/8/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42728 **Depth:** 5.5'-6.5'

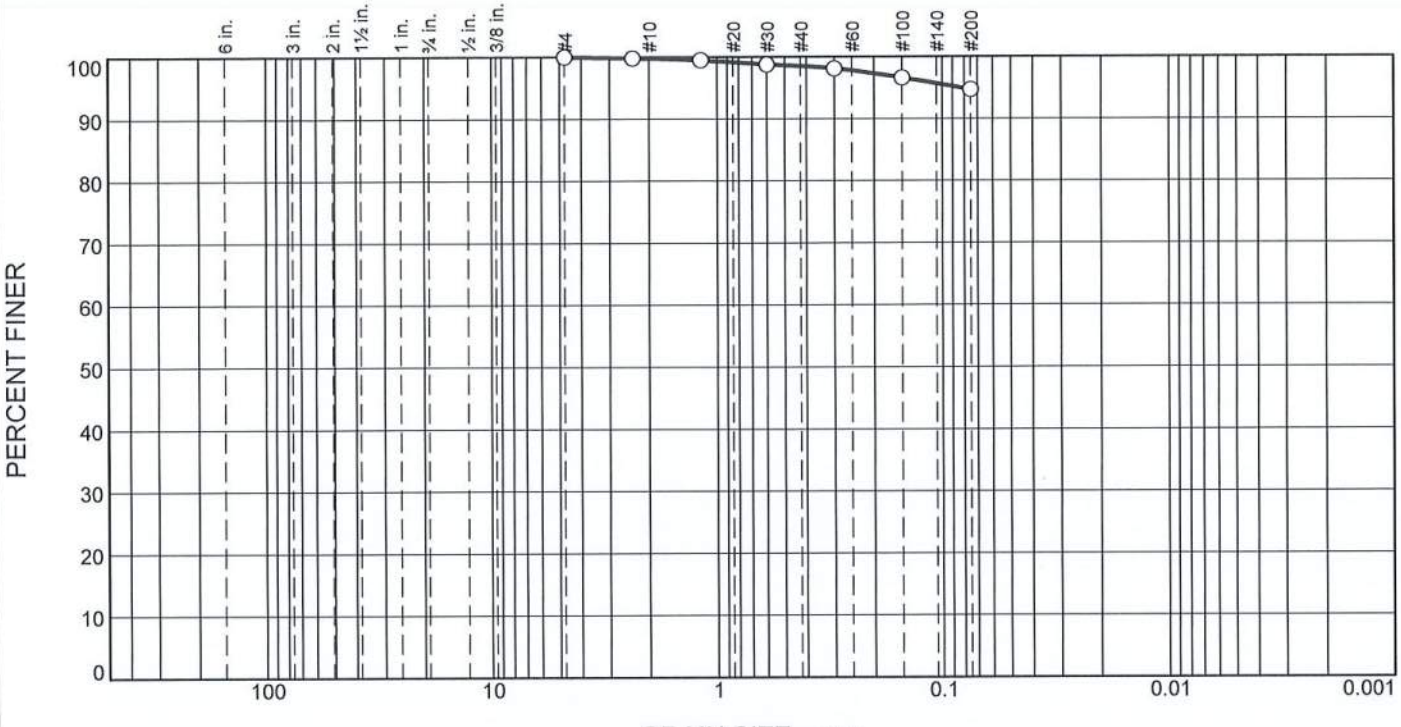
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	1	4	95

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100		
#8	100		
#16	99		
#30	99		
#50	98		
#100	97		
#200	95		

* (no specification provided)

Material Description

Dark brown fat clay

Atterberg Limits (ASTM D 4318)

PL= 28 LL= 53 PI= 25

Classification

USCS (D 2487)= CH AASHTO (M 145)= A-7-6(28)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.07

Date Received: 4/19/19 **Date Tested:** 4/24/19

Tested By: AF

Checked By: JML

Title: PM

Location: MOD CAL: B-2 **Date Sampled:** -

Sample Number: 42748 **Depth:** 13.0'-14.0'

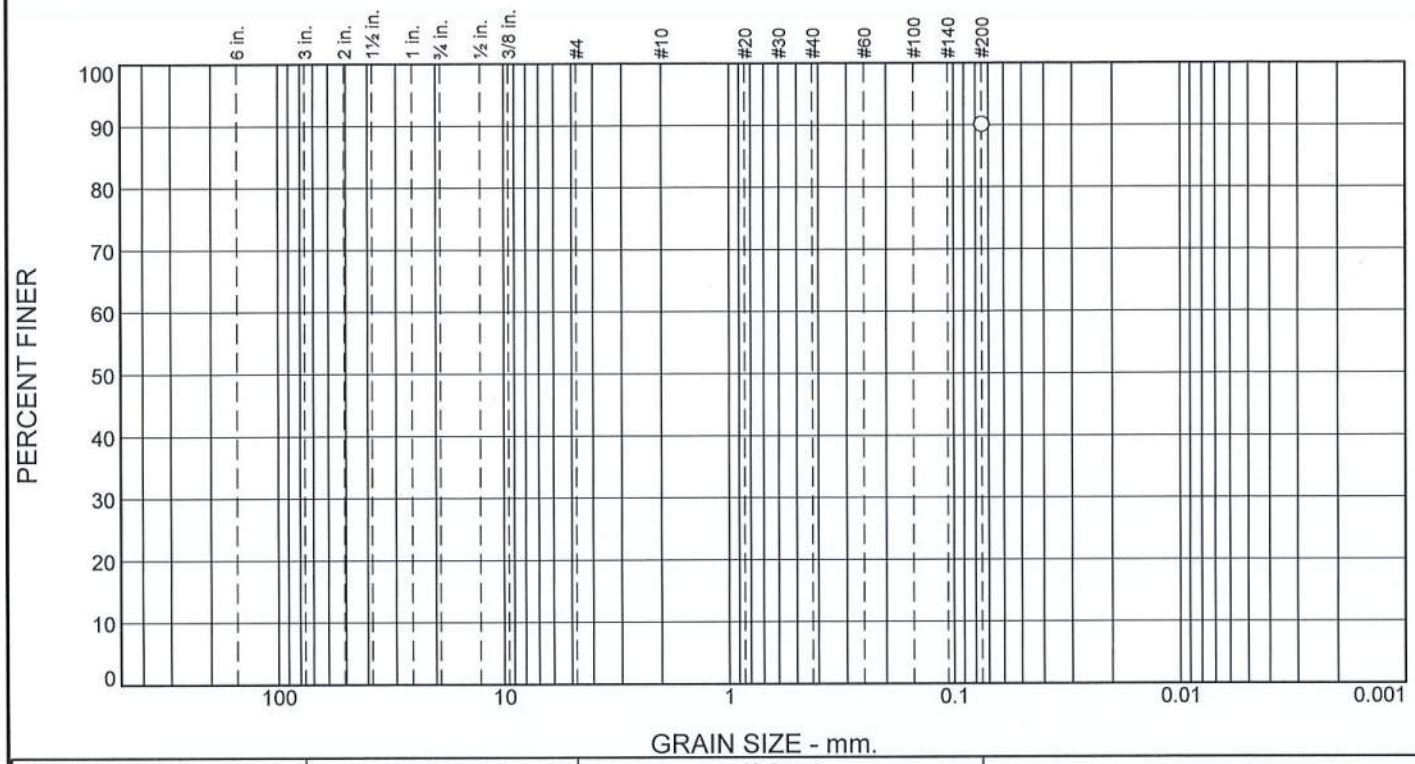
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						90

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	90		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 23 LL= 32 PI= 9

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/8/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42729 **Depth:** 18.0'-19.0'

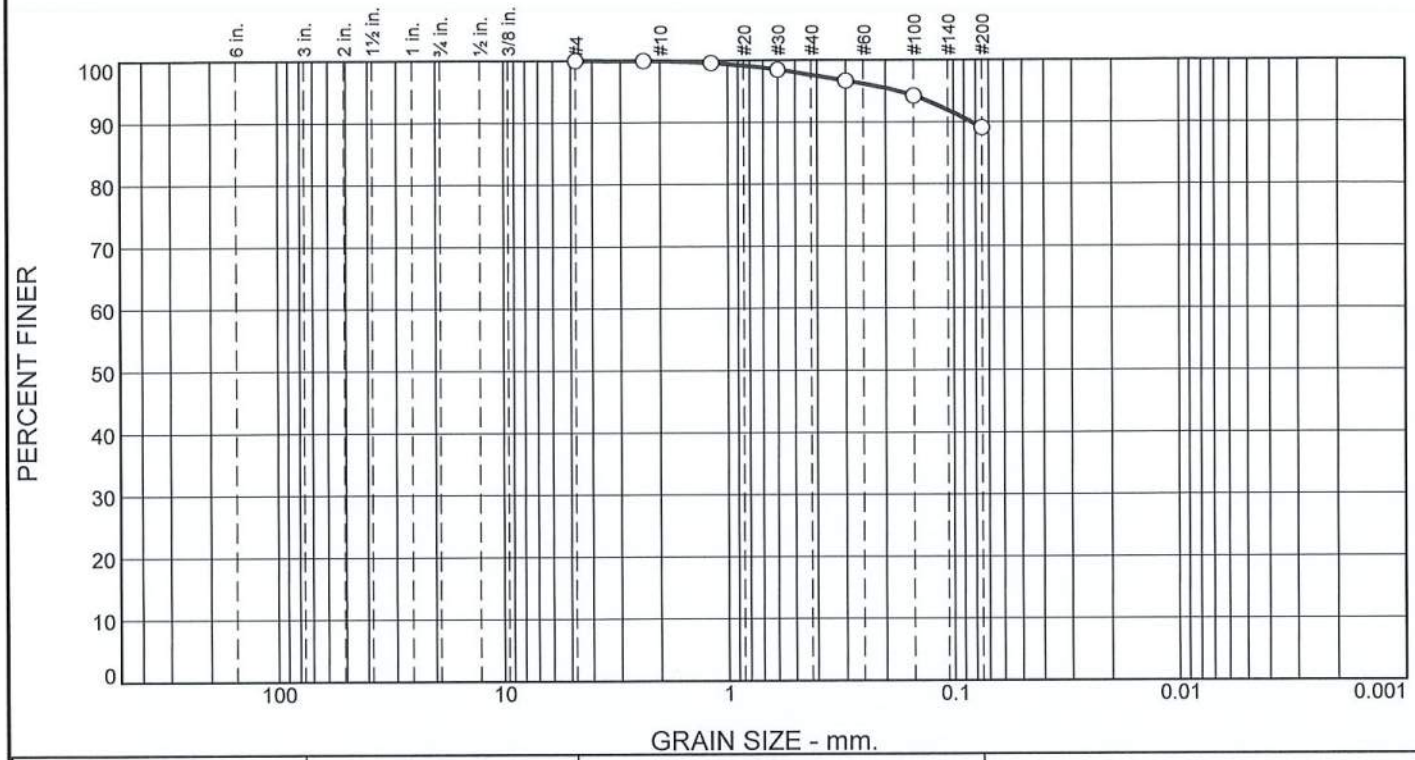
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	2	9	89

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100		
#8	100		
#16	100		
#30	98		
#50	97		
#100	94		
#200	89		

* (no specification provided)

Material Description

Yellow-brown silt

Atterberg Limits (ASTM D 4318)

PL= 29 LL= 34 PI= 5

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-4(5)

Coefficients

D_{90}= 0.0837 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.11

Date Received: 4/19/19 **Date Tested:** 4/30/19

Tested By: JM

Checked By: JML

Title: PM

Location: MOD CAL: B-2 **Date Sampled:** -

Sample Number: 42749 **Depth:** 20.5'-21.5'

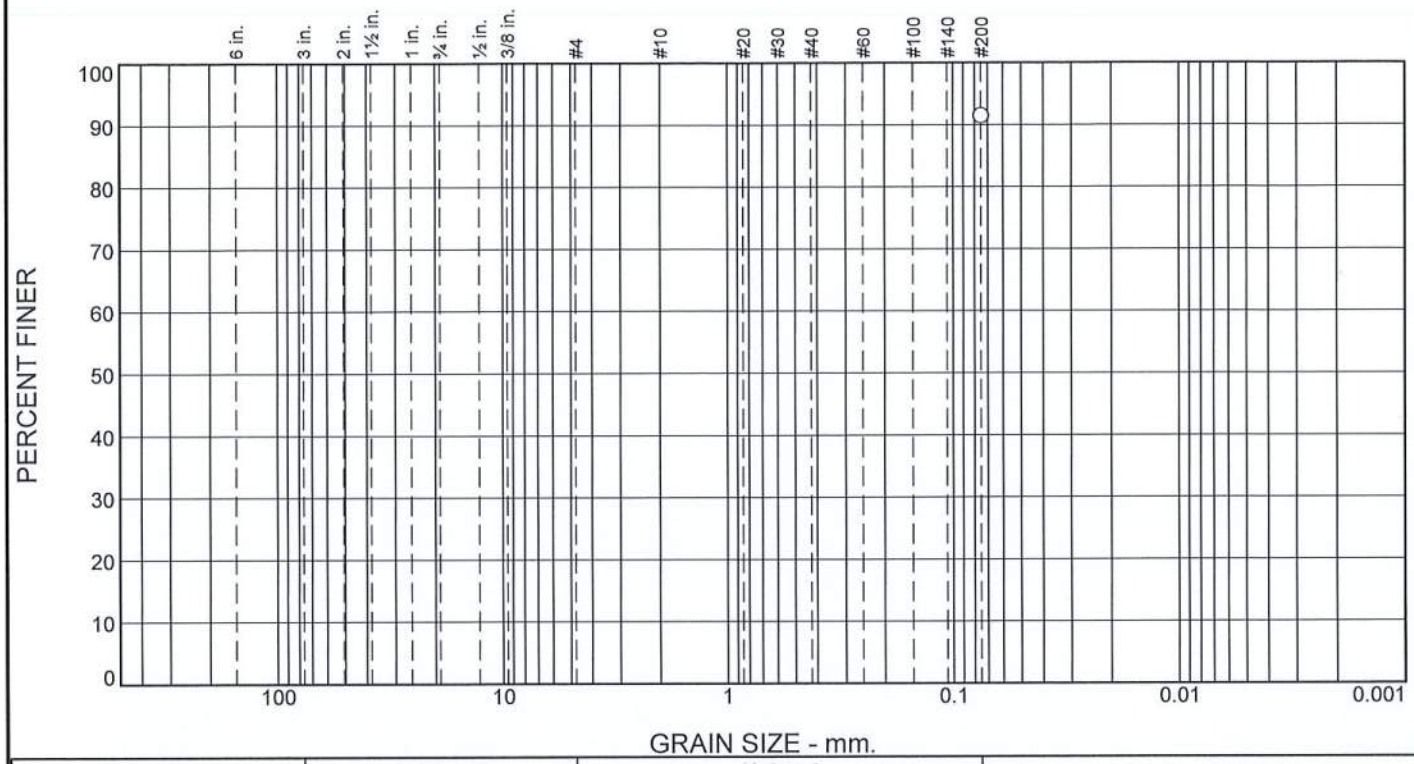
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						91

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	91		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 22 LL= 47 PI= 25

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/7/19

Tested By: RC

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42730 **Depth:** 33.0'-34.0'

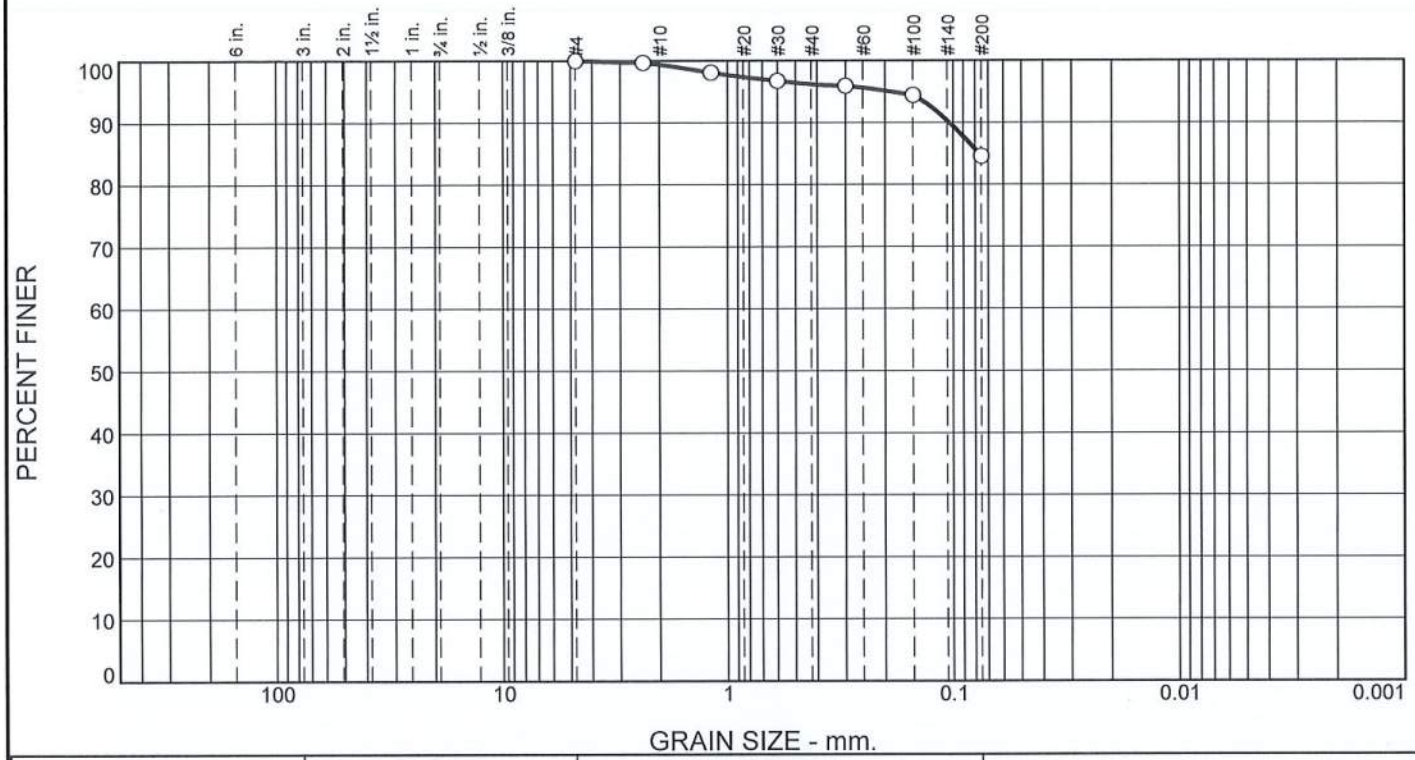
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	1	3	11	85

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100		
#8	100		
#16	98		
#30	97		
#50	96		
#100	94		
#200	85		

* (no specification provided)

Material Description

Brown silt with sand

Atterberg Limits (ASTM D 4318)

PL= 25 LL= 35 PI= 10

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-4(9)

Coefficients

D_{90}= 0.1039 D_{85}= 0.0768 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.15

Date Received: 4/19/19 **Date Tested:** 5/14/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42731 **Depth:** 35.5'-36.5'

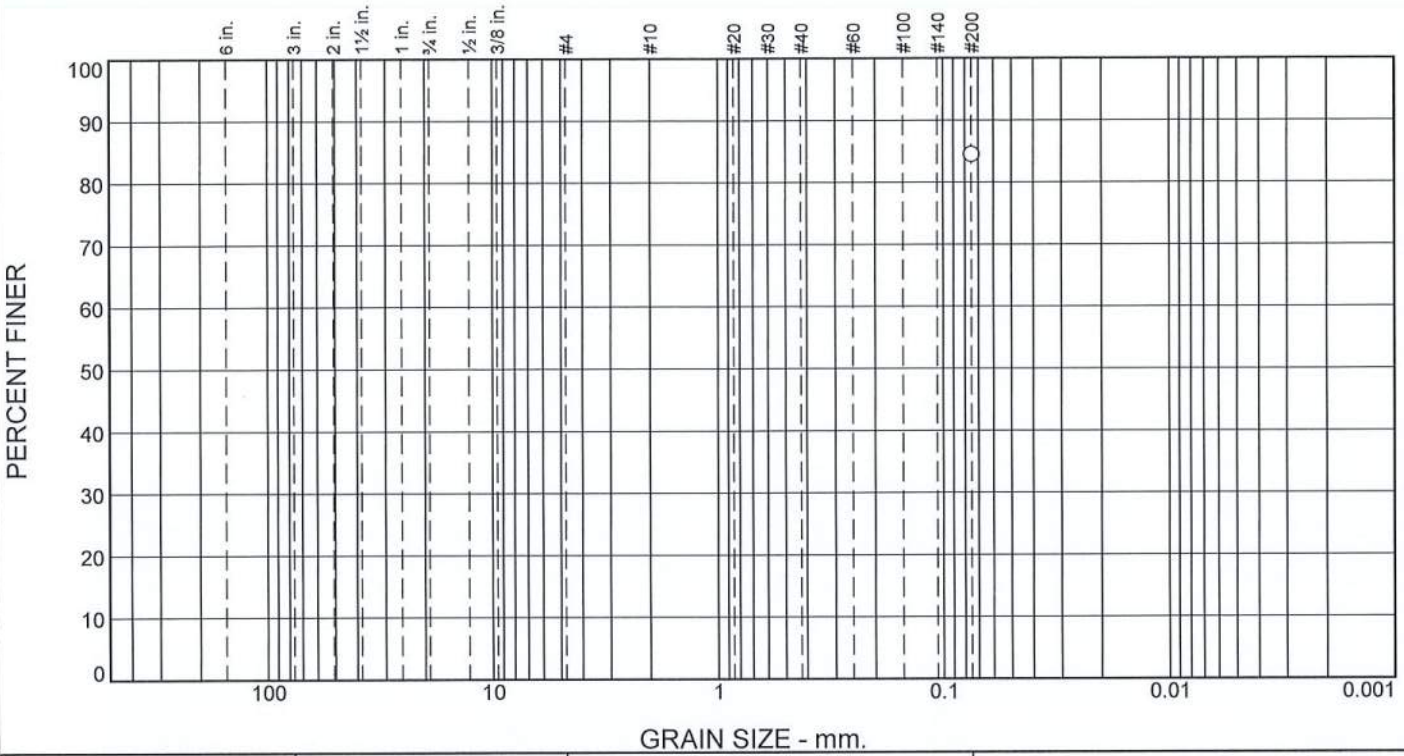
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						85

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	85		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 25 LL= 31 PI= 6

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/7/19

Tested By: RC

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42732 **Depth:** 38.0'-39.0'

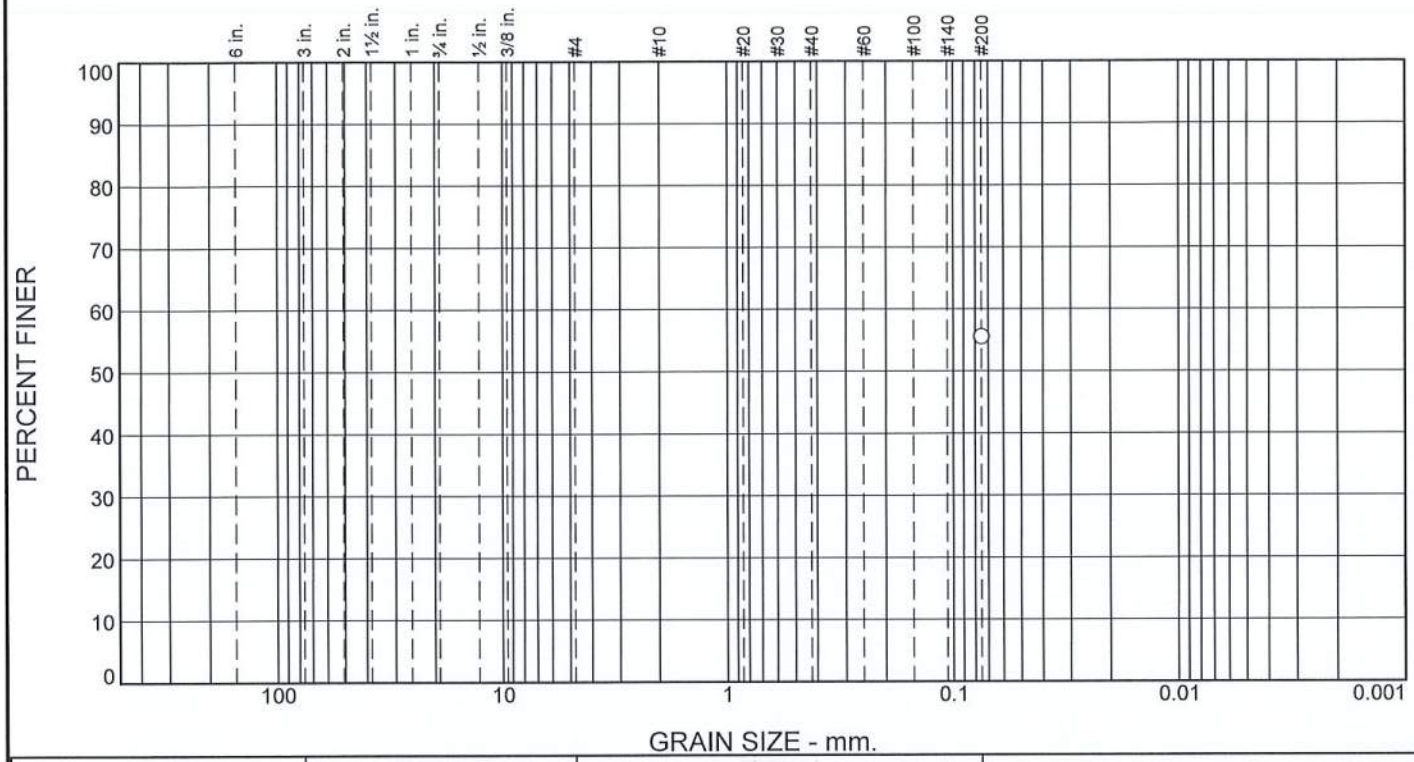
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						56

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	56		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/7/19

Tested By: RC

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42735 **Depth:** 40.5'-41.5'

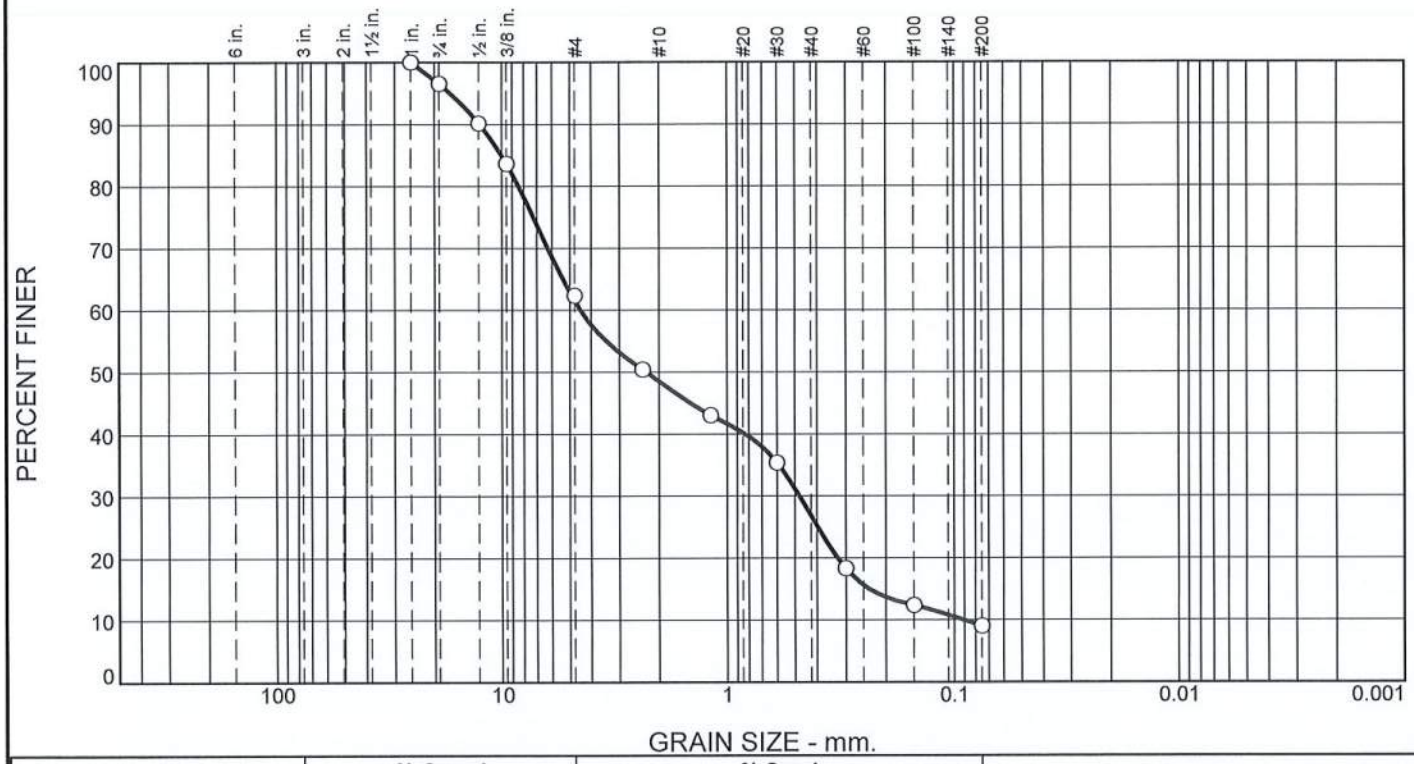
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	3	35	13	22	18	9

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1 Inch	100		
3/4 Inch	97		
1/2 Inch	90		
3/8 Inch	84		
#4	62		
#8	50		
#16	43		
#30	35		
#50	18		
#100	12		
#200	9.0		

* (no specification provided)

Material Description

Brown poorly graded sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-a

Coefficients

D_{90}= 12.5977 D_{85}= 10.0376 D_{60}= 4.4706
D_{50}= 2.2775 D_{30}= 0.4784 D_{15}= 0.2364
D_{10}= 0.0904 C_u= 49.48 C_c= 0.57

Remarks

F.M.=3.99

Date Received: 4/19/19 **Date Tested:** 5/14/19

Tested By: BM/JM

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42733 **Depth:** 45.5'-46.5'

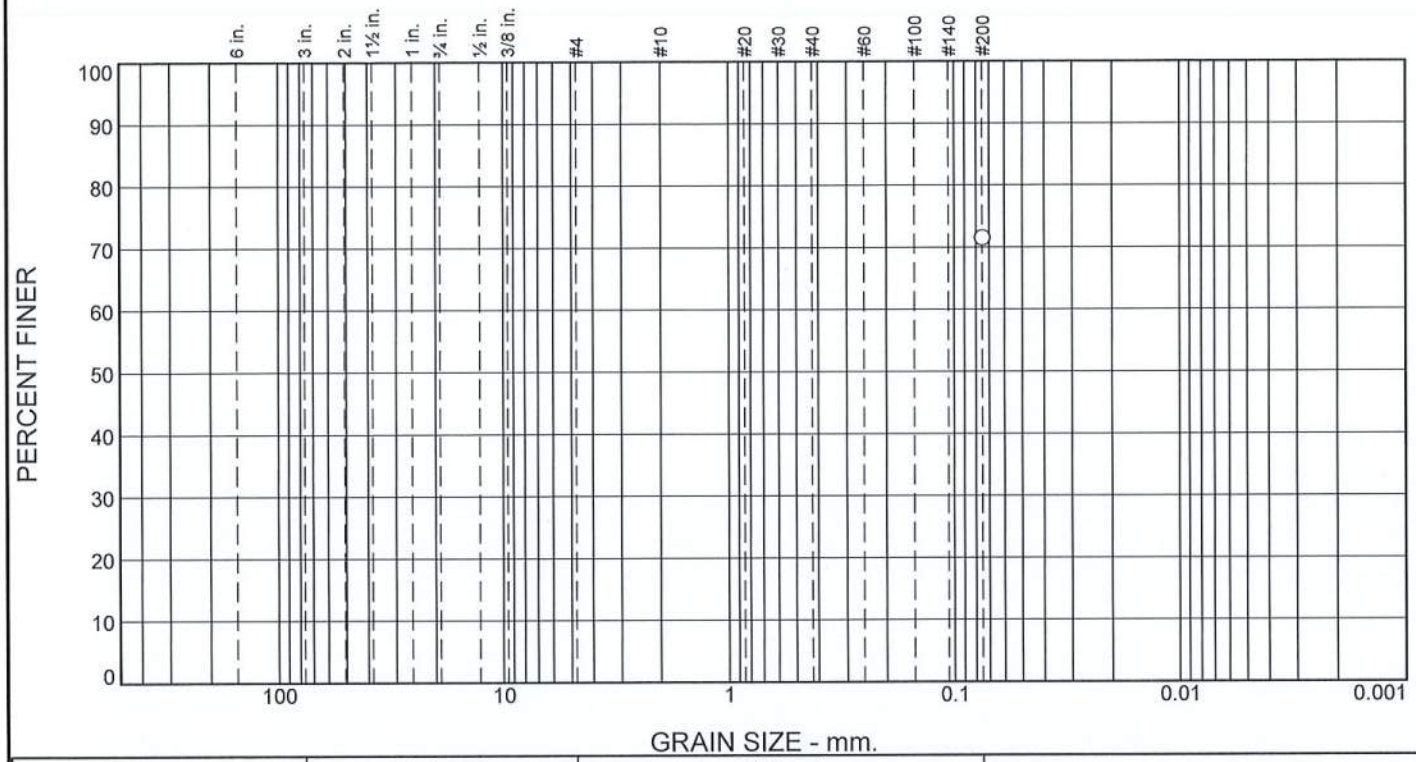
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						72

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	72		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/7/19

Tested By: RC

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42736 **Depth:** 50.5'-51.5'

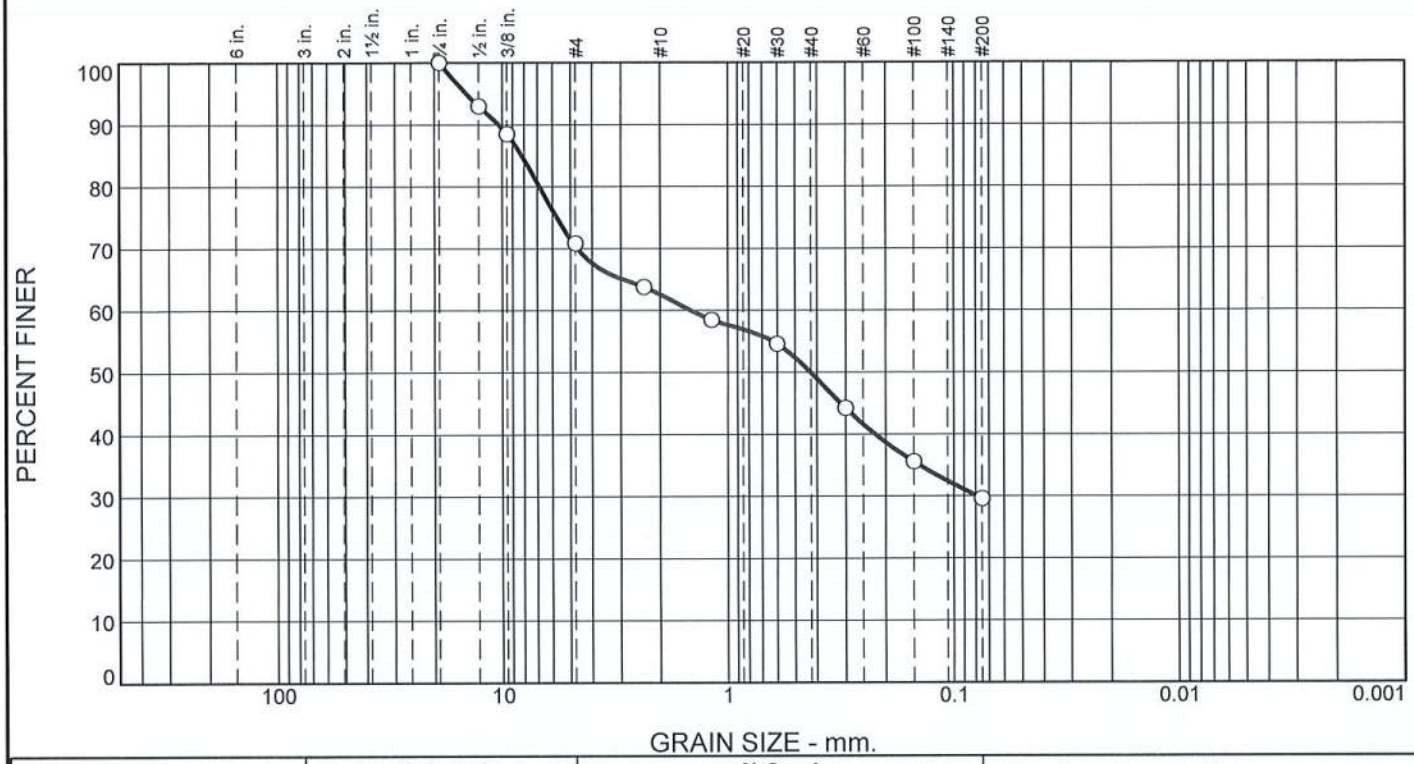
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	30	7	13	20	30

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/4 Inch	100		
1/2 Inch	93		
3/8 Inch	89		
#4	70		
#8	64		
#16	58		
#30	55		
#50	44		
#100	36		
#200	30		

* (no specification provided)

Material Description

Brown silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D_{90}= 10.3618 D_{85}= 8.1911 D_{60}= 1.4615
D_{50}= 0.4273 D_{30}= 0.0791 D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=2.84

Date Received: 4/19/19 **Date Tested:** 5/14/19

Tested By: BM

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42734 **Depth:** 60.5'-61.5'

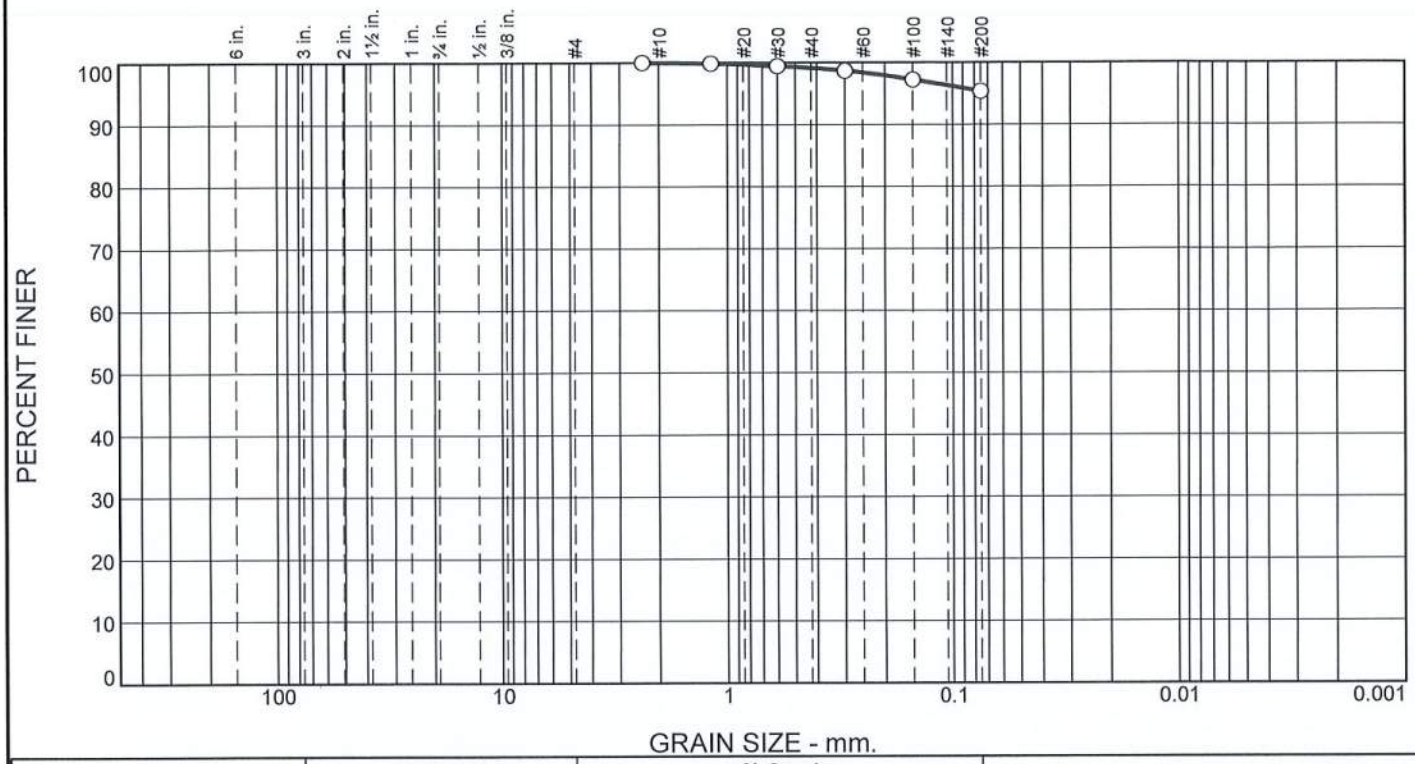
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	1	4	95

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#8	100		
#16	100		
#30	99		
#50	99		
#100	97		
#200	95		

* (no specification provided)

Material Description

Brown lean clay

Atterberg Limits (ASTM D 4318)

PL= 20 LL= 31 PI= 11

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-6(10)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.05

Date Received: 4/19/19 **Date Tested:** 5/14/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42737 **Depth:** 13.0'-14.0'

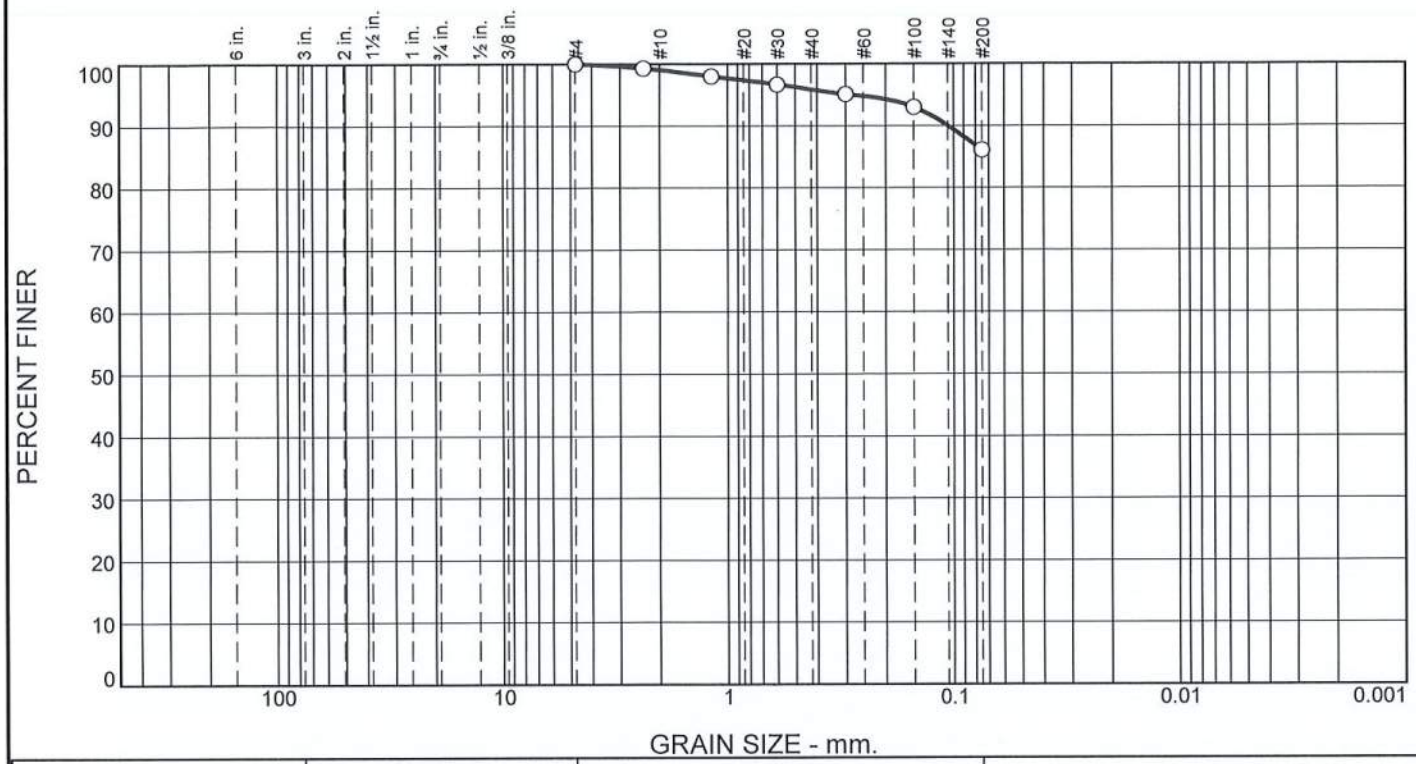
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	1	3	10	86

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100		
#8	99		
#16	98		
#30	97		
#50	95		
#100	93		
#200	86		

* (no specification provided)

Material Description

Yellow-brown silt

Atterberg Limits (ASTM D 4318)

PL= 32 LL= 48 PI= 16

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-7-5(16)

Coefficients

D_{90}= 0.1062 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.18

Date Received: 4/19/19 **Date Tested:** 4/30/19

Tested By: JM

Checked By: JML

Title: PM

Location: MOD CAL: B-3 **Date Sampled:** -

Sample Number: 42750 **Depth:** 18.0'-19.0'

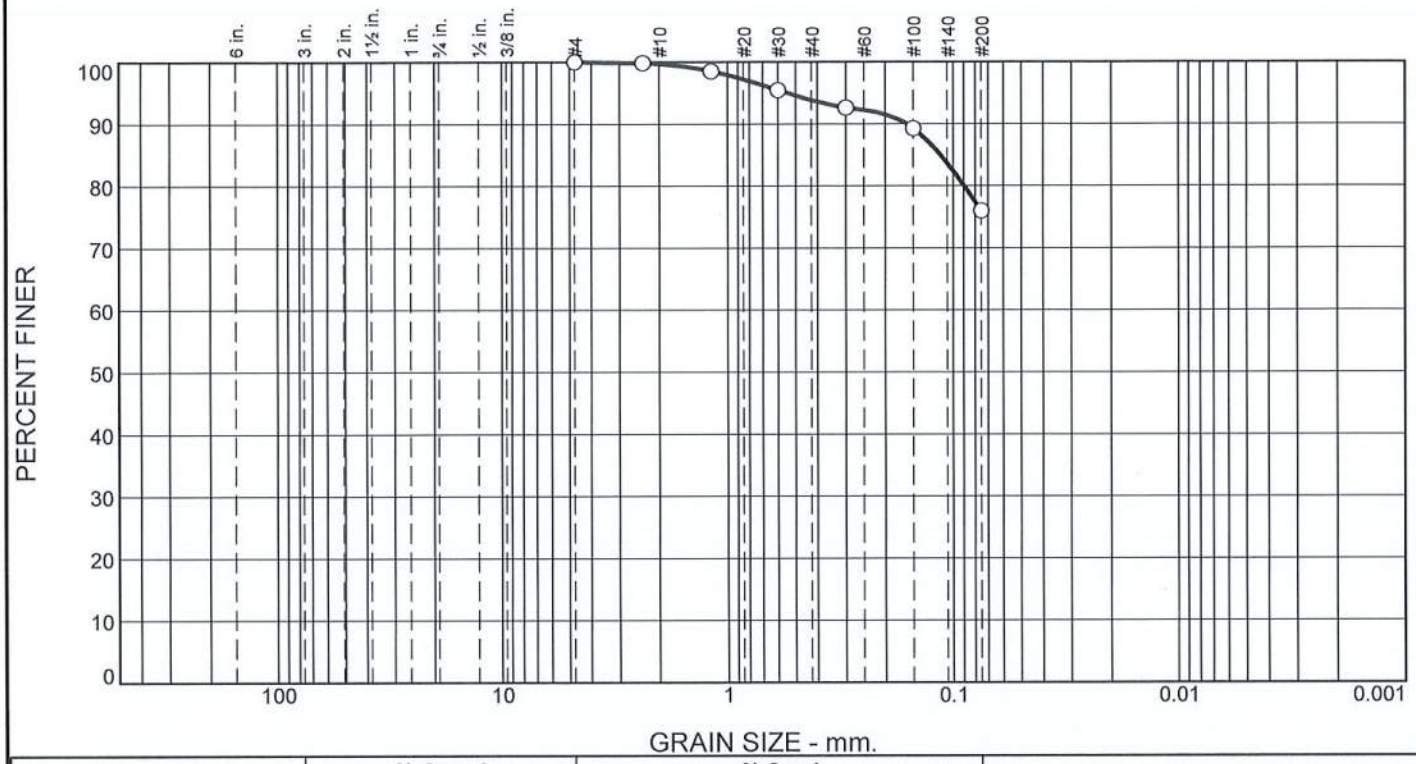
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	6	18	76

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100		
#8	100		
#16	99		
#30	95		
#50	93		
#100	89		
#200	76		

* (no specification provided)

Material Description

Brown silty clay with sand

Atterberg Limits (ASTM D 4318)

PL= 18 LL= 23 PI= 5

Classification

USCS (D 2487)= CL-ML AASHTO (M 145)= A-4(2)

Coefficients

D_{90}= 0.1604 D_{85}= 0.1139 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.24

Date Received: 4/19/19 **Date Tested:** 5/14/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42738 **Depth:** 20.5'-21.5'

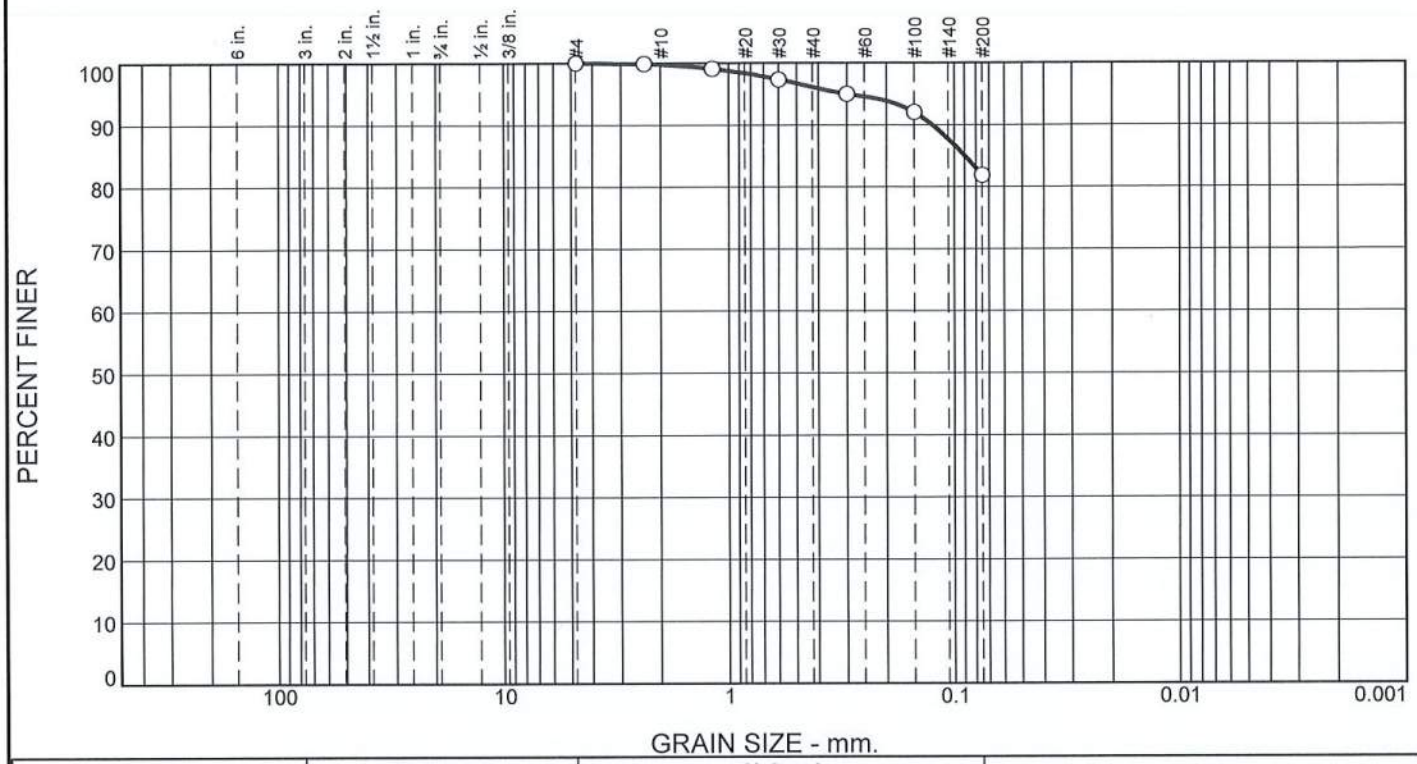
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	4	14	82

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100		
#8	100		
#16	99		
#30	97		
#50	95		
#100	92		
#200	82		

* (no specification provided)

Material Description

Brown silt with sand

Atterberg Limits (ASTM D 4318)

PL= 24 LL= 30 PI= 6

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-4(4)

Coefficients

D_{90}= 0.1249 D_{85}= 0.0898 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.17

Date Received: 4/19/19 **Date Tested:** 5/14/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42739 **Depth:** 23.0'-24.0'

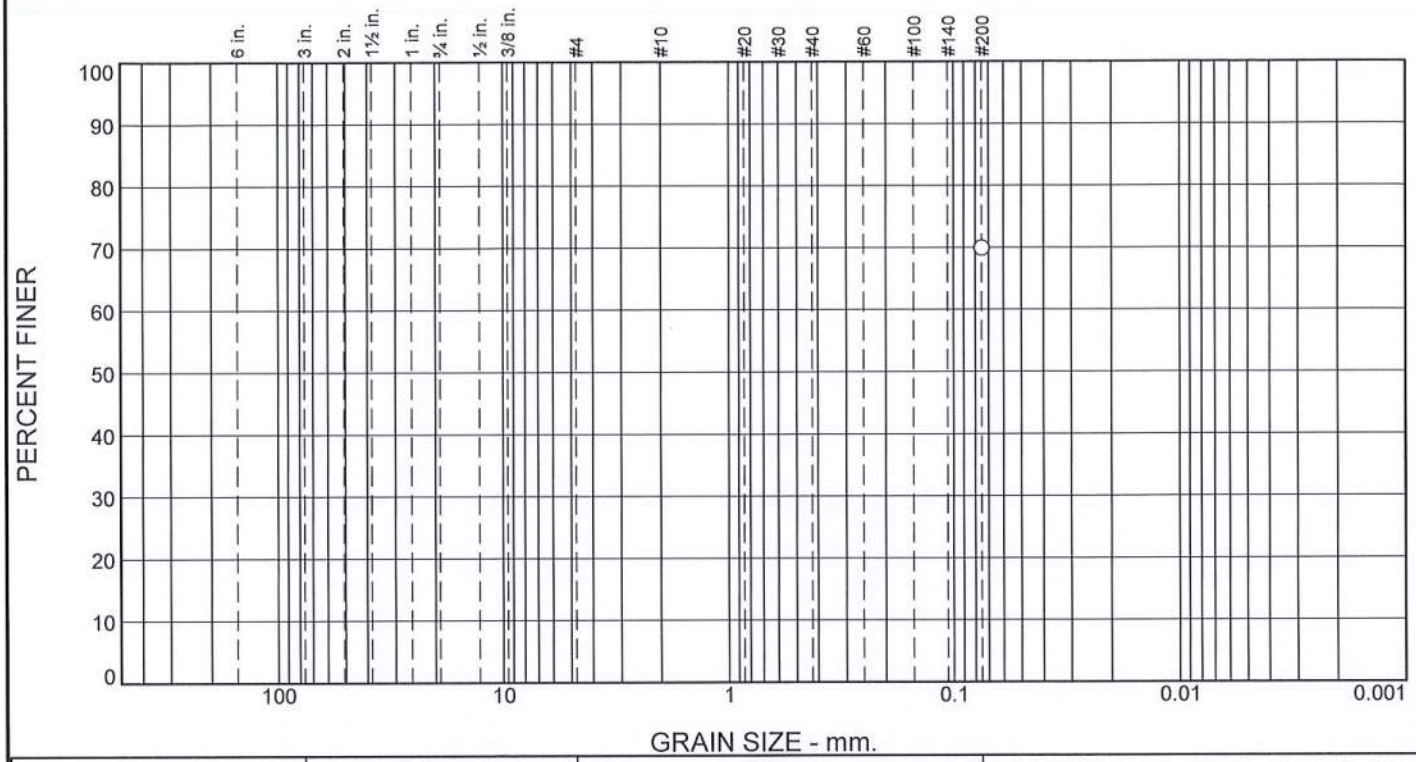
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						70

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	70		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= 23 LL= 26 PI= 3

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/7/19

Tested By: RC

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42740 **Depth:** 30.5'-31.5'

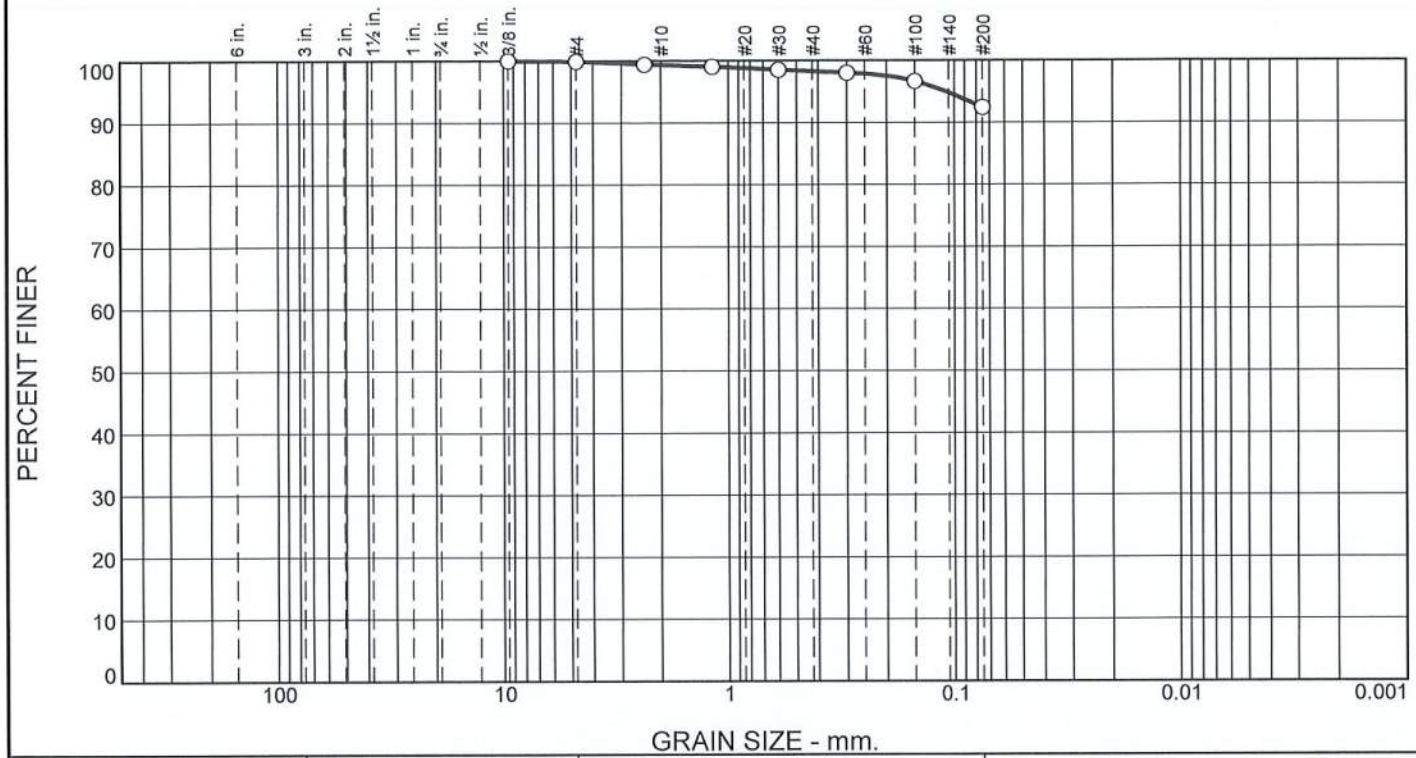
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	1	1	6	92

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8 Inch	100		
#4	100		
#8	99		
#16	99		
#30	99		
#50	98		
#100	97		
#200	92		

* (no specification provided)

Material Description

Brown lean clay

Atterberg Limits (ASTM D 4318)

PL= 17 LL= 28 PI= 11

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-6(9)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.08

Date Received: 4/19/19 **Date Tested:** 4/30/19

Tested By: JM

Checked By: JML

Title: PM

Location: MOD CAL: B-3 **Date Sampled:** -

Sample Number: 42751 **Depth:** 33.0'-34.0'

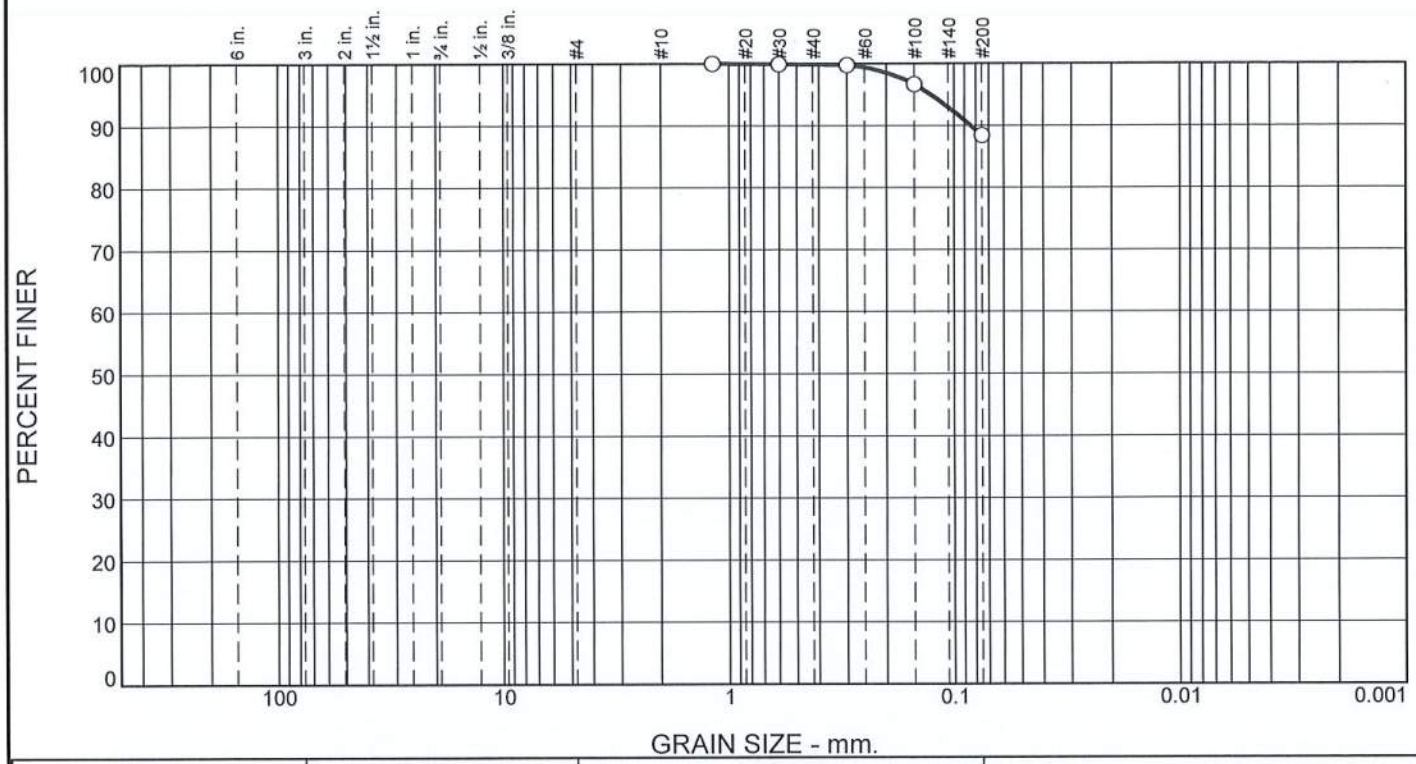
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	0	12	88

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#16	100		
#30	100		
#50	100		
#100	97		
#200	88		

* (no specification provided)

Material Description

Brown lean clay

Atterberg Limits (ASTM D 4318)

PL= 19 LL= 36 PI= 17

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-6(15)

Coefficients

D_{90}= 0.0846 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.04

Date Received: 4/19/19 **Date Tested:** 5/15/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42741 **Depth:** 35.5'-36.5'

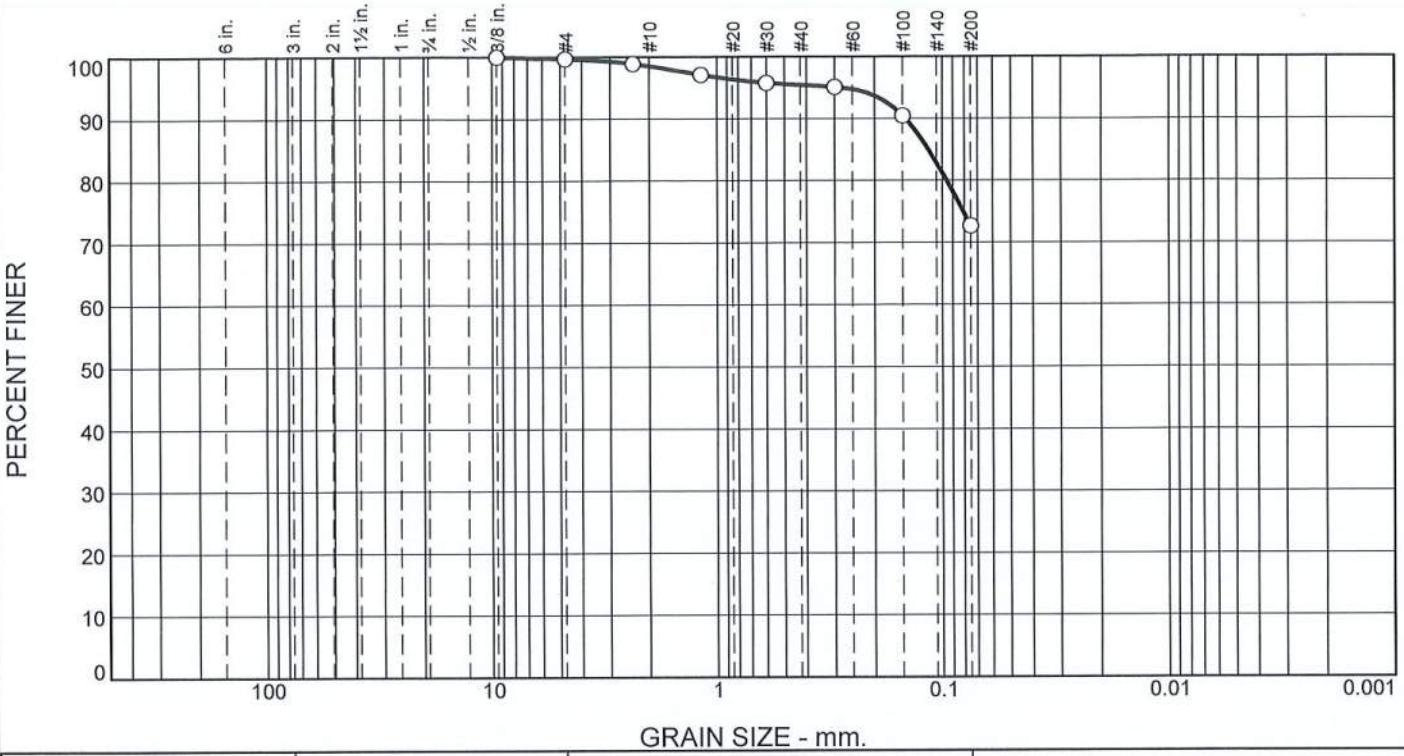
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	1	4	22	73

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8 Inch	100		
#4	100		
#8	99		
#16	97		
#30	96		
#50	95		
#100	90		
#200	73		

* (no specification provided)

Material Description

Brown lean clay with sand

Atterberg Limits (ASTM D 4318)

PL= 22 LL= 31 PI= 9

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-4(5)

Coefficients

D_{90}= 0.1458 D_{85}= 0.1155 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.23

Date Received: 4/19/19 **Date Tested:** 5/15/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42745 **Depth:** 40.5'-41.5'

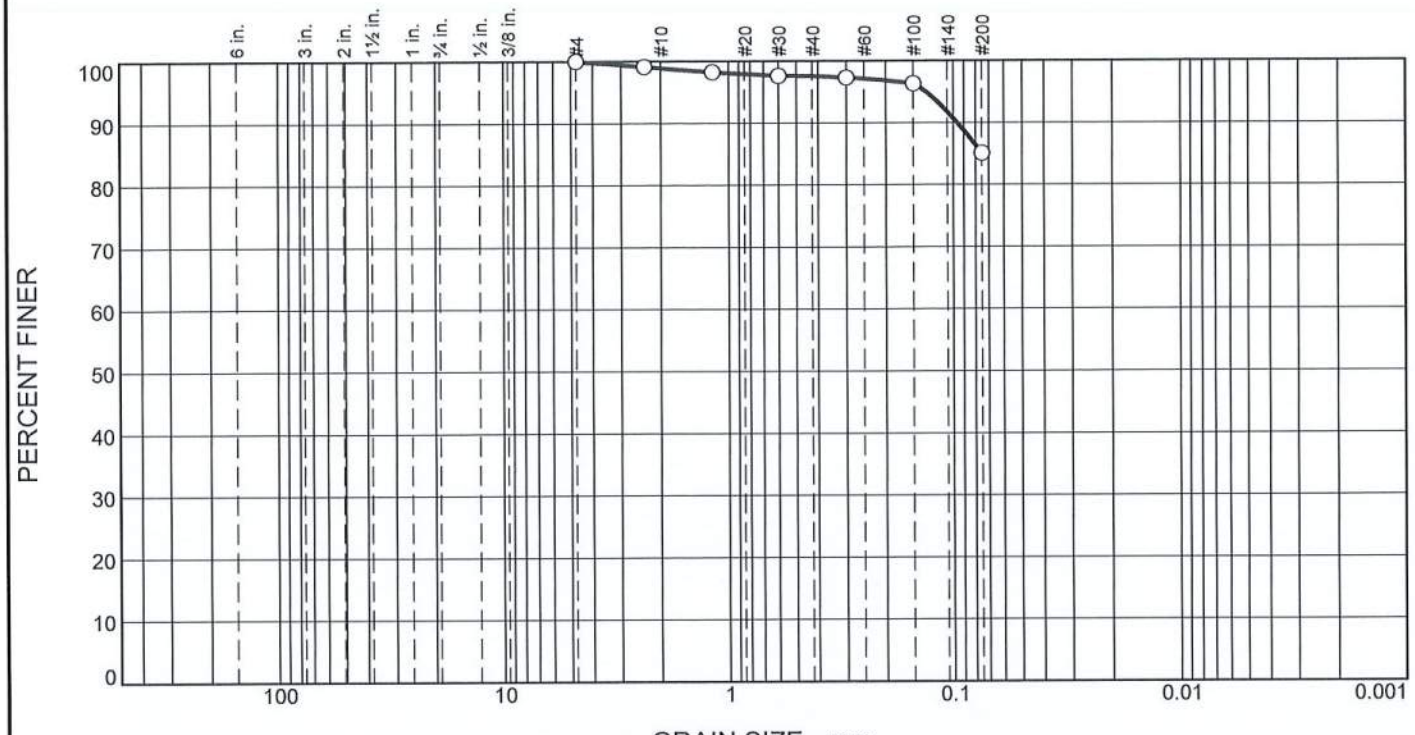
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	1	1	13	85

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100		
#8	99		
#16	98		
#30	98		
#50	97		
#100	96		
#200	85		

* (no specification provided)

Material Description

Brown silt with sand

Atterberg Limits (ASTM D 4318)

PL= 24 LL= 31 PI= 7

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-4(6)

Coefficients

D_{90}= 0.0963 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.11

Date Received: 4/19/19 **Date Tested:** 5/15/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42746 **Depth:** 43.0'-44.0'

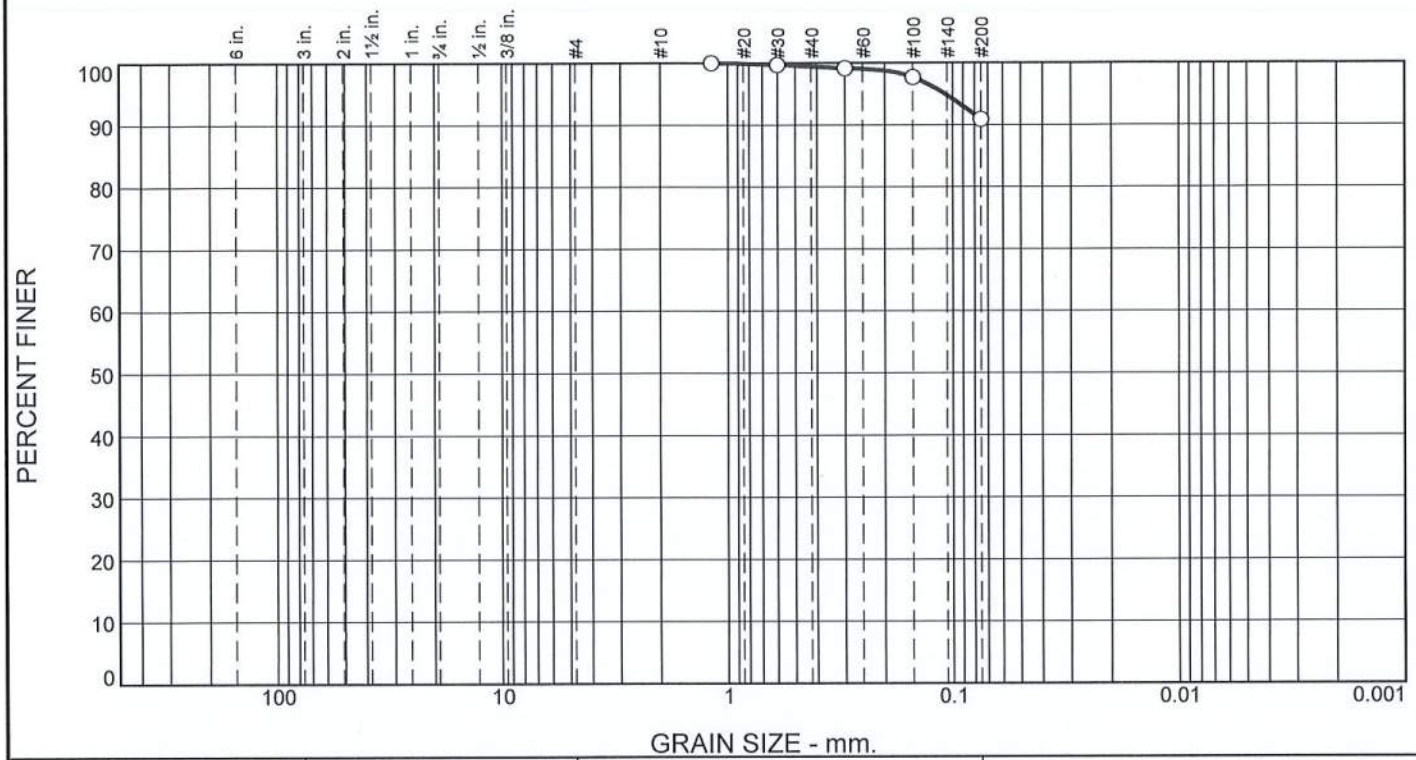
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	1	8	91

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#16	100		
#30	100		
#50	99		
#100	98		
#200	91		

* (no specification provided)

Material Description

Brown lean clay

Atterberg Limits (ASTM D 4318)

PL= 23 LL= 33 PI= 10

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-4(9)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.03

Date Received: 4/19/19 **Date Tested:** 5/15/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42742 **Depth:** 45.5'-46.5'

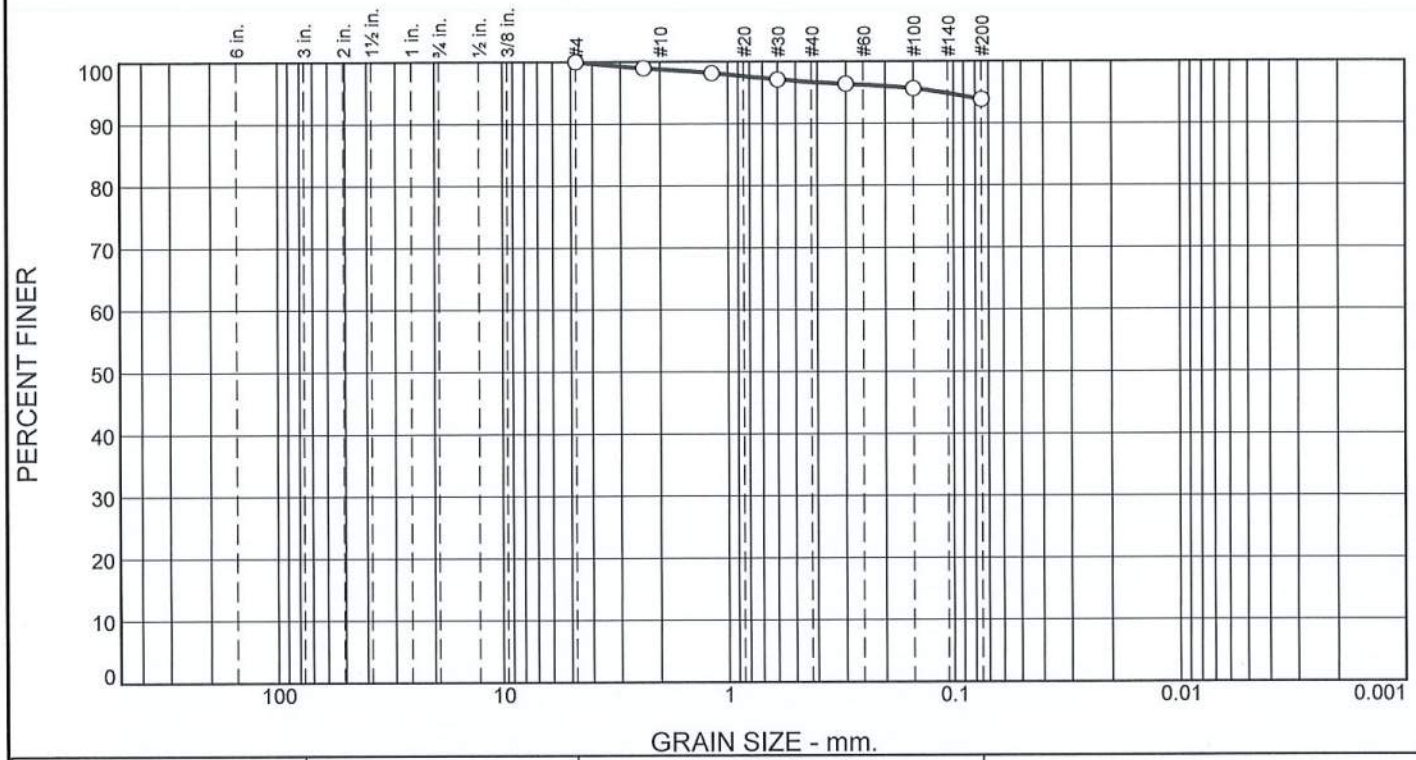
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	1	2	3	94

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100		
#8	99		
#16	98		
#30	97		
#50	96		
#100	96		
#200	94		

* (no specification provided)

Material Description

Brown lean clay

Atterberg Limits (ASTM D 4318)

PL= 22 LL= 34 PI= 12

Classification

USCS (D 2487)= CL AASHTO (M 145)= A-6(12)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.14

Date Received: 4/19/19 **Date Tested:** 5/15/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42743 **Depth:** 50.5'-51.5'

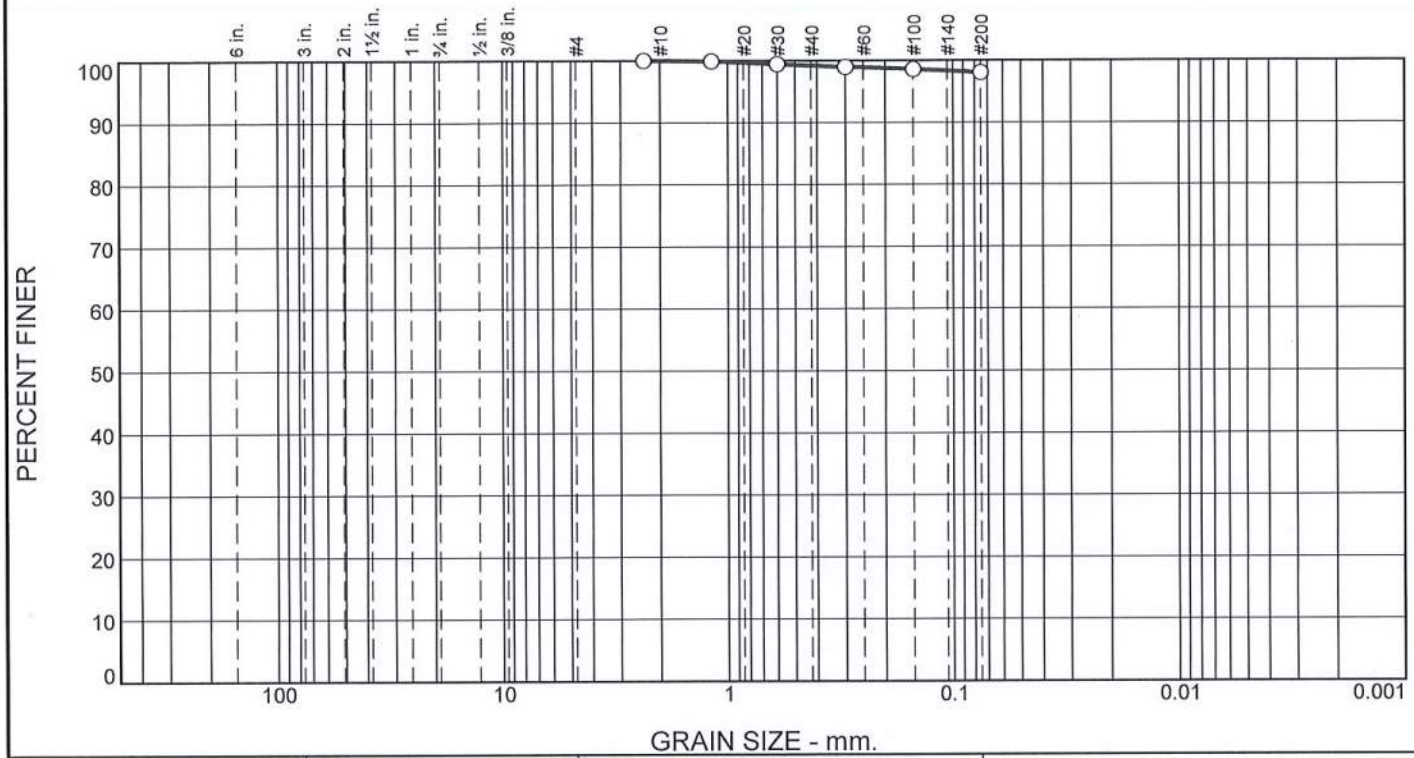
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	1	1	98

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#8	100		
#16	100		
#30	99		
#50	99		
#100	99		
#200	98		

* (no specification provided)

Material Description

Brown silt

Atterberg Limits (ASTM D 4318)

PL= 29 LL= 47 PI= 18

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-7-6(21)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.03

Date Received: 4/19/19 **Date Tested:** 5/15/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-3 **Date Sampled:** -

Sample Number: 42744 **Depth:** 60.5'-61.5'

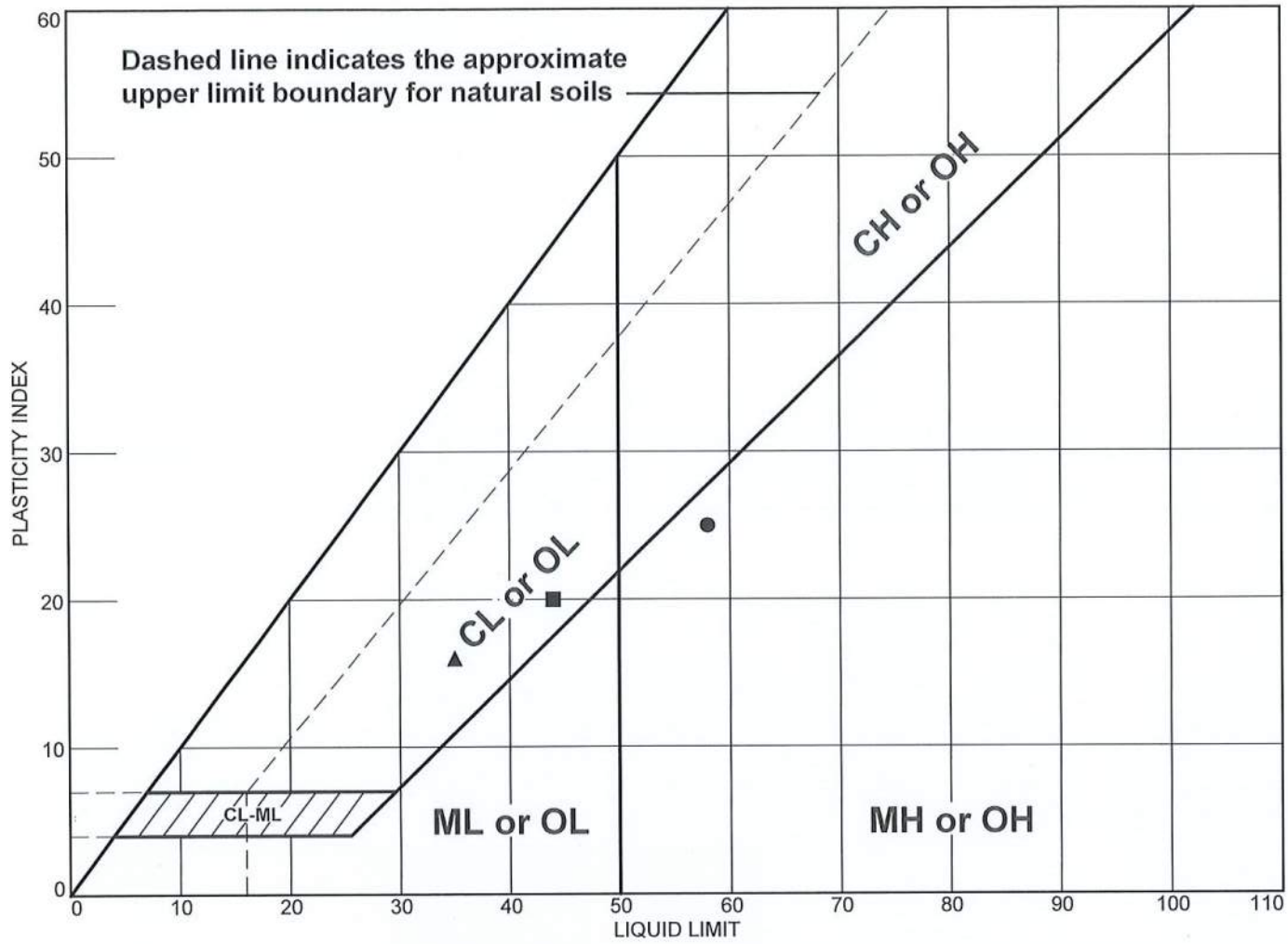
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Colusa

Project No: 19-145 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		58	33	25		92	
■		44	24	20		93	
▲		35	19	16		71	

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

● **Location:** Split Spoon: B-1 **Depth:** 5.5'-6.5' **Sample Number:** 42718

■ **Location:** Split Spoon: B-1 **Depth:** 40.5'-41.5' **Sample Number:** 42719

▲ **Location:** Split Spoon: B-1 **Depth:** 45.5'-46.5' **Sample Number:** 42720

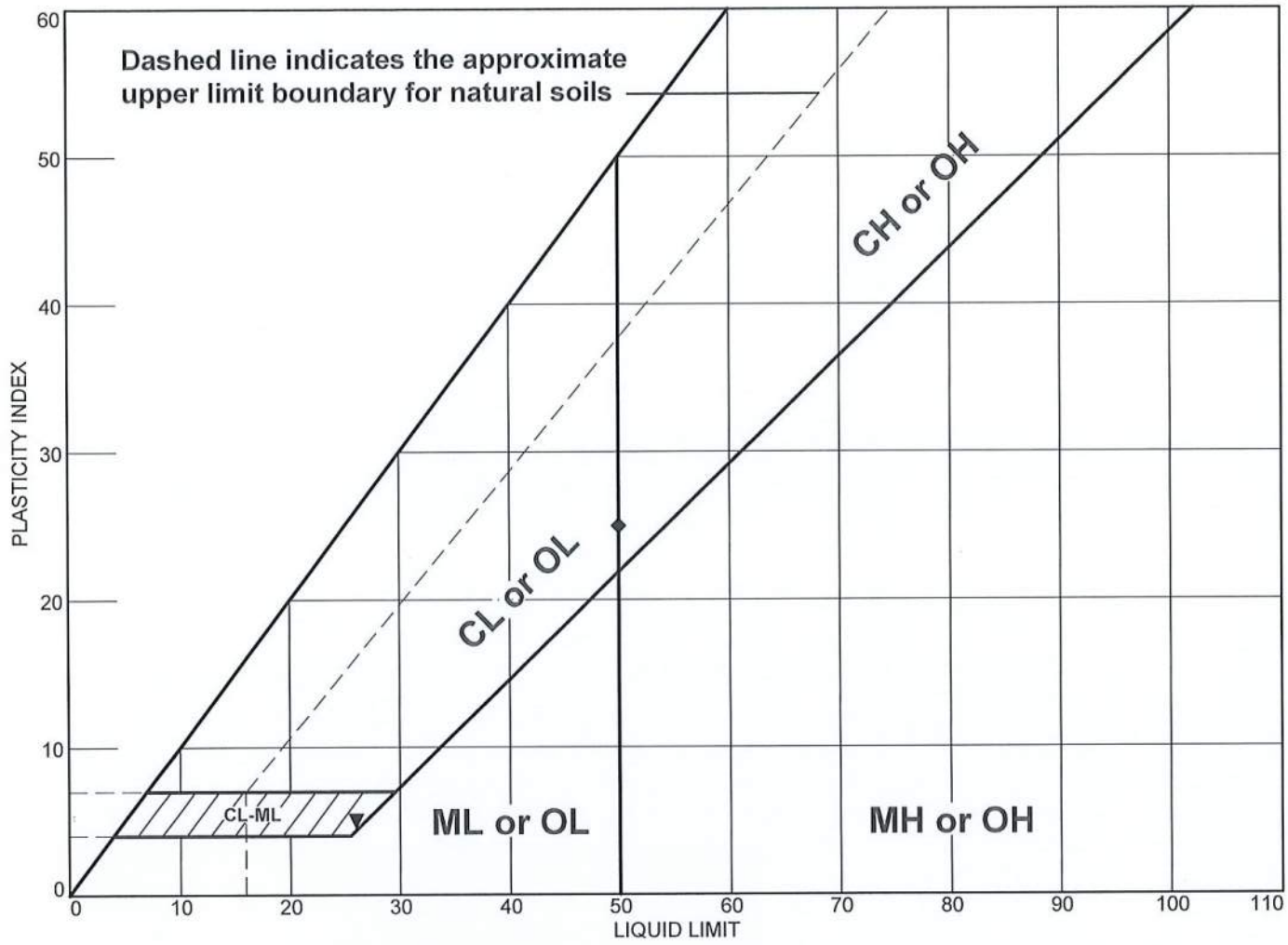
Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: SL **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown poorly graded sand with silt and gravel	NV	NP	NP	28	7.9	SP-SM
■	Brown poorly graded sand with silt and gravel	NV	NP	NP	30	8.2	SP-SM
▲	Brown well-graded gravel with silt and sand	NV	NP	NP	23	7.4	GW-GM
◆		50	25	25		87	
▼		26	21	5		62	

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

● **Location:** Split Spoon: B-1 **Depth:** 35.5'-36.5' **Sample Number:** 42725

■ **Location:** Split Spoon: B-1 **Depth:** 20.5'-21.5' **Sample Number:** 42723

▲ **Location:** Split Spoon: B-1 **Depth:** 25.5'-26.5' **Sample Number:** 42724

◆ **Location:** Split Spoon: B-1 **Depth:** 55.5'-56.5' **Sample Number:** 42721

▼ **Location:** Split Spoon: B-1 **Depth:** 15.5'-16.5' **Sample Number:** 42722

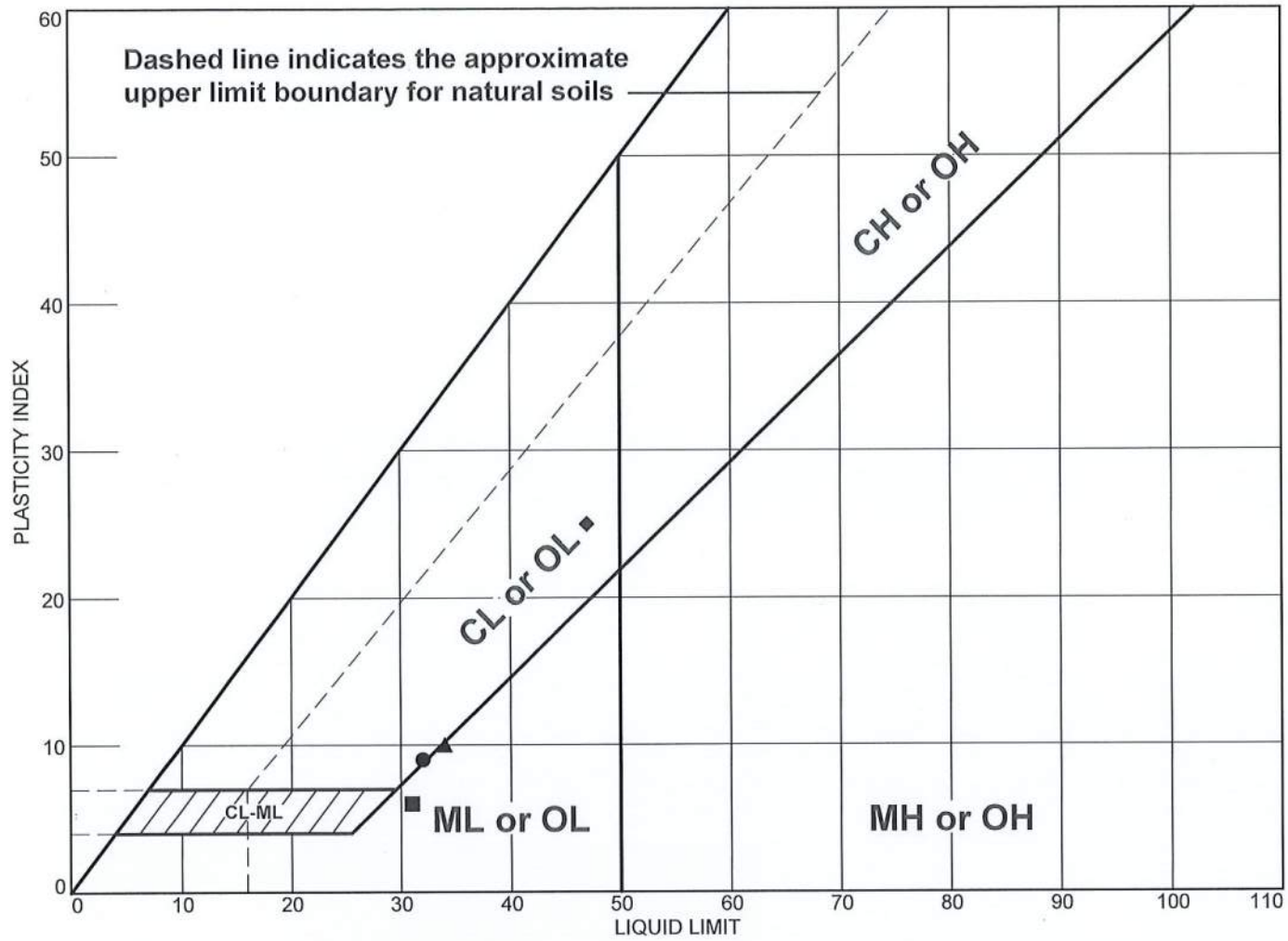
GS GULF SHORE EXPLORATION AND TESTING

Remarks:

Figure

Tested By: ○ JM □ JM △ JM ◇ SL ▽ SL **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		32	23	9		90	
■		31	25	6		85	
▲		34	24	10		86	
◆		47	22	25		91	
▼	Brown poorly graded sand with silt and gravel	NV	NP	NP	27	9.0	SP-SM

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

Remarks:

● **Location:** Split Spoon: B-2 **Depth:** 18.0'-19.0' **Sample Number:** 42729

■ **Location:** Split Spoon: B-2 **Depth:** 38.0'-39.0' **Sample Number:** 42732

▲ **Location:** Split Spoon: B-2 **Depth:** 5.5'-6.5' **Sample Number:** 42728

◆ **Location:** Split Spoon: B-2 **Depth:** 33.0'-34.0' **Sample Number:** 42730

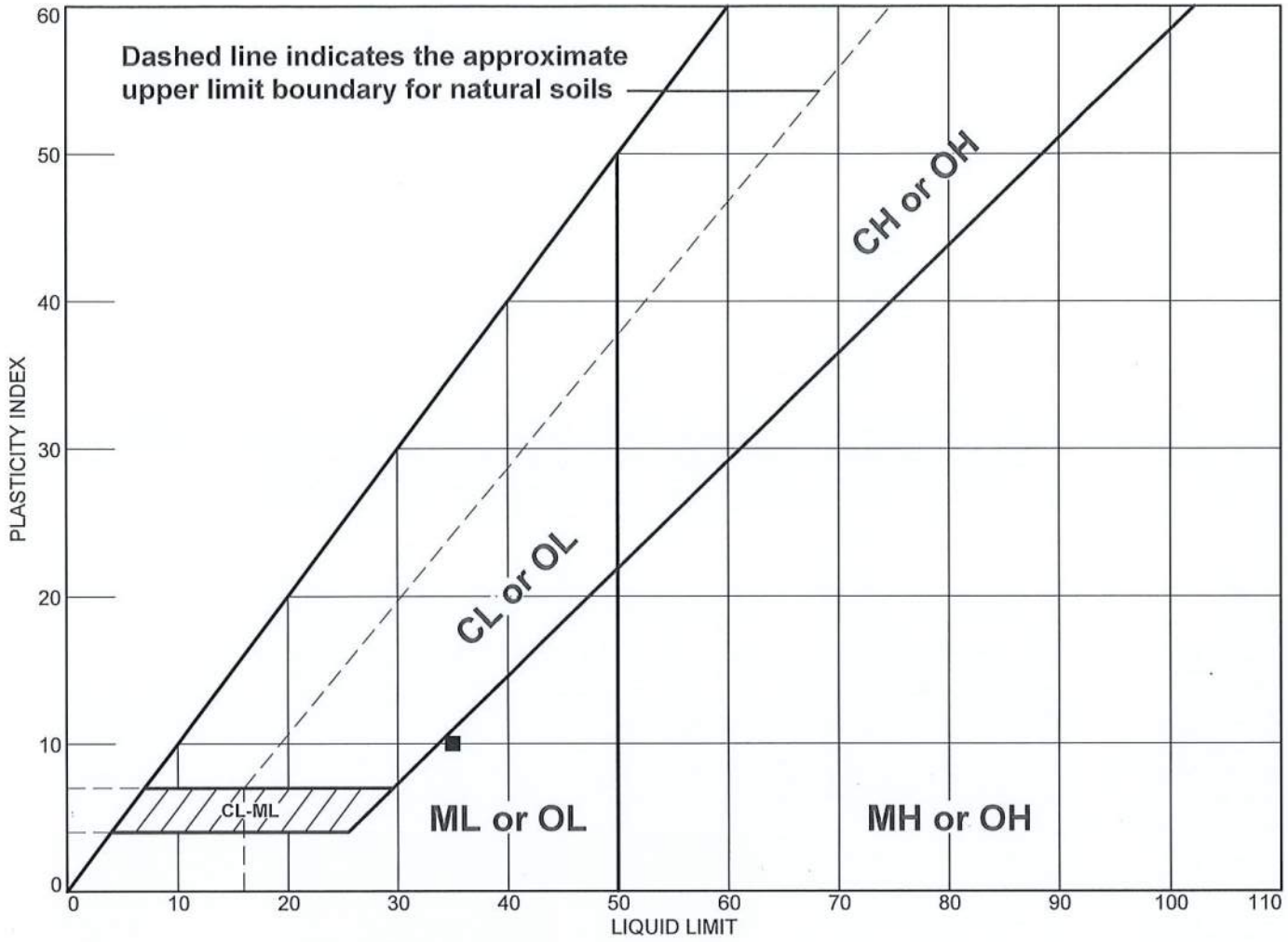
▼ **Location:** Split Spoon: B-2 **Depth:** 45.5'-46.5' **Sample Number:** 42733

GS GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: ○ SL □ SL △ SL ◇ RC ▽ BM **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown silty sand with gravel	NV	NP	NP	50	30	SM
■	Brown silt with sand	35	25	10	96	85	ML

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

● **Location:** Split Spoon: B-2 **Depth:** 60.5'-61.5' **Sample Number:** 42734

■ **Location:** Split Spoon: B-2 **Depth:** 35.5'-36.5' **Sample Number:** 42731

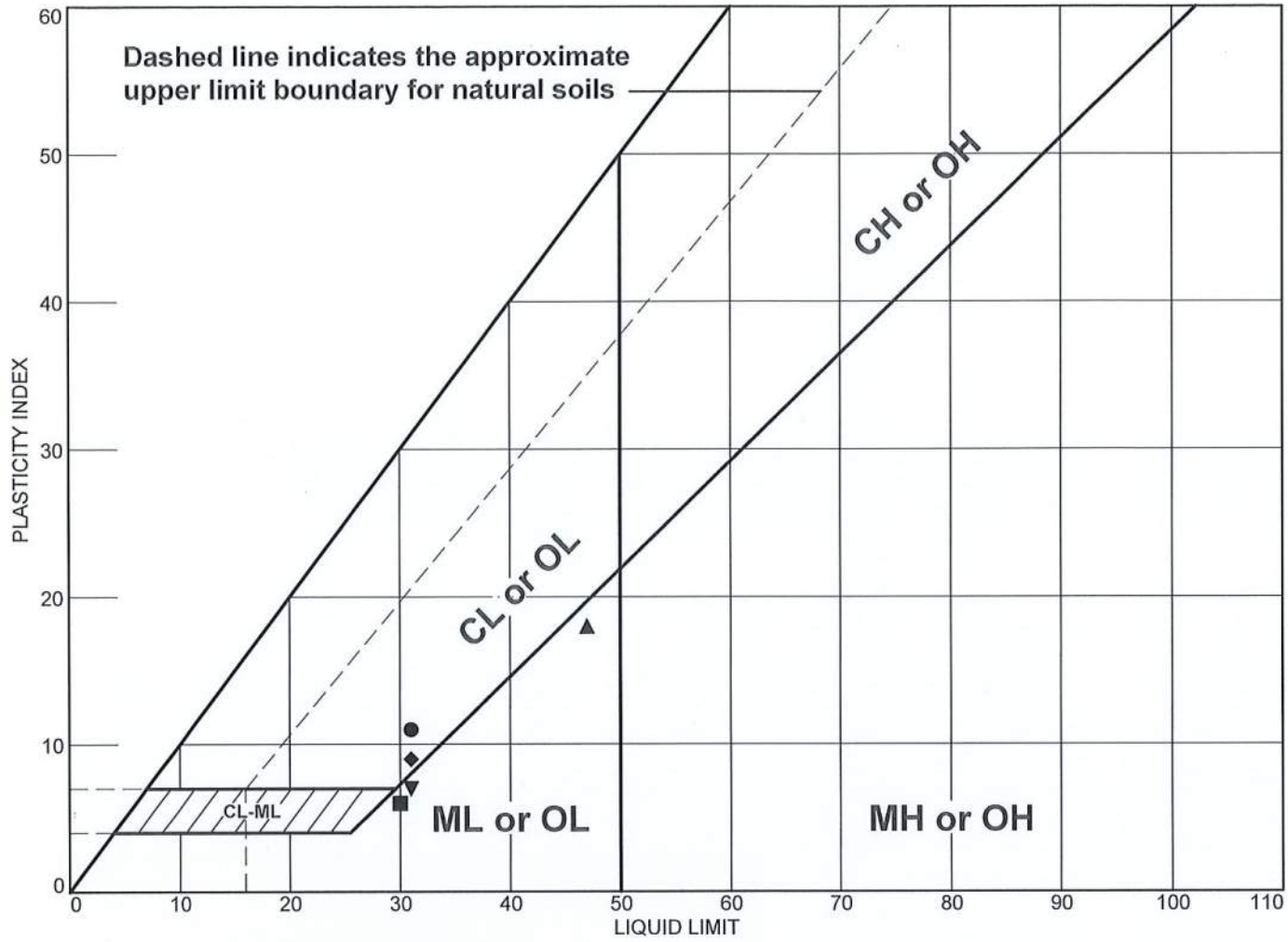
Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: ○ BM □ SL **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown lean clay	31	20	11	99	95	CL
■	Brown silt with sand	30	24	6	96	82	ML
▲	Brown silt	47	29	18	99	98	ML
◆	Brown lean clay with sand	31	22	9	95	73	CL
▼	Brown silt with sand	31	24	7	98	85	ML

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

● **Location:** Split Spoon: B-3 **Depth:** 13.0'-14.0' **Sample Number:** 42737

■ **Location:** Split Spoon: B-3 **Depth:** 23.0'-24.0' **Sample Number:** 42739

▲ **Location:** Split Spoon: B-3 **Depth:** 60.5'-61.5' **Sample Number:** 42744

◆ **Location:** Split Spoon: B-3 **Depth:** 40.5'-41.5' **Sample Number:** 42745

▼ **Location:** Split Spoon: B-3 **Depth:** 43.0'-44.0' **Sample Number:** 42746

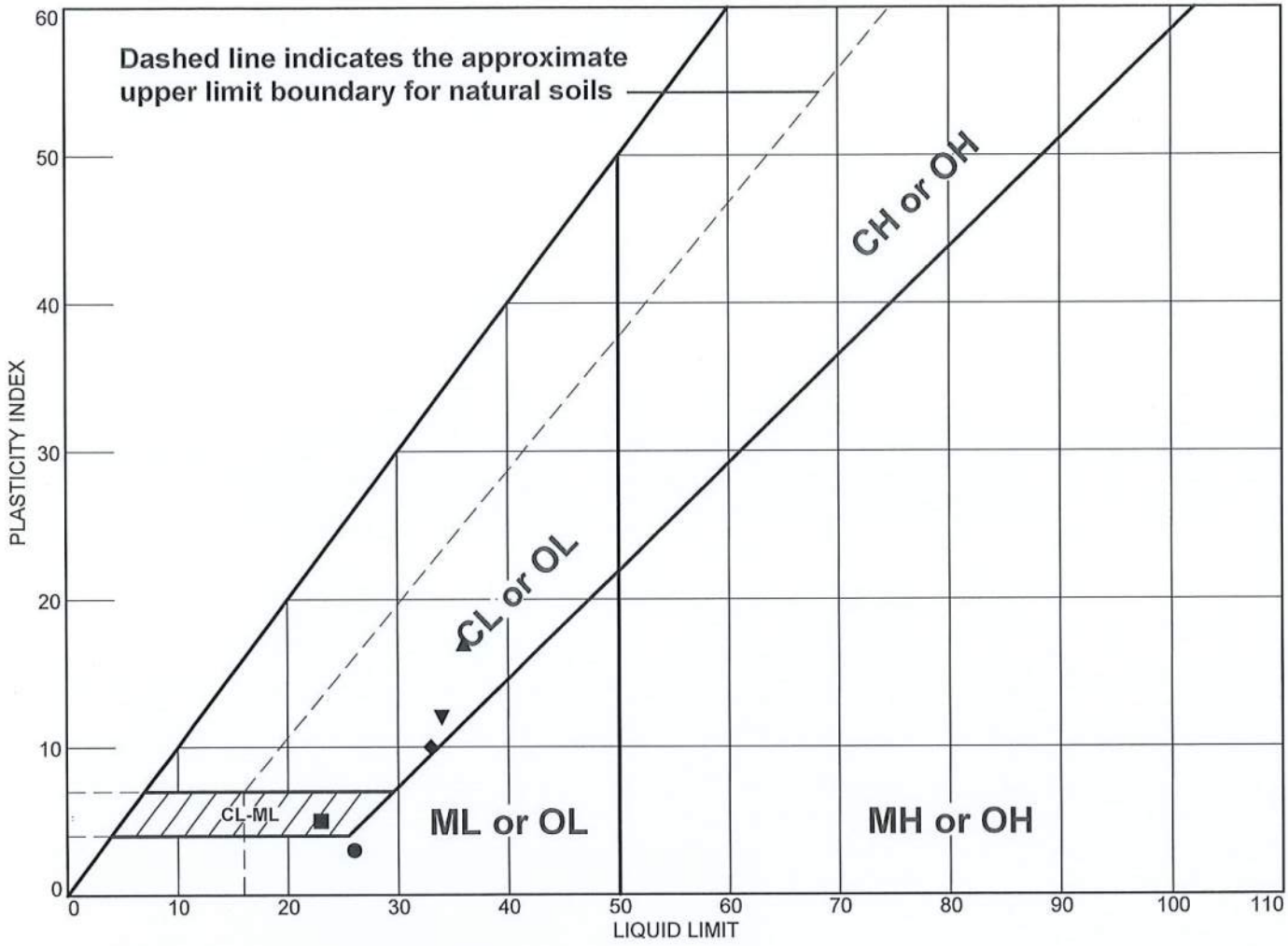
GS GULF SHORE EXPLORATION AND TESTING

Remarks:

Figure

Tested By: SL **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		26	23	3		70	
■	Brown silty clay with sand	23	18	5	94	76	CL-ML
▲	Brown lean clay	36	19	17	100	88	CL
◆	Brown lean clay	33	23	10	99	91	CL
▼	Brown lean clay	34	22	12	97	94	CL

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

● **Location:** Split Spoon: B-3 **Depth:** 30.5'-31.5' **Sample Number:** 42740
■ **Location:** Split Spoon: B-3 **Depth:** 20.5'-21.5' **Sample Number:** 42738
▲ **Location:** Split Spoon: B-3 **Depth:** 35.5'-36.5' **Sample Number:** 42741
◆ **Location:** Split Spoon: B-3 **Depth:** 45.5'-46.5' **Sample Number:** 42742
▼ **Location:** Split Spoon: B-3 **Depth:** 50.5'-51.5' **Sample Number:** 42743

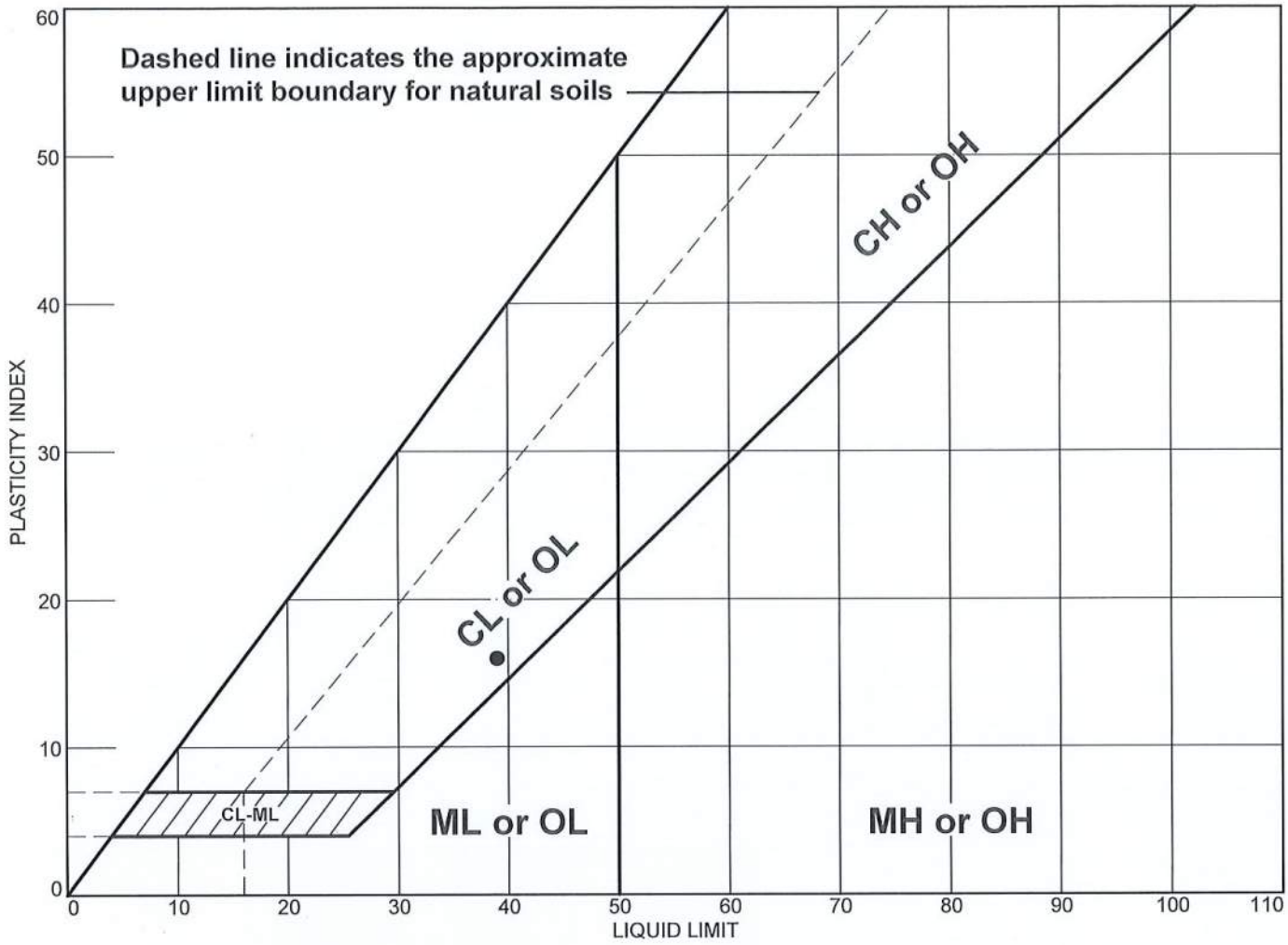
GS GULF SHORE EXPLORATION AND TESTING

Remarks:

Figure

Tested By: SL **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown lean clay with sand	39	23	16	99	80	CL

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

● **Location:** MOD CAL: B-1 **Depth:** 13.0'-14.0' **Sample Number:** 42747

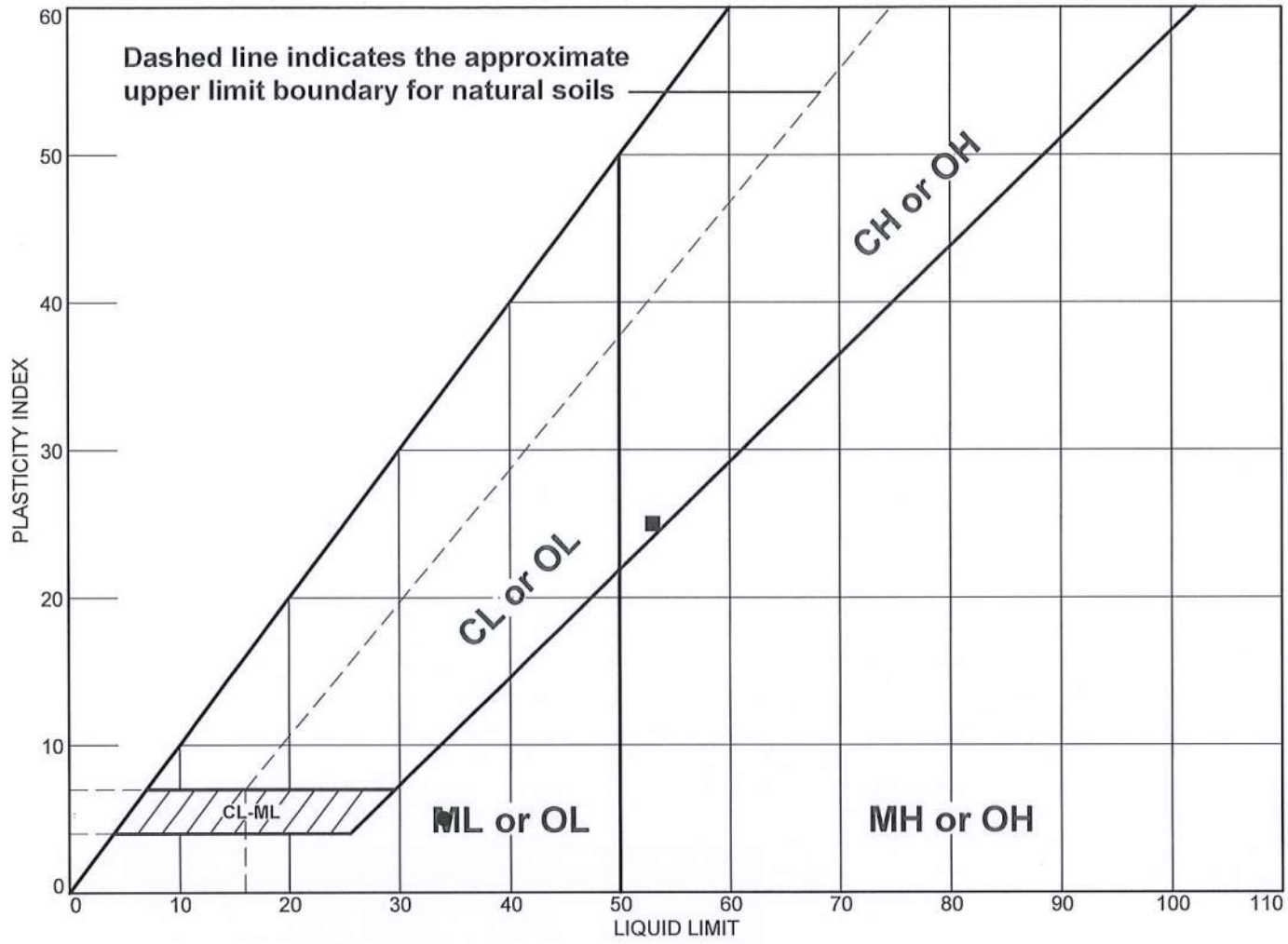
Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: MPW/SL **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellow-brown silt	34	29	5	98	89	ML
■	Dark brown fat clay	53	28	25	99	95	CH

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

● **Location:** MOD CAL: B-2 **Depth:** 20.5'-21.5' **Sample Number:** 42749

■ **Location:** MOD CAL: B-2 **Depth:** 13.0'-14.0' **Sample Number:** 42748

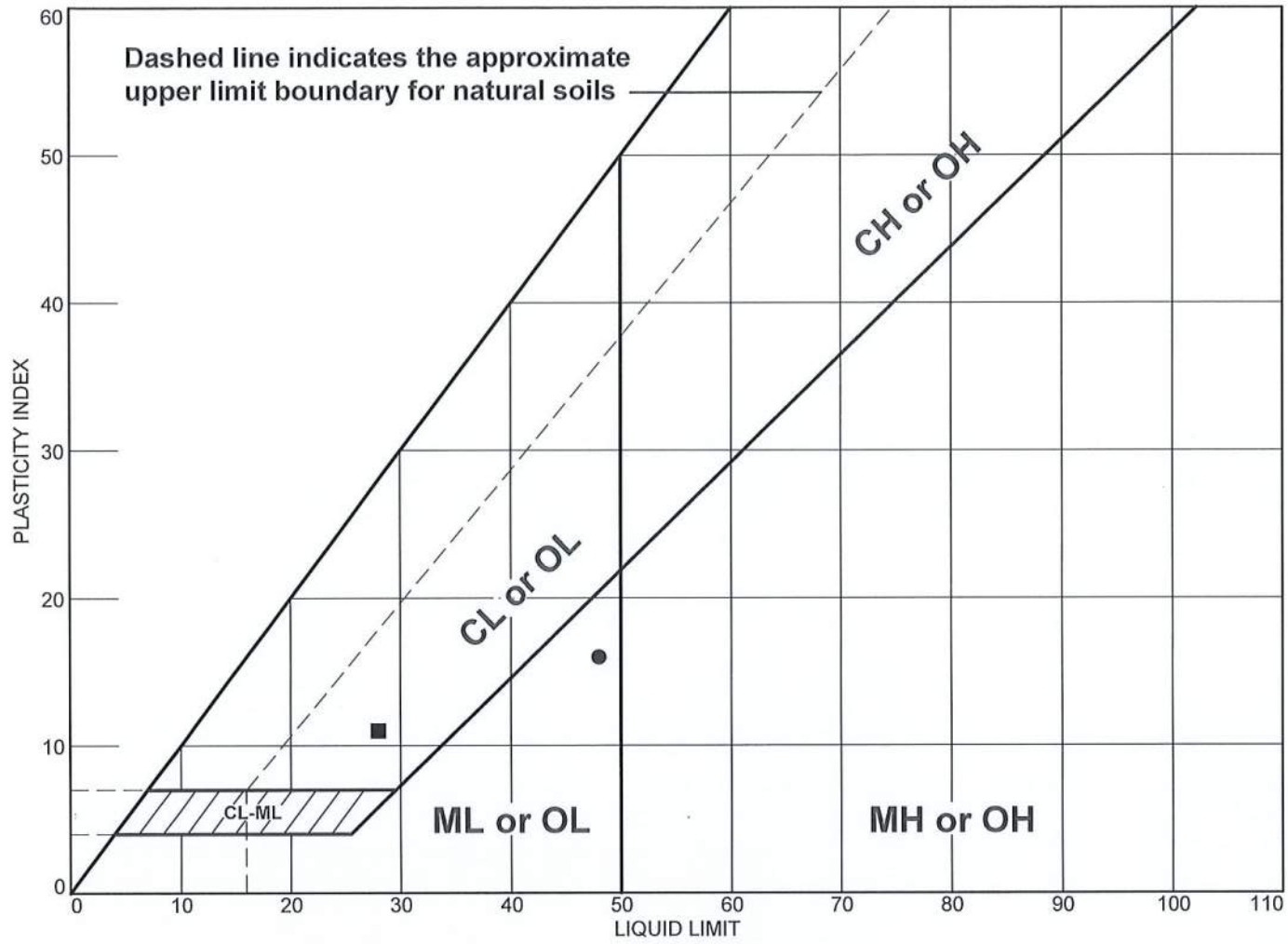
Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: SL **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellow-brown silt	48	32	16	96	86	ML
■	Brown lean clay	28	17	11	98	92	CL

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

● **Location:** MOD CAL: B-3 **Depth:** 18.0'-19.0' **Sample Number:** 42750

■ **Location:** MOD CAL: B-3 **Depth:** 33.0'-34.0' **Sample Number:** 42751

Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: ○ SL □ AF **Checked By:** JML

MOISTURE CONTENT TEST RESULTS

Sample Identification	Depth, ft.	Moisture Content, %
Split Spoon B-1	15.5'-16.5'	28.0

Test Method: ASTM D2216

PROJECT NUMBER:	19-145	May 8, 2019	Small Communities - Colusa

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

MOISTURE CONTENT TEST RESULTS

Sample Identification	Depth, ft.	Moisture Content, %
Split Spoon B-1	45.5'-46.5'	23.3
Split Spoon B-1	20.5'-21.5'	9.5
Split Spoon B-1	25.5'-26.5'	14.2
Split Spoon B-1	35.5'-36.5'	11.3
Split Spoon B-1	18.0'-19.0'	31.2
Split Spoon B-1	30.5'-31.5'	9.0
Split Spoon B-2	33.0'-34.0'	32.3
Split Spoon B-2	38.0'-39.0'	34.8
Split Spoon B-2	40.5'-41.5'	33.2
Split Spoon B-2	50.5'-51.5'	45.2

Test Method: ASTM D2216

PROJECT NUMBER: **19-145** May 7, 2019

Small Communities - Colusa

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

MOISTURE CONTENT TEST RESULTS

Sample Identification	Depth, ft.	Moisture Content, %
Split Spoon B-2	35.5'-36.5'	30.5
Split Spoon B-2	45.5'-46.5'	10.2
Split Spoon B-2	60.5'-61.5'	17.5
Split Spoon B-3	13.0'-14.0'	20.6
Split Spoon B-3	20.5'-21.5'	25.6
Split Spoon B-3	23.0'-24.0'	25.9

Test Method: ASTM D2216

PROJECT NUMBER:	19-145	May 14, 2019	Small Communities - Colusa

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

MOISTURE CONTENT TEST RESULTS

Sample Identification	Depth, ft.	Moisture Content, %
Split Spoon B-3	40.5'-41.5'	28.2
Split Spoon B-3	43.0'-44.0'	31.8

Test Method: ASTM D2216

PROJECT NUMBER:	19-145	May 15, 2019	Small Communities - Colusa

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

SOIL SPECIFIC GRAVITY

Sample Identification	Specific Gravity
Split Spoon B-2 (45.5'-46.5')	2.69
Split Spoon B-2 (60.5'-61.5')	2.61

Test Method: ASTM D854

PROJECT NUMBER:	19-145	May 15, 2019	

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

Small Communities - Colusa

SOIL SPECIFIC GRAVITY

Sample Identification	Specific Gravity
MOD CAL B-1 (13.0'-14.0')	2.60
MOD CAL B-2 (13.0'-14.0')	2.56
MOD CAL B-2 (20.5'-21.5')	2.60
MOD CAL B-3 (18.0'-19.0')	2.63
MOD CAL B-3 (33.0'-34.0')	2.61

Test Method: ASTM D854

PROJECT NUMBER:	19-145	May 16, 2019	

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

Small Communities - Colusa

MOISTURE AND ORGANIC CONTENT TEST RESULTS

Sample Identification	Depth, ft.	Organic Content, %	Moisture Content, %
MOD CAL: B-1	13.0'-14.0'	5.4	27.3
MOD CAL: B-2	13.0'-14.0'	6.9	23.7
MOD CAL: B-2	20.5'-21.5'	5.6	37.1
MOD CAL: B-3	18.0'-19.0'	6.4	31.4
MOD CAL: B-3	33.0'-34.0'	5.3	26.3

Test Method: ASTM D2974

PROJECT NUMBER:	19-145	May 7, 2019	
GULF SHORE EXPLORATION AND TESTING	3362 Fitzgerald Road Rancho Cordova, CA 95742 Phone: (916) 939-4117 FAX: (916) 635-4315		Small Communities - Colusa

MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

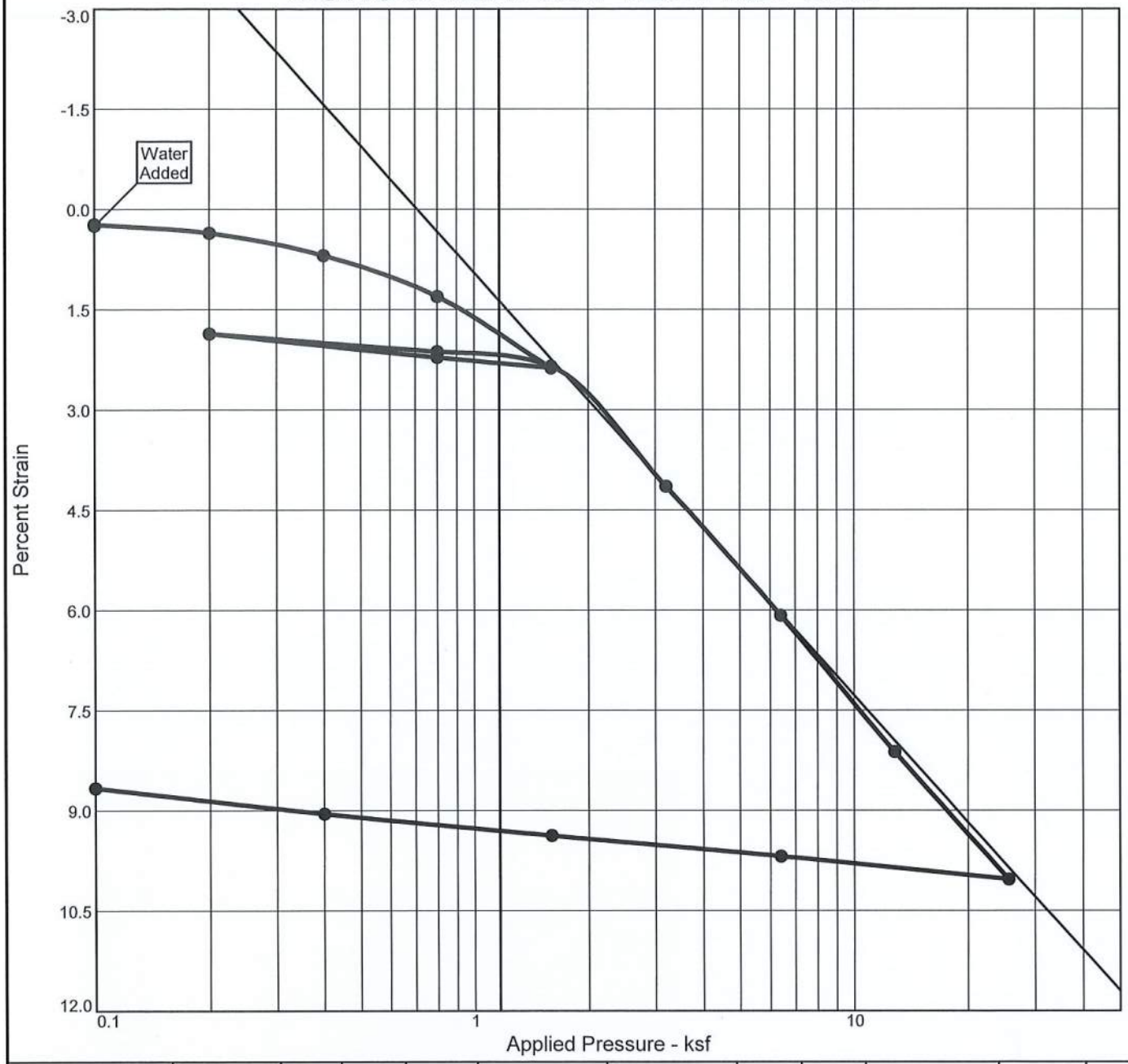
Sample Identification	Depth, ft.	Wet Unit Weight, lb/ft.^{3}	Dry Unit Weight, lb/ft.^{3}	Moisture Content, %
MOD CAL: B-1	13.0'-14.0'	123.9	97.3	27.3
MOD CAL: B-2	13.0'-14.0'	129.1	104.4	23.7
MOD CAL: B-2	20.5'-21.5'	117.2	85.5	37.1
MOD CAL: B-3	18.0'-19.0'	120.0	91.3	31.4
MOD CAL: B-3	33.0'-34.0'	126.9	100.5	26.3

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER:	19-145	April 22, 2019	Small Communities - Colusa

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Swell %	e_o
Sat.	Moist.											
77.5 %	16.4 %	104.7	39	16	2.60	0	1.5	0.10	0.01	0.1	0.0	0.550

MATERIAL DESCRIPTION	USCS	AASHTO
Brown lean clay with sand	CL	A-6(13)

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

Location: MOD CAL: B-1 **Depth:** 13.0'-14.0' **Sample Number:** 42747

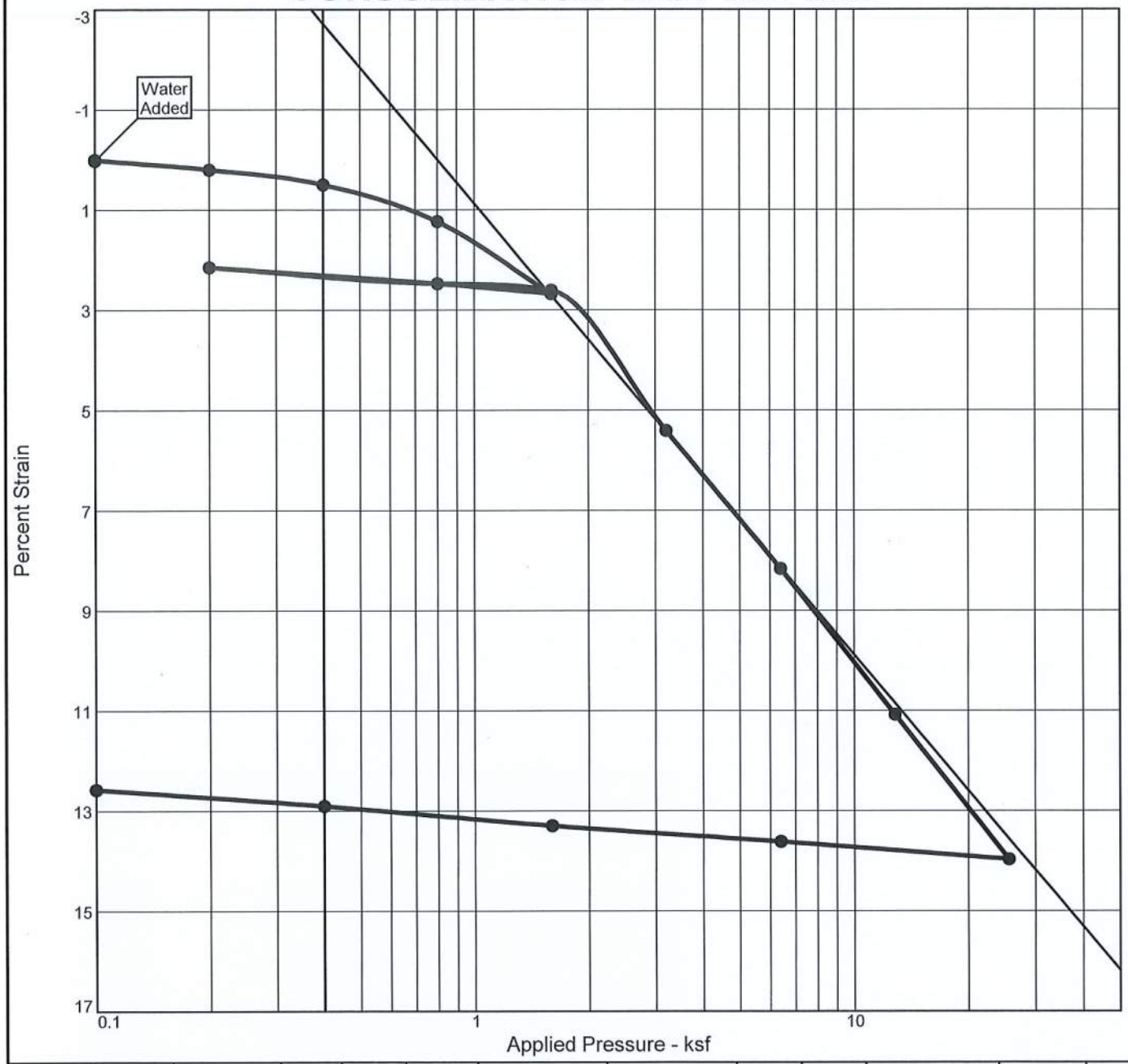
Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: MPW **Checked By:** JML

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Swell %	e_o
98.9 %	21.8 %	102.2	53	25	2.56	0	1.0	0.14	0.01	0.1	0.0	0.564

MATERIAL DESCRIPTION	USCS	AASHTO
Dark brown fat clay	CH	A-7-6(28)

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

Location: MOD CAL: B-2 **Depth:** 13.0'-14.0' **Sample Number:** 42748

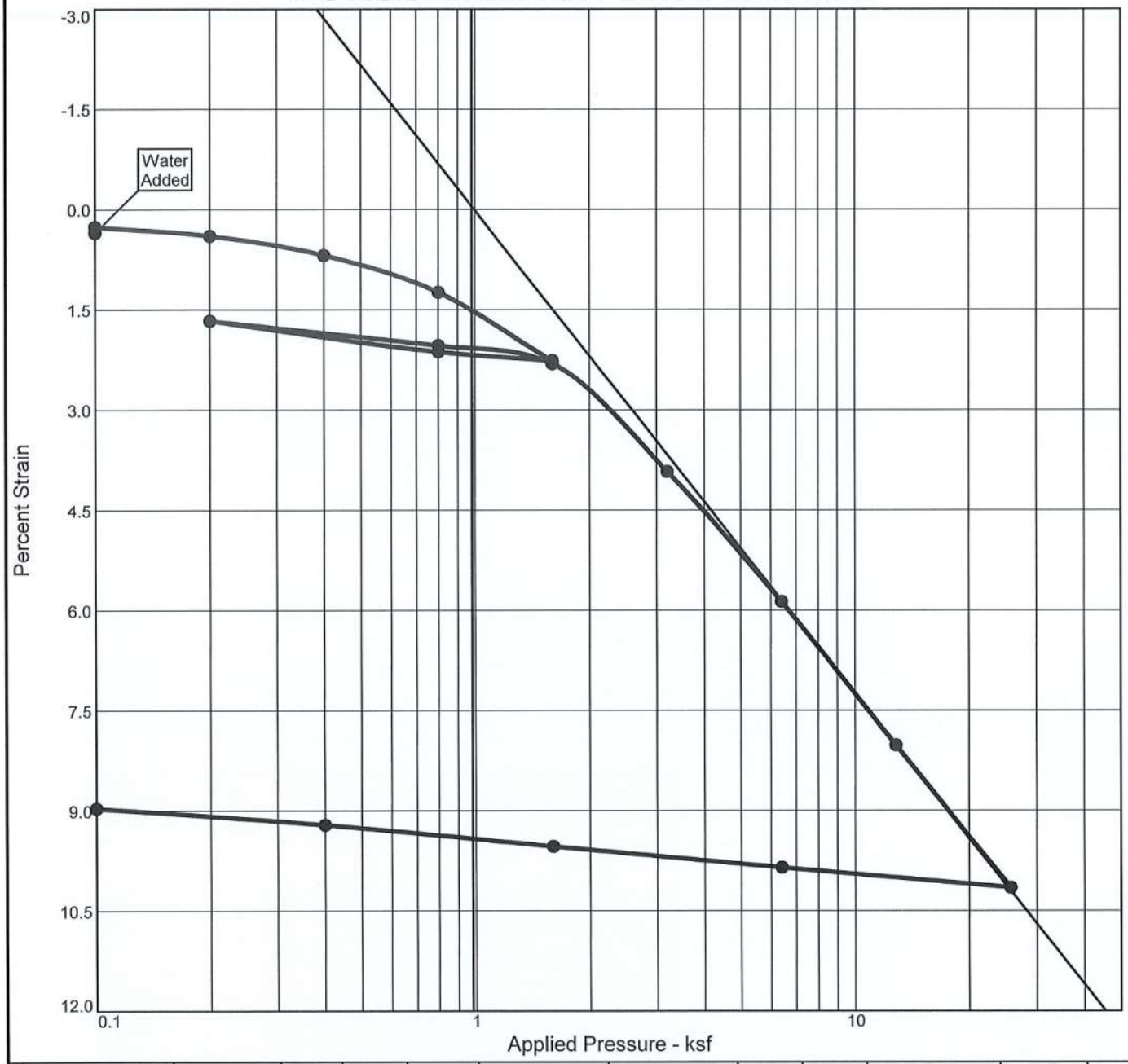
GS GULF SHORE EXPLORATION AND TESTING

Remarks:

Figure

Tested By: MPW **Checked By:** JML

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Swell %	e_o
73.2 %	17.6 %	99.9	34	5	2.60	0	1.8	0.12	0.01	0.2	0.1	0.625

MATERIAL DESCRIPTION	USCS	AASHTO
Yellow-brown silt	ML	A-4(5)

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

Location: MOD CAL: B-2 **Depth:** 20.5'-21.5' **Sample Number:** 42749

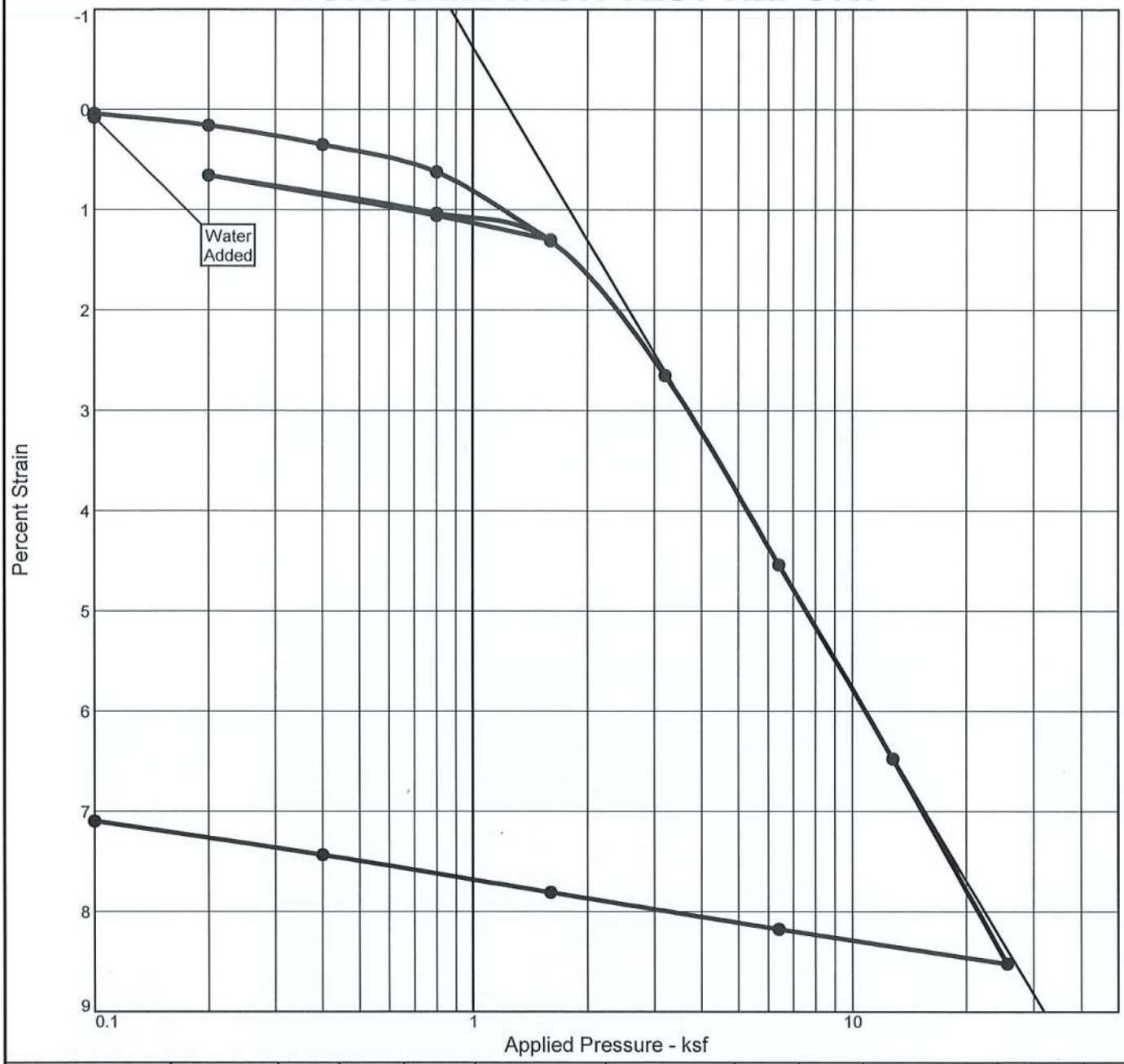
GULF SHORE EXPLORATION AND TESTING

Remarks:

Figure

Tested By: MPW **Checked By:** JML

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Swell %	e_o
97.2 %	27.9 %	93.5	48	16	2.63	0	1.8	0.11	0.01	0.1	0.0	0.756

MATERIAL DESCRIPTION	USCS	AASHTO
Yellow-brown silt	ML	A-7-5(16)

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

Location: MOD CAL: B-3 **Depth:** 18.0'-19.0' **Sample Number:** 42750

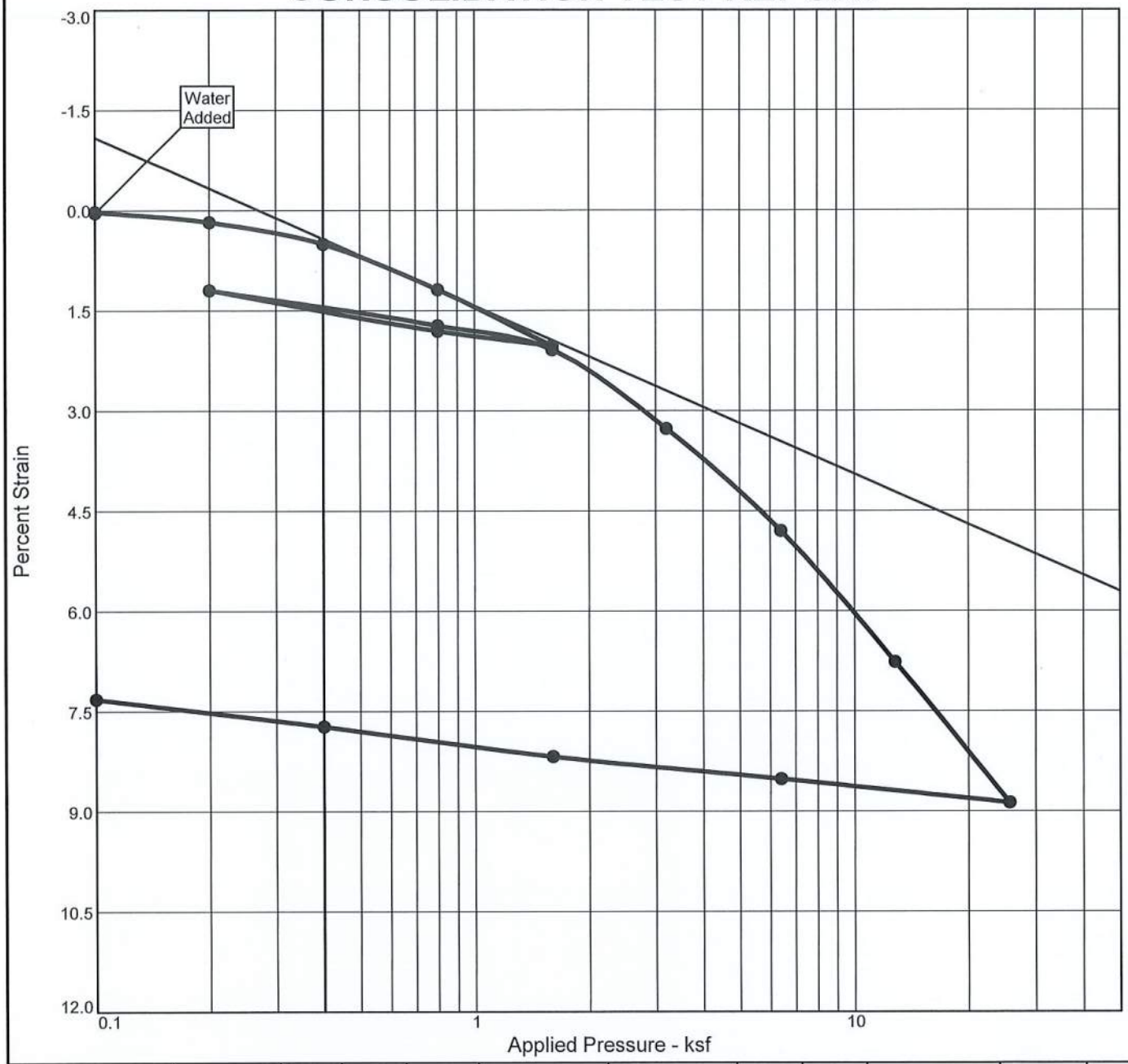
Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: MPW **Checked By:** JML

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Swell %	e_o
98.6 %	25.5 %	97.3	28	11	2.61	0	0.4	0.04	0.01	0.1	0.0	0.675

MATERIAL DESCRIPTION	USCS	AASHTO
Brown lean clay	CL	A-6(9)

Project No. 19-145 **Client:** HDR, Inc.

Project: Small Communities - Colusa

Location: MOD CAL: B-3 **Depth:** 33.0'-34.0' **Sample Number:** 42751

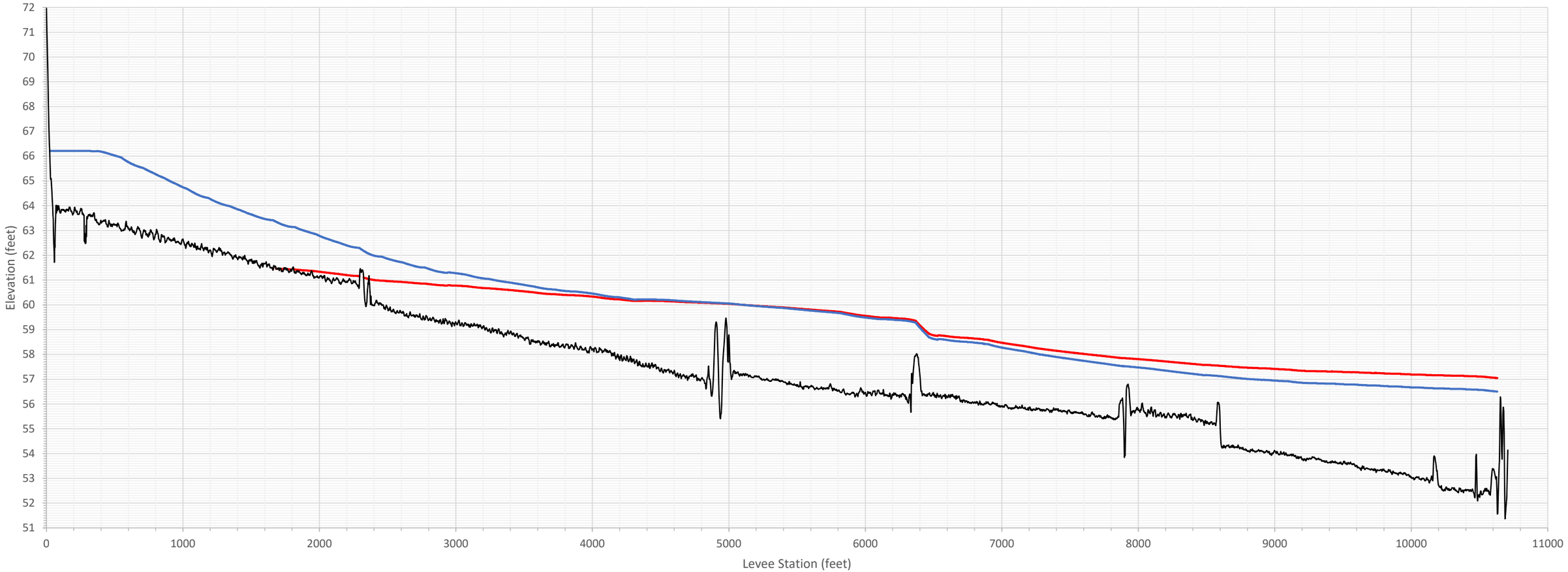
Remarks:

GULF SHORE EXPLORATION AND TESTING

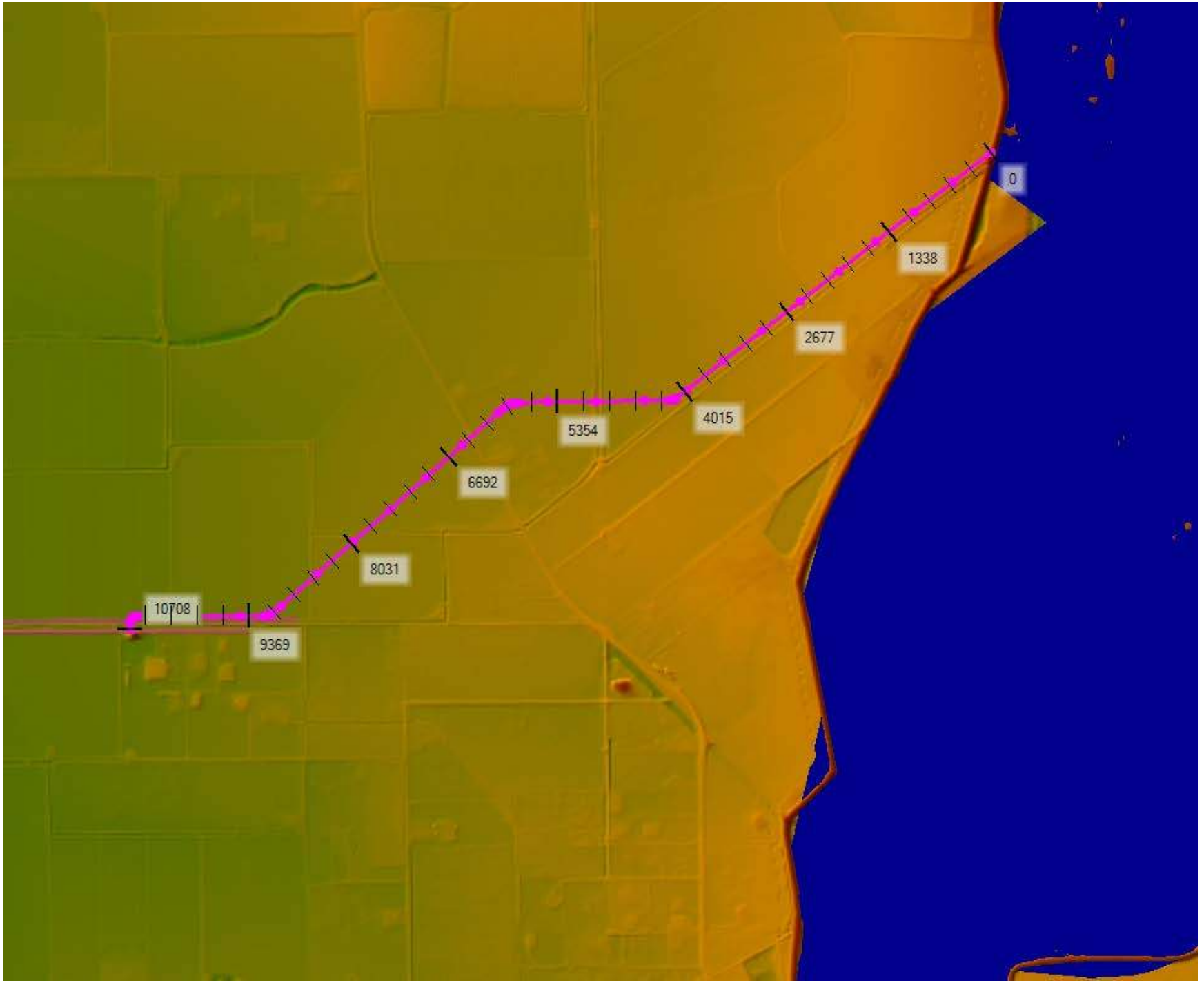
Figure

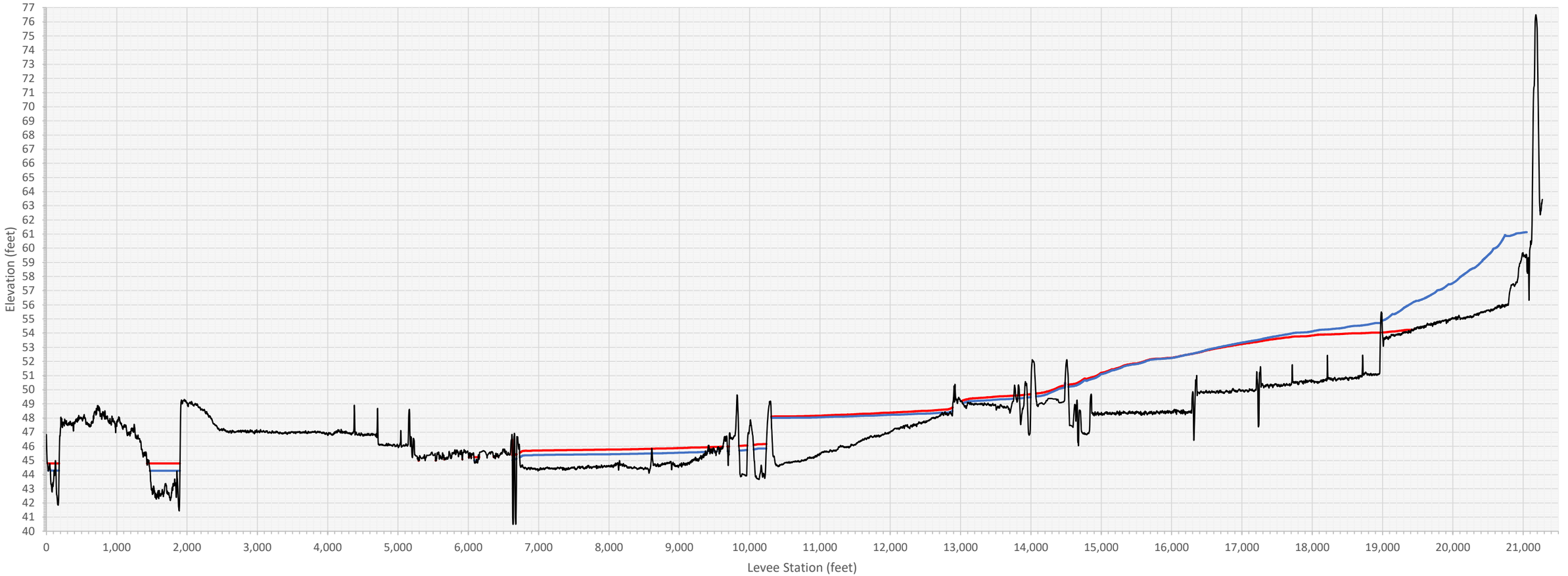
Tested By: MPW **Checked By:** JML

Attachment I – 100 year Water Surface Elevation for Wing Levees

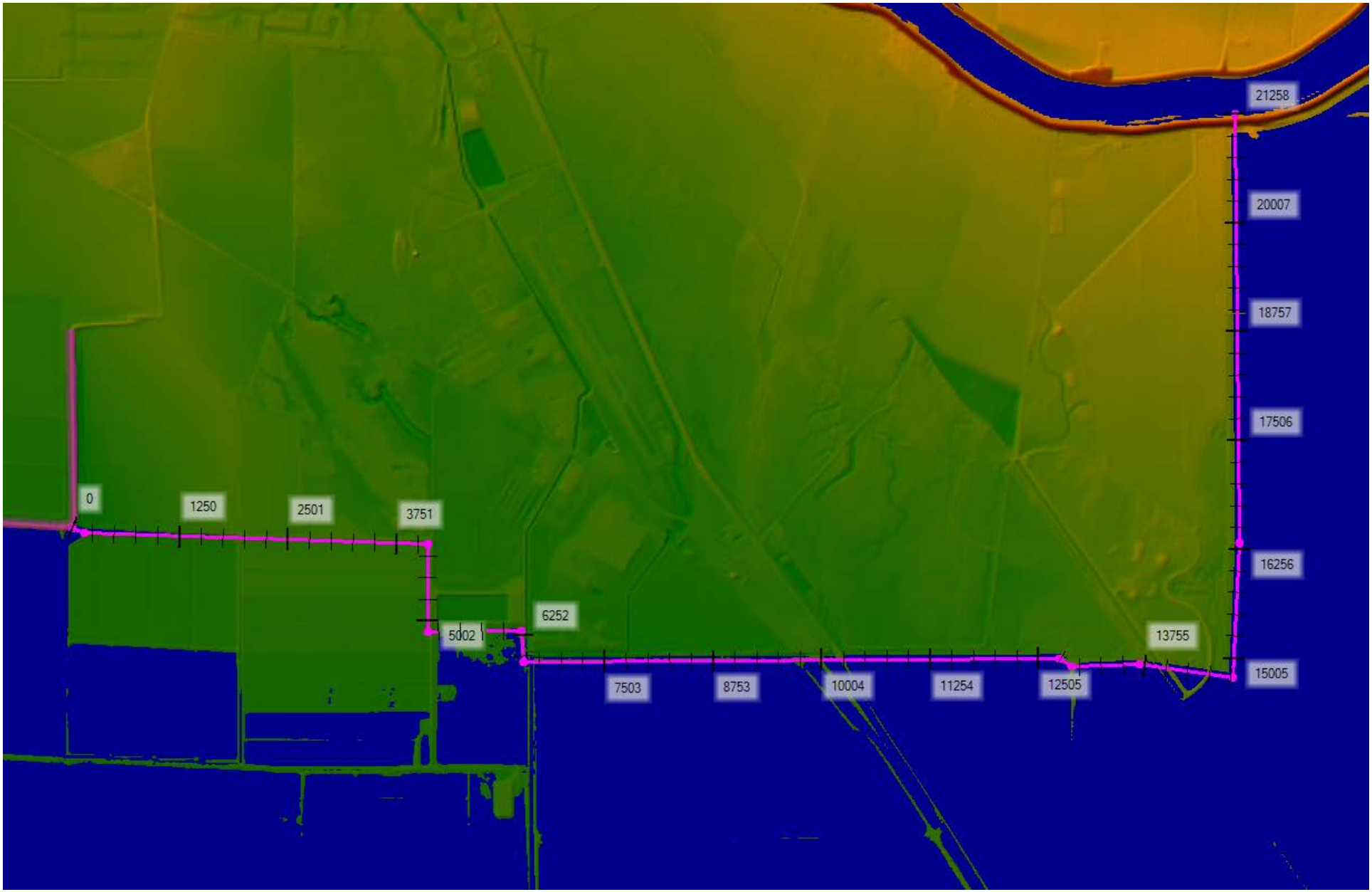


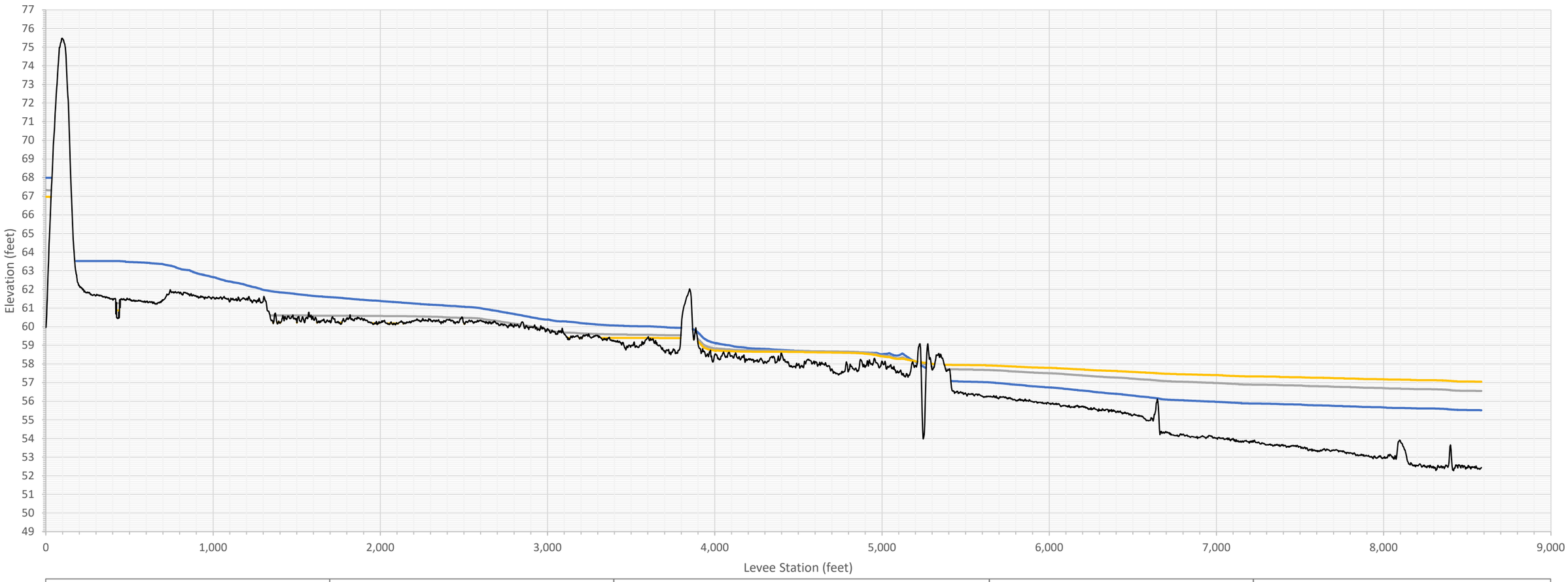
Breach 20k US Alt1 100-Year WSE Breach 10k US Alt1 100-Year WSE Existing Terrain	Alt 1 North Levee Top of Levee Water Surface Profile	**COLUSA COUNTY FLOOD RISK REDUCTION FEASIBILITY STUDY**	**DRAFT**	PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING


0
1338
2677
4015
5354
6692
8031
10708
9369



Breach 30k DS Alt1 100-Year WSE Breach 10k DS Alt1 100-Year WSE Existing Terrain	Alt 1 South Levee Top of Levee Water Surface Profile	**COLUSA COUNTY FLOOD RISK REDUCTION FEASIBILITY STUDY**	**DRAFT**	PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING


0
1250
2501
3751
5002
6252
7503
8753
10004
11254
12505
13755
15005
16256
17506
18757
20007
21258



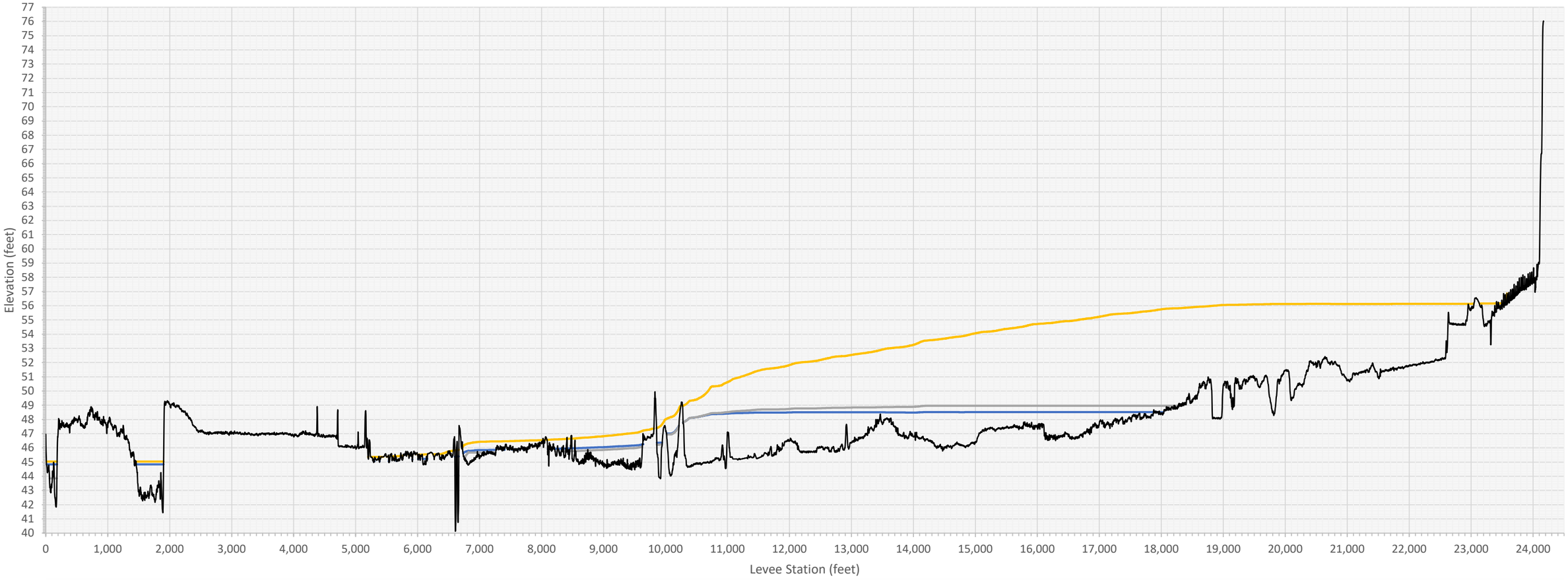
Alt 2 North Levee
Top of Levee Water Surface Profile

COLUSA COUNTY FLOOD RISK REDUCTION FEASIBILITY STUDY

DRAFT

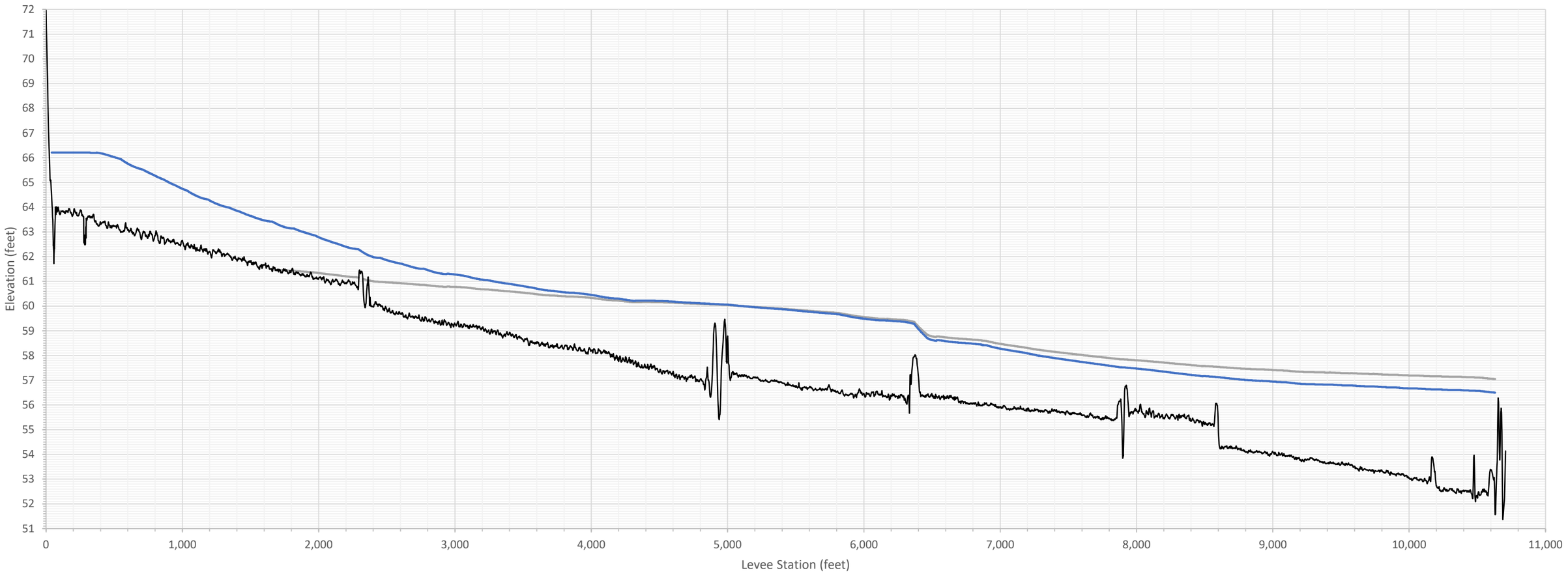
PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING


0
1226
2453
3679
4905
6132
7358
8584

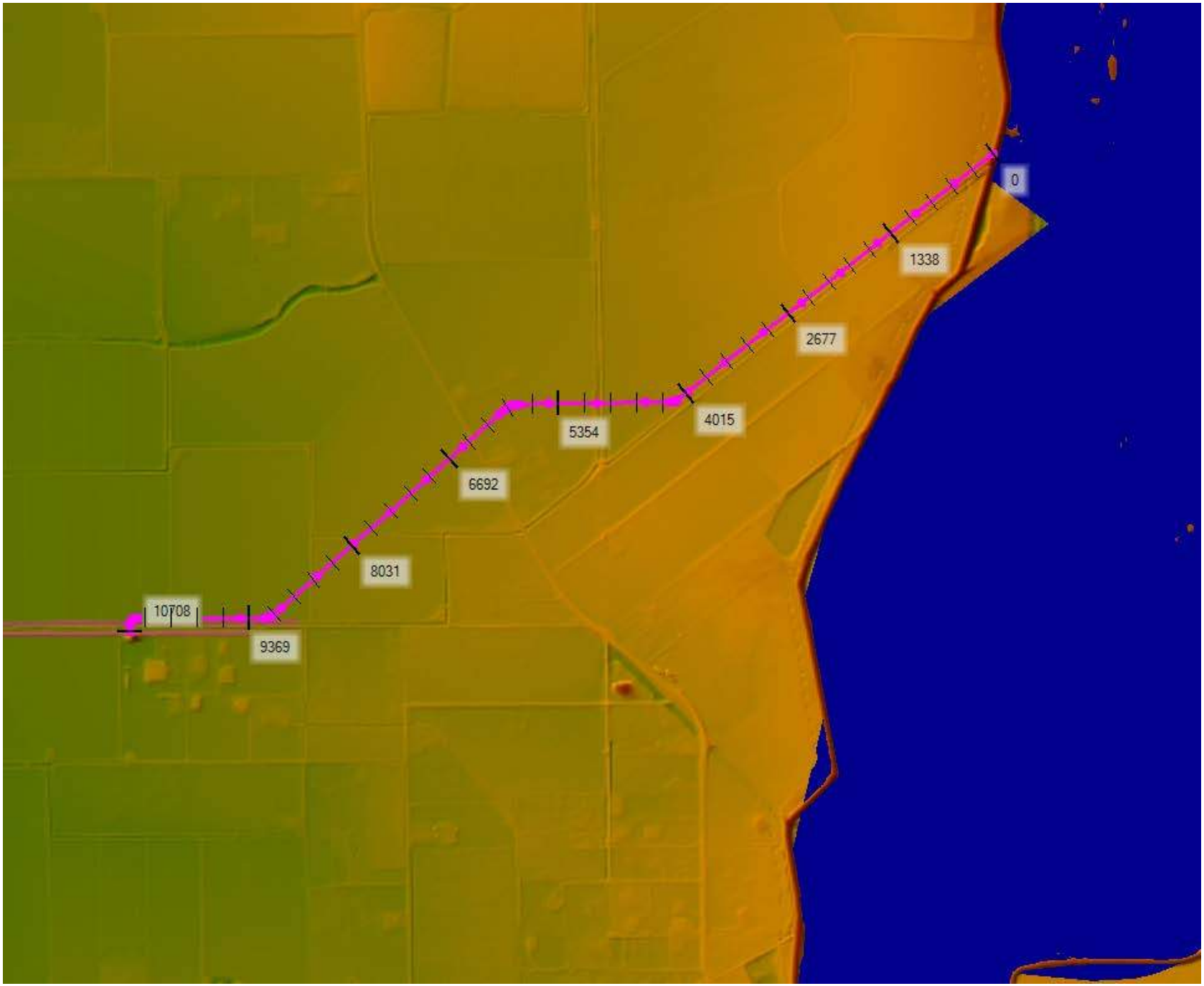


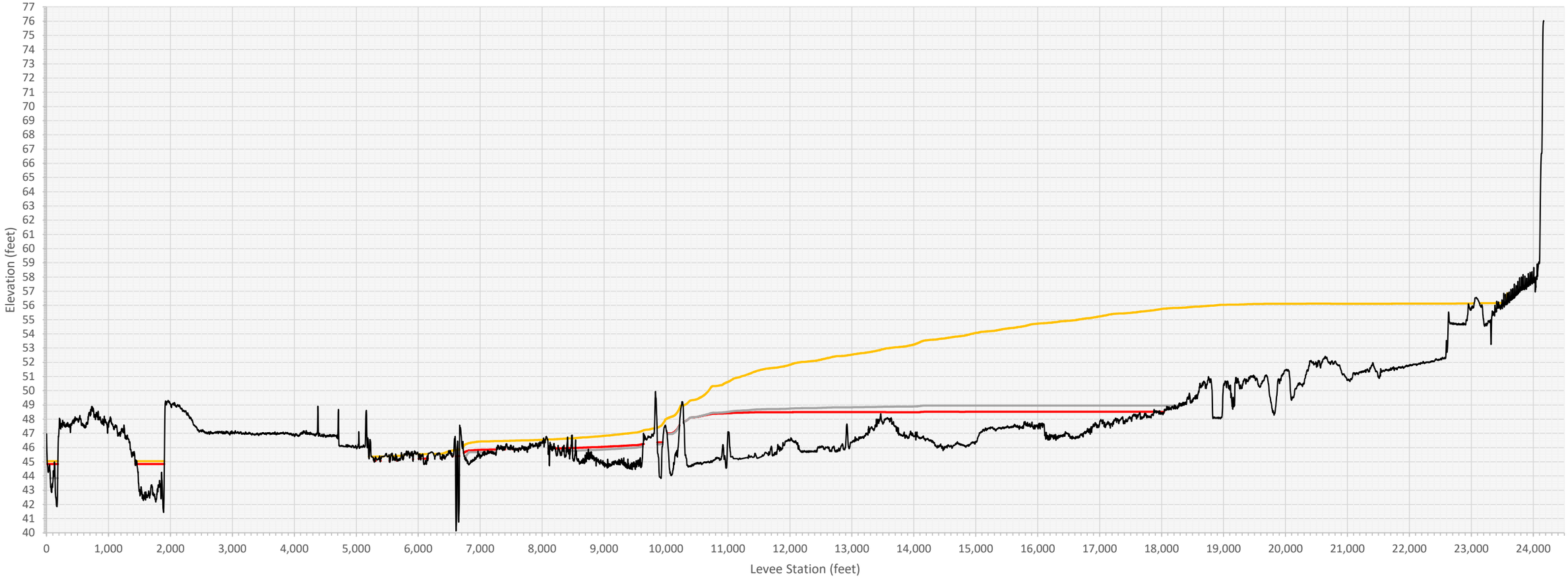
Breach 30k DS Alt2 100-Year WSE Breach 10k DS Alt2 100-Year WSE Breach 5k DS Alt2 100-Year WSE Existing Terrain	Alt 2 South Levee Top of Levee Water Surface Profile	**COLUSA COUNTY FLOOD RISK REDUCTION FEASIBILITY STUDY**	**DRAFT**	PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING


24167
22895
21623
20351
19079
17807
16535
15263
13991
12719
11447
10175
8904
7632
6360
5088
3816
2544
1272
0



Breach 20k US Alt3 100-Year WSE Breach 10k US Alt3 100-Year WSE Existing Terrain	Alt 3 North Levee Top of Levee Water Surface Profile	**COLUSA COUNTY FLOOD RISK REDUCTION FEASIBILITY STUDY**	**DRAFT**	PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING


0
1338
2677
4015
5354
6692
8031
9369
10708



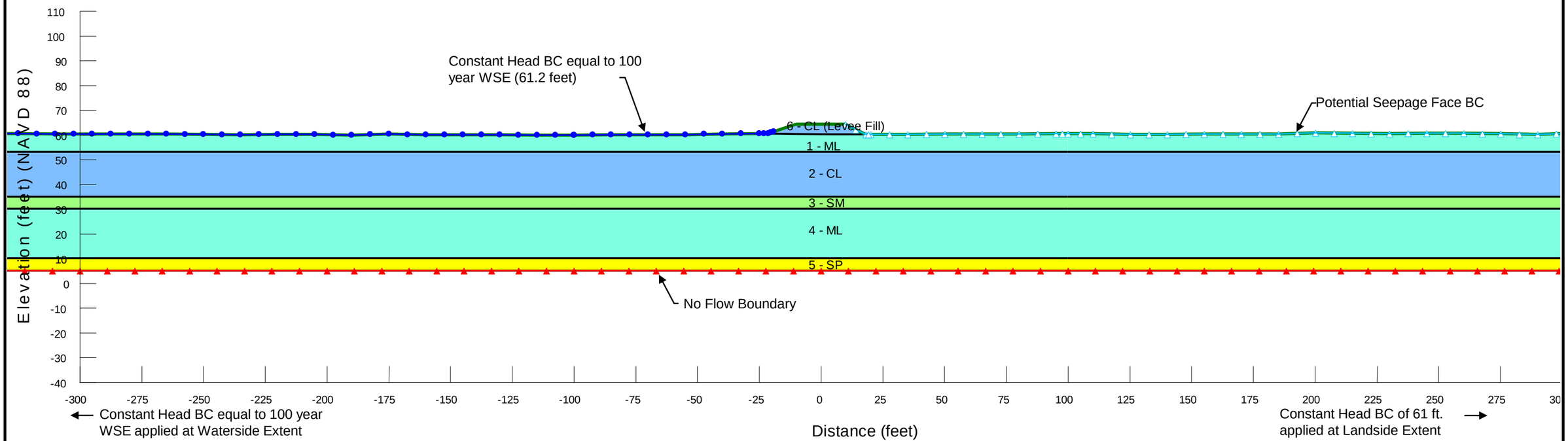
Breach 30k DS Alt3 100-Year WSE Breach 10k DS Alt3 100-Year WSE Breach 5k DS Alt3 100-Year WSE Existing Terrain	Alt 3 South Levee Top of Levee Water Surface Profile	**COLUSA COUNTY FLOOD RISK REDUCTION FEASIBILITY STUDY**	**DRAFT**	PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING


24167
22895
21623
20351
19079
17807
16535
15263
13991
12719
11447
10175
8904
7632
6360
5088
3816
2544
1272
0

Attachment J – Seepage and Stability Analysis for Wing Levees

North Wing Levee Section 1 (North Wing Levee Alt 2 Station 26+78)

Layer	Material	Total Unit Weight (pcf)	Hydraulic Conductivity		
			k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**ML**	120	0.028	1.0E-5	0.25
2	**CL**	120	0.011	4.0E-6	0.25
3	**SM**	125	14.170	5.0E-3	0.25
4	**ML**	120	0.028	1.0E-5	0.25
5	**SP**	125	56.678	2.0E-2	0.25
6	**CL (Levee Fill)**	120	0.011	4.0E-6	0.25



NOTES:

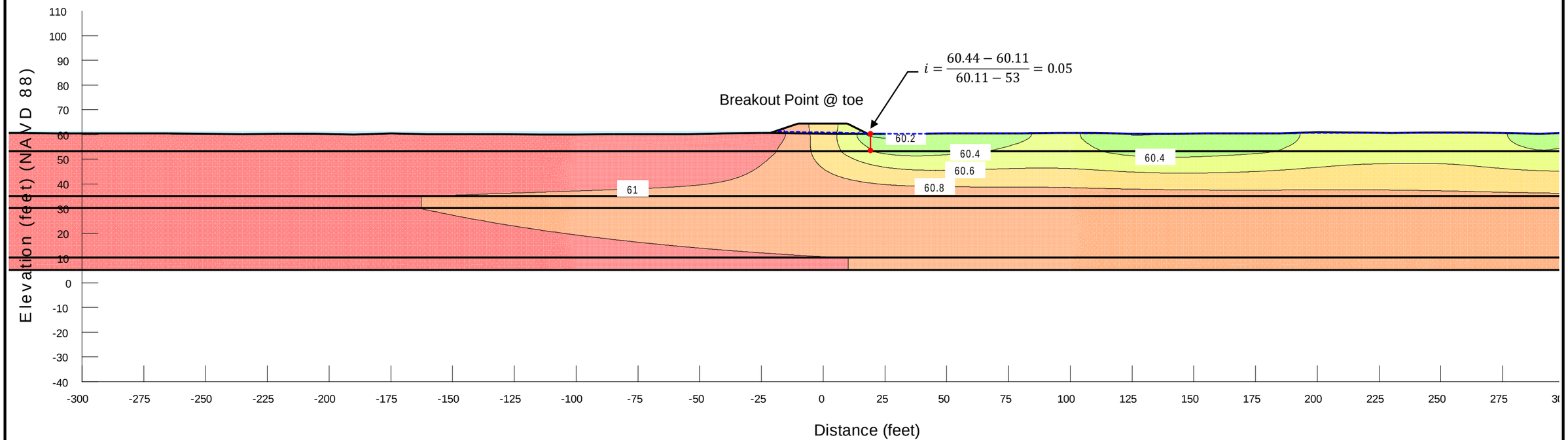
Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 1 (Alt. 2 Stn. 26+78) Seepage Model - 100 year WSE

May 2019 FIGURE J1

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 1 (Alt. 2 Stn. 26+78) Seepage Result - 100 year WSE

May 2019

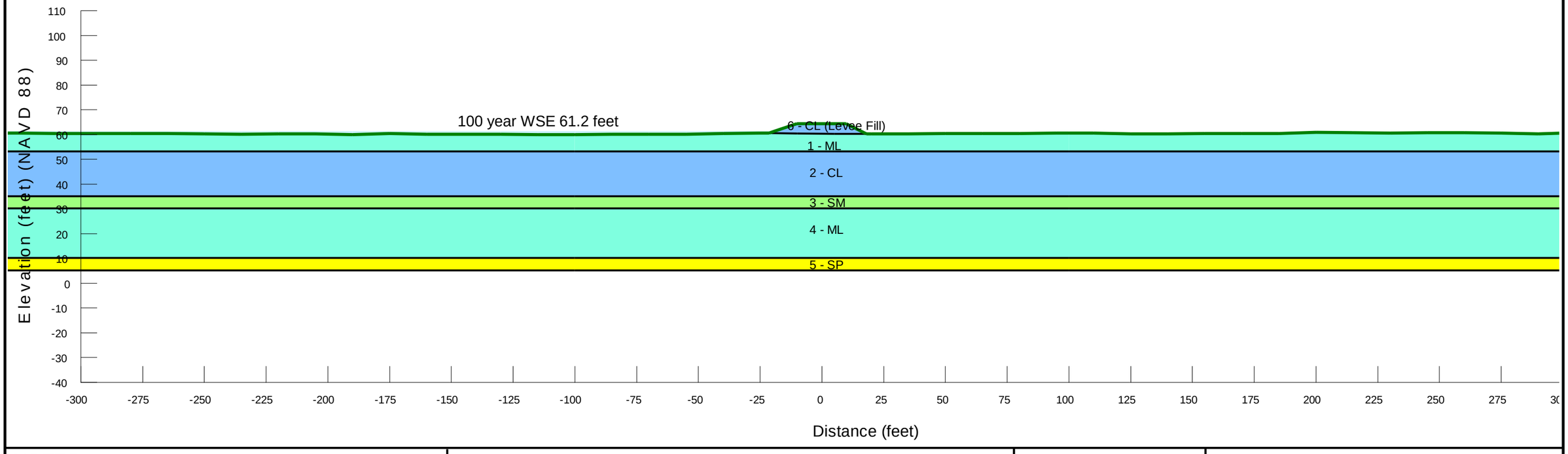
FIGURE J2

North Wing Levee Section 1 (North Wing Levee Alt 2 Station 26+78)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**ML**	120	0	31	360	4
2	**CL**	120	50	31	360	4
3	**SM**	125	0	33	-	-
4	**ML**	120	0	31	360	4
5	**SP**	125	0	33	-	-
6	**CL (Levee Fill)**	120	100	30	360	4

Waterside

Landside

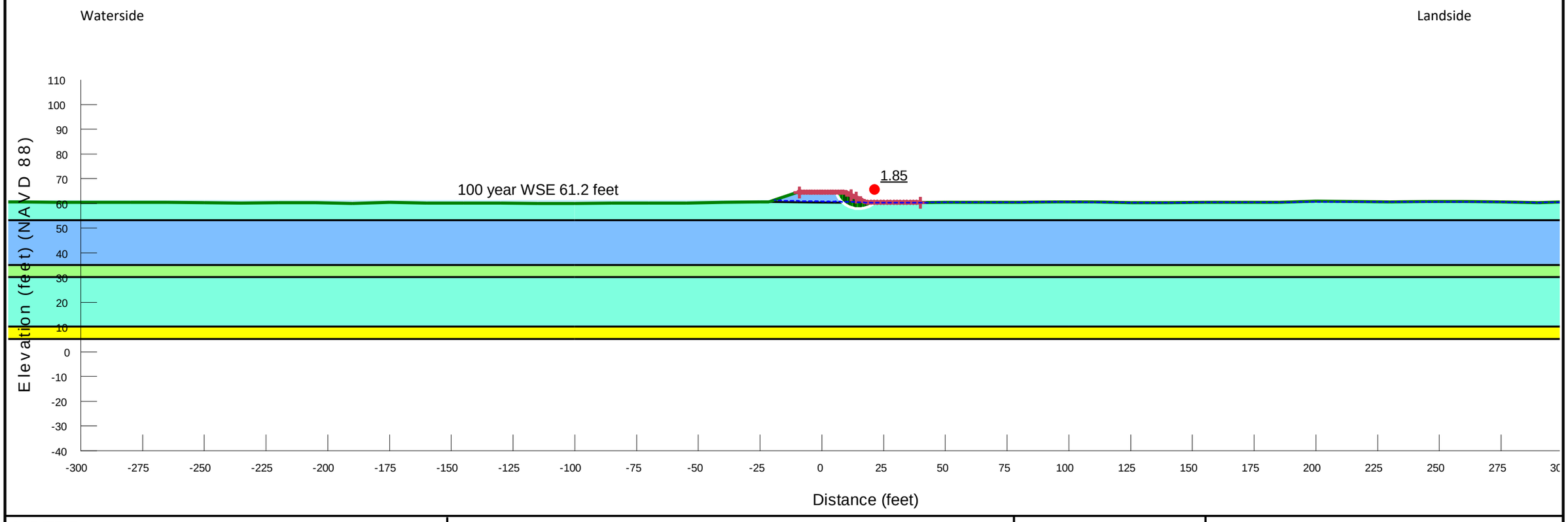


NOTES:

Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 1 (Alt. 2 Stn. 26+78) Stability Model

May 2019 FIGURE J3



NOTES:

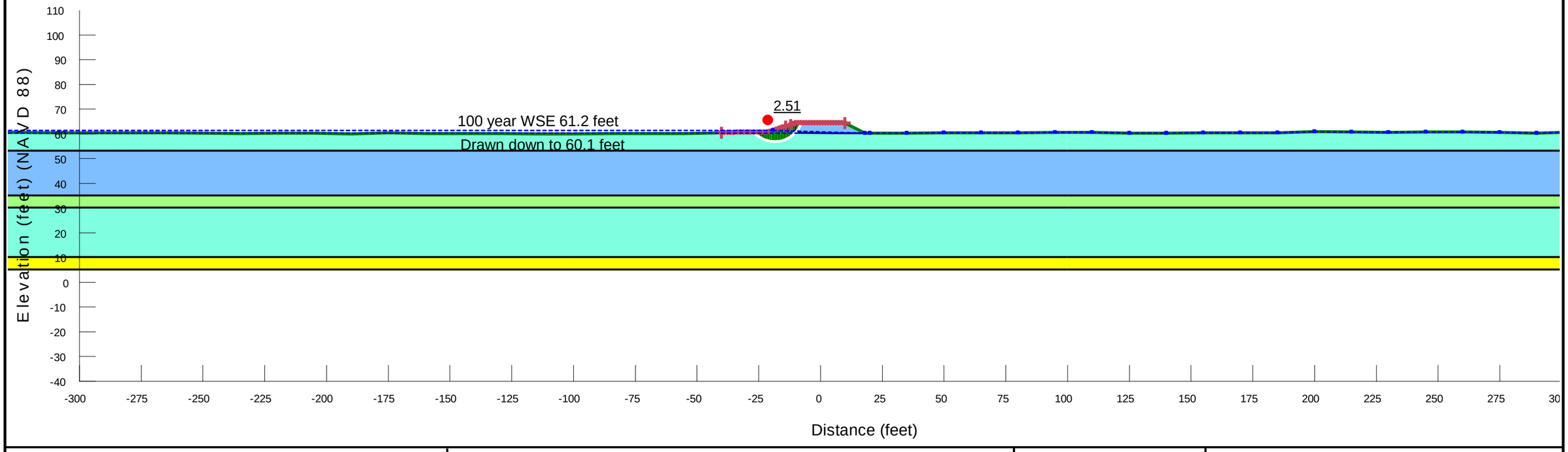
Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 1 (Alt. 2 Stn. 26+78) Steady State Stability Result Landside

May 2019 FIGURE J4

Waterside

Landside



NOTES:

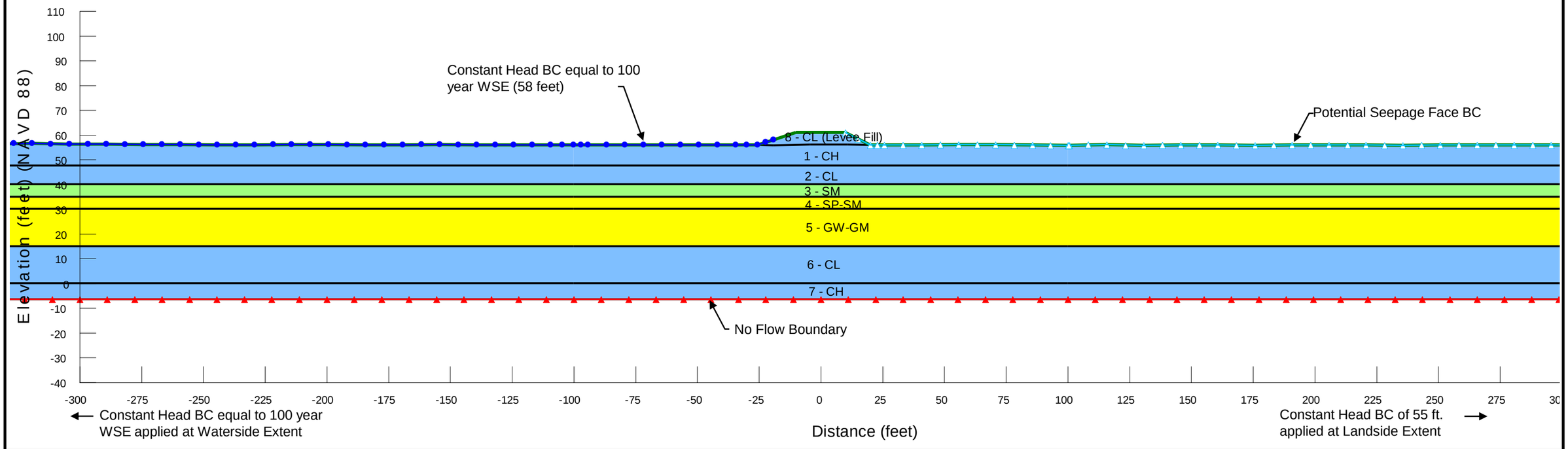
Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 1
(Alt. 2 Stn. 26+78)
Stability Result Waterside RDD

May 2019 FIGURE J5

North Wing Levee Section 2 (North Wing Levee Alt 2 Station 57+93)

Layer	Material	Total Unit Weight (pcf)	Hydraulic Conductivity		
			k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**CH**	120	0.085	3.0E-5	0.25
2	**CL**	120	0.011	4.0E-6	0.25
3	**SM**	125	14.170	5.0E-3	0.25
4	**SP-SM**	125	28.339	1.0E-2	0.25
5	**GW-GM**	130	113.357	4.0E-2	1
6	**CL**	120	0.011	4.0E-6	0.25
7	**CH**	120	0.011	4.0E-6	0.25
8	**CL (Levee Fill)**	120	0.011	4.0E-6	0.25



NOTES:

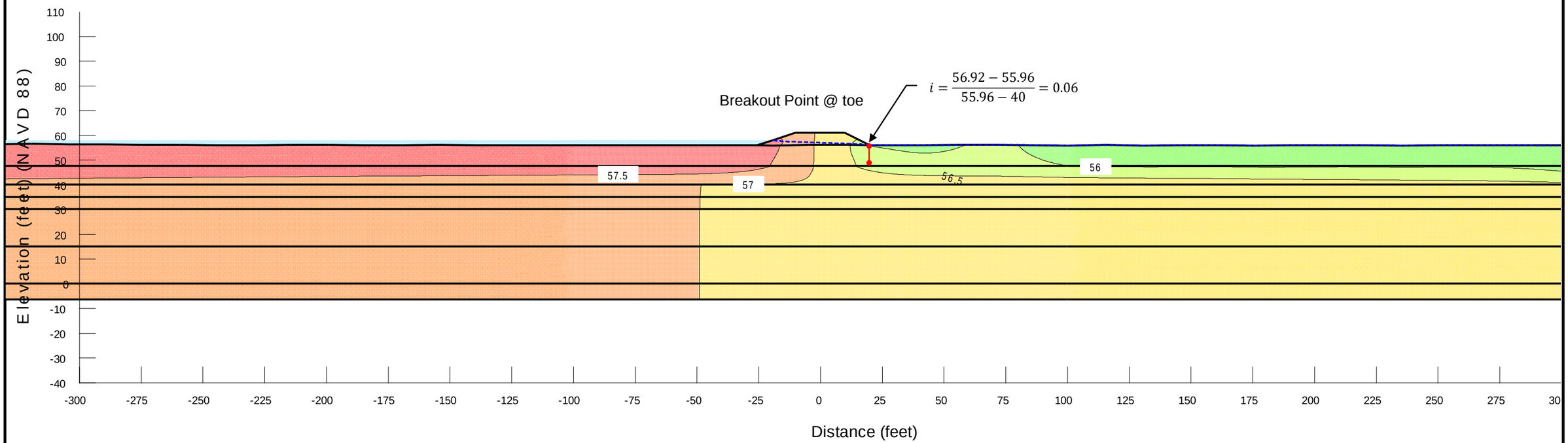
Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 2 (Alt. 2 Stn. 57+93) Seepage Model - 100 year WSE

May 2019 FIGURE J6

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 2 (Alt. 2 Stn. 57+93) Seepage Result - 100 year WSE

May 2019

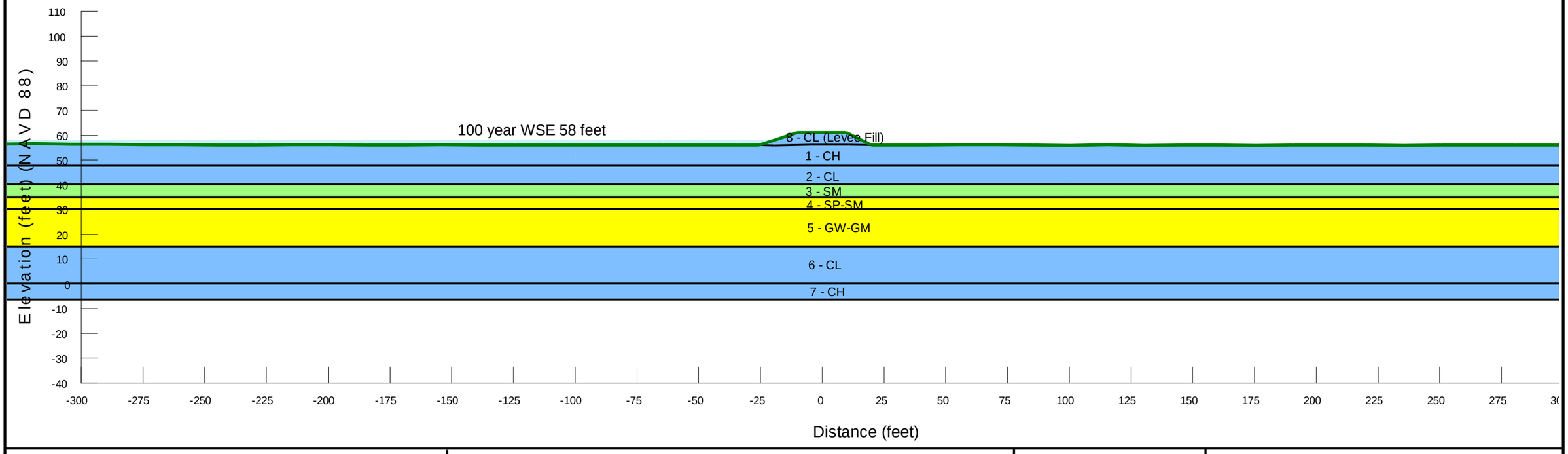
FIGURE J7

North Wing Levee Section 2 (North Wing Levee Alt 2 Station 57+93)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**CH**	120	50	31	360	4
2	**CL**	120	50	31	360	4
3	**SM**	125	0	34	-	-
4	**SP-SM**	125	0	34	-	-
5	**GW-GM**	130	0	35	-	-
6	**CL**	120	0	30	360	4
7	**CH**	120	0	30	360	4
8	**CL (Levee Fill)**	120	100	30	360	4

Waterside

Landside

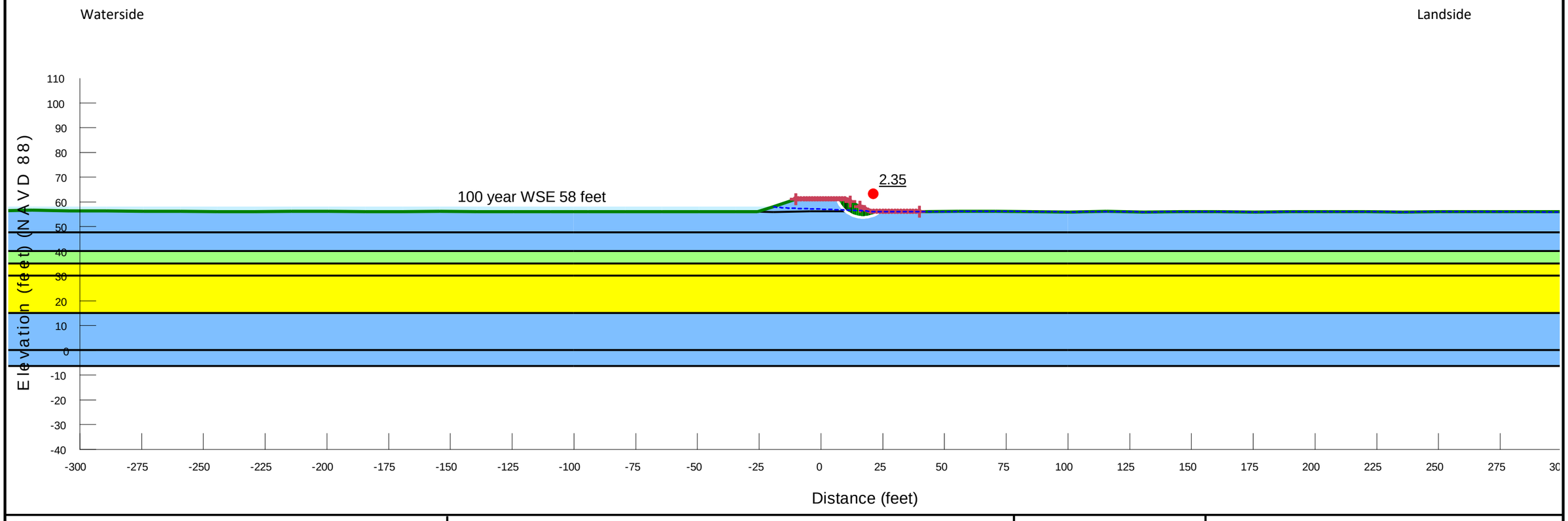


NOTES:

Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 2 (Alt. 2 Stn. 57+93) Stability Model

May 2019 FIGURE J8

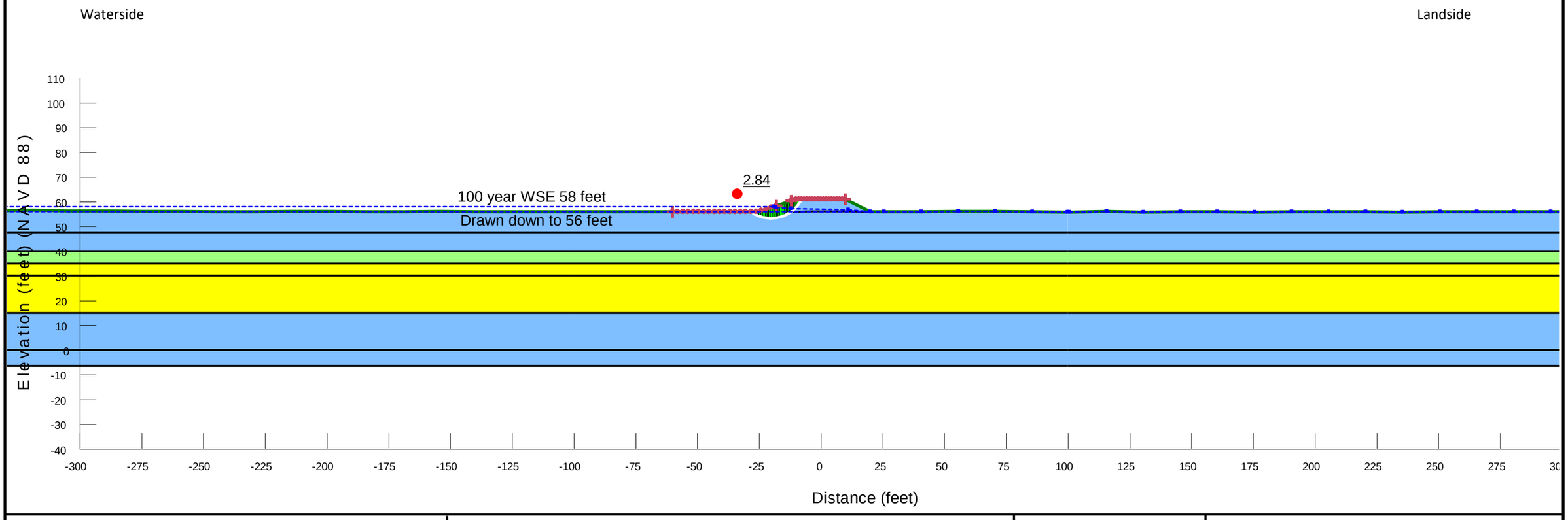


NOTES:

Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 2 (Alt. 2 Stn. 57+93) Steady State Stability Result Landside

May 2019 FIGURE J9



NOTES:

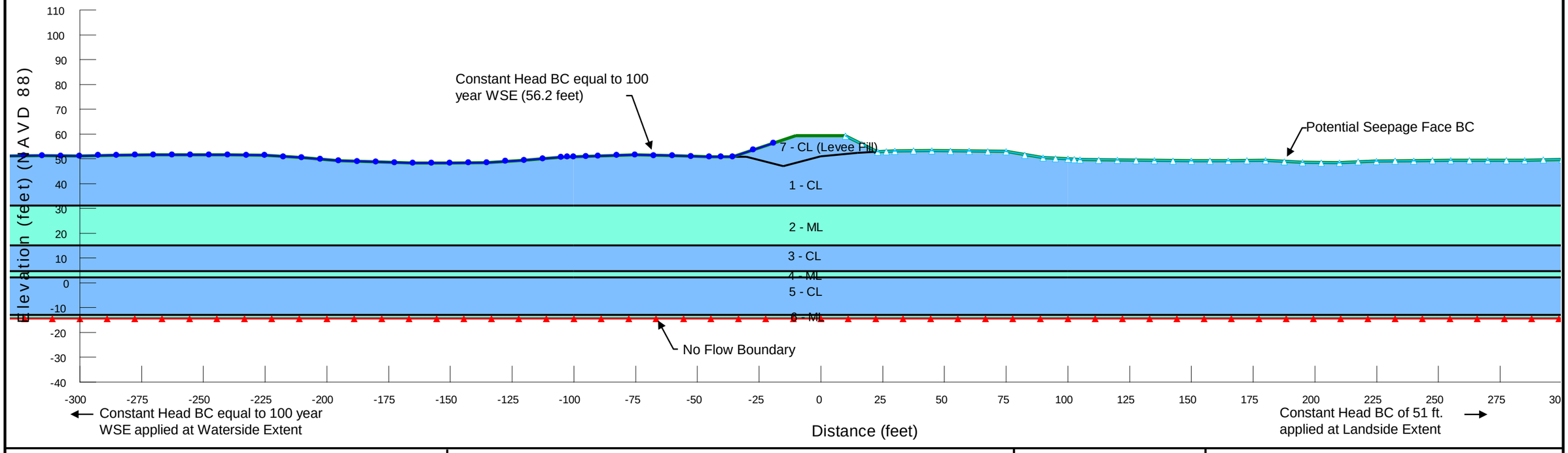
Colusa Flood Risk Reduction Feasibility Study

North Wing Levee Section 2
(Alt. 2 Stn. 57+93)
Stability Result Waterside RDD

May 2019 FIGURE J10

South Wing Levee Section 1 (South Wing Levee Alt 2 Station 194+33)

Layer	Material	Total Unit Weight (pcf)	Hydraulic Conductivity		
			k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**CL**	120	0.011	4.0E-6	0.25
2	**ML**	120	0.028	1.0E-5	0.25
3	**CL**	120	0.011	4.0E-6	0.25
4	**ML**	120	0.028	1.0E-5	0.25
5	**CL**	120	0.011	4.0E-6	0.25
6	**ML**	120	0.028	1.0E-5	0.25
7	**CL (Levee Fill)**	120	0.011	4.0E-6	0.25



NOTES:

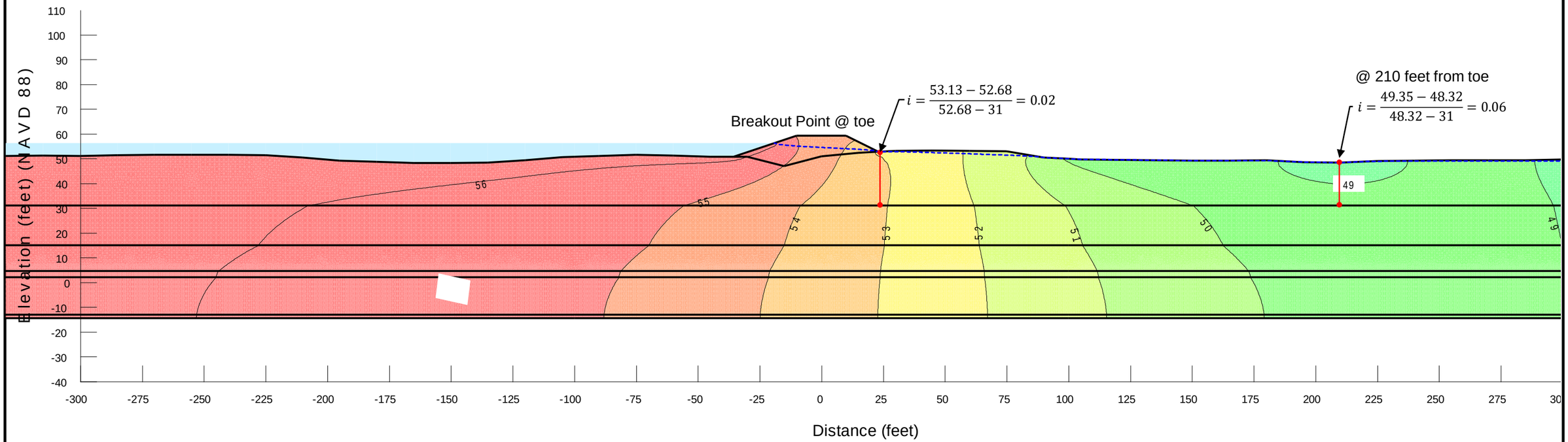
Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 1 (Alt. 2 Stn. 194+33) Seepage Model - 100 year WSE

May 2019 FIGURE J11

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 1 (Alt. 2 Stn. 194+33) Seepage Result - 100 year WSE

May 2019

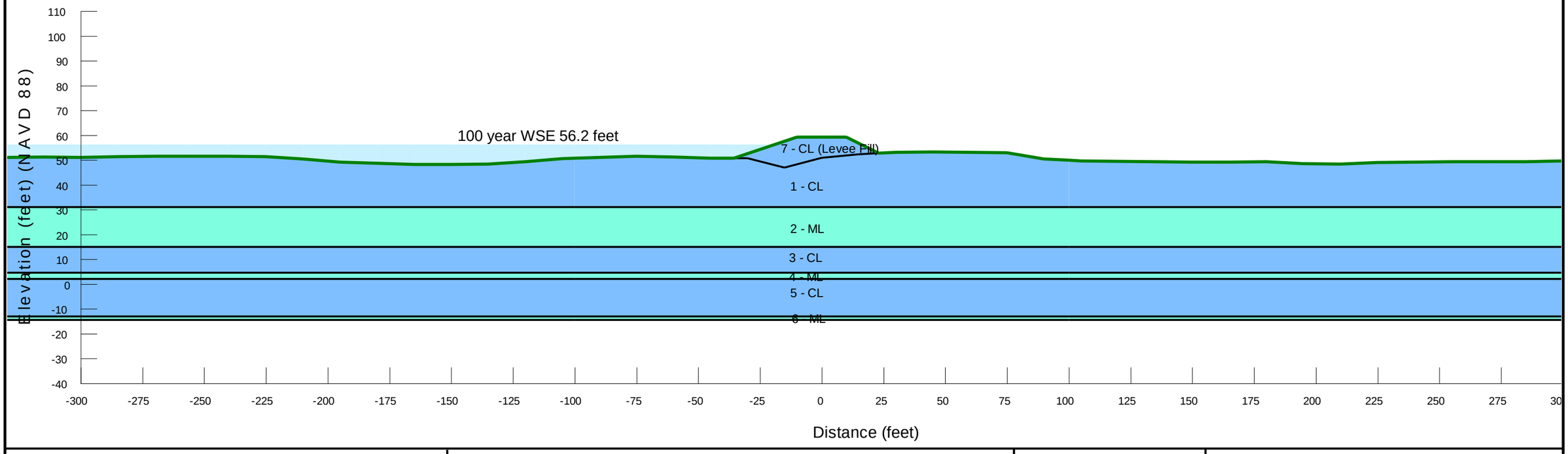
FIGURE J12

South Wing Levee Section 1 (South Wing Levee Alt 2 Station 194+33)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**CL**	120	50	30	360	4
2	**ML**	120	0	31	360	4
3	**CL**	120	100	30	360	4
4	**ML**	120	0	31	360	4
5	**CL**	120	100	30	360	4
6	**ML**	120	0	31	360	4
7	**CL (Levee Fill)**	120	100	30	360	4

Waterside

Landside



NOTES:

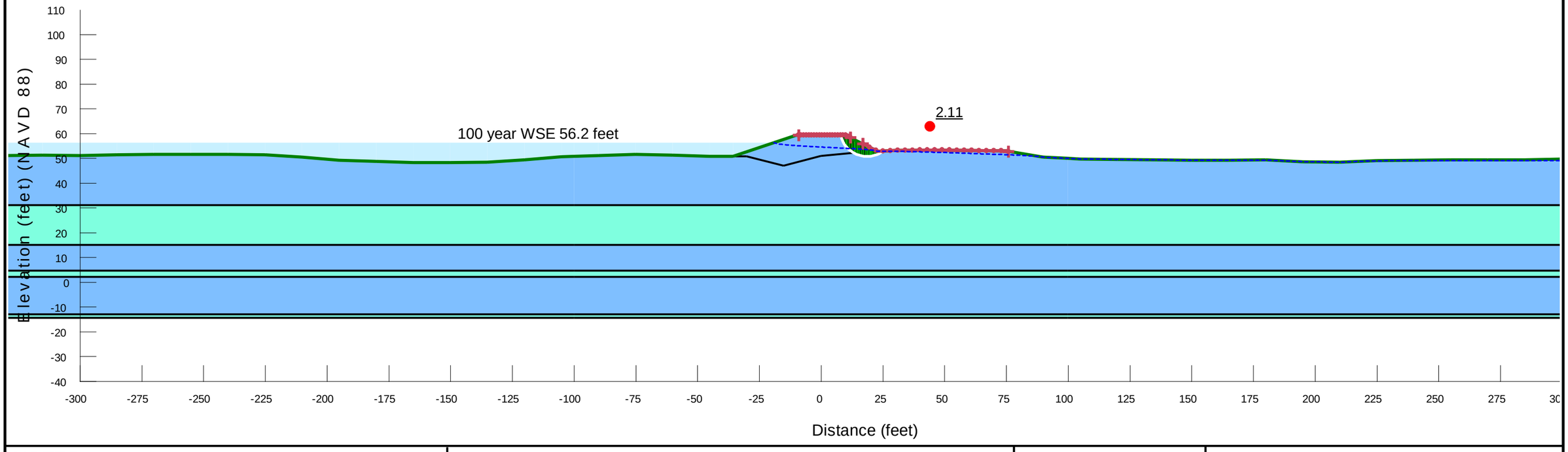
Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 1 (Alt. 2 Stn. 194+33) Stability Model

May 2019 FIGURE J13

Waterside

Landside



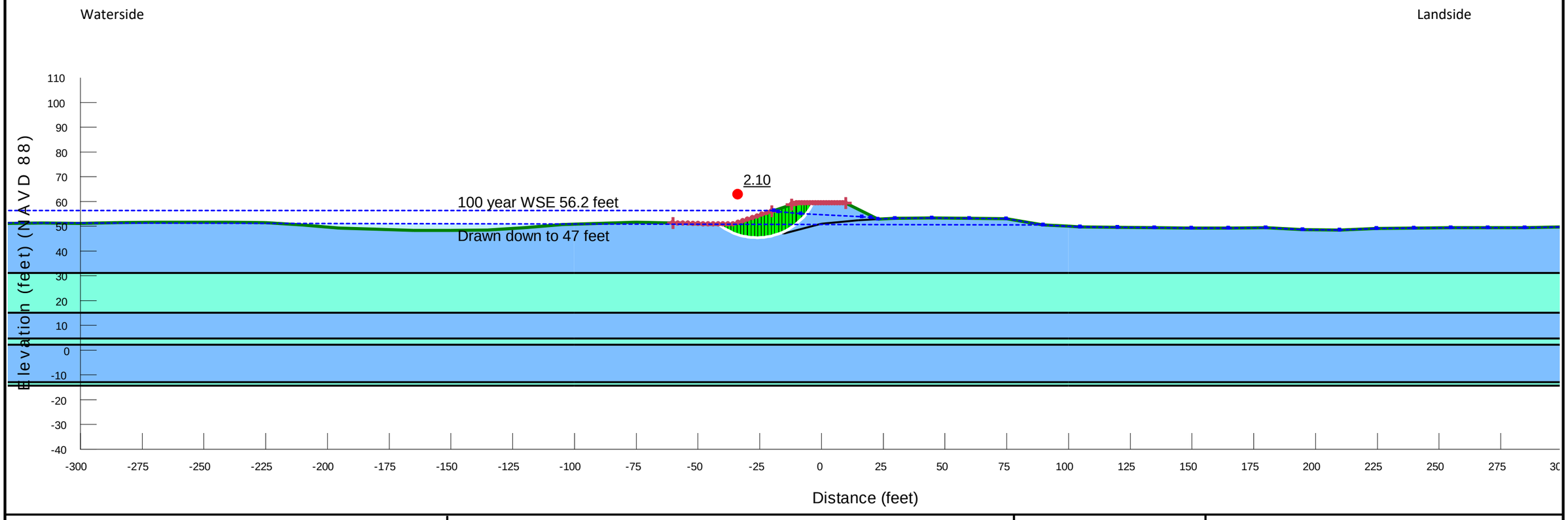
NOTES:

Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 1 (Alt. 2 Stn. 194+33) Steady State Stability Result Landside

May 2019

FIGURE J14



NOTES:

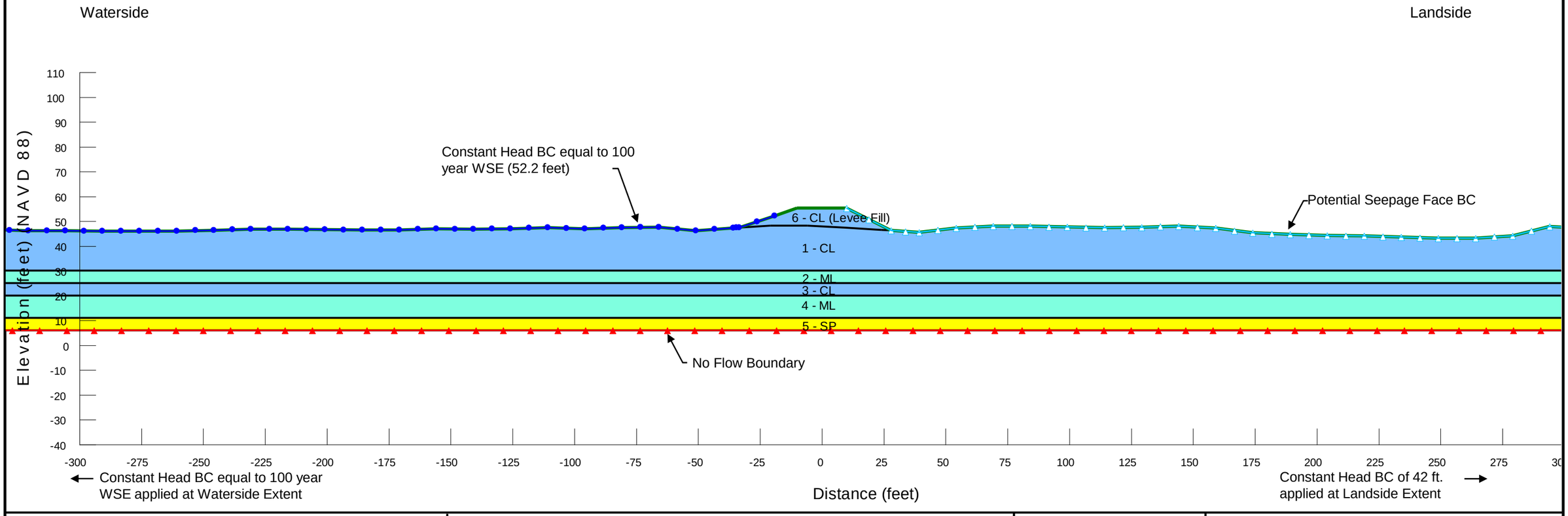
Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 1
(Alt. 2 Stn. 194+33)
Stability Result Waterside RDD

May 2019 FIGURE J15

South Wing Levee Section 2 (South Wing Levee Alt 2 Station 123+41)

Layer	Material	Total Unit Weight (pcf)	Hydraulic Conductivity		
			k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**CL**	120	0.011	4.0E-6	0.25
2	**ML**	120	0.028	1.0E-5	0.25
3	**CL**	120	0.011	4.0E-6	0.25
4	**ML**	120	0.028	1.0E-5	0.25
5	**SP**	125	56.678	2.0E-2	0.25
6	**CL (Levee Fill)**	120	0.011	4.0E-6	0.25



NOTES:

Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 2 (Alt. 2 Stn. 123+41) Seepage Model - 100 year WSE

May 2019 FIGURE J16

Waterside

Landside

$i = \frac{48.39 - 46.25}{46.25 - 30} = 0.13$

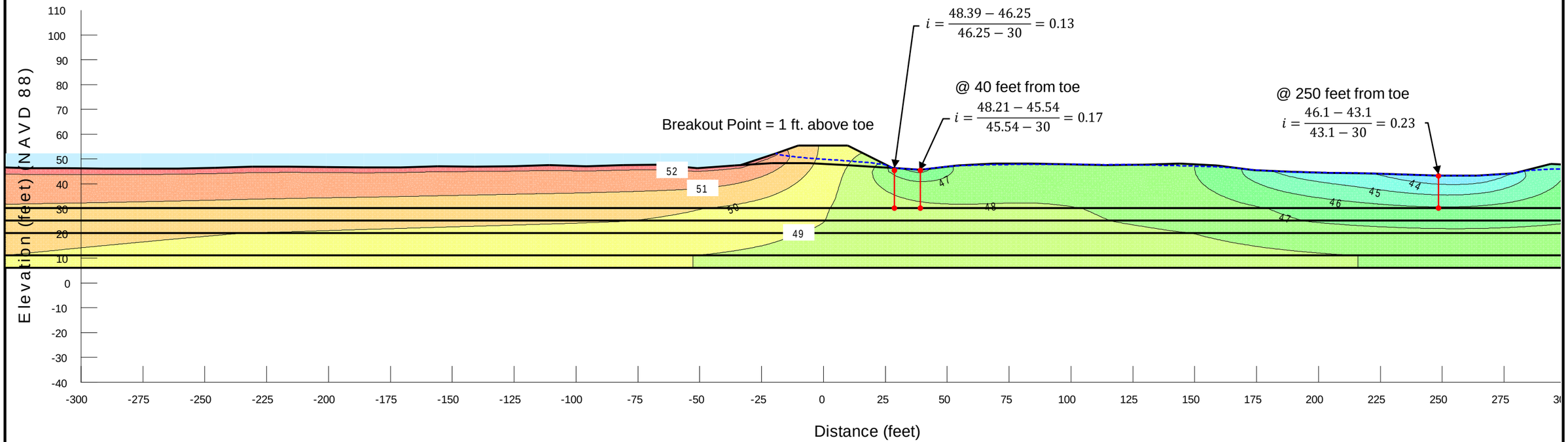
@ 40 feet from toe

$i = \frac{48.21 - 45.54}{45.54 - 30} = 0.17$

@ 250 feet from toe

$i = \frac{46.1 - 43.1}{43.1 - 30} = 0.23$

Breakout Point = 1 ft. above toe



Distance (feet)

NOTES:

Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 2 (Alt. 2 Stn. 123+41) Seepage Result - 100 year WSE

May 2019

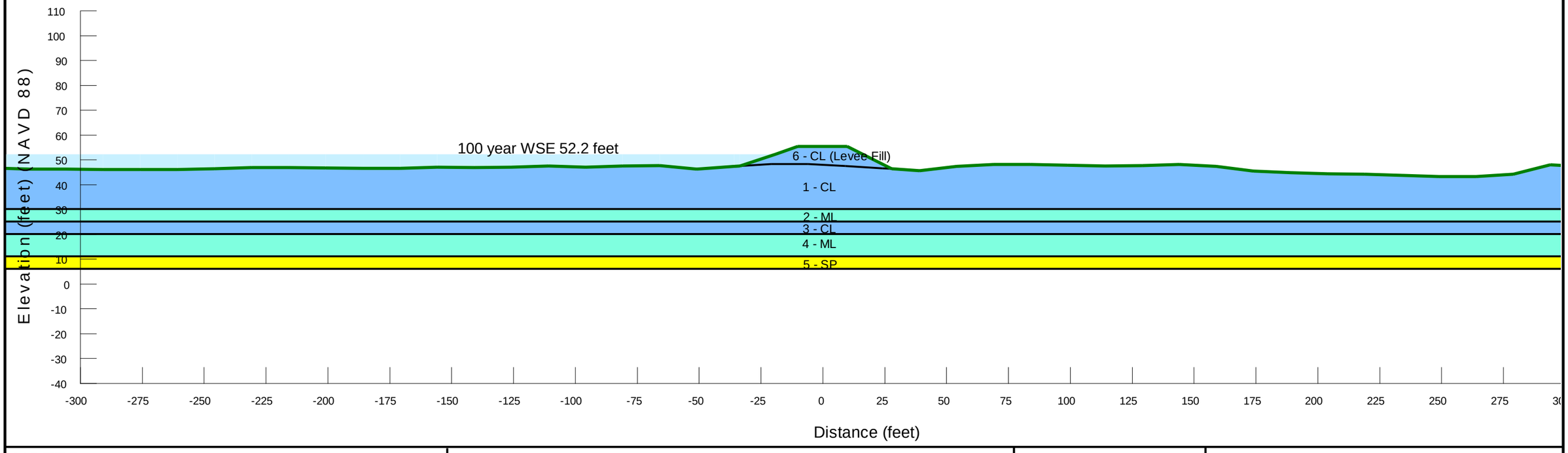
FIGURE J17

South Wing Levee Section 2 (South Wing Levee Alt 2 Station 123+41)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**CL**	120	50	30	360	4
2	**ML**	120	0	31	360	4
3	**CL**	120	100	30	360	4
4	**ML**	120	0	31	360	4
5	**SP**	125	0	33	-	-
6	**CL (Levee Fill)**	120	100	30	360	4

Waterside

Landside



NOTES:

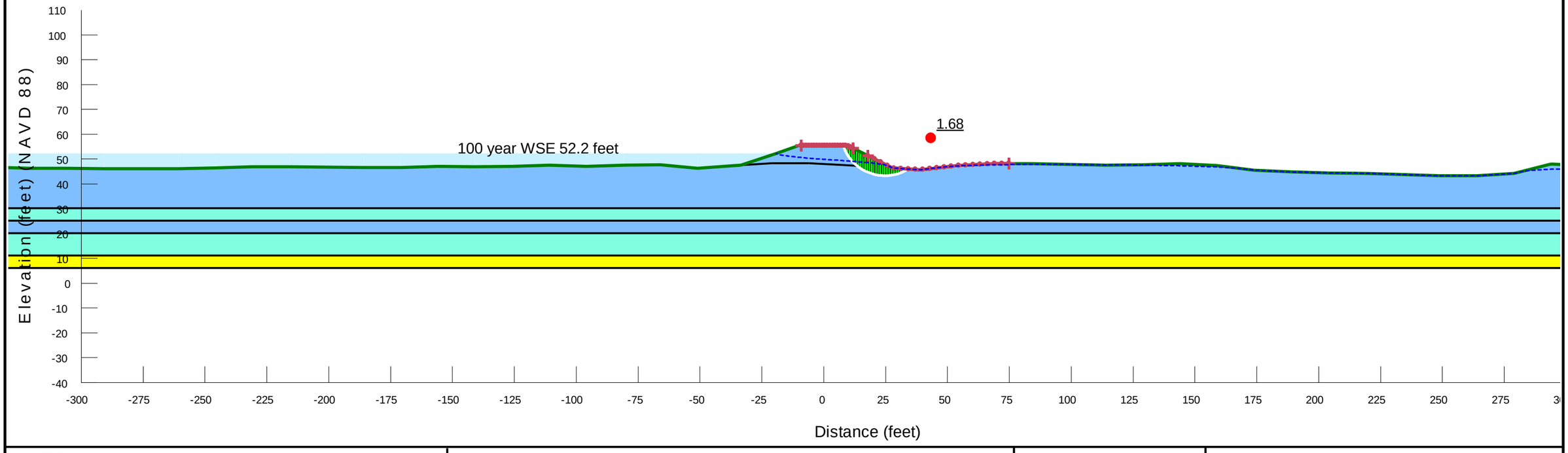
Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 2 (Alt. 2 Stn. 123+41) Stability Model

May 2019 FIGURE J18

Waterside

Landside



NOTES:

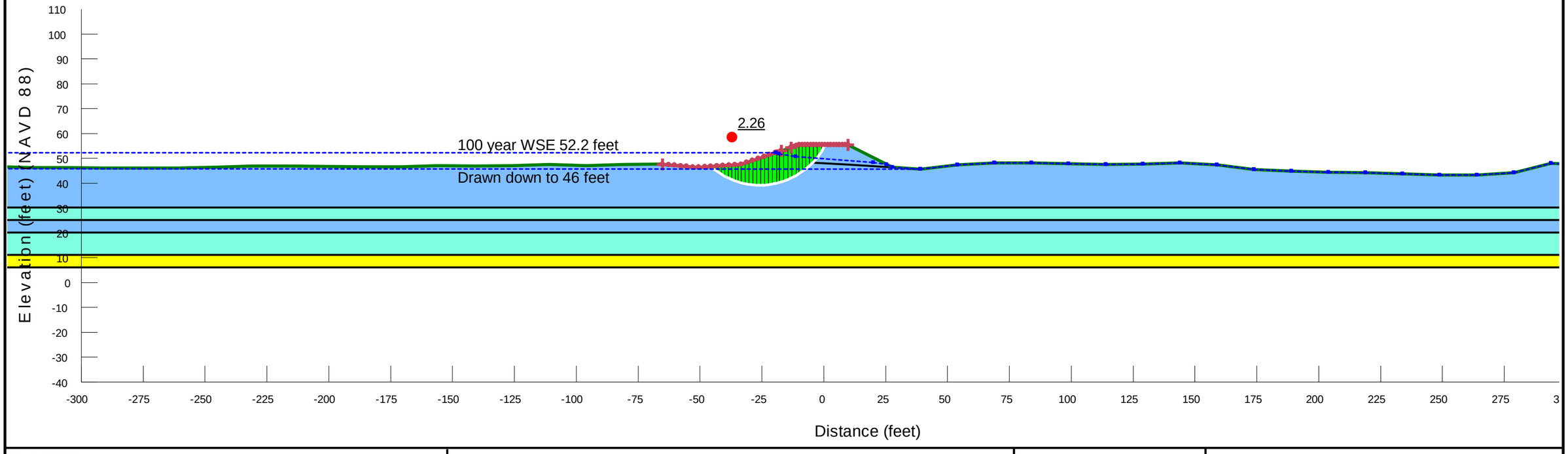
Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 2 (Alt. 2 Stn. 123+41) Steady State Stability Result Landside

May 2019 FIGURE J19

Waterside

Landside



NOTES:

Colusa Flood Risk Reduction Feasibility Study

South Wing Levee Section 2
(Alt. 2 Stn. 123+41)
Stability Result Waterside RDD

May 2019 FIGURE J20

Appendix C
Hydrology & Hydraulics Breach Analysis

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Colusa County Flood Risk Reduction Feasibility Study

City of Colusa

100-year Hydraulic Modeling September 26, 2019

Prepared by: Baron Creager, E.I.T.

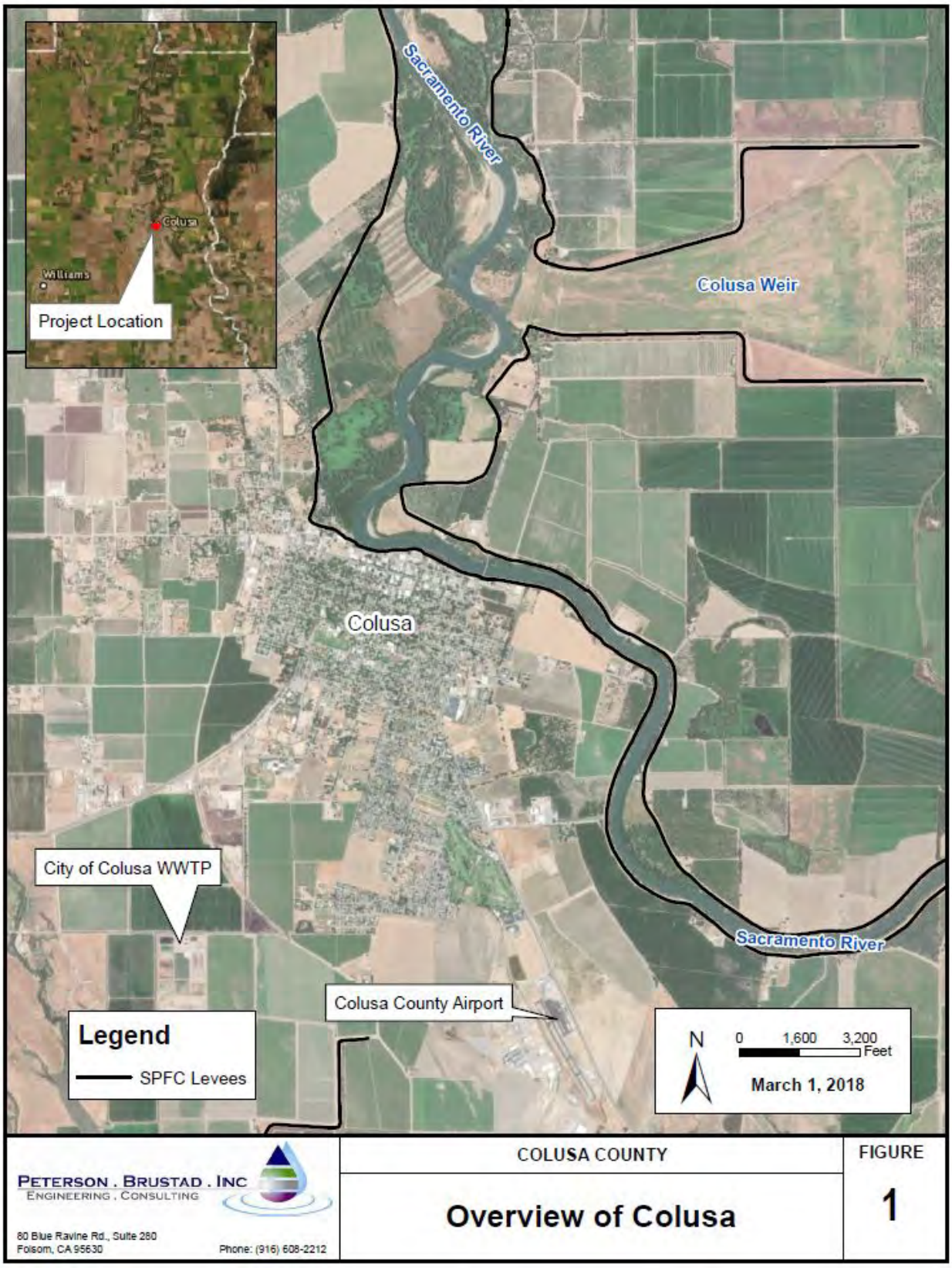
Reviewed by: Chris Fritz, P.E., Michael Pantell P.E.

Introduction

The City of Colusa Flood Risk Reduction Feasibility Study is a locally driven, state-funded project which seeks to identify feasible flood risk reduction measures for the City of Colusa. The study is being funded under DWR's Small Communities Flood Risk Reduction (SCFRR) Program, which is an outgrowth of the State's Central Valley Flood Protection Plan (CVFPP). The primary goal of the feasibility study is to evaluate pre-design alternatives and recommend a preferred alternative to improve the flood protection for the City of Colusa to a level that meets FEMA accreditation standards. An overview of the location of Colusa and the current SPFC levees protecting the community is shown in Figure 1.

As part of the study, Peterson Brustad, Inc. (PBI) used an existing HEC-RAS version 5.0.3 hydraulic model to simulate a series of seven (7) levee breach scenarios along the west bank of the Sacramento River for the one-percent annual exceedance probability (AEP) flood event (i.e. the 100-year flood). The results of these breach simulations were then mapped to show the depths and extents of flooding associated with each breach under existing (pre-project) conditions. PBI then ran a separate set of levee breach simulations for the post-project conditions under various proposed alternatives. The pre- and post-project results were compared to determine the difference in the extents and depths of flooding for each alternative. Comparison maps were also created to show the changes in flood water depths near the community as a result of each proposed alternative.

This technical memorandum (TM) documents the development and results of the hydraulic analyses that were conducted by PBI for the City of Colusa Flood Risk Reduction Feasibility Study. It should be noted that the analyses conducted as part of this study solely focus on the potential flooding impacts associated with breaks along the Sacramento River. Impacts associated with high water in the Colusa Drain or a combined Sacramento River/Colusa Drain flood event were not analyzed as part of this study.


Sacramento River
Colusa
Williams
Project Location
Colusa Weir
Colusa
City of Colusa WWTP
Sacramento River
Colusa County Airport
Legend
SPFC Levees
N
0
1,600
3,200
Feet
March 1, 2018
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COLUSA COUNTY
Overview of Colusa
FIGURE
1

Horizontal and Vertical Datum

The referenced horizontal projection is the North American Datum 1983, California State Plane Coordinate System, Zone II. The referenced vertical datum is the North American Vertical Datum of 1988 (NAVD88). All units are in U.S. Survey feet.

Hydraulic Model Sources & Refinements

Colusa County is currently coordinating with Federal Emergency Management Agency (FEMA) on a Flood Insurance Rate Map (FIRM) remapping effort which is focused on the area protected by the Sacramento River West Levee. As part of this process, FEMA and its STARR II Team developed a HEC RAS 5.0 one-dimensional/two-dimensional (1D/2D) coupled model[1] to simulate the natural valley analysis. FEMA's STARR II team contractor (Atkins) provided a draft version of the model to Colusa County and PBI in February of 2018. The model was originally developed by DWR as part of its Central Valley Floodplain Evaluation and Delineation (CVFED) Program[2] and then further developed by FEMA to add in two-dimensional overbank flow areas.

The 1D reaches in the HEC RAS model were previously calibrated to the 2006 event by DWR as part of the CVFED effort. The recent work by FEMA added in one large 2D flow area approximately 544 square miles in size with a 400-foot by 400-foot grid mesh resolution. The FEMA model includes over 340 miles of levees and embankments. Table 1 shows a summary of the Manning's n values input into the model by FEMA for the new 2-D areas. The Manning's n values are based upon land use classifications and the National Land Cover Database. PBI made no changes to the Manning's n-values.

Table 1. Manning's n values for each Land Use Classification.

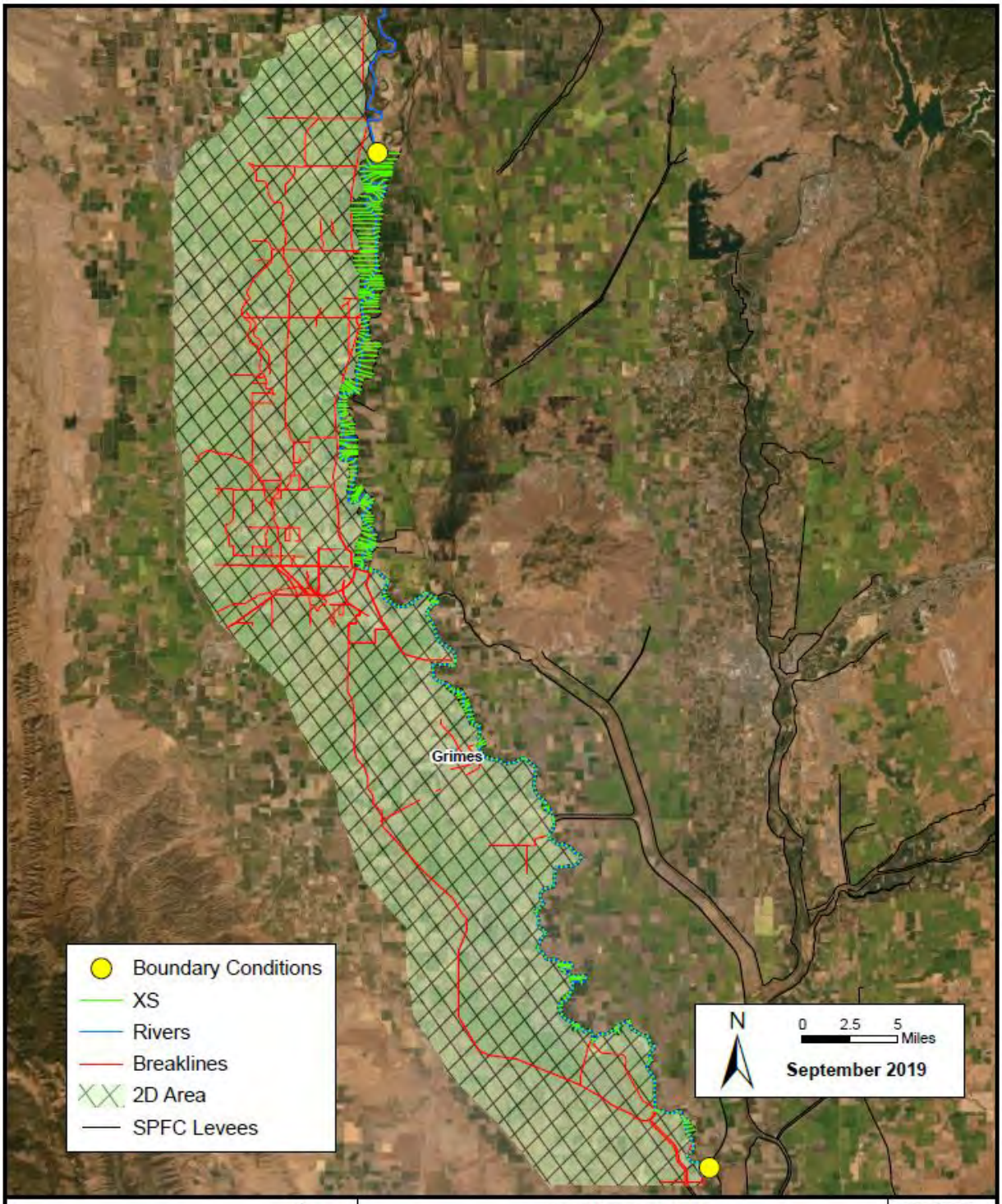
Land Use Classification	Manning's n Roughness Value
Barren land rock/Sand/Clay	0.04
Cultivated crops	0.06
Deciduous forest	0.10
Developed, high intensity	0.15
Developed, low intensity	0.08
Developed, medium intensity	0.10
Developed, open space	0.04
Emergent herbaceous wetlands	0.08
Evergreen forest	0.12
Grassland/Herbaceous	0.05
Open water	0.04
Pasture/Hay	0.06
Shrub/Scrub	0.08
Woody wetlands	0.12

[1] Atkins. February 2018. FEMA Region IX Natural Valley and LAMP Analyses HEC-RAS 1D-2D model for Sacramento River Right Levee in Colusa County, California.
[2] DWR. 2014. *CVFED Upper Sacramento River System HEC-RAS Model Documentation.*

After receiving the model from FEMA, PBI made the following additional refinements to the model as part of this study to better match 100-year CVHS index point flows located downstream throughout the model:

- Shifted the upstream CVHS inflow location from SAC 184 to SAC 169. It was discovered that flow interactions between the Butte Sink and the east bank of the Sacramento River north of river station 174.068 were causing the model lose too much flow into the Butte Sink (some of the tributary inflows into the Butte Sink were removed as part of the updates done by FEMA). Therefore, some model refinements were incorporated into the PBI model to improve model stability and better match downstream CVHS 100-year index point flows.
- Removed lateral structures on the east side of the Sacramento River north of river station 174.068.
- Removed cross sections north of station 174.068.
- Changed the Colusa weir coefficient from 2.6 to 2.1.
- Changed the downstream boundary condition to a stage hydrograph from the 2017 CVFPP hydraulic model – 1997 event for the 100-year return period
- Modified the location of the inflow hydrology (see following section).

Figure 2 shows an overview of the HEC RAS hydraulic model used by PBI.



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COLUSA COUNTY

Hydraulic Model Overview
HEC RAS 5.0

FIGURE
2

Hydrology

The PBI model utilizes 100-year inflows derived from DWR's Central Valley Hydrology Study[3] (CVHS). The PBI model uses the CVHS data associated with the 100% 1997 event for the 100-year return period. The upstream boundary condition for the Sacramento River (RS 174.068) is associated with the SAC-169 CVHS index point which has a 100-year flow of 160,000 cfs. Table 2 summarizes the CVHS 100-year index point flows, previous Comp Study[4] flows, and the resulting 100-year computed flows from PBI's model at each index point location along the study reach.

Table 2. Hydrologic information

Location	RS	Index Point	100-Year Flow at Index Point (cfs)		
			Comp Study	CVHS Flow-Frequency Curve	PBI 100-Year Breach Model
At Butte City	166.837	SAC-169	159,117	160,000	161,145
At Princeton	161.931	-	157,445	-	160,761
Below Moulton Weir	156.342	SAC-158	128,767	128,000	129,334
Below Colusa Weir	145.228	SAC-146	55,715	50,500	50,565
At Colusa	142.949	SAC-143	55,440	50,300	50,409
At Moons Bend	137.753	SAC-138	55,270	50,200	50,355
At Grimes	125.596	-	54,709	-	50,304

Additionally, the downstream boundary condition of the model was set to a stage hydrograph for the 1997 event from the 2017 CVFPP hydraulic model. This stage hydrograph corresponds the 100-year event.

Climate Change and Sea Level Rise

The 2017 CVFPP analyzed the impact of climate change in year 2067 (50 years) on the Sacramento River basin for the 200-year event. The existing 200-year peak flow on the Sacramento River at Moons Bend is 50,900 cfs and DWR's analysis shows that climate change could raise the peak flow to 52,800 cfs. This is an approximate 3.7% increase in flow in the next 50 years. While the CVFPP did not consider the 100-year flow for this reach, the same percent increase in flow can be added to the 100-year event (50,300 cfs) at Colusa to come up with an approximate climate change 100-year flow of 52,100 cfs at Colusa. This increase in flow would result in an approximate 0.8-foot increase in stage within the Sacramento River near Colusa.

Uncertainty in climate change modeling is high, especially when projecting out 50 years. Additionally, within this time frame, many changes to the Sacramento River system can and likely will occur which will affect the water surface elevation in the river. For example, the 2017 CVFPP proposed widening the Fremont weir to allow more flow to enter the Yolo Bypass. The CVFPP performed an analysis to determine the hydraulic impact on the Sacramento River with the Fremont weir widening under 200-year climate change condition. The analysis found a reduction from 0.2 to 0.5 feet along the Sacramento River at Colusa.

[3] DWR. 2015. *Central Valley Hydrology Study.*
[4] USACE. 2002. *Sacramento and San Joaquin River Basins Comprehensive Study.*

While this is not the 100-year climate change analysis, it does show that planned projects will have a positive impact in mitigating climate change over the next half century.

The uncertainty of the climate change analysis combined with the 4-feet of freeboard (3 feet from FEMA standards in addition to 1 additional foot incorporated into the design of the proposed project) gives the project ample resiliency to accommodate climate change over the next 50 years and time to adjust, if needed, based on actual conditions 20-30 years in the future. If the rates of climate change impacts are slower than predicted, no additional modification will be required. If the rates of climate change impacts are faster than predicted, then remedial actions can be taken.

The influence of sea level rise was not considered for the hydrology or hydraulic modeling of this analysis. Future sea level rise projections from the 2017 CVFPP show a mean sea level rise projection of approximately 1.5 feet at the Golden Gate Bridge in 2067. Colusa is located at approximately 45 feet above sea level and would not experience any of the effects of sea level rise given its elevation.

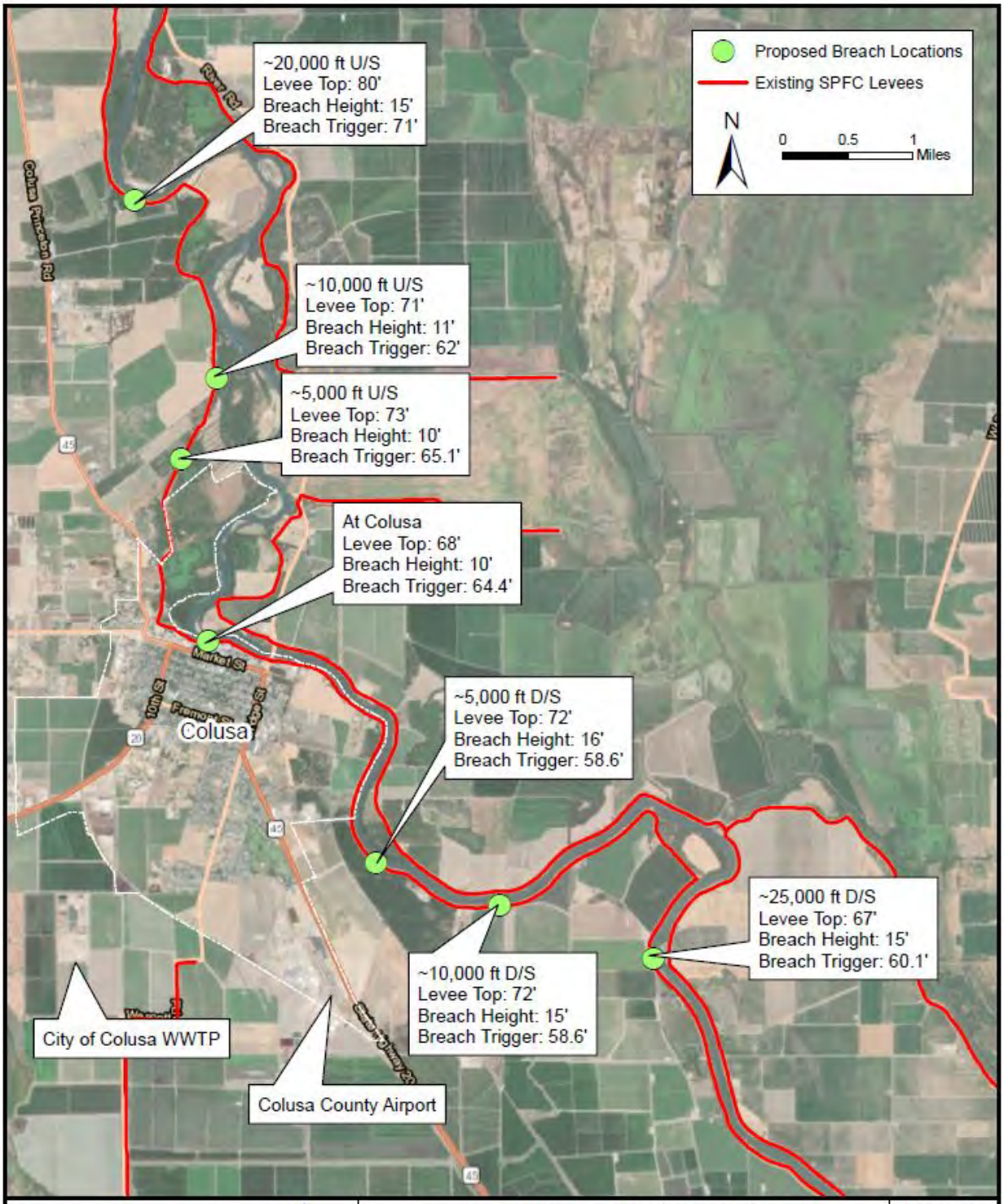
Breach Locations & Parameters

In total, seven (7) breach locations were chosen ranging from 20,000 feet upstream to 25,000 feet downstream of the City to analyze the potential flooding impacts to the city. A breach width of 500-feet was selected considering FEMA guidance, historical breach information, and previous USACE feasibility study information. The 500-foot width assumption is consistent with other levee breach width assumptions used by both USACE and DWR in other recent studies throughout the Central Valley. For example, for levees that are 10-feet in height the 500-ft width is comparable to the width assumption (50 times the levee height) used by DWR for their SB 1278/AB 1965 ULOP informational maps[5]. The 500-foot width is also consistent with FEMA's LAMP guidance[6] which states a that a minimum breach width of 100-feet shall be used for clay levees and 500-feet shall be used for sand levees.

The breach trigger water surface elevations (WSEs) were derived from the NULE reduction heights[7]. The NULE reduction heights were developed from geotechnical evaluations performed by URS Corporation for DWR and included analysis of underseepage, landside stability, through-seepage, and erosion. If the peak WSE did not reach the NULE reduction height, then the breach was initiated when the water reached a height of one foot below the peak WSE.

Figure 3 summarizes the 7 breaches used for this study.

[5] DWR. July 2013. Central Valley Floodplain Evaluation and Delineation – Senate Bill 1278/Assembly Bill 1965 Urban Level of Protection Informational Maps.
[6] FEMA. July 2013. *Analysis and Mapping Procedures for Non-Accredited Levee Systems, New Approach.*
[7] URS Corporation. 2012. *Levee Reliability Technical memorandum.*



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COLUSA COUNTY LEVEE BREACH ANALYSIS

Overview of breach locations for the City of Colusa

FIGURE **3**

Alternatives Modeling

The three proposed project alternatives were provided to PBI from KSN in GIS shapefile format in October of 2017. All alternatives include the Powell Slough Preferred Alternative[8], which connects two existing levees located south and west of Colusa that protect against flood threats from the Colusa Drain. Nonstructural components of each alternative were not modeled as there would be no impact on the results. The three proposed alternatives are shown in each of the figures included in Attachments B and C.

Alternative 1 includes a northern wing levee connecting the existing Powell Slough levee to the west of Colusa with the Sacramento River right-bank levee approximately 10,000 feet upstream of Colusa. An additional southern wing levee connects the existing Colusa Drain levee to the Sacramento River right-bank levee approximately 10,000 feet downstream of Colusa. A nonstructural component is included at the location where the northern wing levee connects to the Sacramento River levee.

Alternative 2 includes wing levees connecting the existing Powell Slough and Colusa Drain levees to the Sacramento River right-bank levee. Differing from Alternative 1, the northern Alternative 2 wing levee connects to the Sacramento River right-bank levee approximately 5,000 feet upstream of Colusa and the southern wing levee connects approximately 5,000 feet downstream of Colusa. Three nonstructural components are included southeast of Colusa along the right-bank of the Sacramento River.

Alternative 3 includes the northern wing levee alignment from Alternative 1, and the southern wing levee alignment from Alternative 2. That is, the northern wing levee connects to the Sacramento River right-bank levee approximately 10,000 feet upstream of Colusa and the southern wing levee connects approximately 5,000 feet downstream of Colusa. Alternative 3 includes the same three nonstructural components included in Alternative 2.

For modeling the hydraulic changes associated with each alternative, PBI simulated each breach location under existing conditions to determine a baseline floodplain. Each alternative levee alignment was coded into the model and the same breach locations were simulated for each Alternative where the levee remained unimproved. Four (4) breach locations for Alternative 1, six (6) breach locations for Alternative 2, and five (5) breach locations for Alternative 3 remained unrepaired and were run for a total of 15 post-project breach runs.

Results

The 100-year levee breach floodplain maps at Colusa for existing conditions are provided in Attachment A. The City of Colusa is inundated due to breaches between the city center and approximately 5,000 ft downstream. The breach at Colusa results in one to five feet of flooding throughout the city. The breach located approximately 5,000 ft downstream inundates the Colusa County Airport with up to five feet of water. Notably, the breach approximately 20,000 feet upstream of Colusa overtops the southern berm protecting the City of Colusa Wastewater Treatment Plant.

[8] HDR. June 15, 2016. *Feasibility Study for the Colusa Drain Flood Reduction Project*.

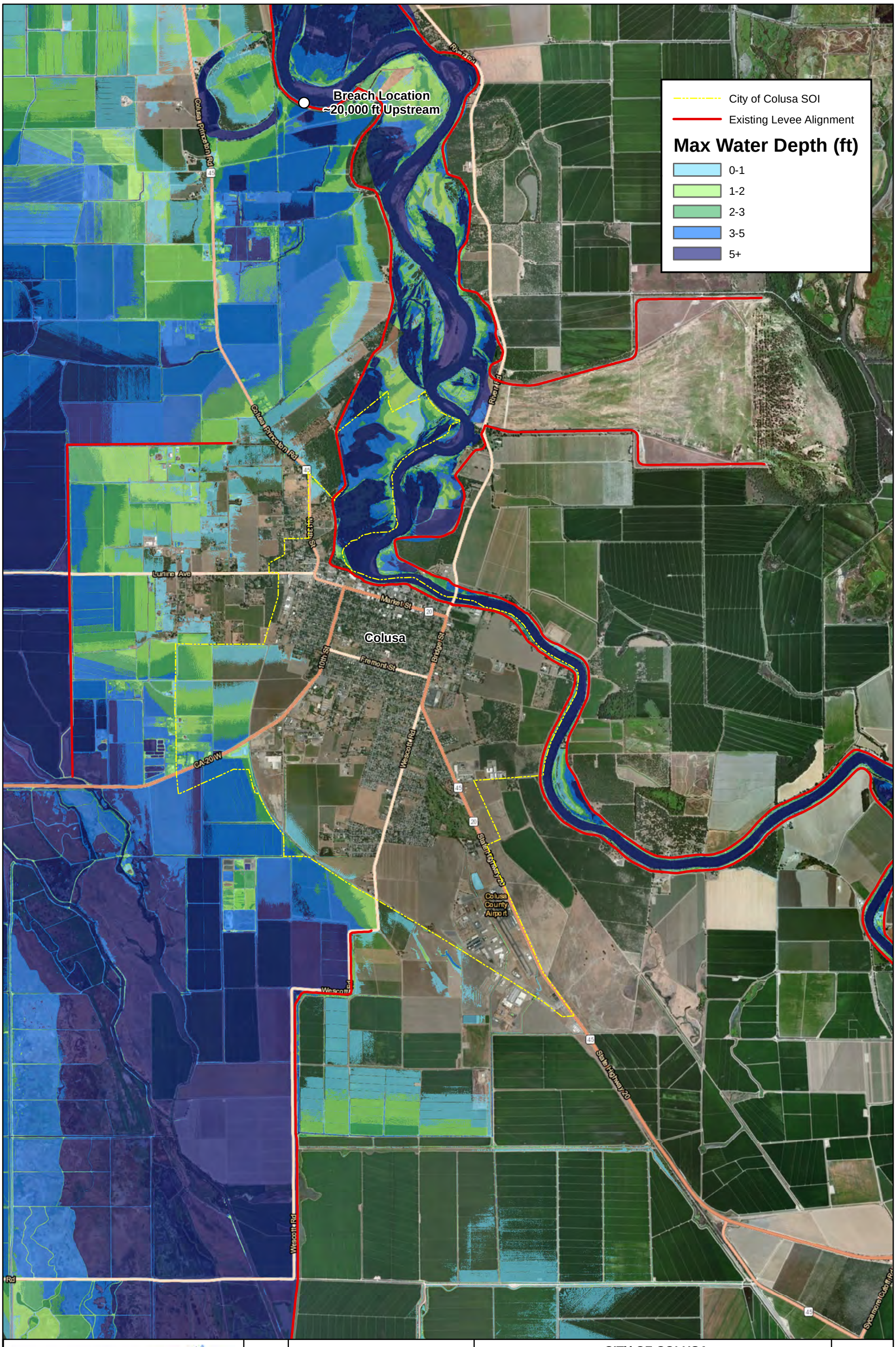
The 100-year levee breach floodplain maps with the implementation of the structural components of Alternatives 1, 2, and 3 are provided in Attachment B.

Attachment C contains comparison maps presenting the change in flood water depth due to each alternative when compared to the existing conditions.

Attachment A

Existing Conditions

Levee Breach Floodplain Maps



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N

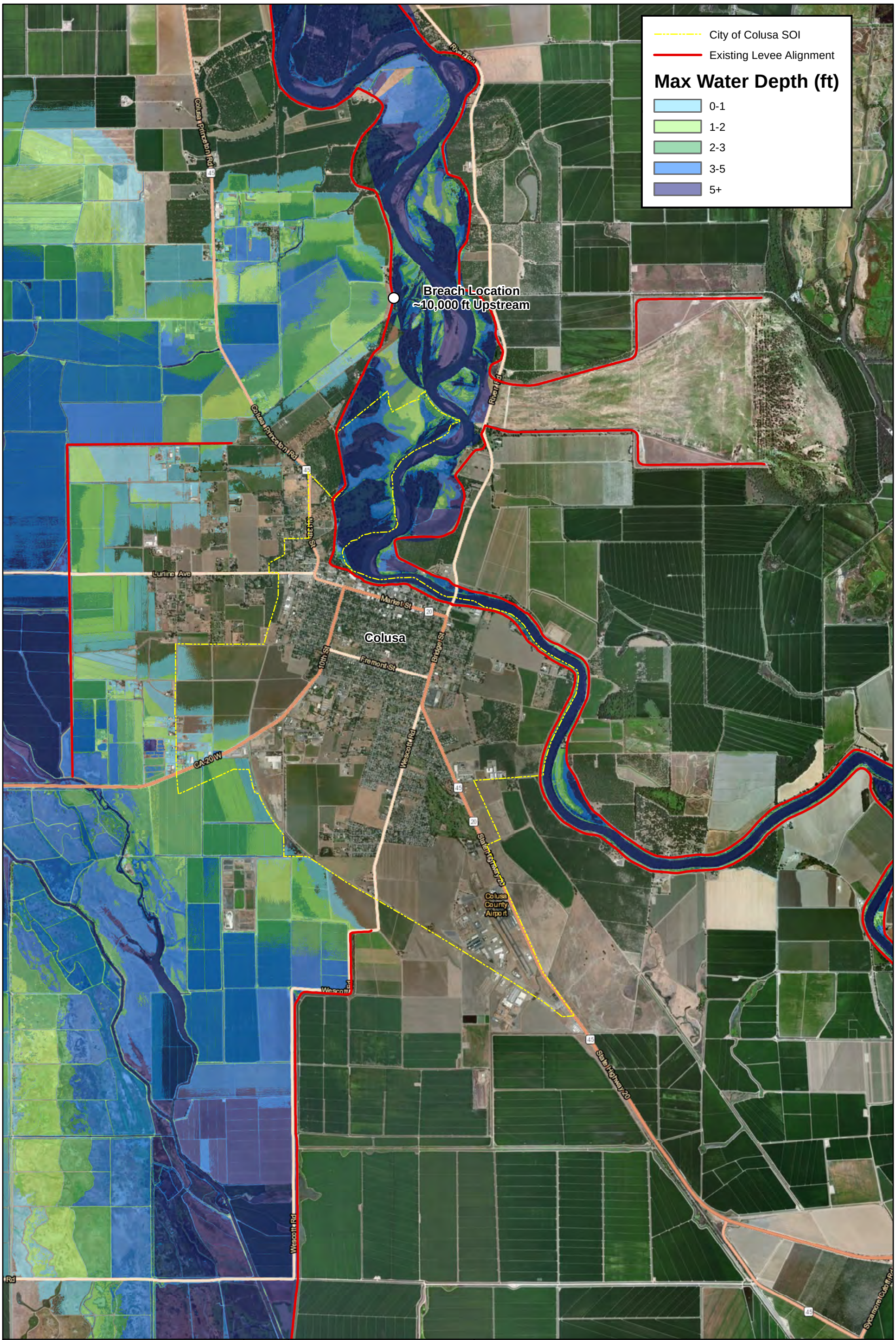
0 0.25 0.5 Miles

May 2018

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Sacramento River levee breach located ~20,000 ft upstream of Colusa

FIGURE
1



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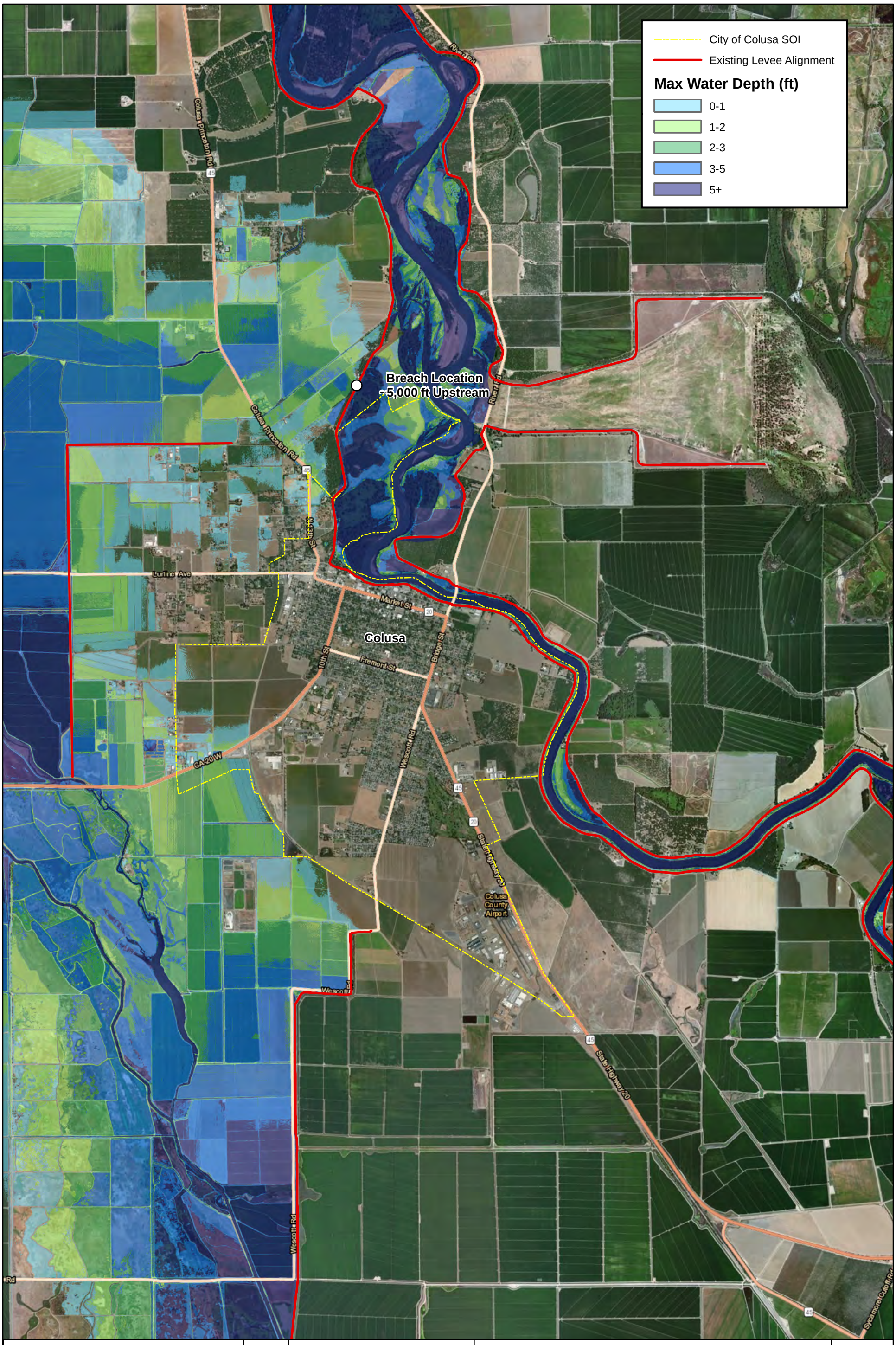
0 0.25 0.5 Miles

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CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Sacramento River levee breach located ~10,000 ft upstream of Colusa

FIGURE 2



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N

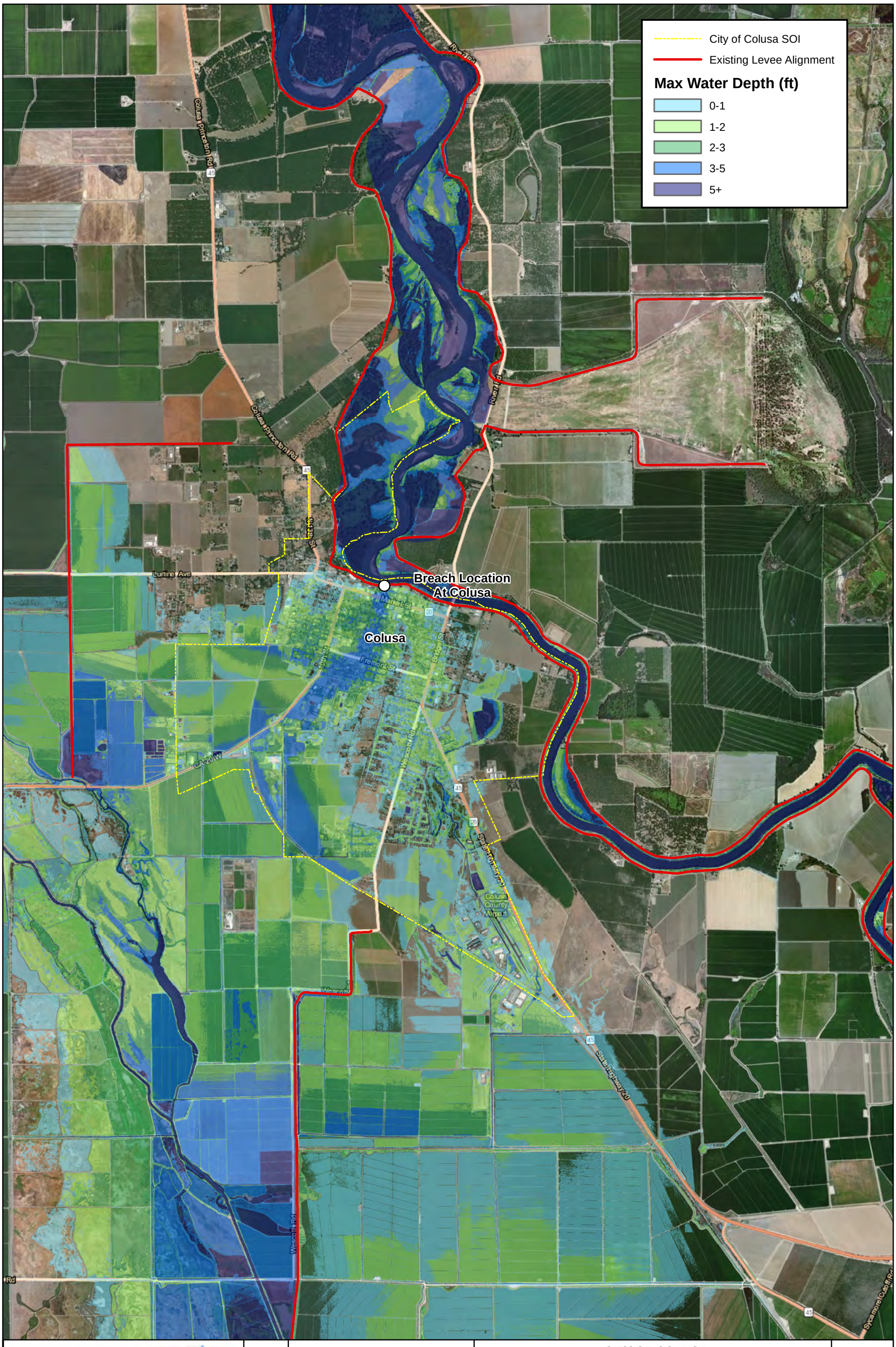
0 0.25 0.5 Miles

May 2018

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Sacramento River levee breach located ~5,000 ft upstream of Colusa

FIGURE
3



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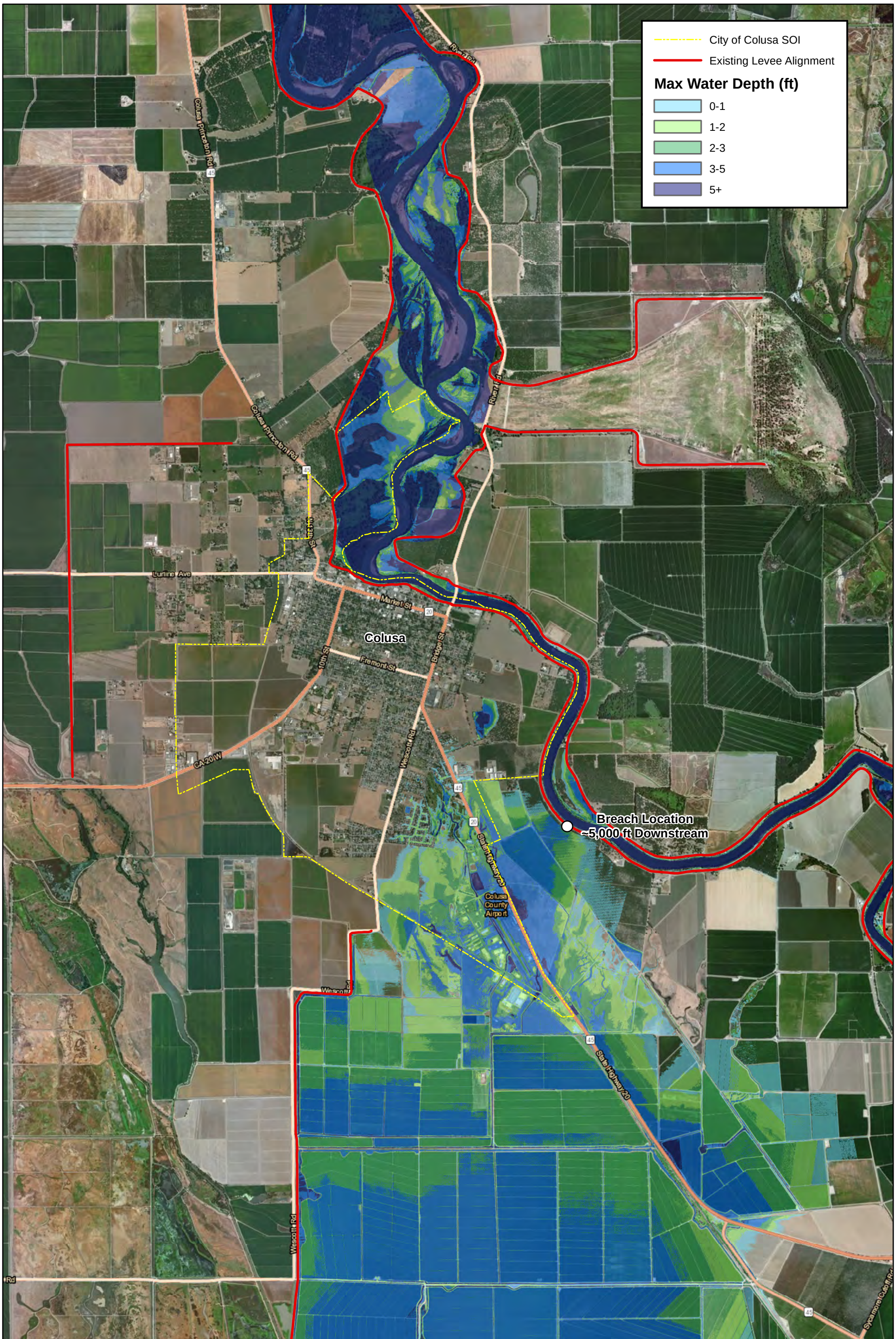
N

May 2018

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Sacramento River levee breach located at Colusa

FIGURE
4



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N

0 0.25 0.5 Miles

May 2018

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Sacramento River levee breach located ~5,000 ft downstream of Colusa

FIGURE
5

City of Colusa SOI

Existing Levee Alignment

Max Water Depth (ft)

0-1

1-2

2-3

3-5

5+

Colusa

Breach Location
~10,000 ft Downstream

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N

0 0.25 0.5 Miles

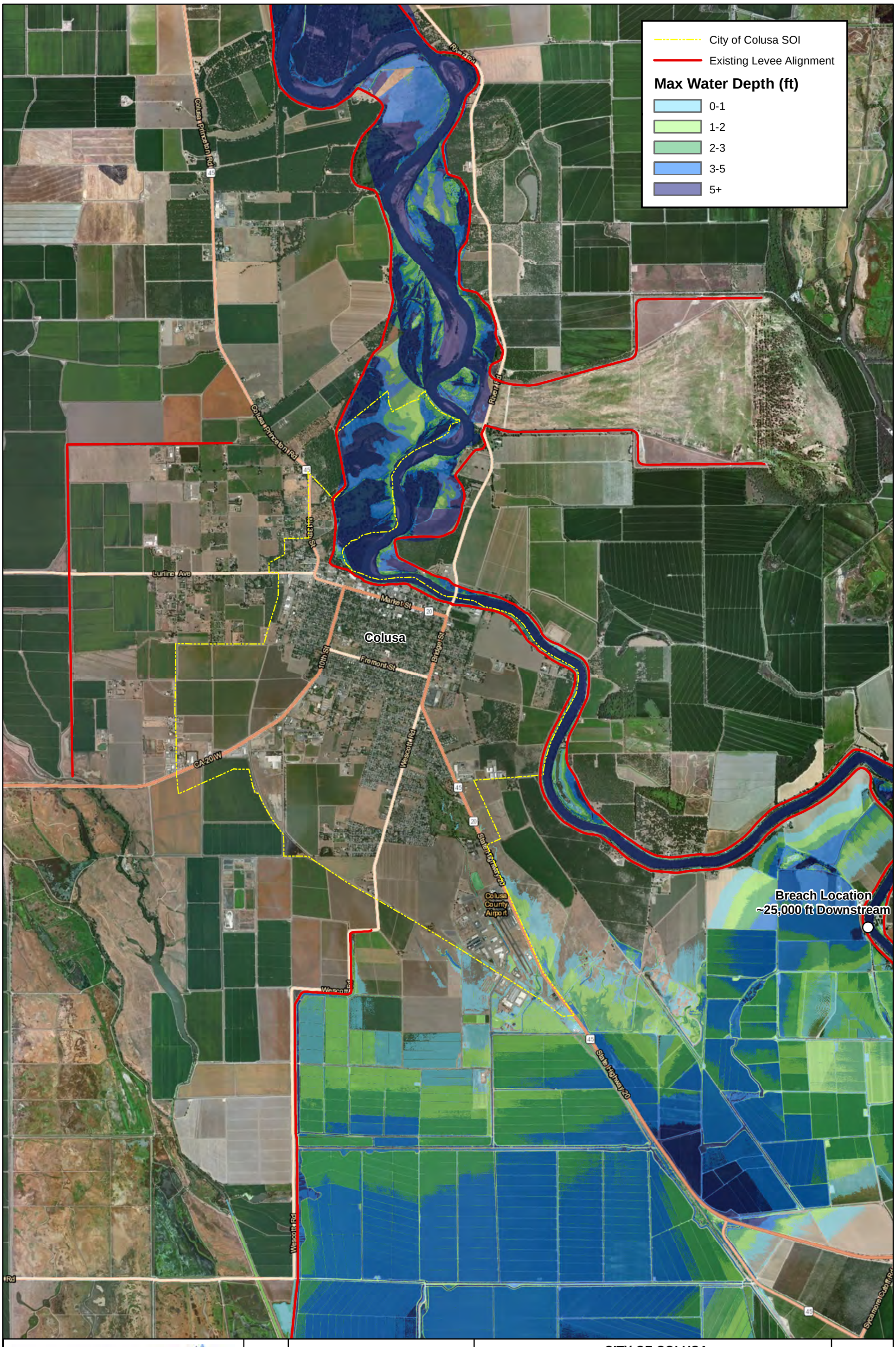
May 2018

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Sacramento River levee breach located ~10,000 ft downstream of Colusa

FIGURE

6



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N

0 0.25 0.5 Miles

May 2018

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

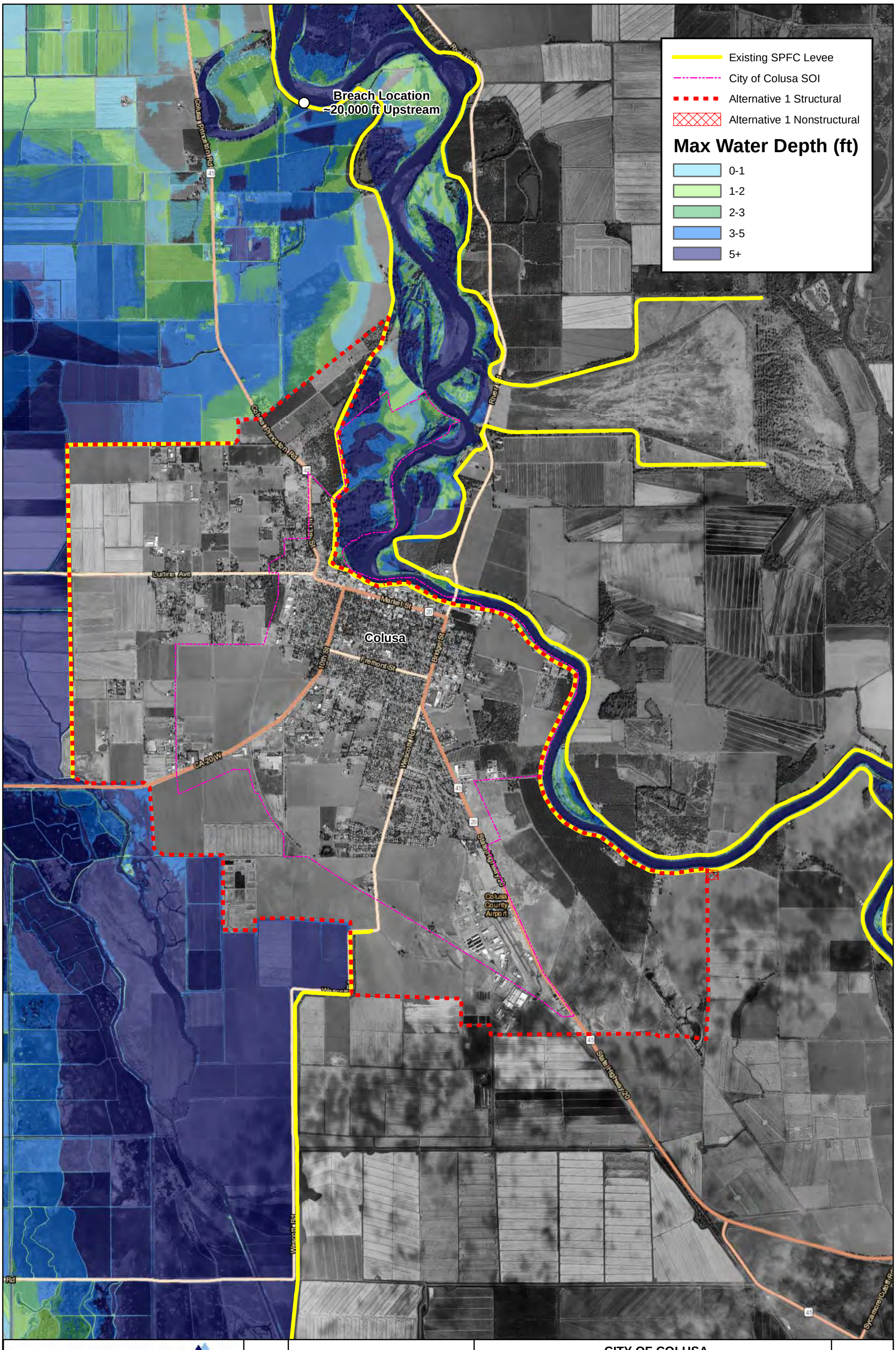
Sacramento River levee breach located ~25,000 ft downstream of Colusa

FIGURE
7

Attachment B

Proposed Alternatives

Levee Breach Floodplain Maps



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Folsom, CA 95630
Phone: (916) 608-2212

N

0 0.25 0.5 Miles

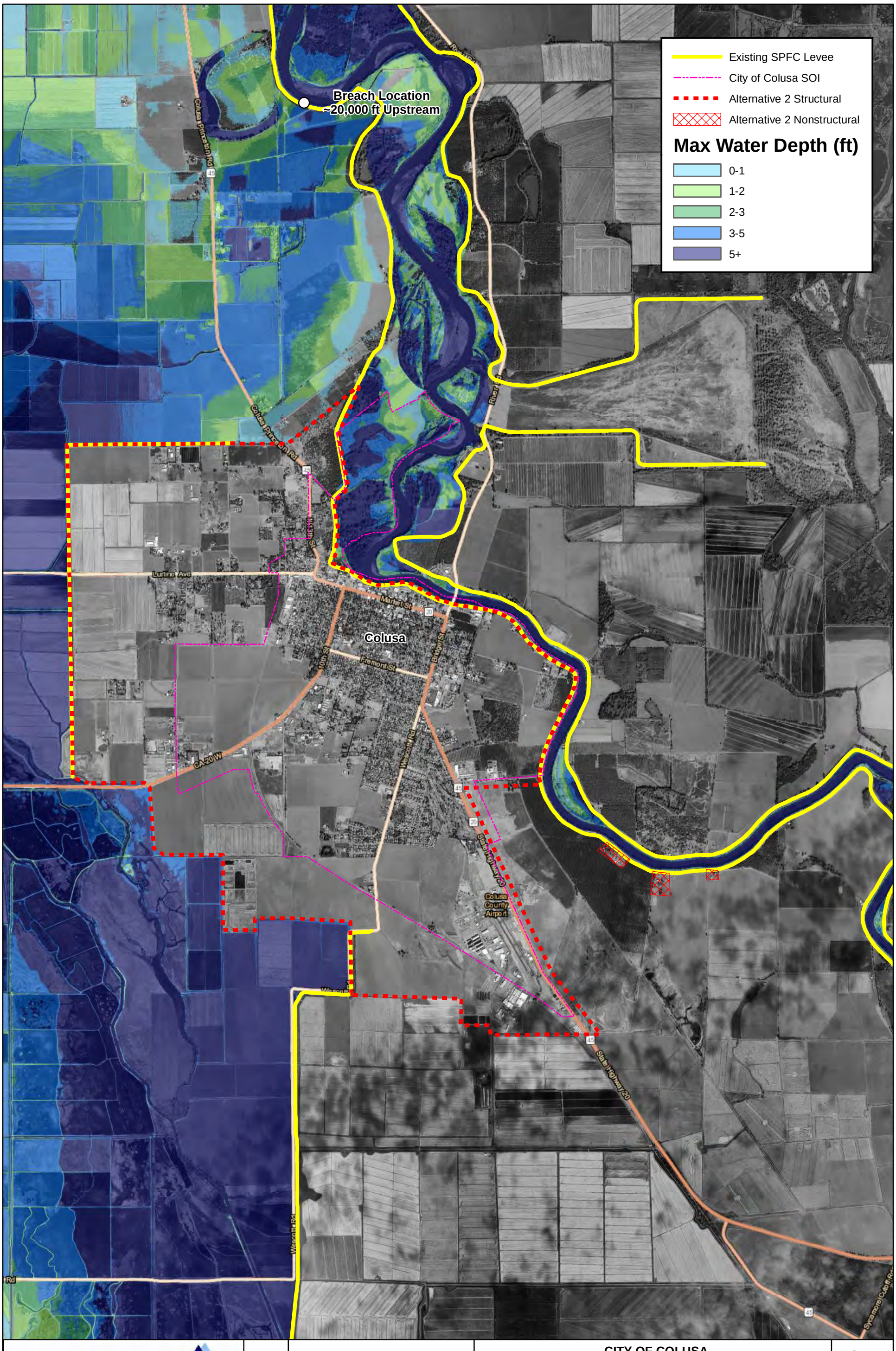
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 1 with Sacramento River levee breach located ~20,000 ft upstream of Colusa

FIGURE

-



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N

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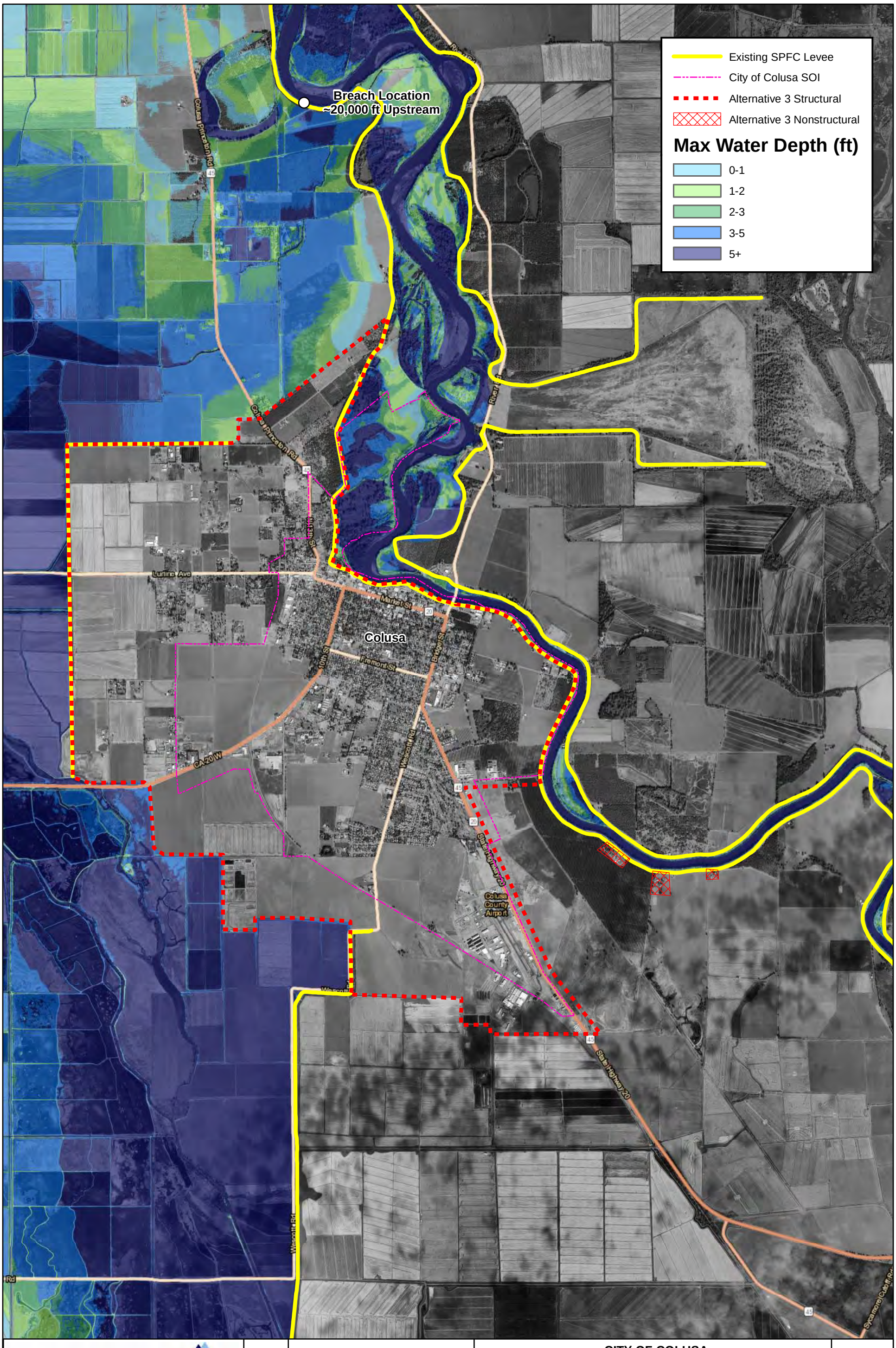
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

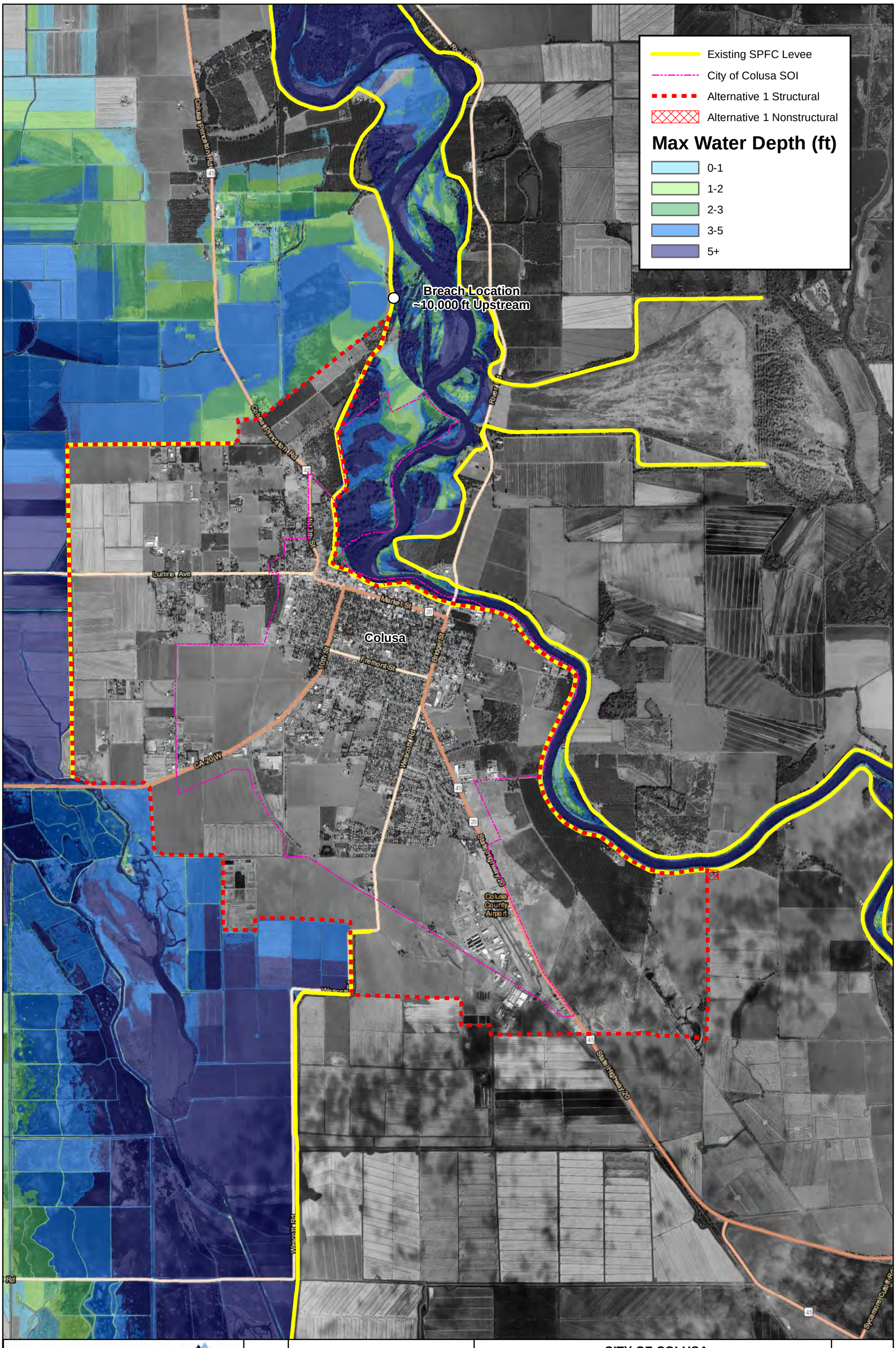
Alternative 2 Sacramento River levee breach located ~20,000 ft upstream of Colusa

FIGURE

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PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING 80 Blue Ravine Rd, Suite 280 Folsom, CA 95630 Phone: (916) 608-2212	N	0 0.25 0.5 Miles **January 2019**	**CITY OF COLUSA** **FLOOD RISK REDUCTION FEASIBILITY STUDY** **Alternative 3 Sacramento River levee breach located ~20,000 ft upstream of Colusa**	**FIGURE** -



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ENGINEERING . CONSULTING
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Folsom, CA 95630
Phone: (916) 608-2212

N

0 0.25 0.5 Miles

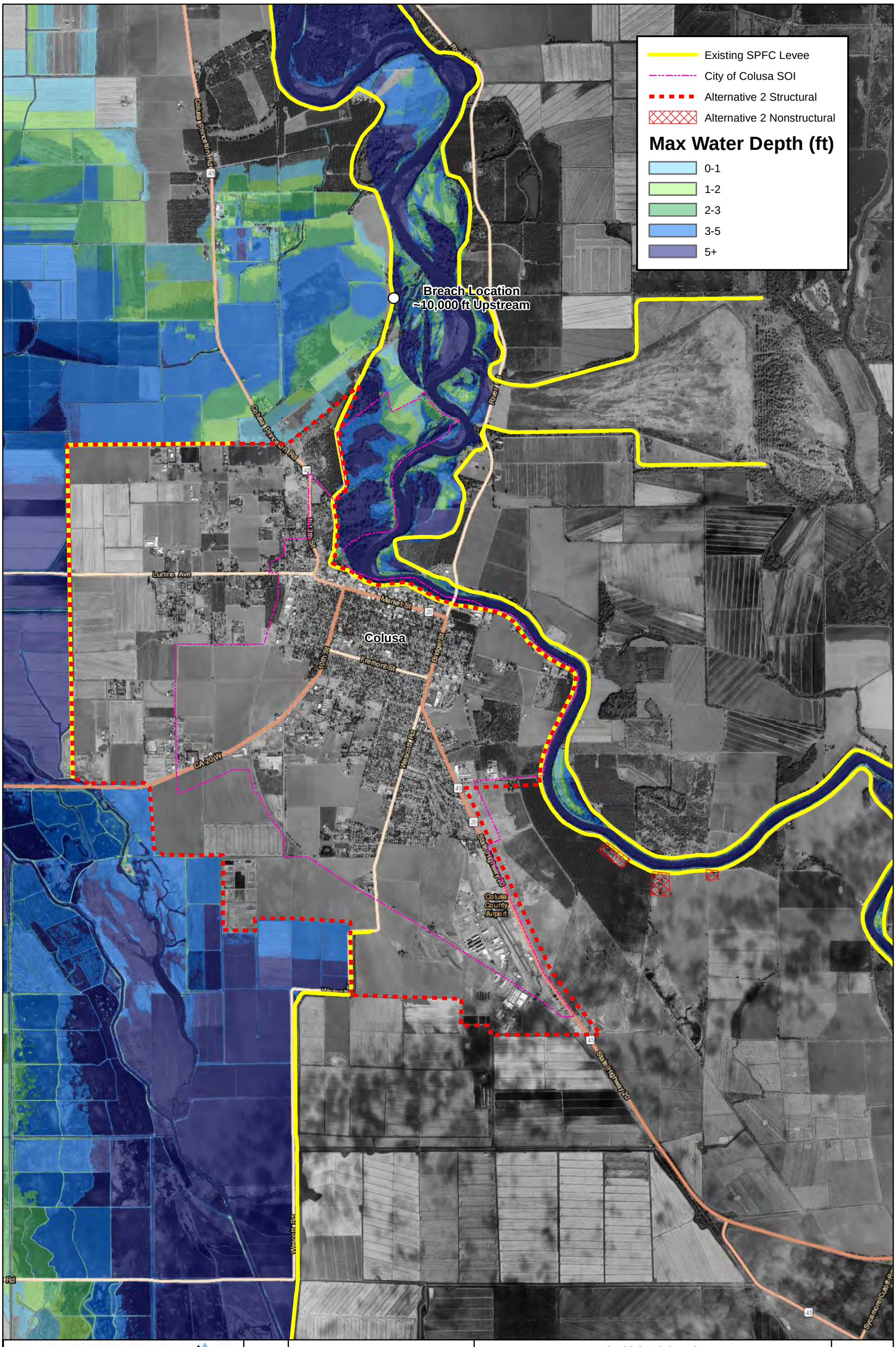
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 1 with Sacramento River levee breach located ~10,000 ft upstream of Colusa

FIGURE

-



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Phone: (916) 608-2212

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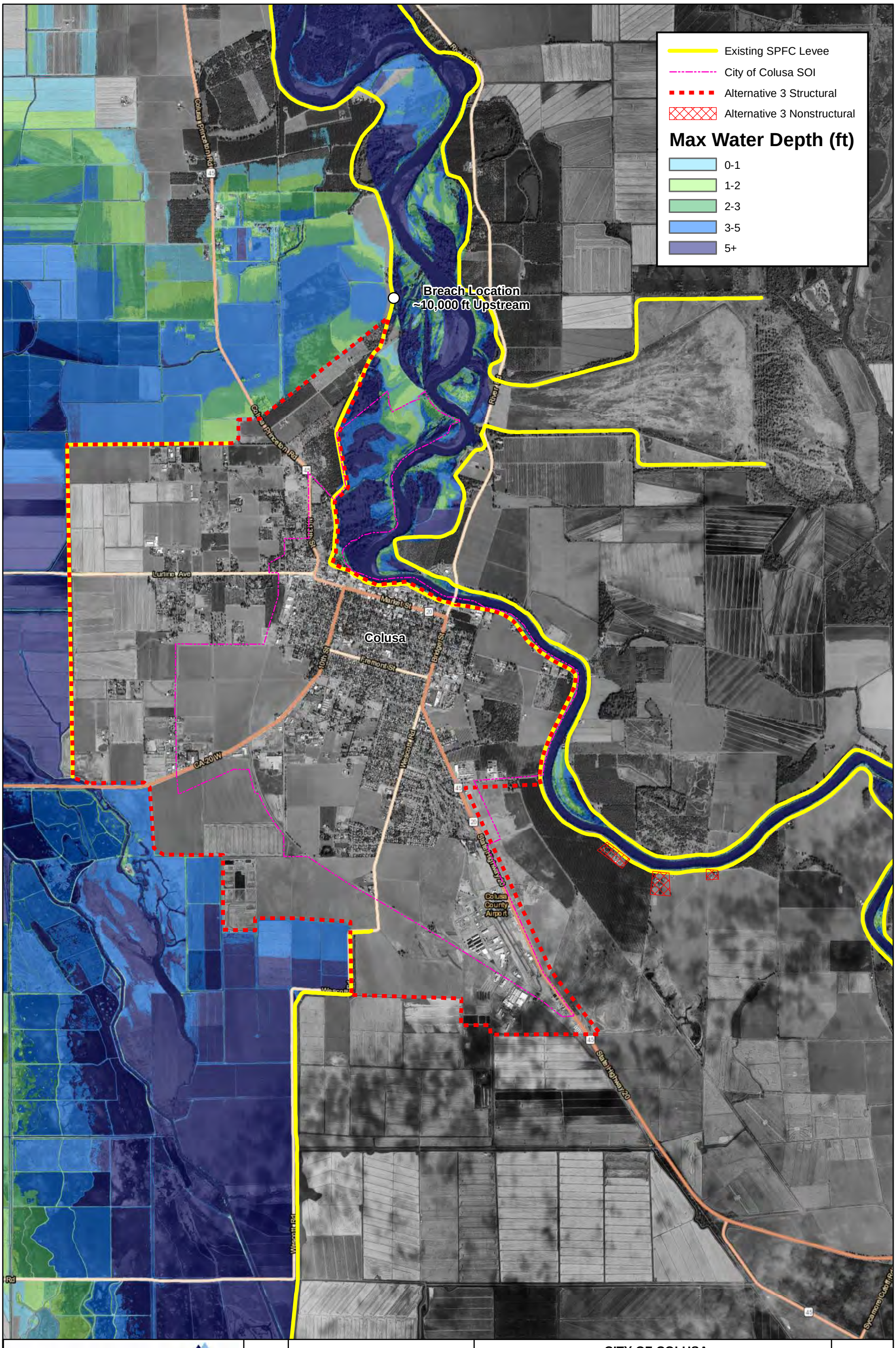
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 with Sacramento River levee breach located ~10,000 ft upstream of Colusa

FIGURE

-



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80 Blue Ravine Rd, Suite 280
Folsom, CA 95630
Phone: (916) 608-2212

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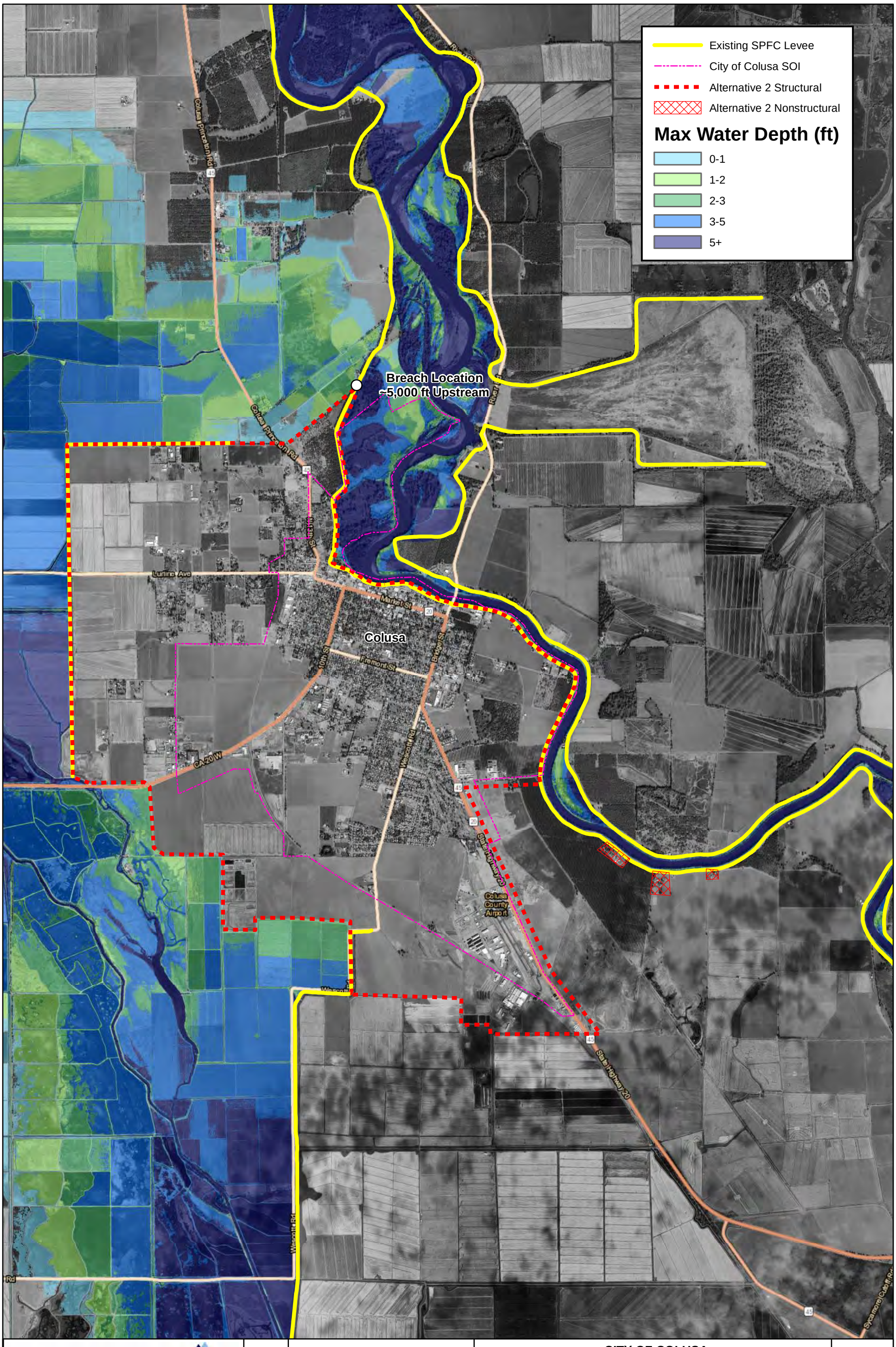
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 3 with Sacramento River levee breach located ~10,000 ft upstream of Colusa

FIGURE

-



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ENGINEERING . CONSULTING

80 Blue Ravine Rd, Suite 280
Folsom, CA 95630
Phone: (916) 608-2212

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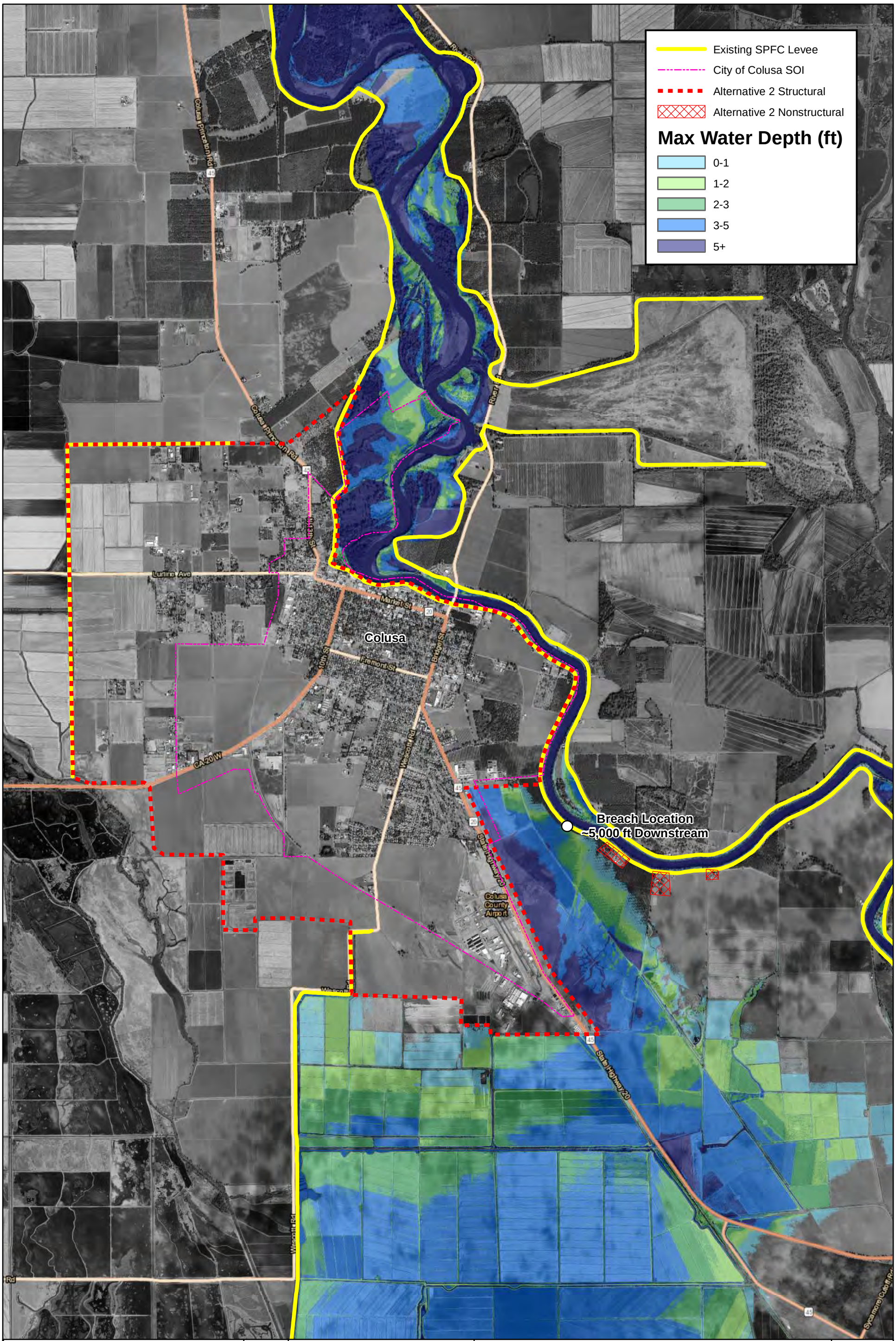
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 Sacramento River levee breach located ~5,000 ft upstream of Colusa

FIGURE

-



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ENGINEERING . CONSULTING

80 Blue Ravine Rd, Suite 280
Folsom, CA 95630
Phone: (916) 608-2212

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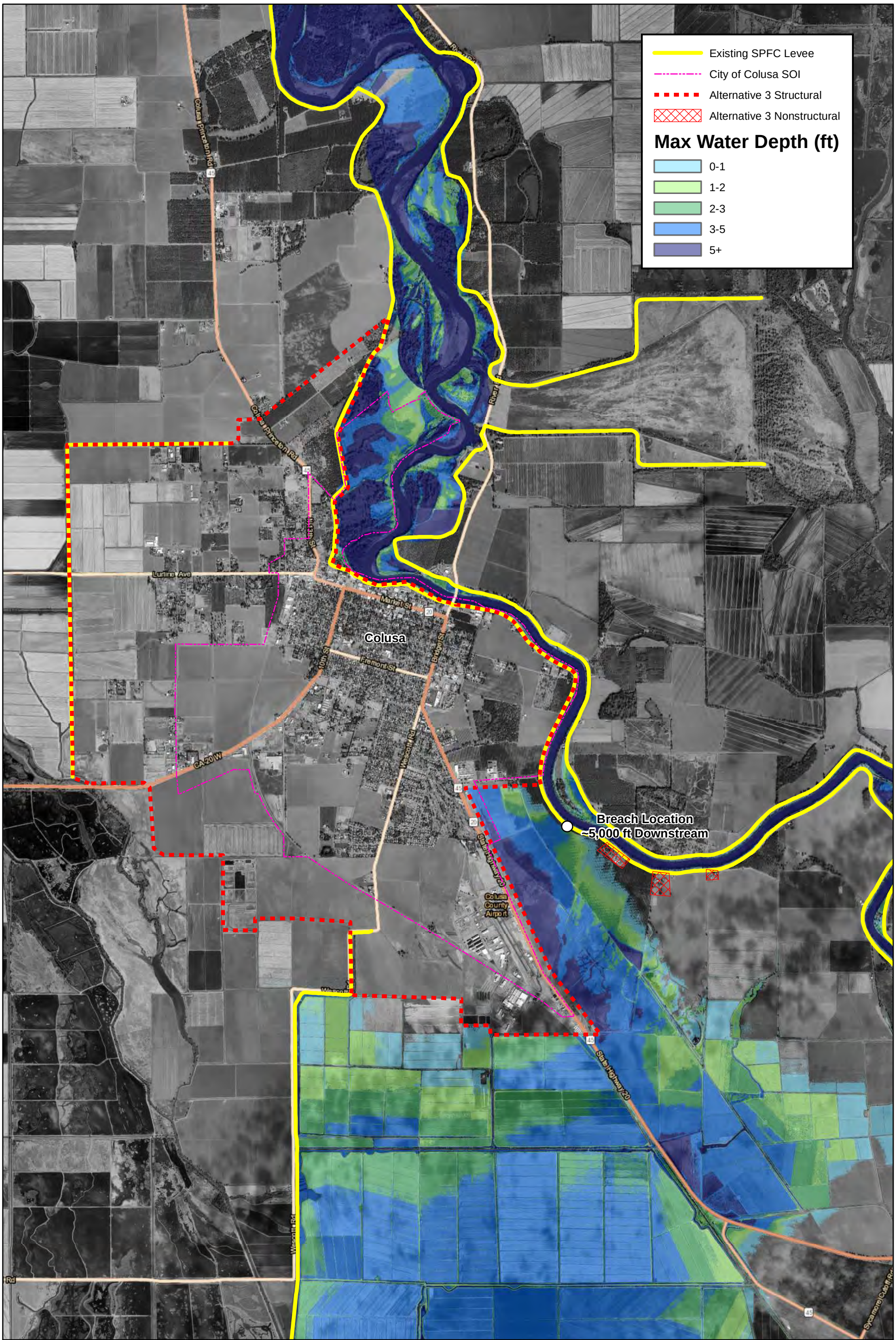
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 Sacramento River levee breach located ~5,000 ft downstream of Colusa

FIGURE

-



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

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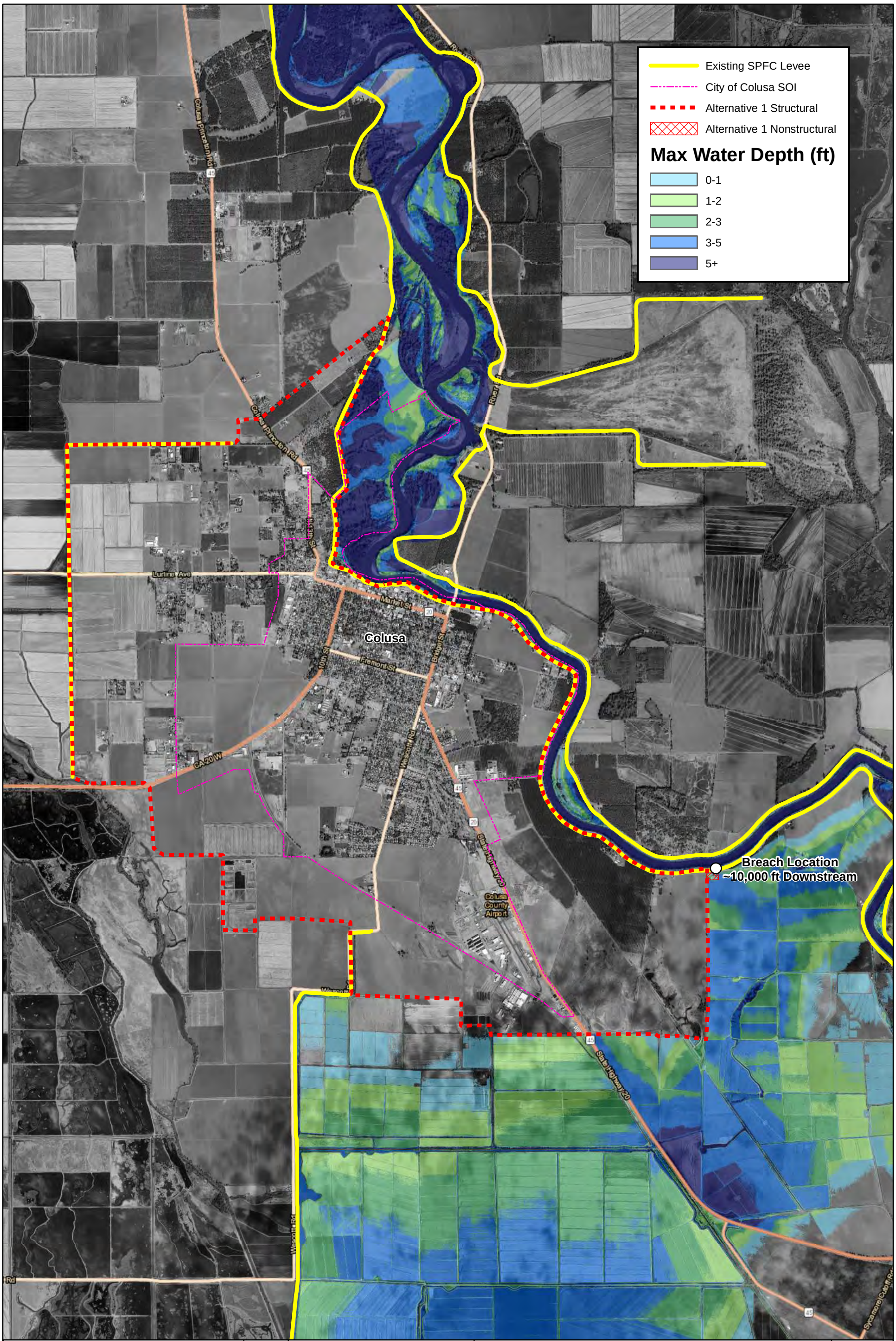
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 3 Sacramento River levee breach located ~5,000 ft downstream of Colusa

FIGURE

-



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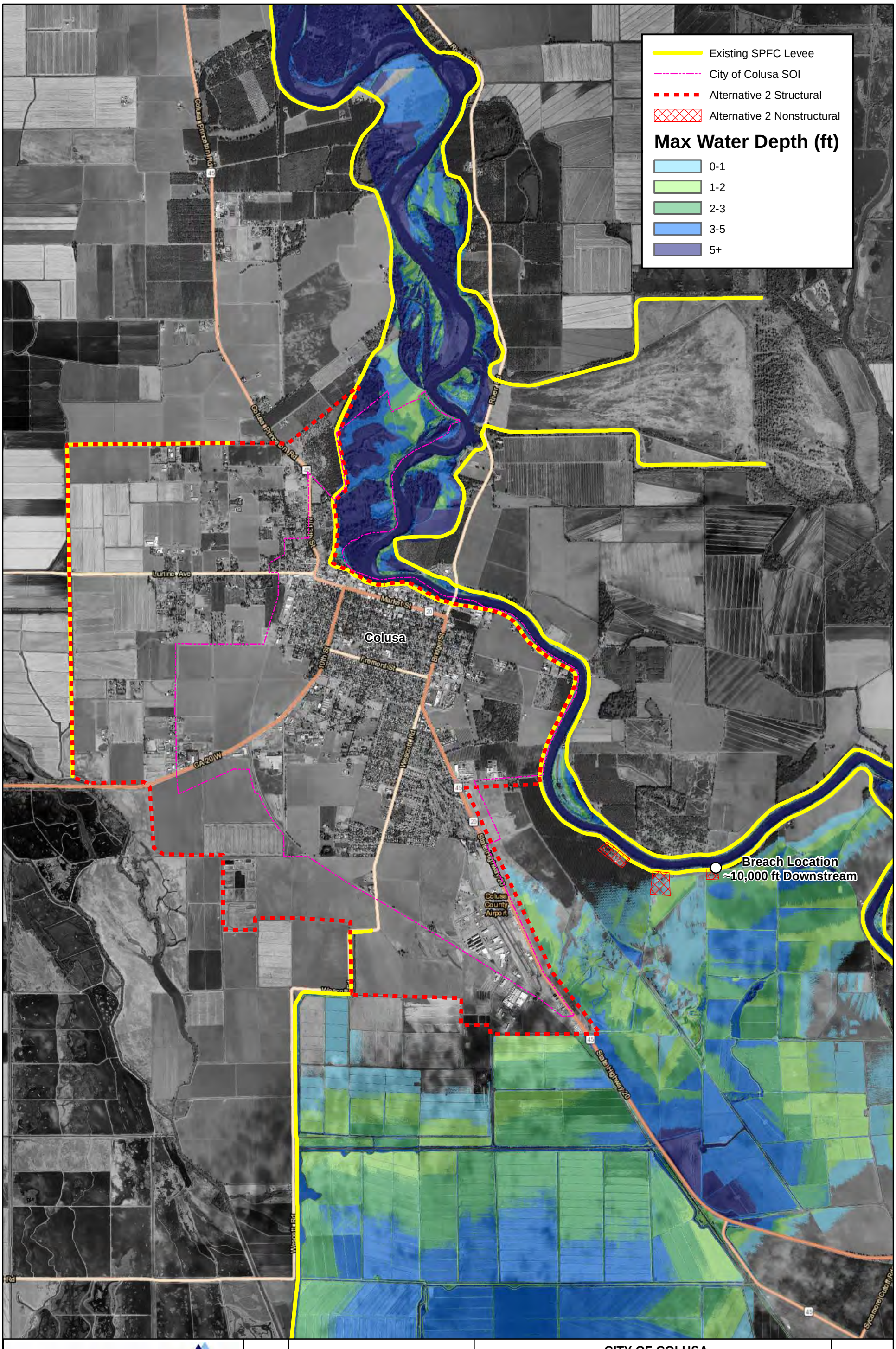
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 1 with Sacramento River levee breach located ~10,000 ft downstream of Colusa

FIGURE

-



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

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N

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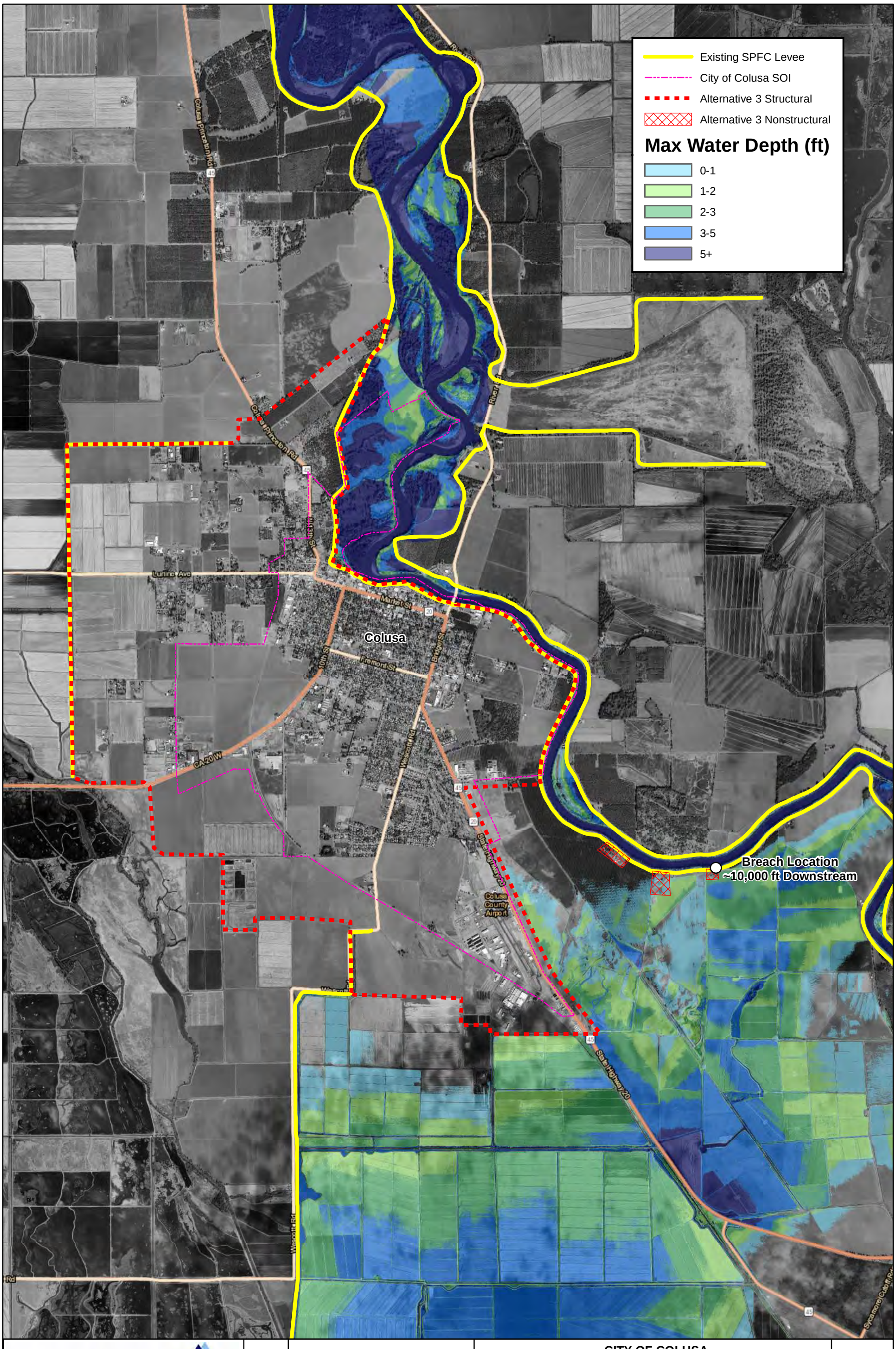
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 with Sacramento River levee breach located ~10,000 ft downstream of Colusa

FIGURE

-



PETERSON . BRUSTAD . INC
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N

0 0.25 0.5 Miles

January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 3 with Sacramento River levee breach located ~10,000 ft downstream of Colusa

FIGURE

-

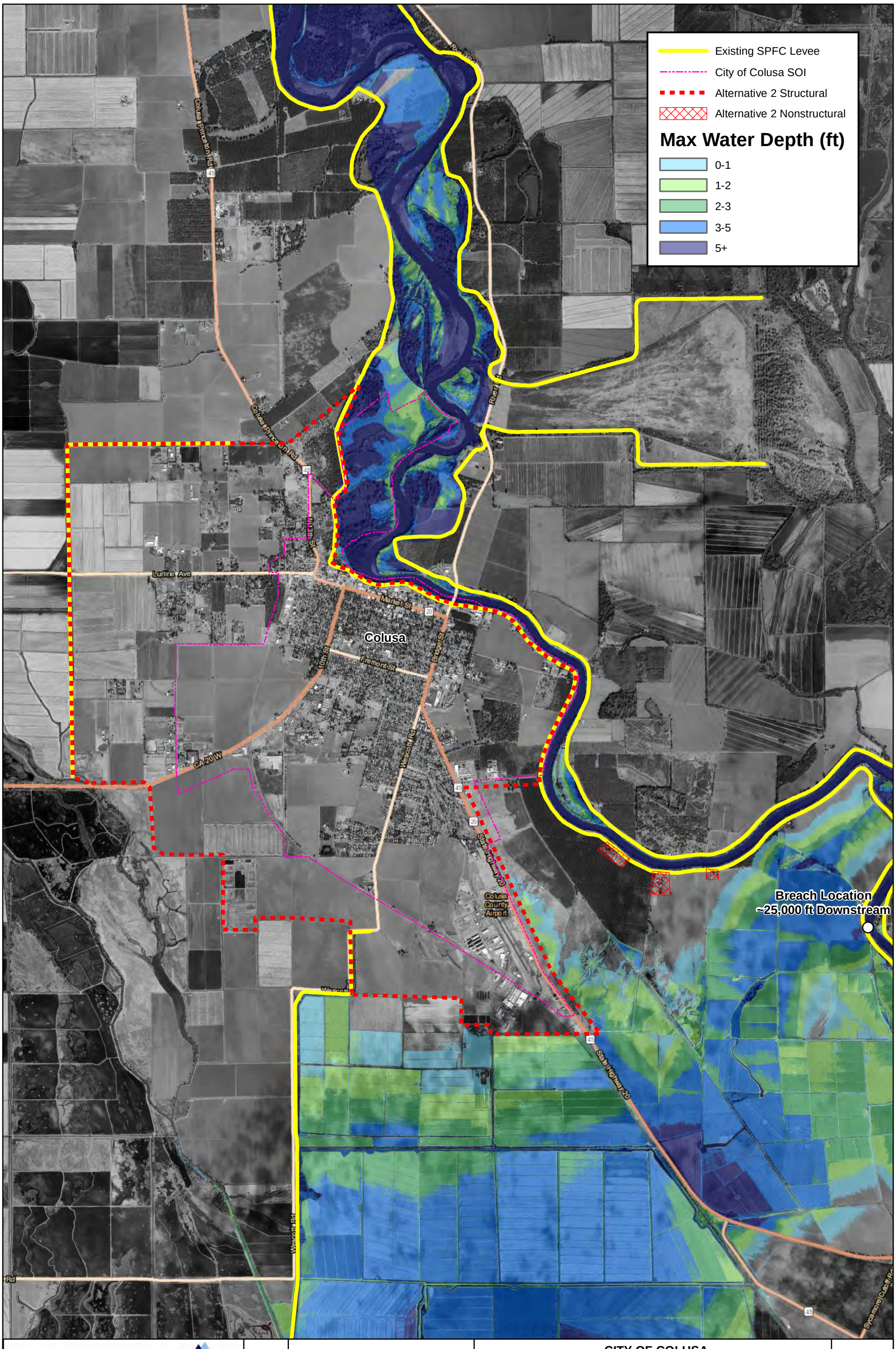
Existing SPFC Levee
City of Colusa SOI
Alternative 1 Structural
Alternative 1 Nonstructural

Max Water Depth (ft)

0-1
1-2
2-3
3-5
5+

Colusa
Breach Location
~25,000 ft Downstream

PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING 80 Blue Ravine Rd, Suite 280 Folsom, CA 95630 Phone: (916) 608-2212	N	0 0.25 0.5 Miles **January 2019**	**CITY OF COLUSA** **FLOOD RISK REDUCTION FEASIBILITY STUDY** **Alternative 1 with Sacramento River levee breach located ~25,000 ft downstream of Colusa**	**FIGURE** -



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

80 Blue Ravine Rd, Suite 280
Folsom, CA 95630
Phone: (916) 608-2212

N

0 0.25 0.5 Miles

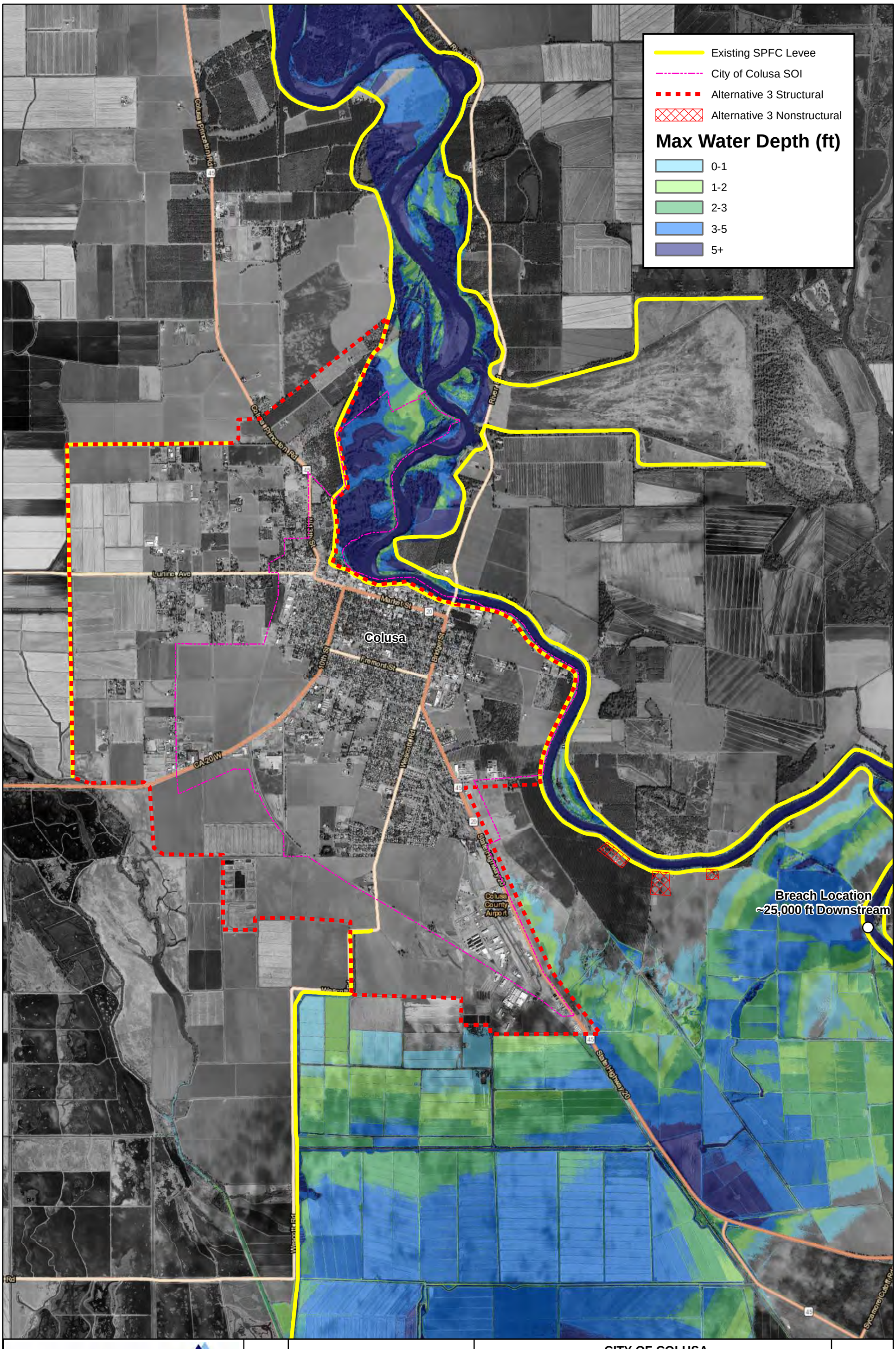
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 with Sacramento River levee breach located ~25,000 ft downstream of Colusa

FIGURE

-



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N

0 0.25 0.5 Miles

January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 3 with Sacramento River levee breach located ~25,000 ft downstream of Colusa

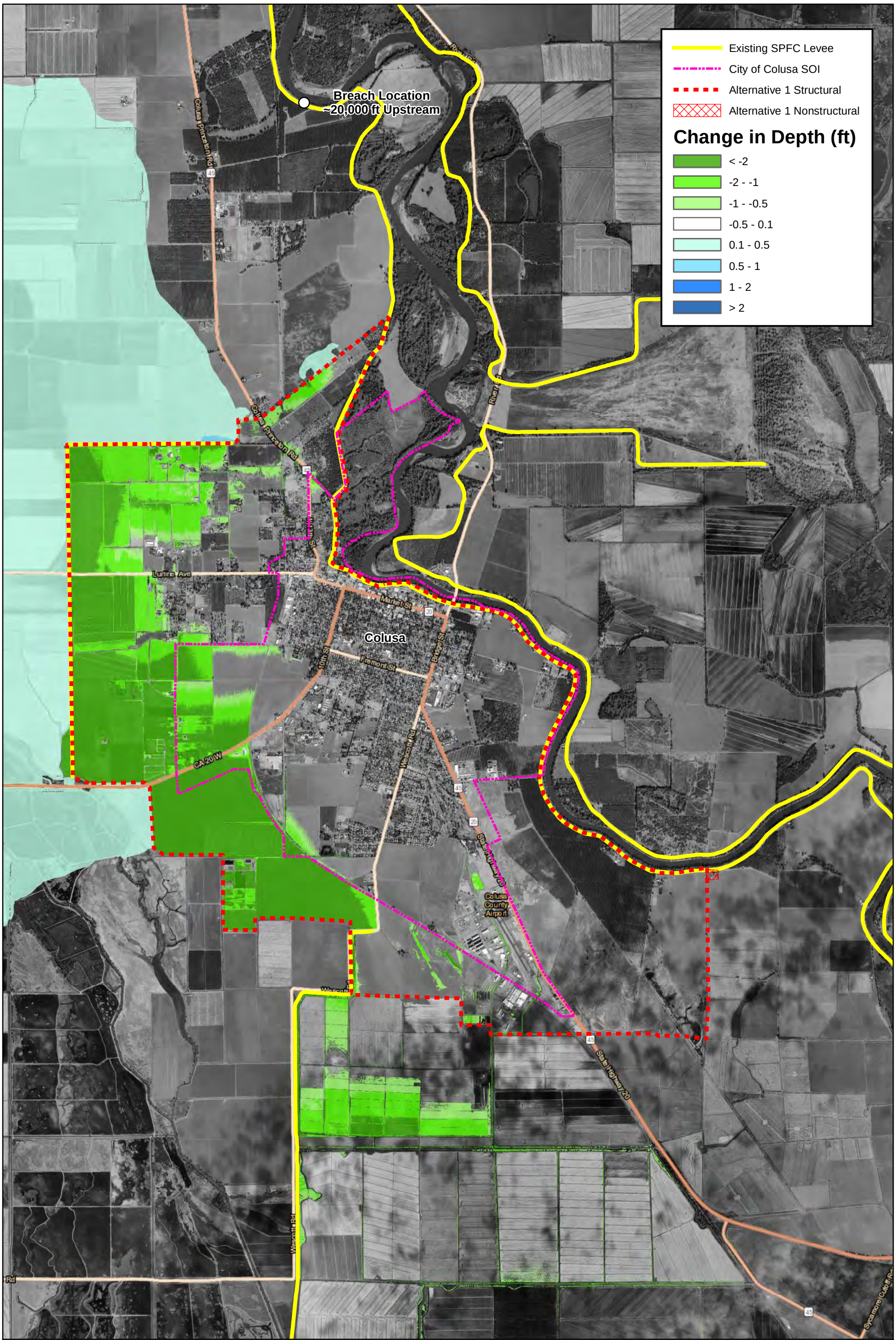
FIGURE

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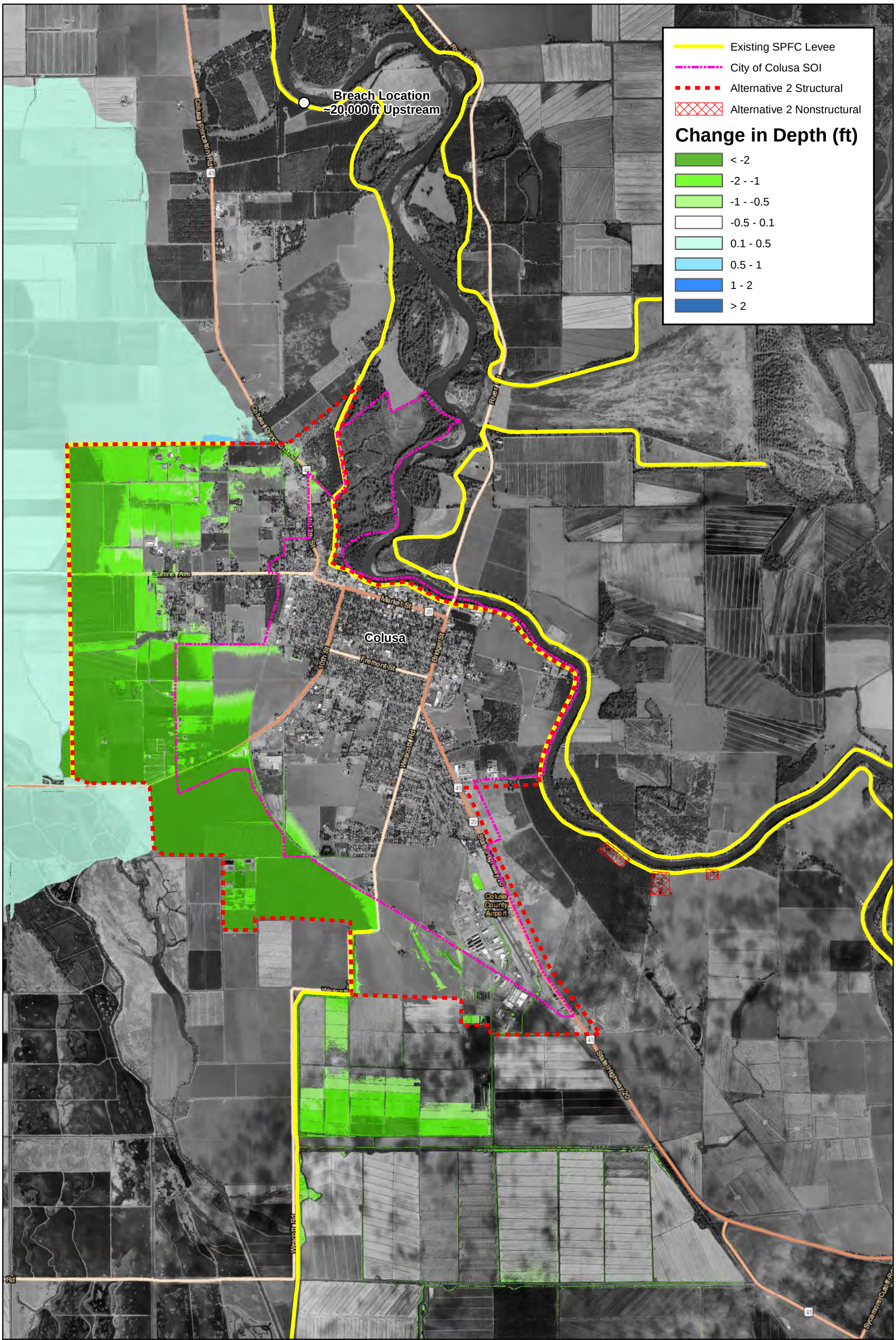
Attachment C

Existing Conditions vs. Proposed Alternatives

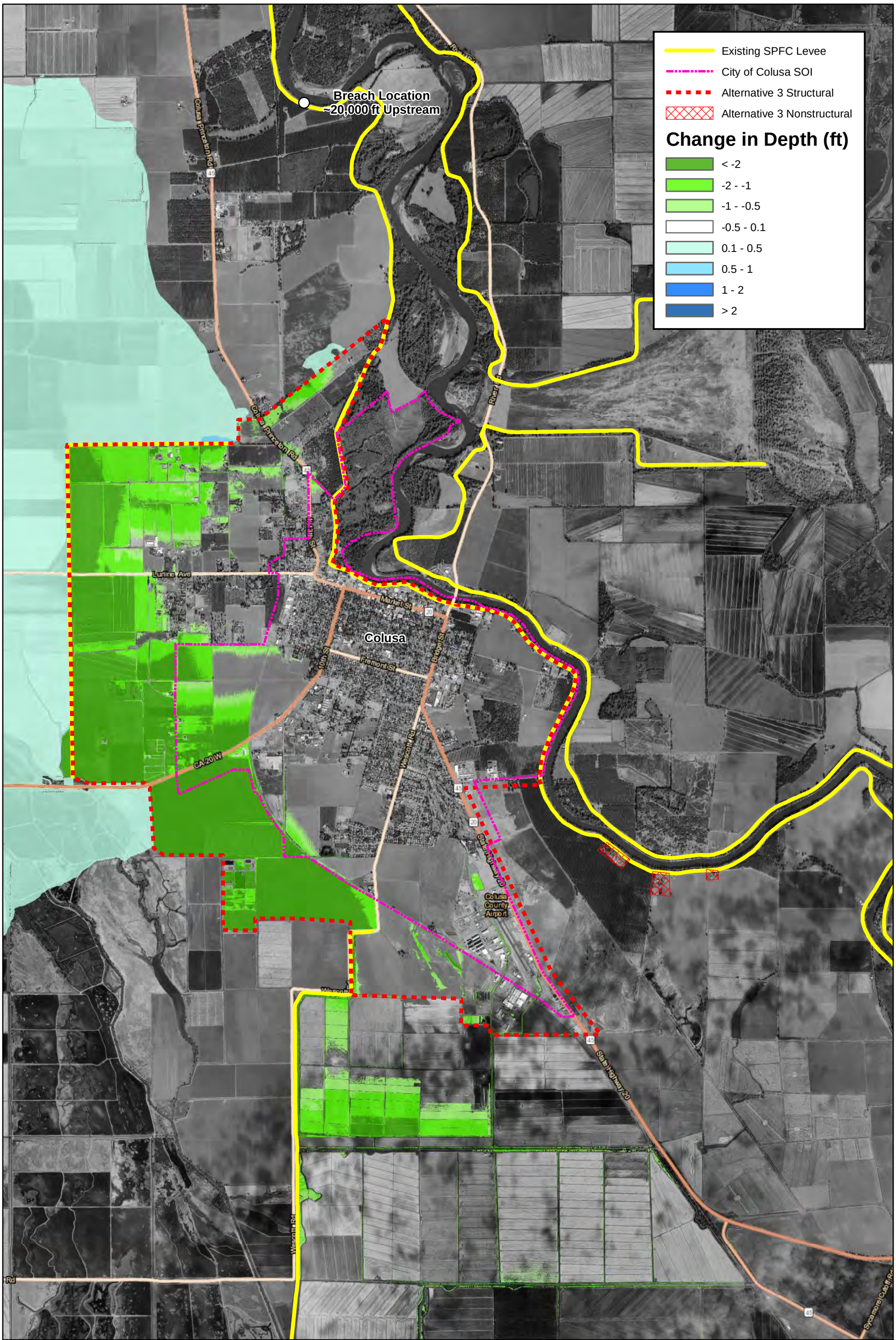
Comparison Maps



PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING 80 Blue Ravine Rd, Suite 280 Folsom, CA 95630 Phone: (916) 608-2212	N	0 0.25 0.5 Miles **January 2019**	**CITY OF COLUSA** **FLOOD RISK REDUCTION FEASIBILITY STUDY** **Alternative 1 vs. Baseline** **Sacramento River levee breach** **located ~20,000 ft upstream of Colusa**	**FIGURE** **-**



PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING 80 Blue Ravine Rd, Suite 280 Folsom, CA 95630 Phone: (916) 608-2212	N	0 0.25 0.5 Miles **January 2019**	**CITY OF COLUSA** **FLOOD RISK REDUCTION FEASIBILITY STUDY** **Alternative 2 vs. Baseline** **Sacramento River levee breach** **located ~20,000 ft upstream of Colusa**	**FIGURE** **-**



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING
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N

0 0.25 0.5 Miles

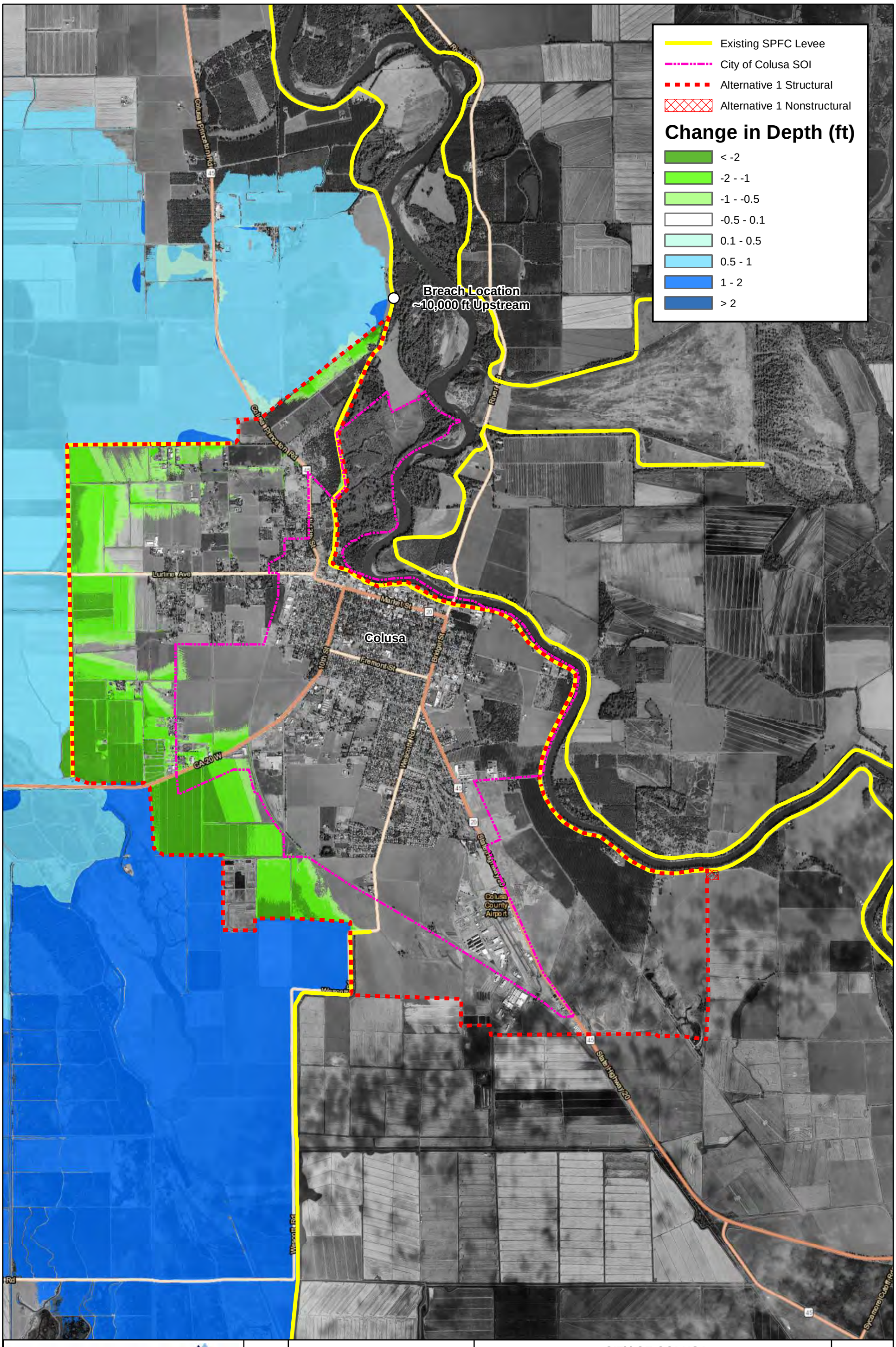
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

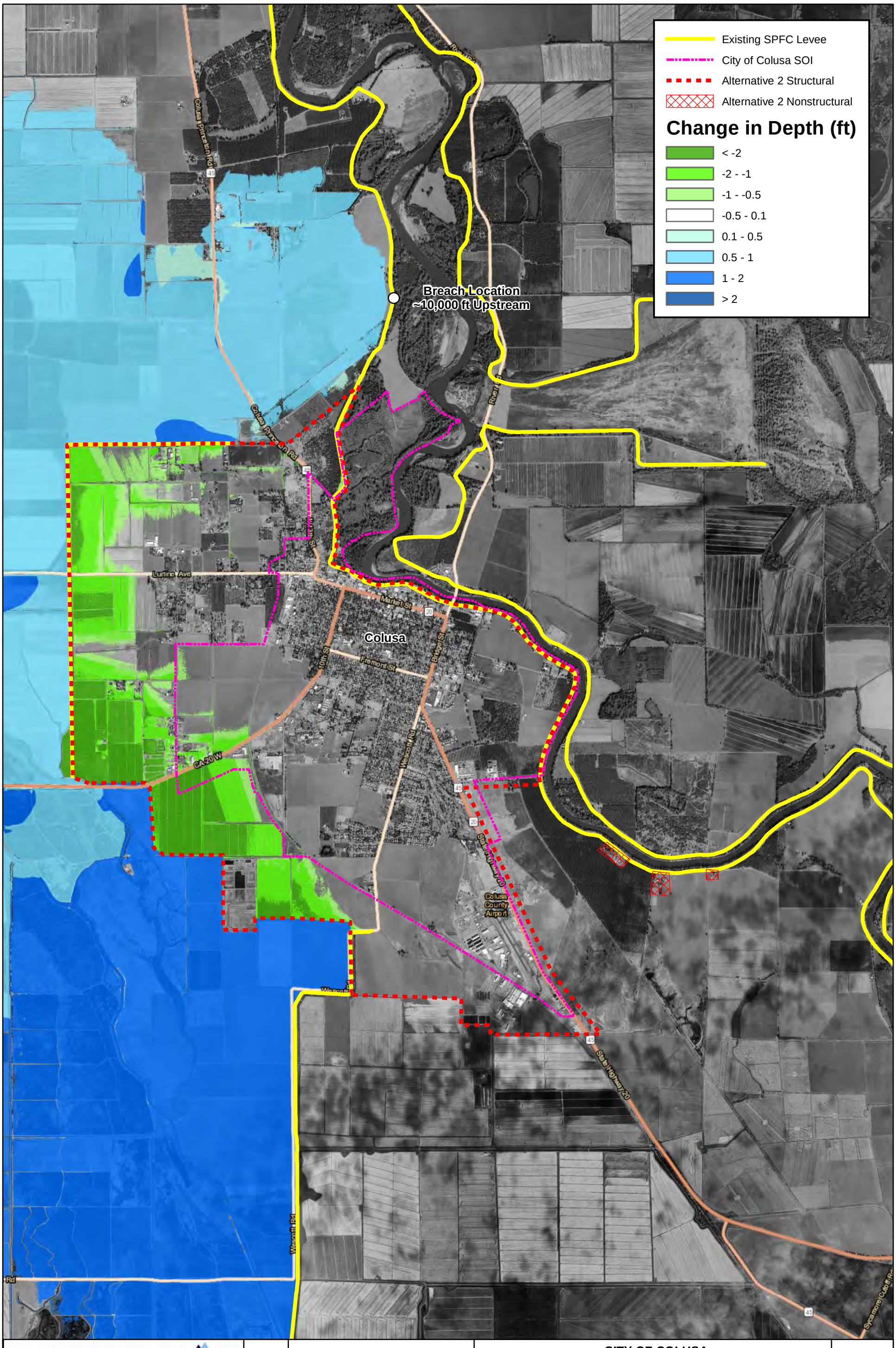
Alternative 3 vs. Baseline
Sacramento River levee breach
located ~20,000 ft upstream of Colusa

FIGURE

-



PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING 80 Blue Ravine Rd, Suite 280 Folsom, CA 95630 Phone: (916) 608-2212	N	0 0.25 0.5 Miles **January 2019**	**CITY OF COLUSA** **FLOOD RISK REDUCTION FEASIBILITY STUDY** **Alternative 1 vs. Baseline** **Sacramento River levee breach** **located ~10,000 ft upstream of Colusa**	**FIGURE** **-**



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

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Phone: (916) 608-2212

N

0 0.25 0.5 Miles

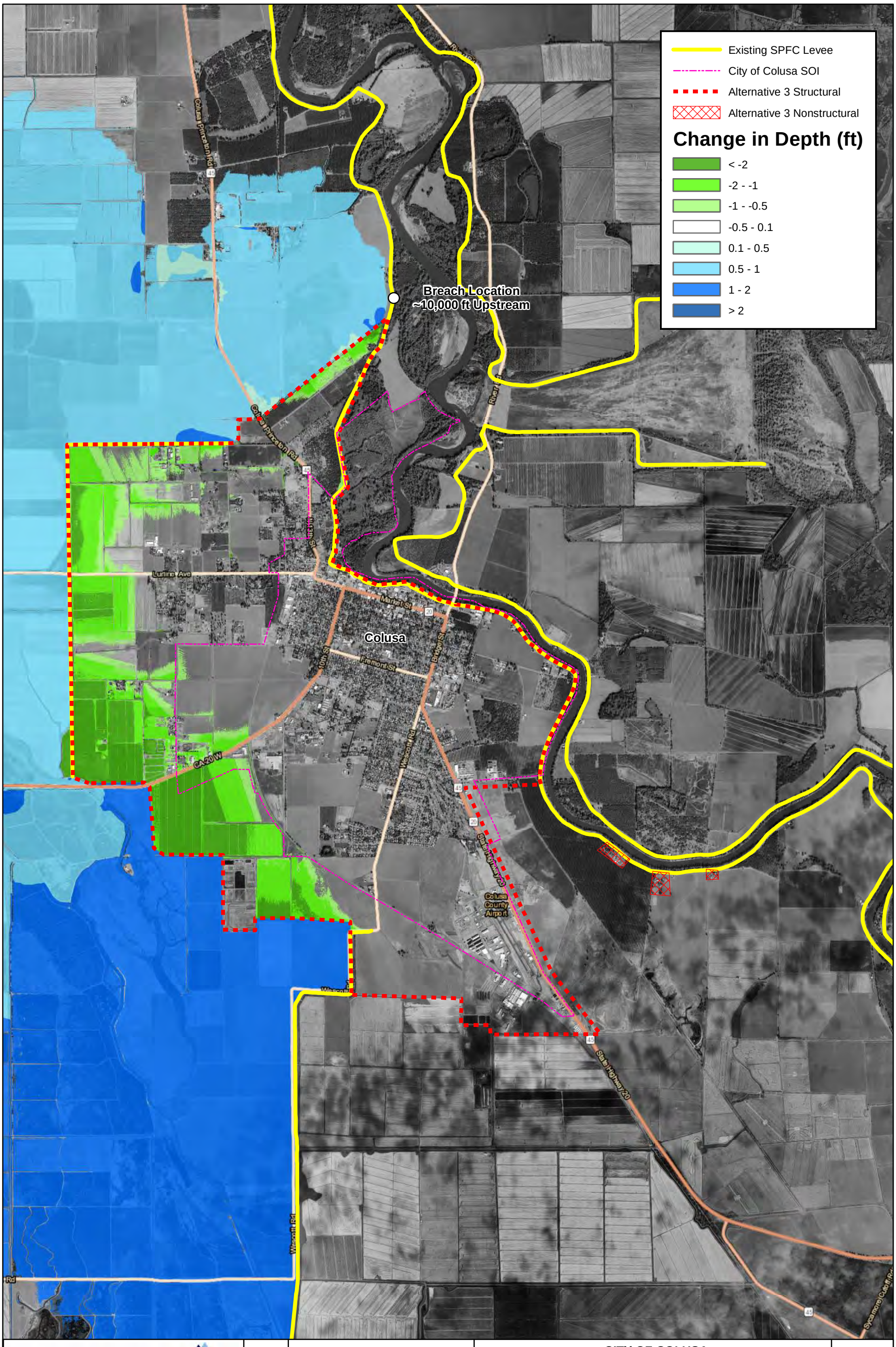
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

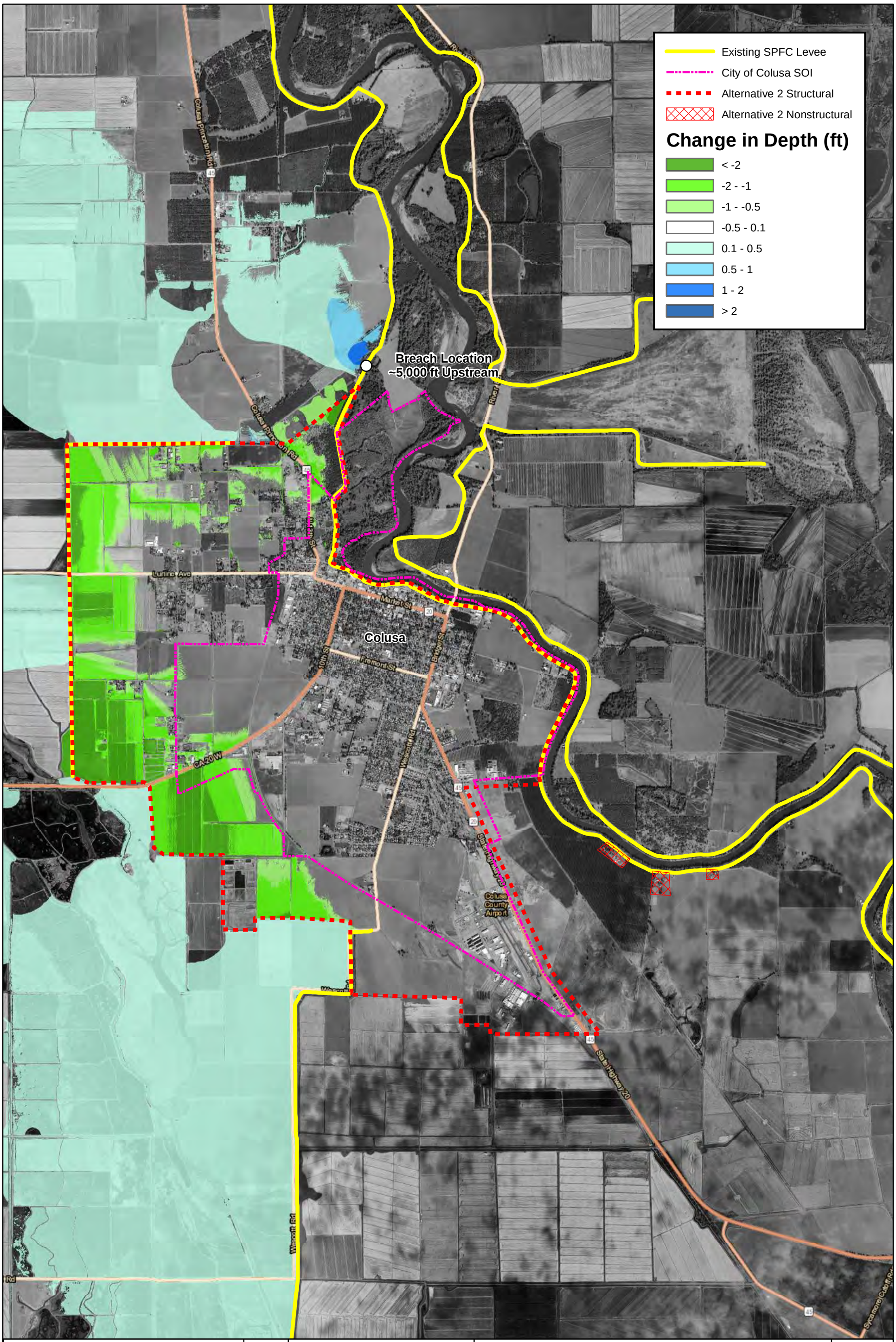
Alternative 2 vs. Baseline
Sacramento River levee breach
located ~10,000 ft upstream of Colusa

FIGURE

-



PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING 80 Blue Ravine Rd, Suite 280 Folsom, CA 95630 Phone: (916) 608-2212	N	0 0.25 0.5 Miles **January 2019**	**CITY OF COLUSA** **FLOOD RISK REDUCTION FEASIBILITY STUDY** **Alternative 3 vs. Baseline** **Sacramento River levee breach** **located ~10,000 ft upstream of Colusa**	**FIGURE** **-**



PETERSON . BRUSTAD . INC
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0 0.25 0.5 Miles

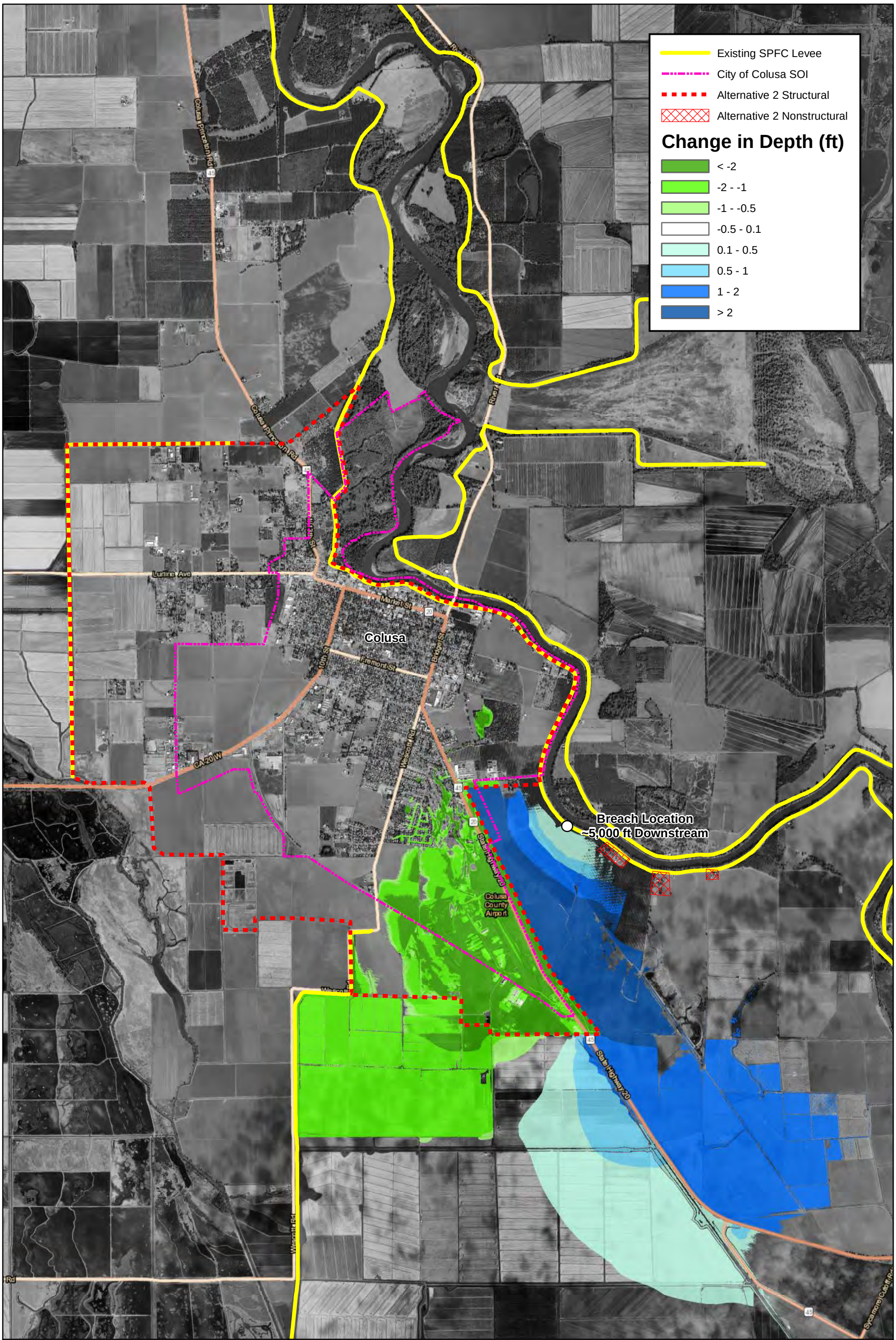
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 vs. Baseline
Sacramento River levee breach
located ~5,000 ft upstream of Colusa

FIGURE

-



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N

0 0.25 0.5 Miles

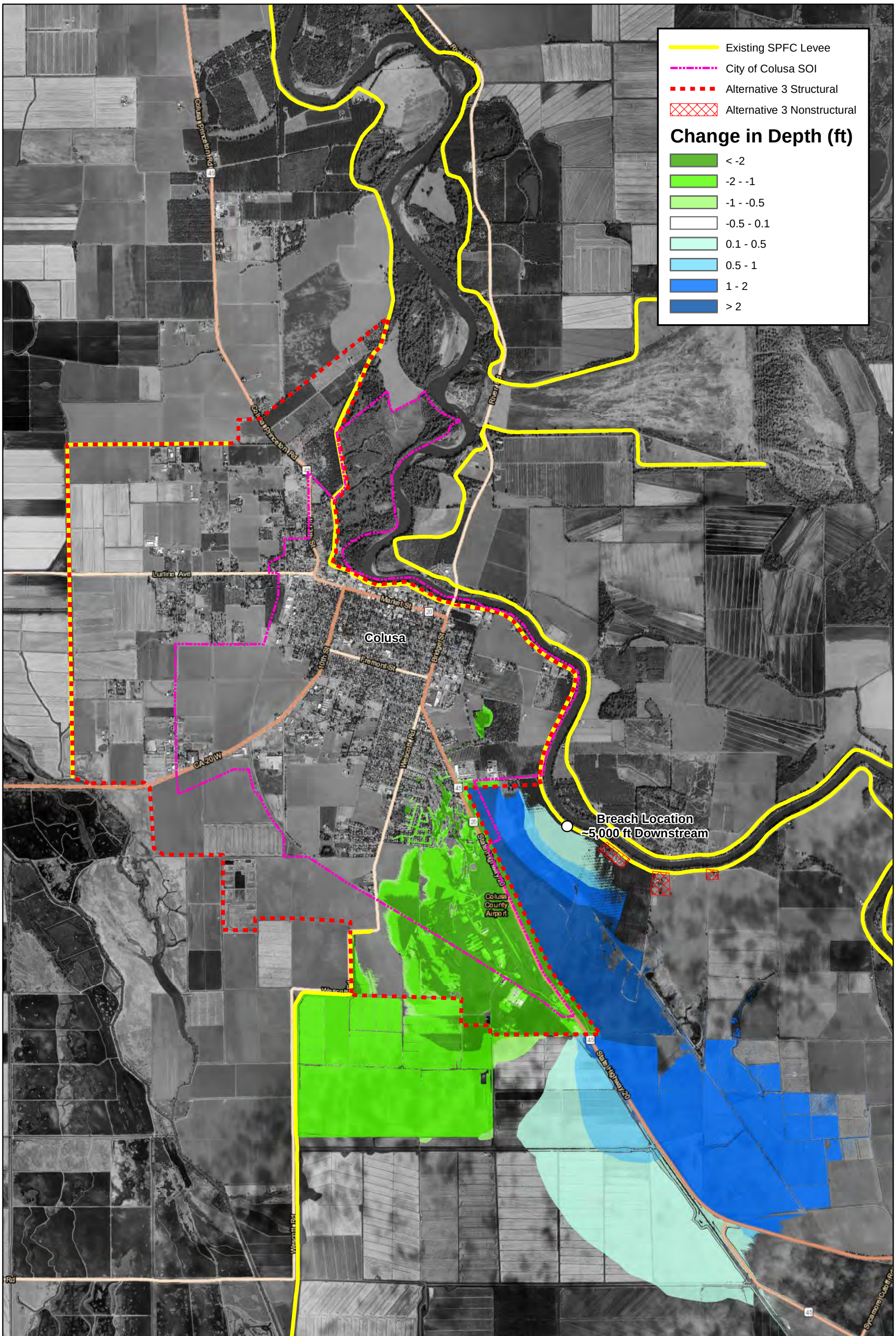
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 vs. Baseline
Sacramento River levee breach
located ~5,000 ft downstream of Colusa

FIGURE

-



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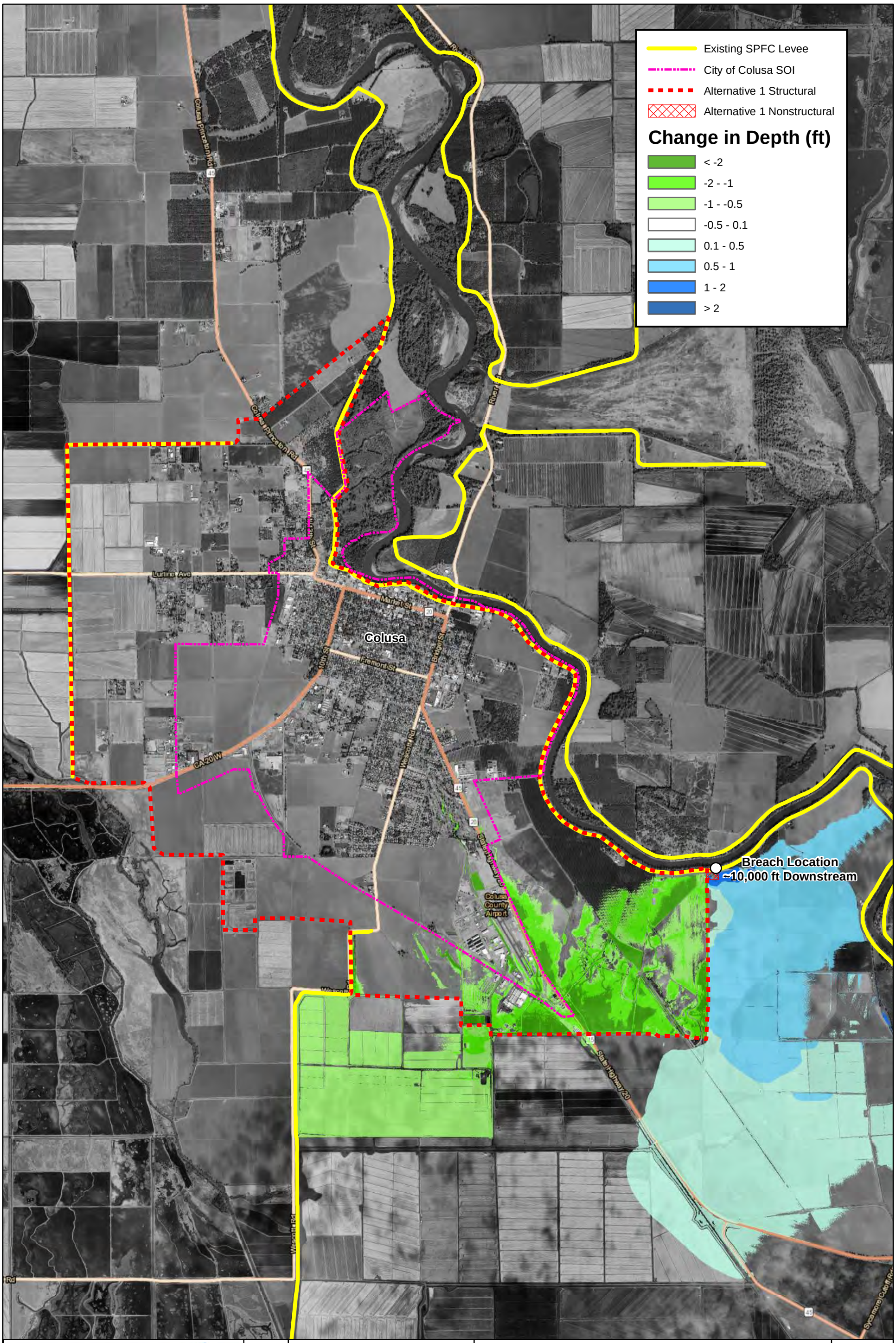
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 3 vs. Baseline
Sacramento River levee breach
located ~5,000 ft downstream of Colusa

FIGURE

-



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N

0 0.25 0.5 Miles

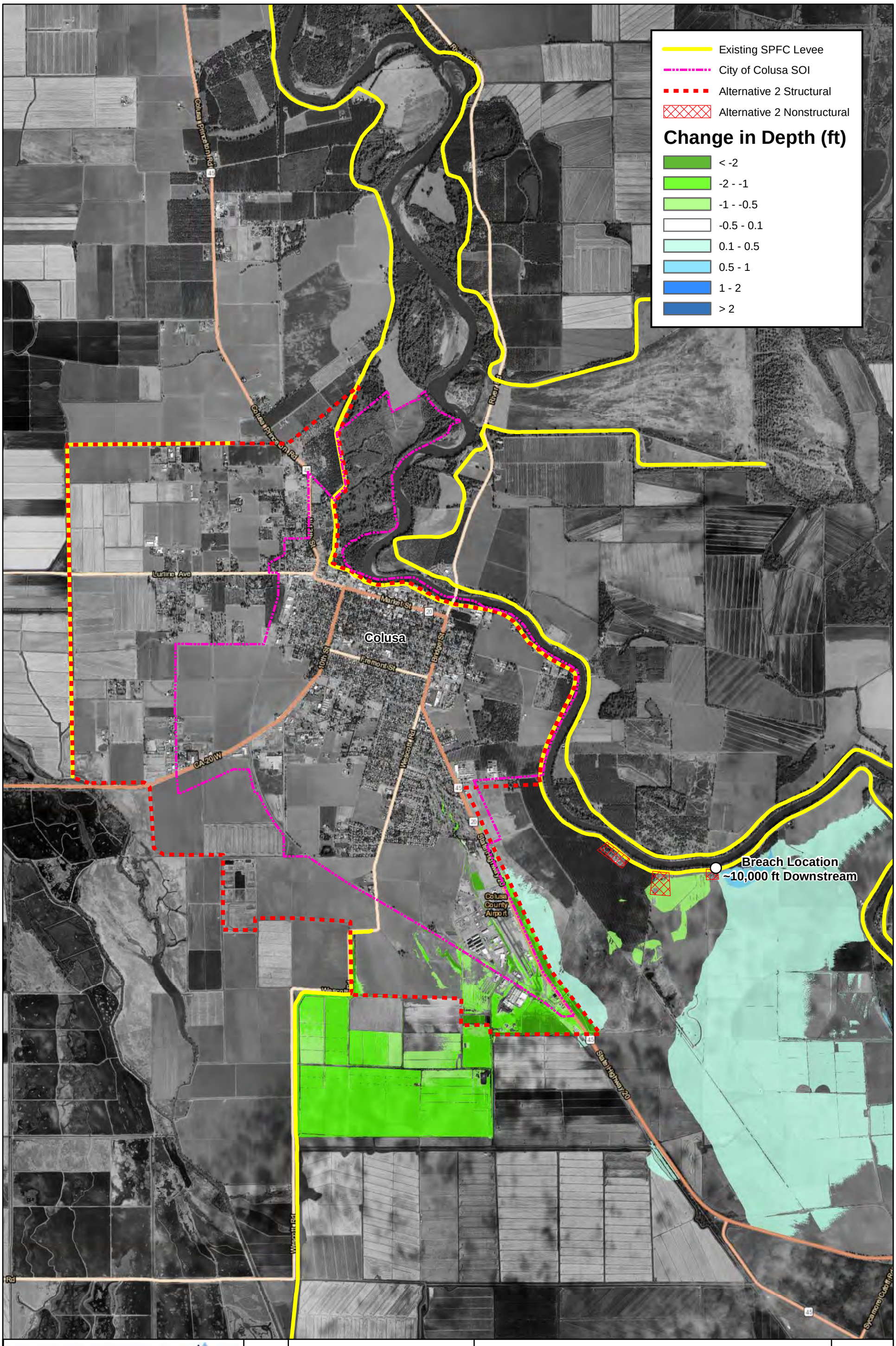
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 1 vs. Baseline
Sacramento River levee breach
located ~10,000 ft downstream of Colusa

FIGURE

-



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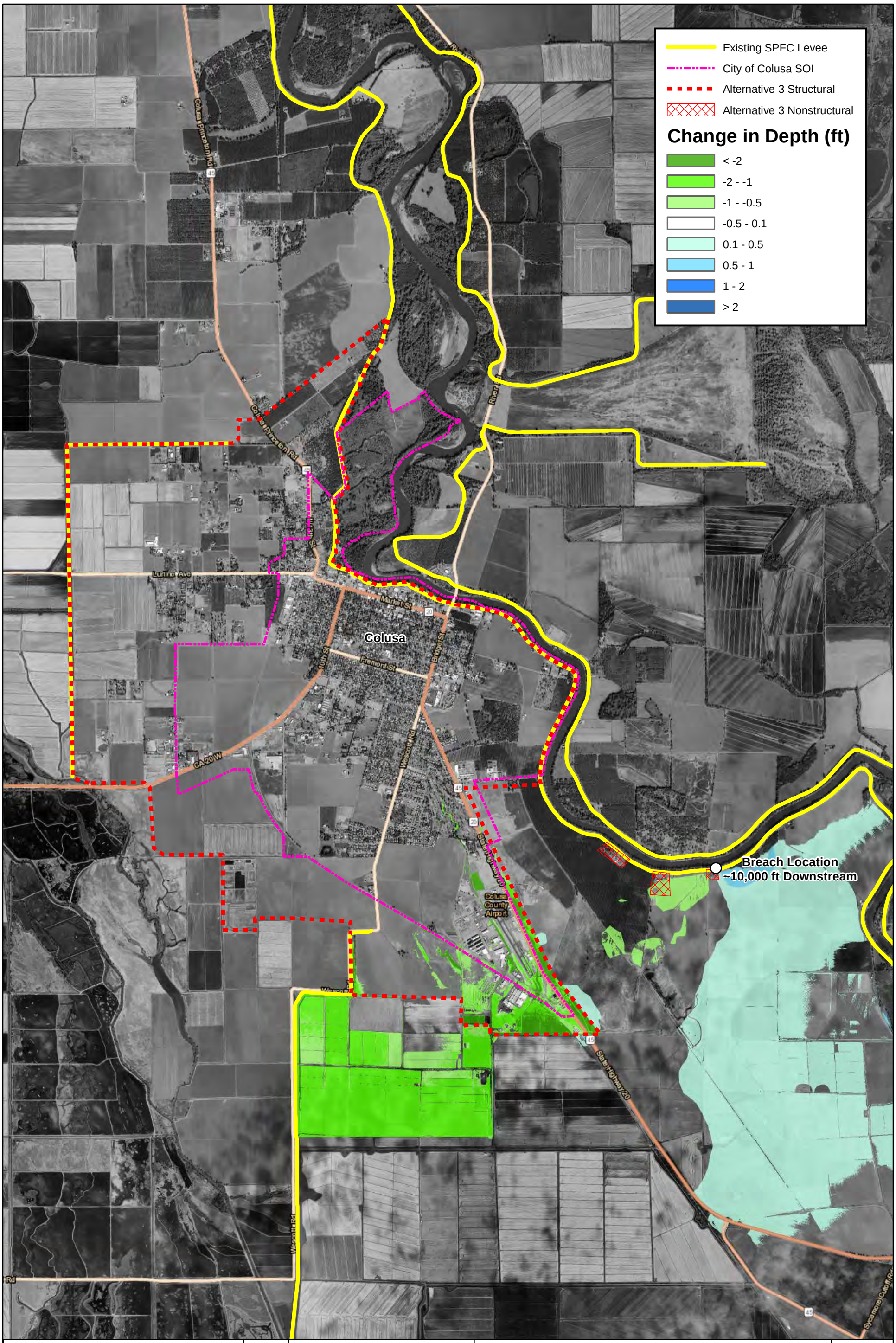
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 vs. Baseline
Sacramento River levee breach
located ~10,000 ft downstream of Colusa

FIGURE

-



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

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0 0.25 0.5 Miles

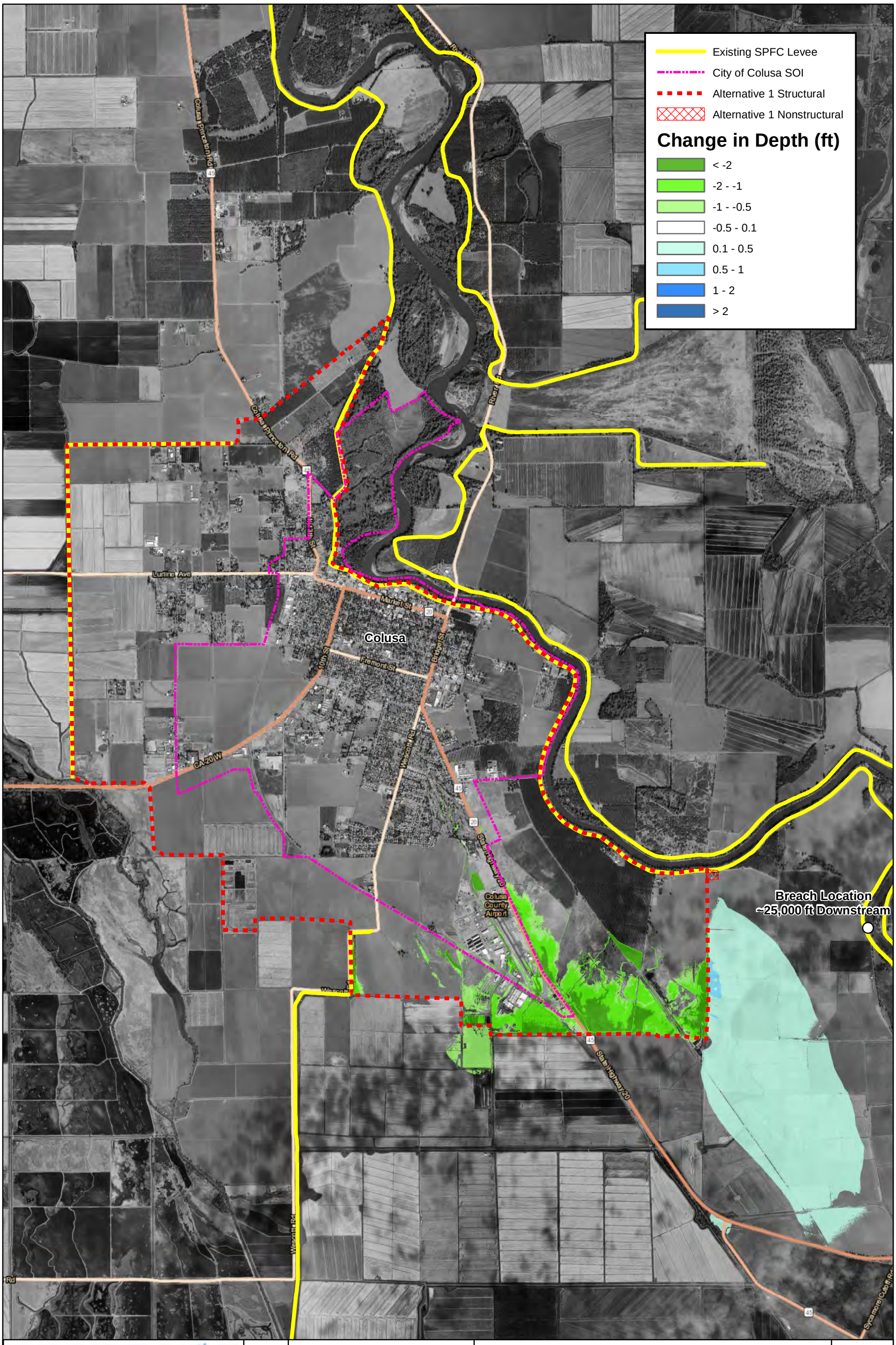
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 3 vs. Baseline
Sacramento River levee breach
located ~10,000 ft downstream of Colusa

FIGURE

-



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

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N

0 0.25 0.5 Miles

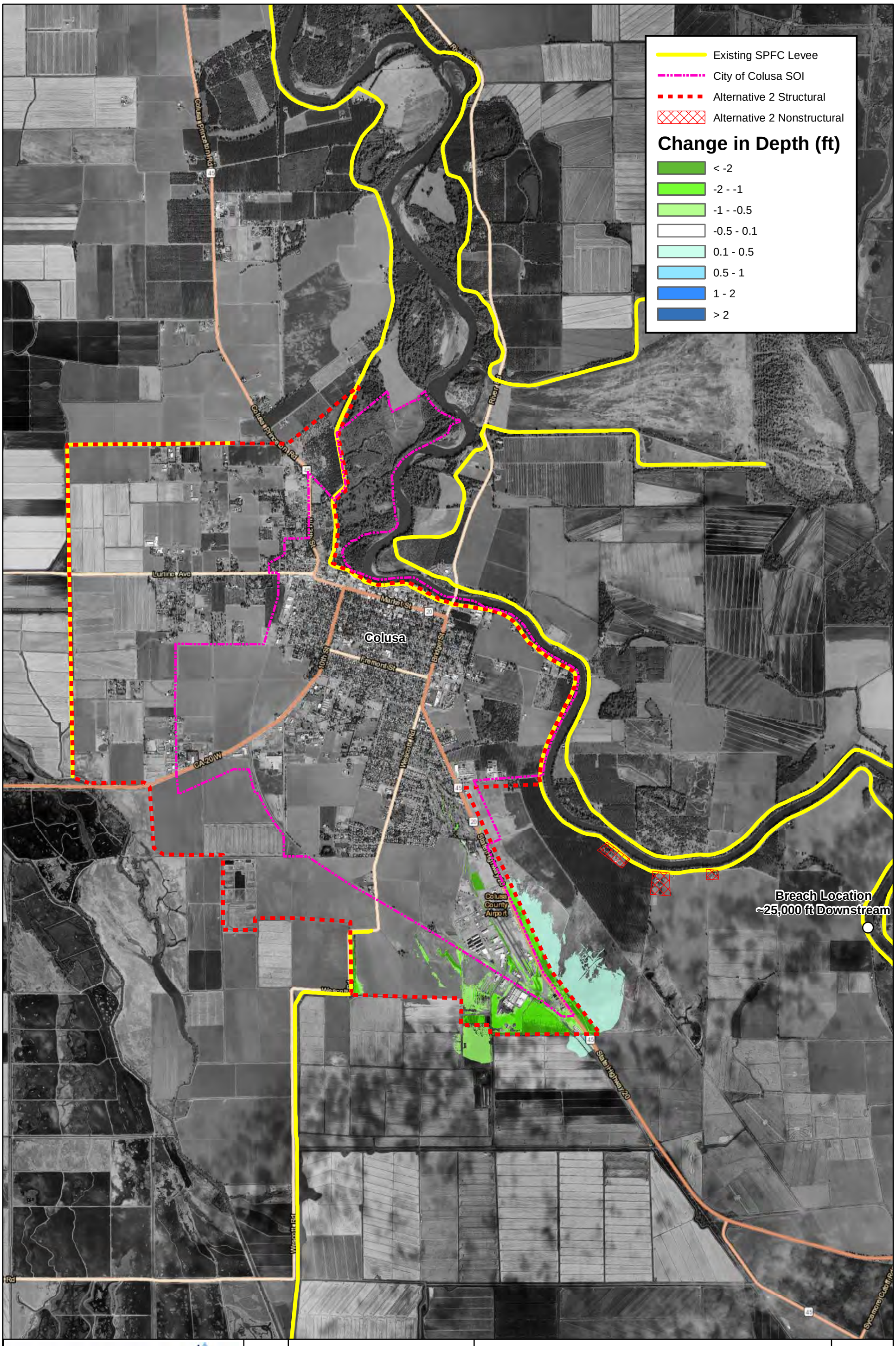
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 1 vs. Baseline
Sacramento River levee breach
located ~25,000 ft downstream of Colusa

FIGURE

-



PETERSON . BRUSTAD . INC
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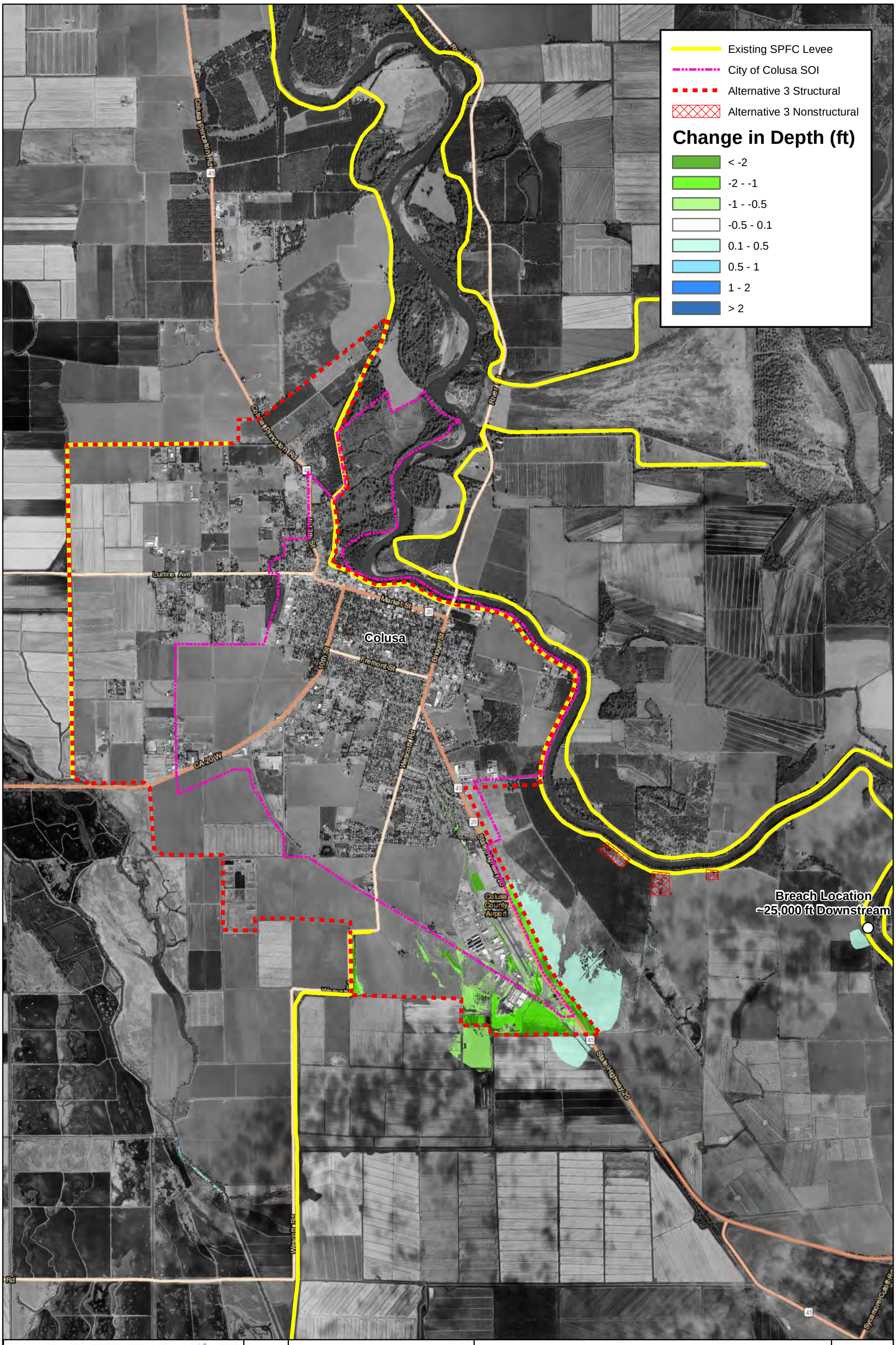
January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 2 vs. Baseline
Sacramento River levee breach
located ~25,000 ft downstream of Colusa

FIGURE

-



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0 0.25 0.5 Miles

January 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 3 vs. Baseline
Sacramento River levee breach
located ~25,000 ft downstream of Colusa

FIGURE

-

PETERSON . BRUSTAD . INC .
ENGINEERING . CONSULTING

Colusa County Flood Risk Reduction Feasibility Study

City of Colusa: 100-Year Hydraulic Modeling – Alternatives 3 & 6

October 30, 2019

Prepared by: Brittney Salvador, E.I.T.

Reviewed by: Michael Pantell, P.E. & Chris Fritz, P.E.

Introduction

The City of Colusa Flood Risk Reduction Feasibility Study is a locally driven, state-funded project which seeks to identify feasible flood risk reduction measures for the City of Colusa. The study is being funded under the Department of Water Resources' (DWR) Small Communities Flood Risk Reduction (SCFRR) Program. The primary goal of the feasibility study is to evaluate alternatives and recommend a preferred alternative to improve flood protection for the City of Colusa to a level that meets Federal Emergency Management Agency (FEMA) Accreditation standards.

In January 2019, Peterson Brustad, Inc. (PBI) performed a hydraulic analysis for an initial array of three (3) alternatives provided by KSN. The hydraulic analysis included updating an existing FEMA hydraulic model (HEC-RAS version 5.0.3) and a series of levee breach scenarios along the west bank of the Sacramento River for the 100-year flood event. The results of these breach simulations were mapped to show the depths and extents of flooding associated with each breach under pre- and post-project conditions for each of the alternatives. The January technical memorandum (TM) was updated in September of 2019[1].

In August 2019, KSN revised the alternatives to create six (6) final alignments. At this time, it was requested that PBI analyze Alternatives 3 and 6, shown in Figures 1 and 2. Additionally, it was requested that only the breaches to the north of Colusa be analyzed for these two alternatives. It should be noted that the numbering of the alternatives changed during selection of the final array of alternatives; therefore, Alternative 3 discussed throughout this TM does not correspond with Alternative 3, as presented in PBI's previous TM in September 2019. This TM documents the hydraulic analysis of Alternatives 3 and 6 for the City of Colusa Flood Risk Reduction Feasibility Study.

[1] PBI. *City of Colusa Flood Risk Reduction Feasibility Study, 100-Year Hydraulic Modeling Technical Memorandum.* September 2019.

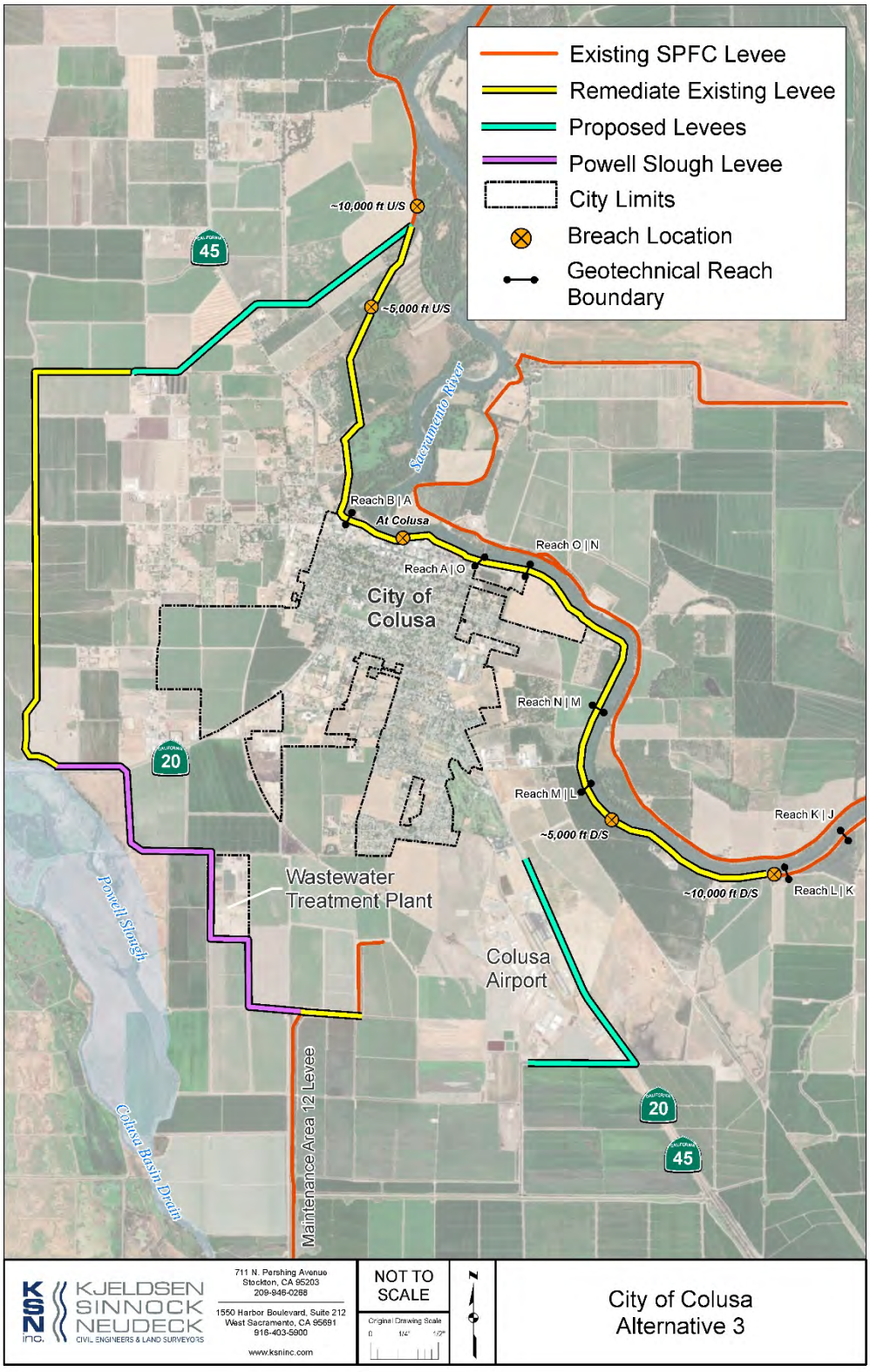


Figure 1: Final Alternative 3 Alignment

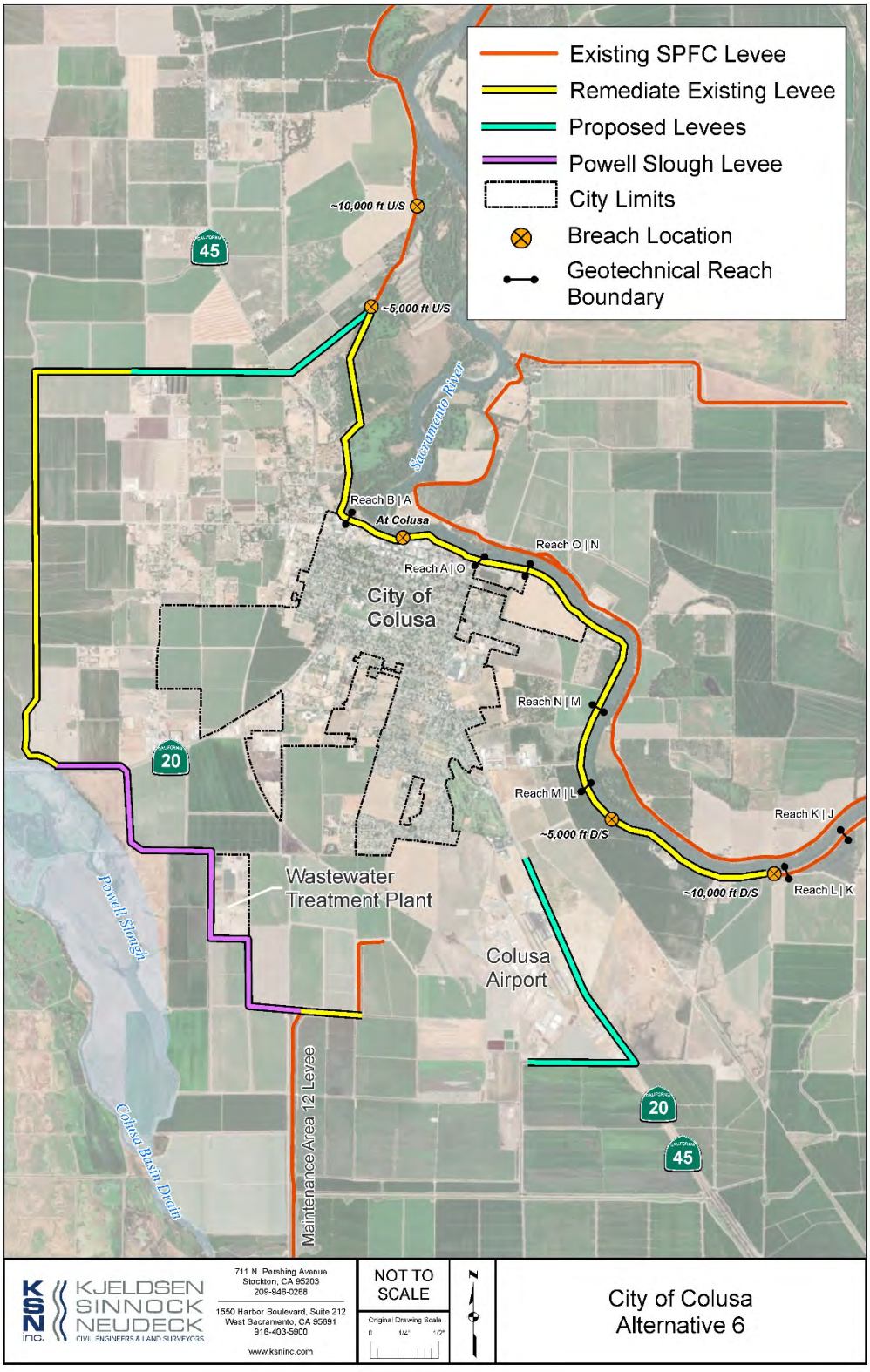


Figure 2: Final Alternative 6 Alignment

Additional Alternatives Modeling

Using the same hydraulic model and breach parameters outlined in the original 100-Year Hydraulic Analysis TM, the following steps were used to model Alternatives 3 and 6:

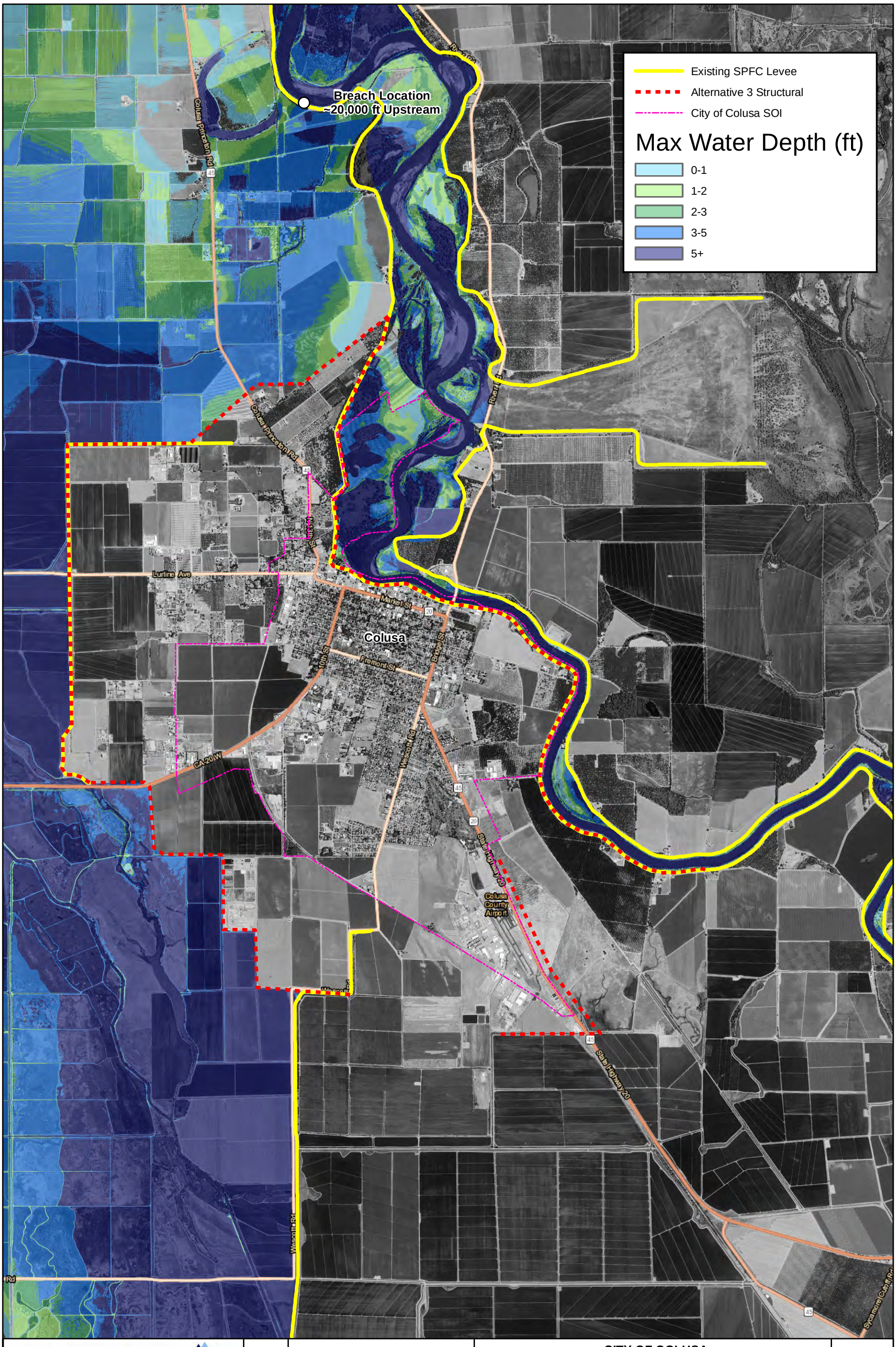
1) Simulate breach scenarios at 2 sites for Alternative 3: 20,000 ft and 10,000 ft upstream of Colusa.
2) Simulate breach scenarios at 3 sites for Alternative 6: 20,000 ft, 10,000 ft, and 5,000 ft upstream of Colusa.

Results

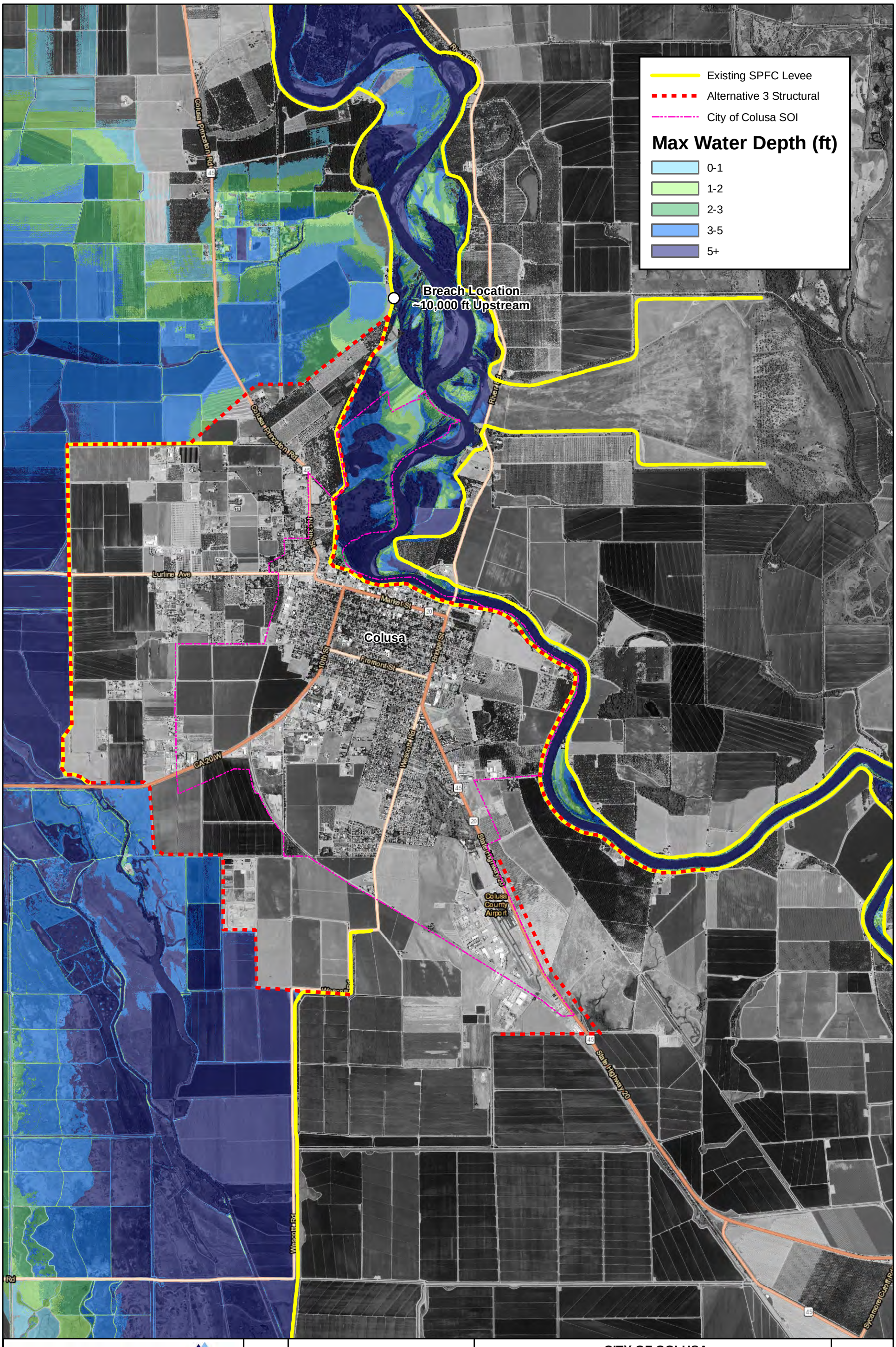
The 100-year levee breach floodplain maps for Alternatives 3 and 6 are provided in Attachment A of this TM. In all upstream breaching scenarios, the City of Colusa and the Colusa Wastewater Treatment Plant are protected during the 100-year flood event.

Attachment A

Levee Breach Floodplain Maps



PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING 80 Blue Ravine Rd, Suite 280 Folsom, CA 95630 Phone: (916) 608-2212	N	0 0.25 0.5 Miles **August 2019**	**CITY OF COLUSA** **FLOOD RISK REDUCTION FEASIBILITY STUDY** **Alternative 3 with Sacramento River levee breach located ~20,000 ft upstream of Colusa**	**FIGURE** **1**



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N

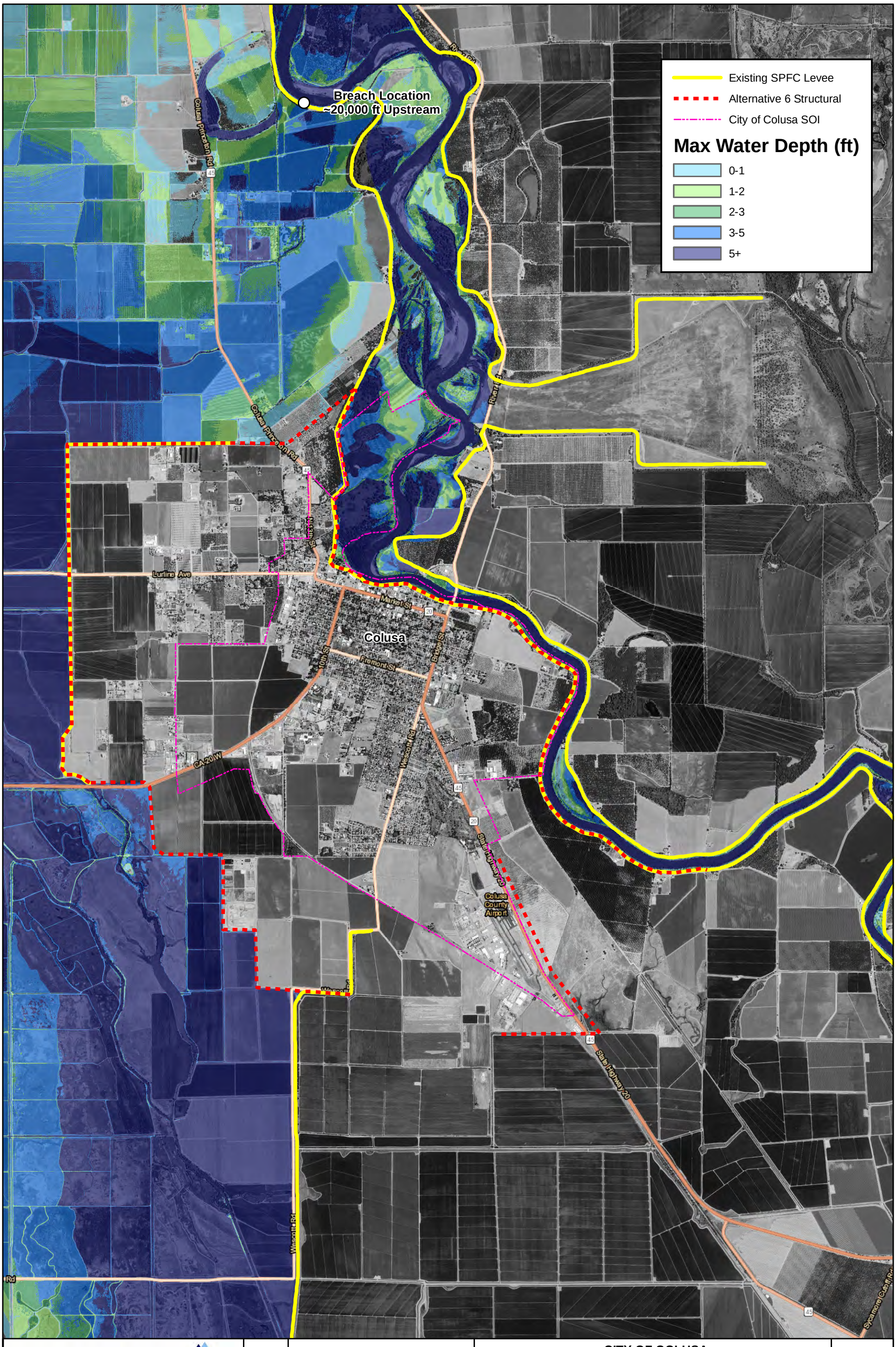
0 0.25 0.5 Miles

August 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 3 with Sacramento River levee breach located ~10,000 ft upstream of Colusa

FIGURE
2



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N

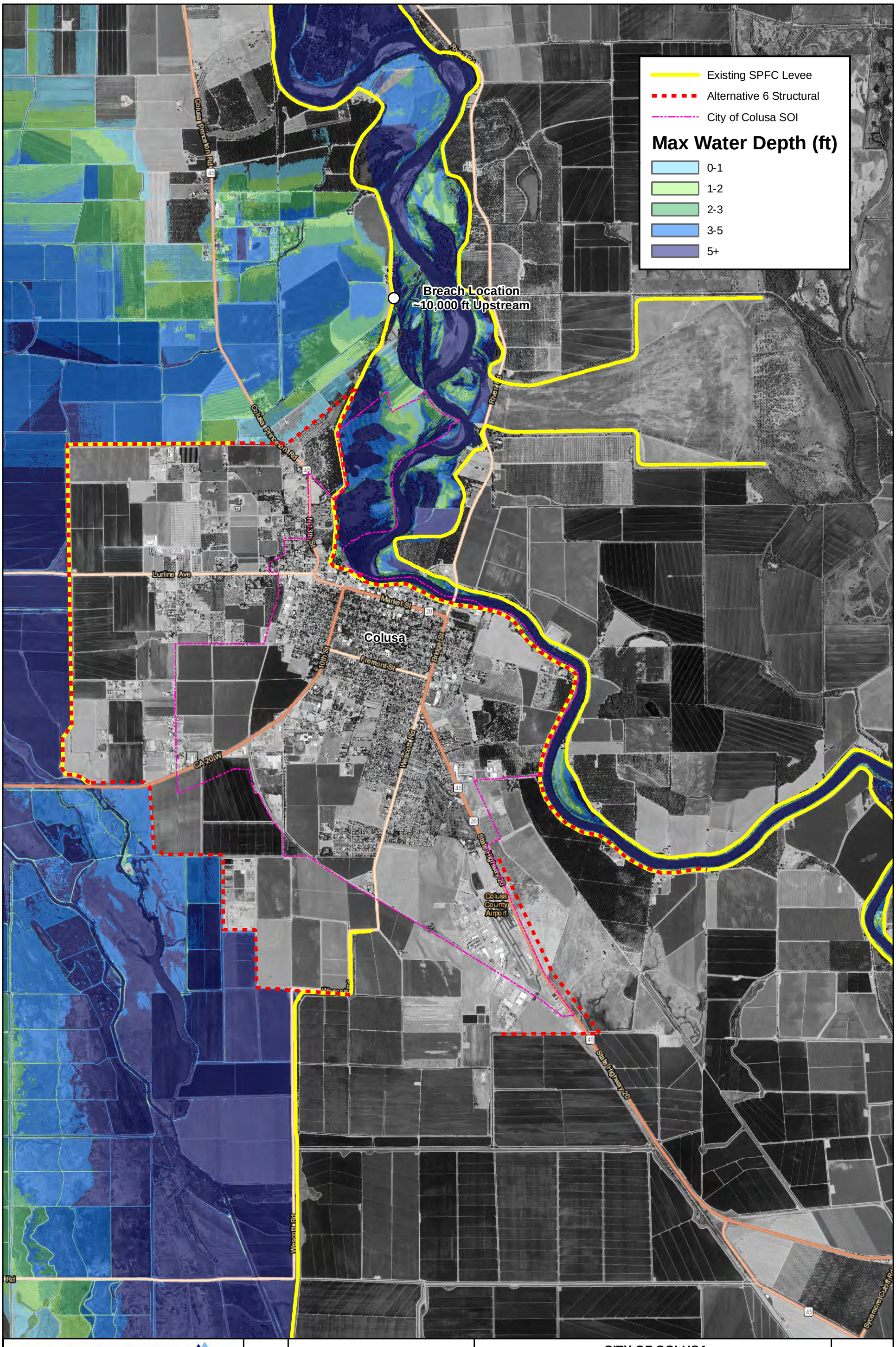
0 0.25 0.5 Miles

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CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 6 with Sacramento River levee breach located ~20,000 ft upstream of Colusa

FIGURE
3



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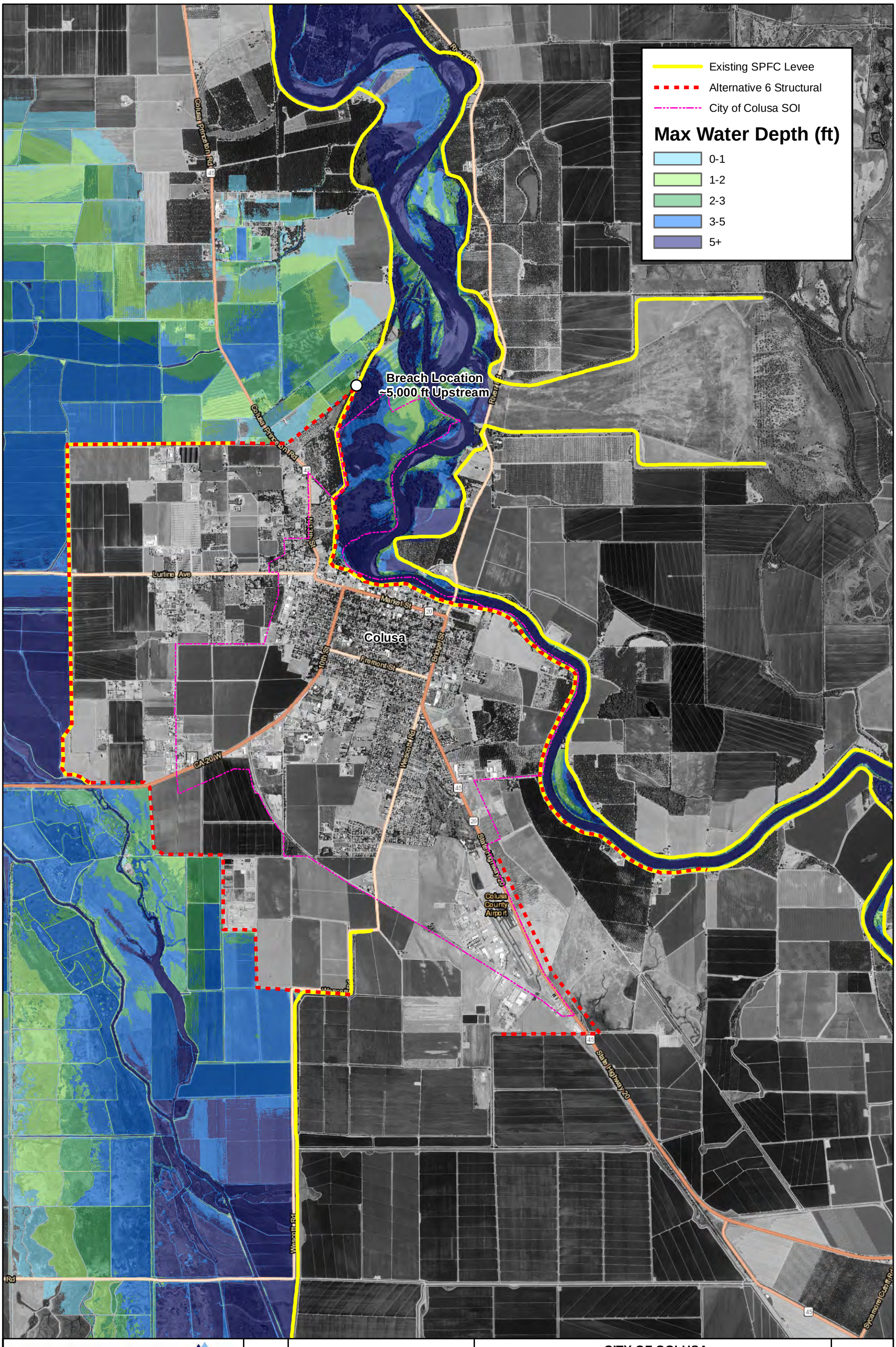
0 0.25 0.5 Miles

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CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 6 with Sacramento River levee breach located ~10,000 ft upstream of Colusa

FIGURE
4



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N

0 0.25 0.5 Miles

August 2019

CITY OF COLUSA
FLOOD RISK REDUCTION FEASIBILITY STUDY

Alternative 6 Sacramento River levee breach located ~5,000 ft upstream of Colusa

FIGURE
5

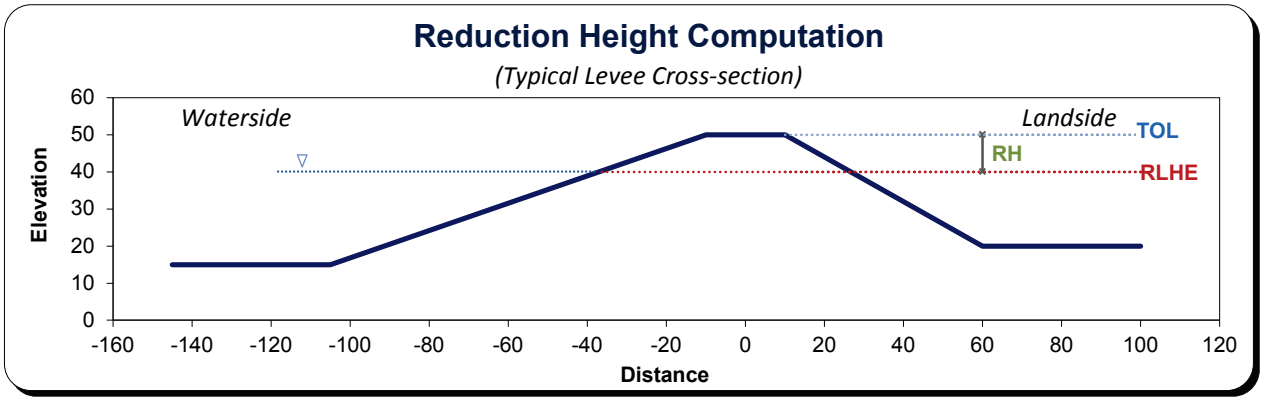
URS Corporation
2870 Gateway Oaks Drive, Suite 150
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Fax: 916.679.2900

Technical Memorandum

Prepared For	Atkins North America, Inc.
Project	California Department of Water Resources Contract 4600008062, Task Order 68, Work Order 2 CVFED Program Levee Reliability Study
Date	September 27, 2012
Subject	Levee Reliability Technical Memorandum
Prepared By	Loren Murray (URS Corporation)
Reviewed By	Rich Millet (URS Corporation), Nagesh Malyala (URS Corporation), Don Kurosaka (URS Corporation)

EXECUTIVE SUMMARY

This technical memorandum (TM) presents the process used to develop reliable levee height elevations (RLHEs) for Central Valley levees based on the available information provided by DWR's Urban and Non-Urban Levee Evaluation Programs (ULE and NULE Programs). These data will support the hydraulic modeling efforts being performed under the California Department of Water Resources' (DWR's) Central Valley Floodplain Evaluation and Delineation (CVFED) Program, one of several programs in DWR's FloodSAFE Initiative. The process consists of computing the reduction height (RH); i.e., the distance from the top of levee (TOL) to the RLHE (see Figure E-1).



$RH = TOL - RLHE$ *where:* RH - Reduction Height (computed)
TOL - Top of Levee
RLHE - Reliable Levee Height Elevation

Figure E1 Reduction Height Computation Process Diagram for the CVFED Program

CVFED Program flood risk areas will be identified based on potential levee flood releases that will maximize identification of flood hazard areas. Levee flood release conditions (resulting in landside inundation) will be analyzed under conditions where flood flow either encroaches into levee freeboard or exceeds a RLHE.

The inundation mapping based on RLHEs represents that area of the Central Valley vulnerable to potential flood risk associated with hydrologic/hydraulic events which exceed the Federal/State project levee's design criteria.

The method for determining RLHEs was guided by an experienced Technical Review Panel (TRP) of geotechnical experts assigned to this effort. The TRP was presented with the team's approach and procedures for deriving RLHEs. TRP recommendations aided the team in effectively applying complex engineering approaches to datasets unique to both Urban and Non-Urban levees. TRP recommendations included: a.) Urban RLHEs will be performance-based derived from deterministic analyses associating water surface elevations (WSEs) versus geotechnical parameters; b.) Urban levee reliable height elevations will be based on the failure mode that reduces the reliable levee height the greatest based on deterministic performance results for underseepage, through seepage or landside stability; c.) current erosion abatement practices nullify erosion failure mode potential for Urban levees; and d.) reliability of Non-Urban levees will be based on a subjective derived probability of failure P(f) = 5% (estimated to be representative of levee performance at or near design criteria parameters consistent with the deterministic Urban levee results; see Figure E-2).

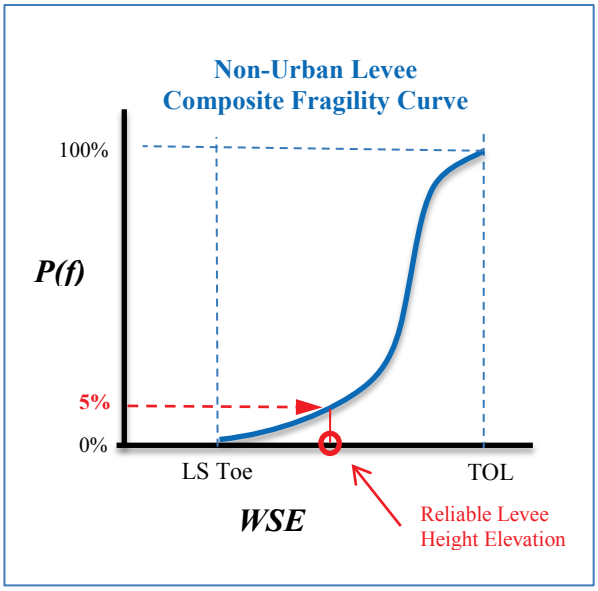


Figure E-2

For Urban reaches, engineering analyses were performed to develop performance relationships for WSE versus exit gradient (i_e) at the landside levee toe (using the SEEPW application), WSE versus factor of safety (FS) for landside stability, and for WSE versus landside slope "breakout elevation" (BE) of the phreatic water surface. Parameters compatible with current Federal/State criteria were used to select the WSE associated with levee reliability including a seepage gradient of i_e = 0.5 (at landside levee toe), a FS = 1.4 (for landside slope stability), and a BE = 1% of total levee height, for underseepage, stability and through seepage, respectively. The RH was then derived by subtracting the RLHE from the TOL elevation for each Urban levee reach. Appendix A presents a tabulation of the RH by Urban levee reach.

The method employed for determining RLHEs on Non-Urban levee segments was based on the probabilistic assessment of a composite failure probability versus water surface elevation relationship that encompasses effects of levee performance against underseepage, through seepage, landside stability and erosion. The performance of the levee segment being analyzed was qualitatively assessed for each failure mode independently, and then mathematically combined to produce a comprehensive failure probability (P(f)) versus WSE for each Non-Urban levee segment. The RLHE for a segment would be based on the WSE associated with a P(f) = 5%. In unique instances where the erosion failure mode dominated the result with respect to the other failure modes, a more detailed review and possible compensation for the erosion probability failure mode was to be considered.

For Non-Urban levee segments, the WSE corresponding to a composite failure probability value of P(f) = 5% is utilized. As previously noted, the P(f) = 5% values are representative of levee performance at or near design criteria parameters. Similar to the Urban levee reaches, the RH was then derived by subtracting the RLHE from the TOL elevation for each Non-Urban levee segment. Appendix A presents a tabulation of the RH by Non-Urban levee segment.

The TOL was chosen as the reference datum from which to identify a RH primarily because the LIDAR dataset utilized by the ULE and NULE projects for assessing project levees in the Central Valley is consistent with levee crown elevations ascertained from the LIDAR dataset collected by the CVFED Program for their flood modeling. The use of a “levee toe” datum lacked consistency due to the difficulty in selecting the same physical toe location in the ULE/NULE Programs and the CVFED Program.

The CVFED hydraulic modeling development teams will identify existing TOL elevations for their models, and then reduce those levee elevations by the derived RH values to arrive at a representative RLHE for modeling purposes.

1.0 BACKGROUND

The CVFED Program is one of several programs within DWR's FloodSAFE Initiative. The CVFED Program has multiple goals, including improving the quality and accuracy of flood hazard data and mapping available to local communities. The program is developing new topographic data and updating hydrologic and hydraulic data and models, which will be used to better understand the risk of flooding in the Central Valley and to support evaluation and design of potential actions and projects to help manage the risk.

The derivation of levee reliability data (reduction heights [RHs] and reliable levee height elevations [RLHEs]) described in this Technical Memorandum (TM) supports development of DWR hydraulic models that are necessary for simulating existing-condition hydraulic performance in the Central Valley's flood control infrastructure, consistent with flood protection assurances made by the State of California to its constituents residing in and near flood-prone regions.

Atkins, through their Task Order 68 requested URS Corporation to support their role in the development of riverine hydraulic models under the CVFED Program. This TM also supports DWR's development of levee reliability data for both Project and some limited and specific non-Project levees in the Central Valley. As noted above, levee reliability data used in this TM are based on geotechnical information and failure probability data developed under DWR's ULE (Urban Levee Evaluations) and NULE (Non-Urban Levee Evaluation) Programs.

URS derived levee reliability data from levee geotechnical investigations, data, and analyses developed under the ULE and NULE Programs, and levee performance assessments developed under the NULE Program. The RLHE, defined for ULE levees as the elevation of levees for which State of California levee design criteria are met based on the best data available at the time of preparing this TM. For NULE levees, the RLHE is defined as the water surface elevation at which P(f) = 5%. The RH, which will be used in CVFED models to adjust the TOL elevation, is computed by subtracting the derived RLHE from the TOL elevation.

The ULE Program was implemented by URS Corporation and addresses approximately 400 miles of levees. The NULE Program was implemented by URS in the Sacramento River basin, and Kleinfelder in the San Joaquin River basin, for a total of 1,600 miles.

2.0 OVERVIEW OF THE RLHE AND RH DEVELOPMENT PROCESS

The RH is the primary output of this study. Before the RH can be computed, a definition of reliable levee height elevation (RLHE) had to be established. For this study, the RLHE is that height of flood water for which the levee (for selected segment or reach) meets accepted performance or design criteria. Levee performance for flood waters above this "reliable" height may still meet the primary purpose of protecting life and property, but outside of established performance criteria thresholds.

In order to derive a RLHE, assessment criteria and approaches were established to accommodate four predominant failure mechanisms likely to affect the system performance: underseepage, through seepage, stability and erosion. Under the scope of DWR's ULE and NULE Programs, levee performance potential (of existing systems) was assessed differently for Urban levees and Non-Urban levees, and thus the approach to establish RLHEs is different for each program (see Figure 1).

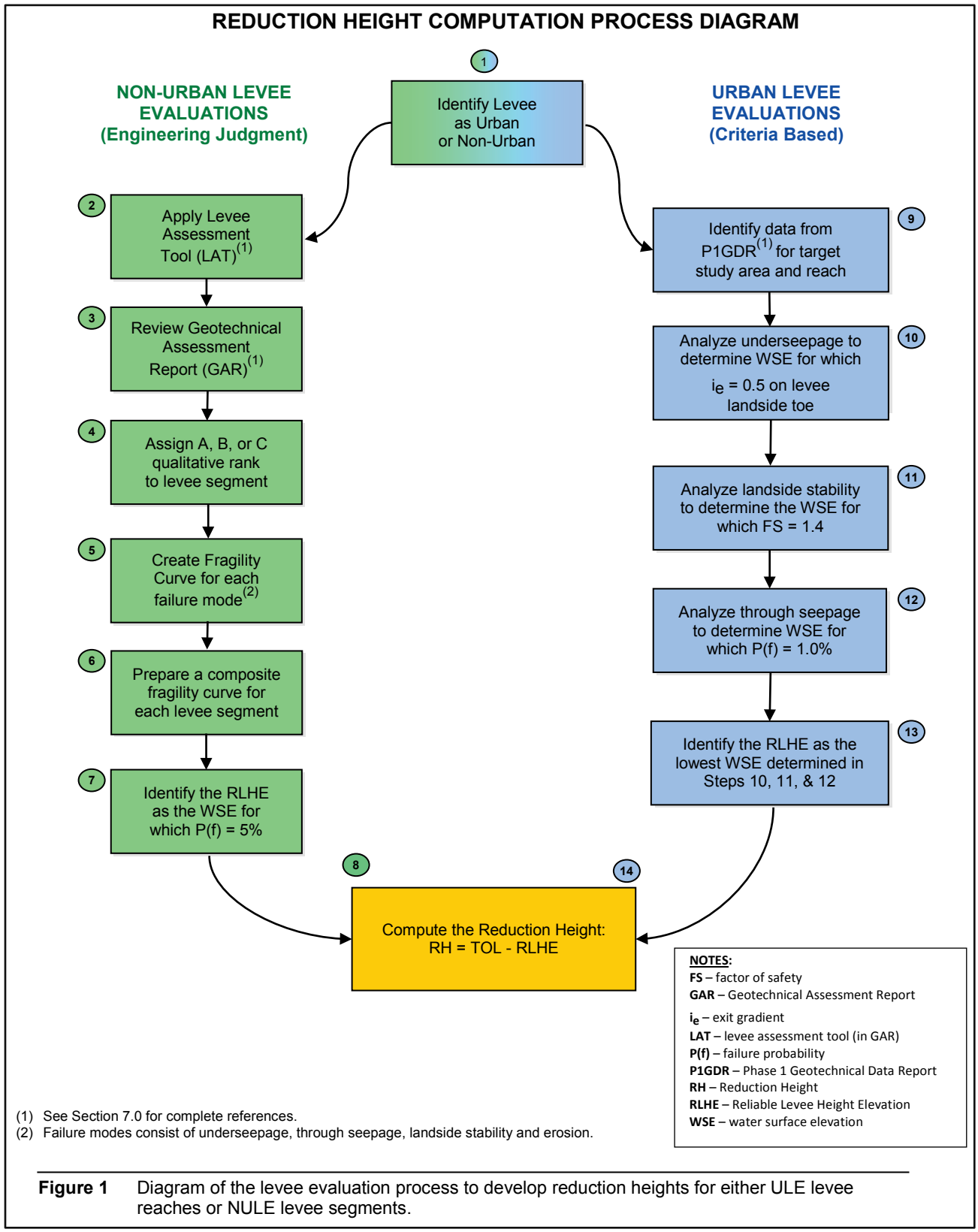


Figure 1 Diagram of the levee evaluation process to develop reduction heights for either ULE levee reaches or NULE levee segments.

2.1 Non-Urban Levee Segments

For Non-Urban levees, where no detailed geotechnical analyses had been completed by DWR's NULE Program at the time of this study, subjective engineering judgment assessments were made for each of the four failure modes and probability failure relationships for each of the failure modes were established and combined mathematically into a composite fragility curve.

For Non-Urban levees, a subjective probabilistic approach was used. Non-Urban Project failure probability curves were developed based on the qualitative (probabilistic) assessment categorizations of the Non-Urban levee segments (URS, 2011, and Kleinfelder, 2011). Non-Urban Project curves used the Geotechnical Assessment Report (GAR) (URS, 2011) categorizations that were determined by comparing levee past performance (i.e., documented historical performance) against anticipated geotechnical performance based on geotechnical hazard indicators. The Non-Urban Project's GAR categorizations are not typically used for failure probability curve development; thus, DWR and the U.S. Army Corps of Engineers (USACE) prompted URS and Kleinfelder to build a tool to develop curves following the general concepts of USACE's Engineer Technical Letter (ETL) 1102-2-556 (USACE, 1999). The approach used to develop the curves for Non-Urban levees was reviewed by a team of experts from DWR, USACE, and selected consultants.

For Non-Urban levees, DWR decided that the acceptable threshold for the CVFED Program occurs when the water surface elevation (WSE) is associated with a combined probability of failure P(f)=5%. The P(f) = 5% values are representative of levee performance at or near design criteria parameters for better consistency with the deterministic Urban levee results.

2.2 Urban Levee Reaches

For Urban levees, levee reliability requires consistency with the design criteria established by DWR to validate the state's commitment to providing protection for the State Plan of Flood Control. The levee reliability threshold for Urban levees is defined as conditions where levee performance can reasonably be expected to meet or exceed design criteria, and where an Urban level of protection (ULOP) as prescribed by State Senate Bill 5 is incorporated into the levee performance requirements.

For Urban levees, DWR used criteria procedures consistent with Federal/State procedures to ensure that the derivation of RLHEs was based on established protocols and processes. Figure 2 shows the criteria-based procedures and protocol hierarchy from which RLHEs are derived for Urban levees.

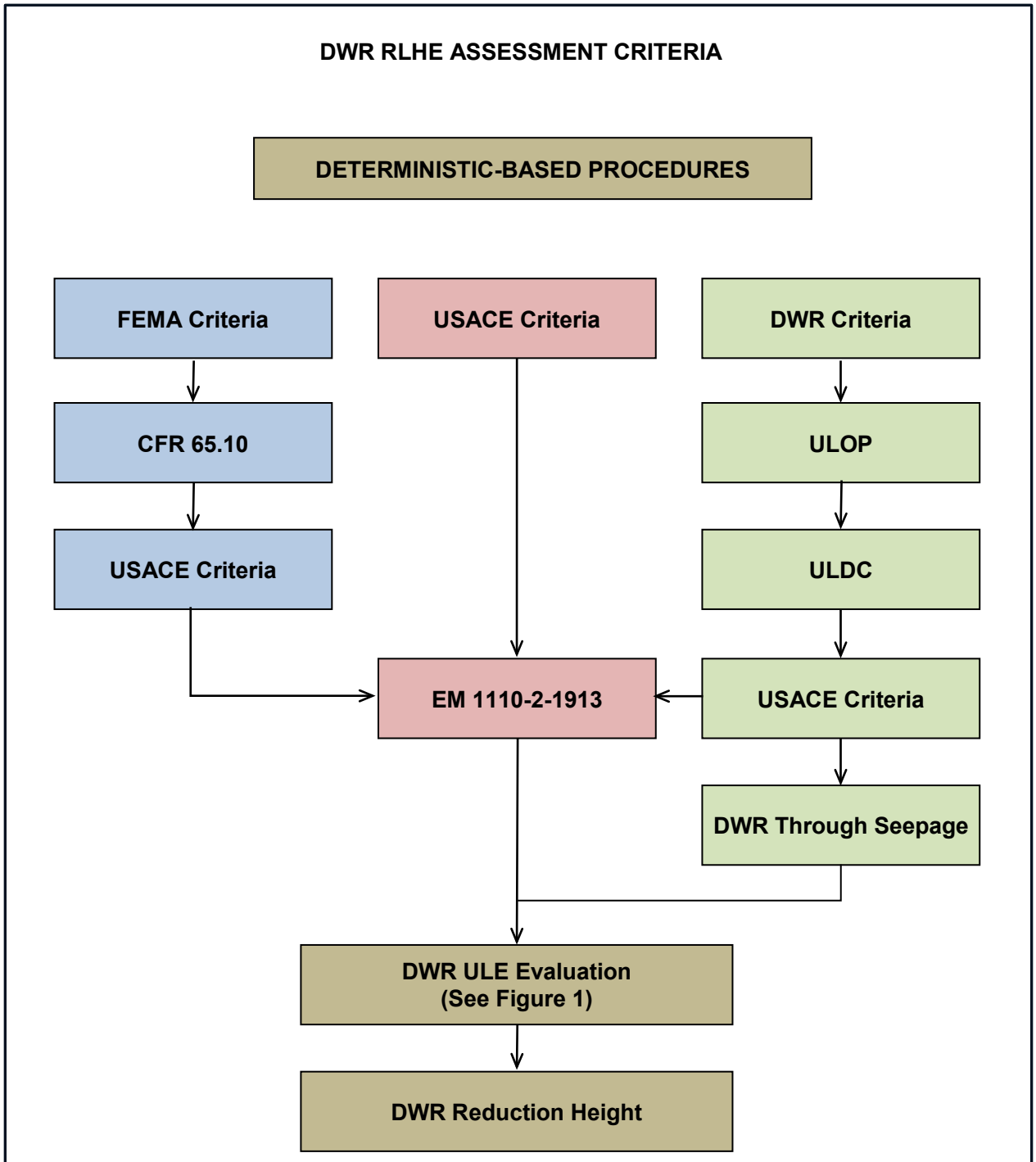


Figure 2 Critical approach and institutional protocols, regulations, and guidelines requisite to the derivation of RLHEs and RHs.

For the purposes of this TM, analyses of levee performance to ascertain a RLHE is based on a deterministic criteria approach that assesses acceptable performance versus WSE. For underseepage-related performance, the acceptable performance metric for an Urban levee is when the exit gradient (i_e) at the levee landside toe is at or below i_e = 0.5. In the case of landside slope stability, the acceptable performance metric is when the factor of safety (FS) against slope failure is at or above 1.4. For through seepage, the acceptable performance metric is when the height above the landside toe of the daylighting phreatic water surface though an erodible soil layer is equal to 1% of the height of the levee. Erosion failure modes are accommodated by other DWR programs as they approach or endanger the physical levee prism authorized by the federal flood control program(s), and thus the erosion failure mode was dismissed from further consideration in the derivation of RLHEs. The Urban levee deterministic approach for deriving a RLHE is presented in greater detail in Section 3 of this TM.

3.0 IMPLEMENTATION OF THE RLHE AND RH PROCESS

The CVFED Program flood risk areas will be identified based on potential levee flood releases that will maximize identification of hazard areas where levee criteria are no longer met. Levee flood release conditions will be analyzed for situations where flood flow either encroaches into levee freeboard or exceeds a RLHE. Both left and right bank release conditions will be analyzed to derive the maximum lateral extent of performance vulnerability of the potential floodplain. Accomplishing this task requires deriving maximum RLHEs for each levee element in the State Plan of Flood Control.

Levee freeboard encroachments are not part of this assignment, and are being derived by others to support the CVFED Program and hydraulic analyses.

3.1 CVFED Program Considerations

As noted above, URS derived the levee reliability data from geotechnical data developed and analyzed under the ULE and NULE Programs. The approach adopted for developing RLHEs is based on the level of information available at the time of this study. Urban levee reliability data were derived using Phase 1 Geotechnical Data Reports (P1GDR) field data and associated preliminary analyses results (see Section 7.0 for a complete list of references). Non-Urban levee reliability data were derived using information in the Geotechnical Assessment Reports (URS, 2011, and Kleinfelder, 2011).

3.2 Independent Technical Review Panel (TRP) Guidance

As part of this assignment, DWR requested a written compilation of the TRP's review and recommendations. This section of the TM describes:

- Presentation to the TRP
- Discussions between the study team and the TRP regarding approach
- Protocols employed
- Derived results
- TRP guidance and recommendations for moving forward

Task Order 68 Work Order 2 (Atkins, 2011) prescribed the identification and contribution of a TRP under Subtask 3 titled Technical Review Panel Input and Coordination. The Task Order stipulates *"…a Technical Review Panel will be convened to provide insight and feedback toward improving the outcome of the CVFED Program assignment, particularly with regard to the transformation of fragility curve information to the levee reliability results defined in this Task Order.*"

TRP members include:

- Dr. Leslie Harder (HDR, Inc.)
- Mr. Rick Stauber (Kleinfelder)
- Mr. Richard Millet (URS)

The TRP was engaged shortly after URS developed an approach and defined a procedure to evaluate RLHEs. TRP recommendations have been employed to derive RLHEs throughout the Central Valley for application to the CVFED Program's hydraulic modeling assignment.

3.2.1 TRP Presentation

The Atkins-URS team convened a meeting with the TRP and presented:

- An overview the CVFED Program's mission
- The purpose for developing failure probability data (for other DWR programs)
- An approach for how criteria-based and failure probability data could be assessed to support the CVFED Program's mission
- An approach for deriving levee reliability information in support of the CVFED Program's mission deliverables to the State of California

The team presented an overview of the CVFED Program's mission and purpose to inform the TRP about the purpose of its assignment. In summary, the CVFED Program's overall mission is to determine areas at risk of flooding and to estimate flood depths for a 100-year, 200-year, and 500-year flood event associated with performance of State Plan of Flood Control infrastructure.

The team then discussed the approach for how failure probability data could be assessed to support the CVFED Program's mission. For Non-Urban levees, the TRP was to identify the failure probability value associated with the WSE that would represent the stage at which a levee was deemed reliable. WSE exceeding this elevation implies that the representative levee element no longer meets design criteria (which is necessary for the state to provide assurances of protection within the State Plan of Flood Control) and is no longer considered reliable.

For Urban levee reaches (as defined in the ULE Project), the lowest WSE corresponding to the acceptable geotechnical performance criteria from each of the levee failure modes (landside stability, underseepage and through seepage) was considered as the reliable height for that reach. Urban levee performance was based on deterministic analyses comparing varying water surface elevations against resultant levee performance responses for each water surface assessed.

For Non-Urban levee segments, the WSE corresponding to a composite failure probability value of P(f) = 2% and P(f) = 5% was considered. The TRP, in conjunction with DWR and as noted above, felt the P(f) = 5% value provided DWR with a condition similar in performance to previous studies,

and was more representative of levee performance at or near design criteria parameters with Urban levee results.

3.2.2 TRP Recommendations

TRP recommendations based on initial study results, included:

Urban Levees:

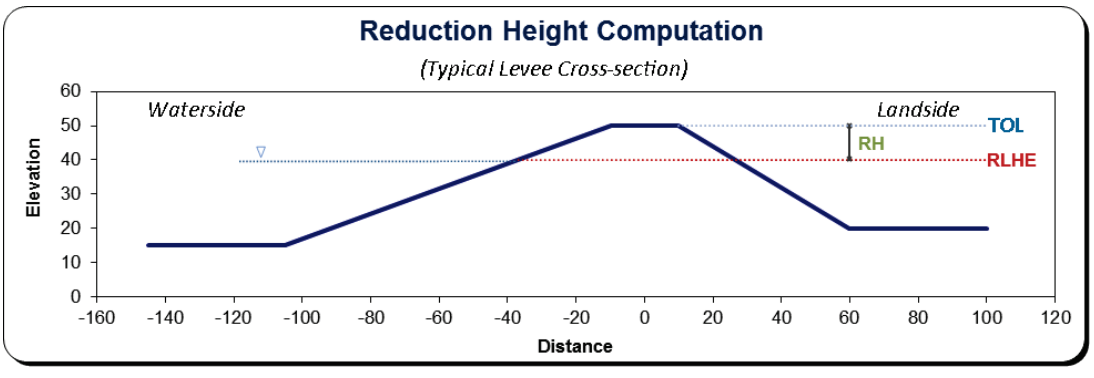
- RLHEs for Urban levees would be based on deterministic analyses for exit gradient of 0.5 or less for underseepage at the landside levee toe, a factor of safety of 1.4 or more for landside stability, and the phreatic surface daylighting through an erodible soil layer at 1% of levee height or less for through seepage.
- As DWR's philosophy is to abate erosion-related issues before they become critical in Urban areas (based on the significant consequence of failure), the TRP agrees that the erosion failure mode can be eliminated from Urban levee reliability determination.
- Use the lowest reliable stage derived from each levee failure mode (i.e., landside stability, underseepage and through seepage) to obtain the reliable levee height for Urban levee reaches.

Non-Urban Levees:

- Approval of the computed probabilistic approach to ascertaining reliable stage associated with a P(f) = 5% based on the composite failure probability curve of a Non-Urban levee segment. Although the TRP initially decided that erosion should be ignored as a failure mode based on the assumption that it would be repaired before it became critical, the TRP finally determined erosion should be included as a failure mode, but erosion should be constrained where preliminary analyses concluded it was overly dominant in the composite probability failure results.

3.2.3 Reduction Height

As discussed previously, because of the difficulty in selecting a consistent landside toe elevation for the CVFED and ULE/NULE Programs, it was decided to use the TOL as the reference datum. RH is defined as the distance from the TOL down to the RLHE (see Figure 3). The resulting RHs for both Urban levee reaches and Non-Urban levee segments are provided in Appendix A.



$RH = TOL - RLHE$ *where:* RH - Reduction Height (computed)
TOL - Top of Levee
RLHE - Reliable Levee Height Elevation

Figure 3 Reduction Height Computation Process Diagram for the CVFED Program

3.3 Non-Urban Levee Reliability Determination

In Phase 1 of the NULE Project, data were collected and used to characterize the levees. This process used Non-Urban levee segment data, including past performance history, geomorphic mapping, and office-based review of reported geologic and geotechnical data (maps and reports). Using this information, DWR's Levee Assessment Tool (LAT) was then employed, which facilitated a methodical assessment of levee information to derive hazard indicator scores for categorizing levee segment conditions.

Each levee segment was categorized A, B, C or LD (GAR: URS, 2011, and Kleinfelder, 2011). The categorization was done for each of four failure modes (underseepage, stability, through seepage and erosion). These levee categorizations (qualitative rankings) become important in developing RLHEs for Non-Urban levee segments.

Categorization was performed for only one water surface elevation, the assessment WSE, which, where available, was generally the 1955/57 water surface. All NULE Project characterizations and results were, therefore, for the single assessment WSE. To produce fragility curves for each NULE Project segment, fragility curves for each failure mode were developed. A representative figure (Figure 4) is shown below.

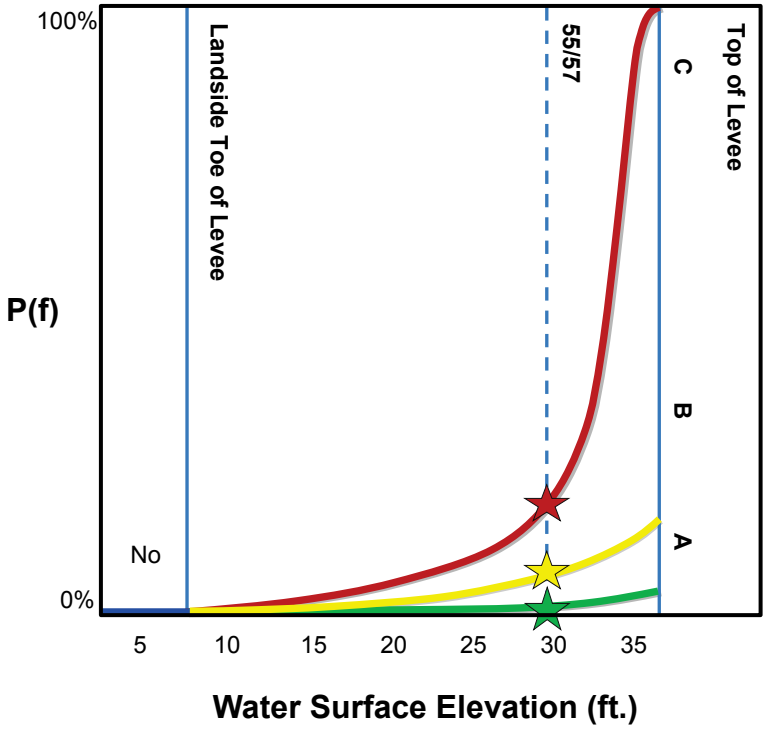


Figure 4 Conceptual NULE Project Fragility Curves, Categories A, B and C.

These independent failure mode fragility curves are then mathematically combined applying the following formula:

$$P(f) = 1 - [(1-P(f)_{underseepage})\bullet(1-P(f)_{throughseepage})\bullet(1-P(f)_{stability})\bullet(1-P(f)_{erosion})]$$

The result is a composite failure probability function for the segment. Thus, two levees with similar failure mode categorizations and similar topographic profiles will have similar failure probability curves. The derived RLHEs for Non-Urban levees are derived from assessment of the fragility curve in association with a target probability of failure value.

3.3.1 Underseepage, Stability and Through Seepage

For Non-Urban levees, underseepage, stability and through seepage hazard level was based on a qualitative appraisal as to the potential for through seepage. The range of hazard level values is:

- Hazard Level A. When water reaches the assessment water surface elevation, there is a low likelihood of either levee failure or the need to flood fight to prevent levee failure.
- Hazard Level B. When water reaches the assessment water surface elevation, there is a moderate likelihood of either levee failure or the need to flood fight to prevent levee failure.
- Hazard Level C. When water reaches the assessment water surface elevation, there is a high likelihood of either levee failure or the need to flood fight to prevent levee failure.
- Lacking Sufficient Data (LD). Currently lacking sufficient data regarding past performance or hazard indicators.

For Non-Urban levee segments under analysis, the assessment WSE is the 55/57 design water surface for which many flood control levees throughout the Central Valley were designed and constructed.

Upon selecting a hazard level (A, B or C), a probability of failure P(f) is applied to that elevation (a P(f) is not established for the LD hazard level.) The respective P(f) values at the 55/57 water surface elevation for A, B and C are: P(f)A = 0.5%, P(f)B = 2%, and P(f)C = 16%. These control points were established by the TRP. The other two key elevations that establish the shape of the probability of failure curve are the elevation of the landside levee toe, and the levee crest. Probabilities of failure for the landside toe and the crest are set as: P(f)toe = 0%, and P(f)crest = 100%, respectively. The resultant P(f) versus WSE relationship again developed using curve fitting functions appears as depicted in Figure 4. More detailed discussion of the hazard levels is found in the Fragility Curve Development TM (URS, 2011).

3.3.2 Erosion

A review of the preliminary results on Non-Urban segments, in conjunction with recognition that the other failure modes are not entirely independent from erosion processes, required additional considerations for erosion. It was determined that erosion would be considered, but constrained where preliminary analyses portrayed erosion as overly dominant in the composite probability failure results.

Where it was determined that the NULE Project RLHE from the cumulative P(f) curve was much lower by considering erosion than by considering only the hazards from underseepage, through seepage, and stability (erosion-dominated probability curve), rules were developed to normalize the reliable height. This was done by removing the erosion P(f) from the cumulative P(f).

The equations used to determine the final RLHE are shown below:

If erosion is category "A", and the $\frac{RLHE_C}{RLHE_{UTS}} > 75\%$

where:

$RLHE_C$ = reliable levee height from the cumulative P(f) curve for all four failure modes; and

$RLHE_{UTS}$ = average of reliable levee heights from the underseepage, through seepage and stability curves

then the cumulative P(f) is calculated based on the formula in the fragility curve technical memo.

$$P(f) = \left(1 - [\left(1 - P(f)_{Underseepage}\right)x\left(1 - P(f)_{Throughseepage}\right)x\left(1 - P(f)_{Stability}\right)x\left(1 - P(f)_{Erosion}\right)]\right)$$

If erosion is category "A", and the $\frac{RLHE_C}{RLHE_{UTS}} \leq 75\%$ then the $P(f)_{Erosion}$ is removed from the cumulative P(f). Also, If erosion is category "B" or category "C", then the $P(f)_{Erosion}$ portion of the cumulative $P(f)$ is removed as well, resulting in application of the following equation:

$$P(f) = \left(1 - \left(1 - P(f)_{Underseepage}\right)x\left(1 - P(f)_{Throughseepage}\right)x\left(1 - P(f)_{Stability}\right)\right)$$

3.3.3 Reduction Height Results

Upon development of the composite fragility curve for a given levee segment, the curve was assessed to ascertain the WSE associated with a P(f) = 5%. This WSE represented the estimated RLHE for CVFED purposes. This elevation was then compared to the segment's TOL elevation and the difference between the TOL and RLHE was calculated to compute the RH below the TOL to be imported into the hydraulic modeling to derive the RLHE of levee segments for CVFED modeling purposes.

3.4 Urban Levee Reliability Determination

As noted above, based upon the greater availability of geotechnical information, RLHEs for Urban levees were based upon deterministic criteria compatible with the USACE and DWR design criteria (see Figure 1).

3.4.1 Underseepage and Landside Stability

For steady-state underseepage and steady-state stability, historical data and field and laboratory geotechnical data collected during the initial phase of the ULE Program were used as input to calculate average vertical exit gradients (i_e) and stability factors of safety (FS) for various flood elevations for each respective cross section location. Thus, underseepage exit gradients and landside stability FS were derived by computational methods using SEEPW and SLOPEW software applications in conjunction with geometry and stratigraphy obtained from field data collection and laboratory analyses of materials collected in the field. This resulted in a levee reach performance relationship between WSE and i_e, and between WSE and FS. Thus, the WSEs could be identified for

the acceptable geotechnical criteria to arrive at RLHEs for each reach. Since reliable performance was determined by DWR to correlate to levee performance conditions when these are met, the WSE associated with these threshold criteria conditions represent the RLHEs for underseepage and for landside stability conditions.

3.4.2 Through Seepage

Unlike procedures or protocols for analyzing levee underseepage or levee stability, there is no U.S. Army Corps of Engineers or DWR-prescribed guidance or procedure for analyzing through seepage conditions in levee easements. Thus, a procedure to aid DWR's geotechnical evaluation effort required the development of an analytical procedure to assess the Urban Levee through seepage hazard potential. This procedure was reviewed and approved for use by an independent panel of experts in the geotechnical field (URS TM, 11/28/11). A summary of the procedure is provided in Figure 5, and a more detailed discussion of the procedure is provided in Appendix B.

For through seepage, a relationship was derived by analyses between various water surface elevations (WSE and their projected phreatic water surface through the levee under steady-state conditions) culminating in a daylighting or breakout elevation (BE) on the landside slope of the levee (URS, 2012) through an erodible soil layer. The WSE associated with a landside slope breakout elevation equal to 1% of the levee height above the landside toe elevation was determined to be the WSE associated with the maximum RLHE for the Urban reach in question.

3.4.3 Erosion

In Urban and Urbanizing areas, erosion failure modes are accommodated by other DWR (and USACE representing Federal interests) programs as they approach or endanger the physical levee prism authorized by the federal flood control program(s), and thus DWR decided that the erosion failure mode would be dismissed from further consideration in the derivation of reliable levee heights.

3.4.4 Reduction Height Results

After deriving a RLHE for each of the three failure modes (underseepage, through seepage, and stability), the WSE which represents the lowest RLHE for each reach was selected. Upon tabulation of RLHEs for each levee reach, a review was performed to check for major elevation discontinuities between adjoining reaches. Where noticeable discontinuities were found, a further review was made to validate the cause(s) of the dramatic differences, and adjustments were made where appropriate by the expert review team. Again, as with the Non-Urban levees, the difference between the TOL and RLHE was calculated to compute the RH to be used in the hydraulic modeling for CVFED modeling purposes (see Figure 3).

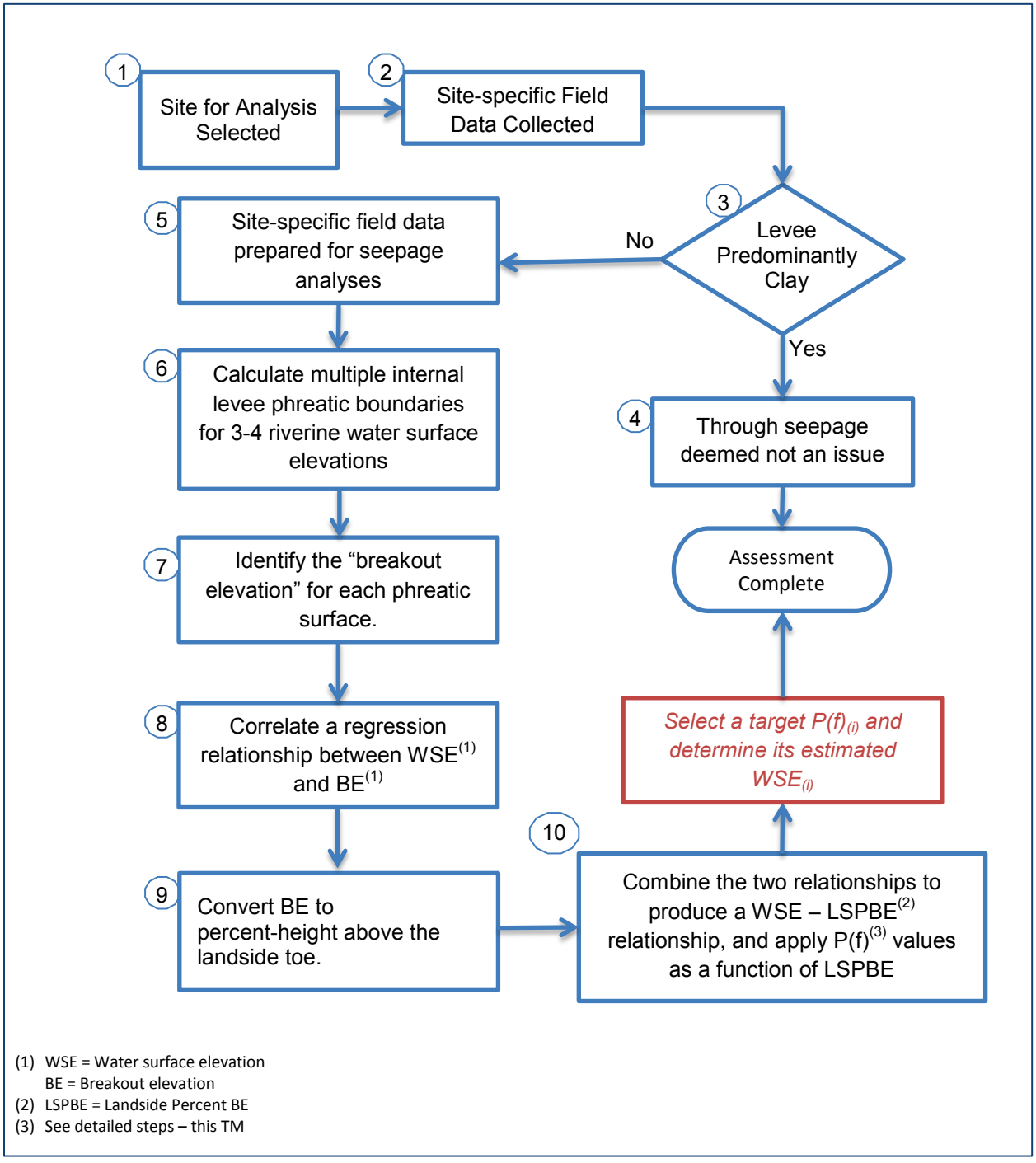


Figure 5 Process flow diagram in the derivation of the reliable levee height elevation for through seepage in erodible layers of an Urban levee reach.

4.0 GAP ANALYSIS

Locations where Urban geotechnical data and Non-Urban fragility curve data were not readily available were identified as gaps. To establish RHs for these gaps, an expert panel including representatives from DWR, URS Corporation (URS) and Kleinfelder was formed. Panel members included:

- Mr. Steve Mahnke (DWR)
- Mr. Richard Millet (URS)
- Mr. Ray Costa (DWR consultant)

The panel used professional engineering judgment and extensive levee system performance to assign a RH to each gap. In some cases, nearby reaches with similar levee conditions provided adequate deterministic or fragility curve information to make an assessment of the gap area, while for other gaps, a minimum value was used based on the levee height and condition.

4.1 Urban and Non-Urban Levee Data Gaps

The Non-Urban Project has a total of 318 segments listed in the CVFED Program dataset (Appendix A), and the Urban Project has a total of 383 reaches listed in the CVFED Program dataset (Appendix A). Gaps were the result of a multitude of reasons such as newly constructed levees, refurbished levee reaches, levee reach improvements currently under design and slated for near future construction, levee reaches either already replaced by new setback levees or targeted for setback replacement in the near future, or levee reaches in Urban areas that essentially provide freeboard protection (i.e., under a design condition, these reaches may not experience flood water physically in contact with them).

4.2 Gap Resolution

The expert panel for Gap Resolution reviewed, as noted above, the available geotechnical, past performance and other non-intrusive data in combination with their collective personal institutional knowledge of the regional infrastructure to derive estimated RHs for both Urban and Non-Urban gaps. Gaps were analyzed by the panel and the RLHE determined by evaluating nearby segments or reaches with a defined RLHE and a similar geomorphic and geotechnical condition. A minor amount of additional probability analyses was performed for Non-Urban gap conditions where RHs were warranted to support hydraulic modeling efforts.

4.2.1 Non-Urban Levee Gap Resolution

Additional probabilistic analyses to derive RHs were performed by URS to resolve most of the Non-Urban gaps. This included twenty-five (25) segments in the Sacramento River Basin NULE project area, and five (5) segments in the San Joaquin River Basin NULE project area. Some Non-Urban segments were dismissed based on their lack of sufficient length or height. It was deemed by DWR that under these conditions, these minor segments were unlikely to significantly impact the CVFED hydraulic modeling efforts, or have any influence on the outcome of the hydraulic modeling.

4.2.2 Urban Levee Gap Resolution

With a majority of the data gaps existing in the Urban levee settings, the expert panel for Gap Resolution reviewed the available geotechnical data and analyses, past performance and other non-intrusive data in combination with their collective personal institutional knowledge of the regional infrastructure to derive estimated RLHEs for these reaches. Data for 6 reaches in the ULE Program areas of Chico, Calaveras River, Mormon Slough were developed through new or updating deterministic analyses data using the additional exploration information available through the ULE Program Supplemental Geotechnical Data Reports (SGDR). Several gaps were analyzed by the expert panel and the RH determined by evaluating nearby reaches with a defined RLHE and a similar geotechnical condition. In some instances, the method for determining the RLHE was either to extrapolate from a nearby deterministic point to interpolate between available points, or to apply a criterion such as “top of levee minus 2 feet”. The minimum value for the distance between RLHE and approximate landside toe elevation was 2 feet in all cases.

5.0 RESULTS

Reduction Heights for both Urban levee reaches and Non-Urban levee segments were derived as described in Sections 3 and 4 and are provided in tabulated form in Appendix A. Geo index shape files presenting the same data have been provided to Atkins under separate cover.

6.0 LIMITATIONS

This TM is for the use and benefit of DWR and its CVFED Program. Use by any other party is at their own discretion and risk.

This TM’s results and/or recommendations should not to be used as a basis for design, construction, remedial action or major capital spending decisions.

The geotechnical data used for this assessment were obtained from the early phases of the ULE and NULE Programs as well as the resulting documentation produced as part of those efforts. Additional geotechnical data are being collected and analyzed by DWR but were not available at the time of this assignment. Consequently, estimated RLHEs and RHs developed may be changed or require adjustment upon completion of on-going and future geotechnical analyses and testing.

The derivation of a RLHE produces a levee height that represents the maximum levee height attributable to meeting DWR’s current criteria. It does not necessarily represent a height beyond which levee failure and flood consequences are likely to occur. Any delineated spatial inundation boundary associated with exceedance of the levee’s RLHE represents an area where levee design criteria can no longer be assured by DWR. Not meeting design criteria does not necessarily indicate a levee failure is imminent or likely.

7.0 REFERENCES

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APPENDIX A

Detailed Reduction Height Results

Appendix A - CVFED Levee Reliability Data							
Item No.	Segment Number	Levee Height [1]	Reduction Height [2]	Item No.	Segment Number	Levee Height[1]	Reduction Height [2]
North NULE Locations							
1	24	13.0	5.7	58	142	19.0	5.2
2	35	20.0	5.5	59	144	16.5	7.6
3	40	19.5	7.0	60	145	8.0	2.7
4	47	8.2	2.7	61	146	13.5	7.5
5	52	22.0	5.4	62	147	13.0	5.0
6	54	13.0	6.0	63	148	7.0	1.9
7	55	6.5	3.8	64	149	18.5	9.4
8	56	5.0	1.8	65	150	16.0	9.8
9	57	10.5	0.3	66	152	16.8	6.0
10	58	10.5	1.8	67	154	10.5	5.0
11	59	8.0	0.0	68	155	15.5	0.3
12	60	29.0	0.0	69	158	17.0	8.0
13	61	11.0	0.0	70	159	14.5	6.8
14	62	8.5	1.7	71	160	13.2	5.2
15	63	2.0	0.0	72	161	14.0	2.8
16	64	4.0	2.0	73	162	14.0	5.0
17	65	17.0	3.2	74	163	17.5	4.1
18	67	14.5	2.7	75	164	22.5	12.3
19	68	12.5	1.4	76	165	10.8	5.4
20	77	3.5	0.8	77	166	17.1	8.6
21	78	4.0	1.4	78	167	7.5	1.8
22	79	5.5	1.8	79	168	9.0	2.4
23	80	6.0	0.3	80	169	7.0	0.9
24	89	15.0	5.1	81	171	19.0	8.7
25	90	11.0	3.0	82	172	16.0	6.3
26	100	12.0	2.7	83	173	17.5	3.0
27	101	23.0	4.5	84	174	20.0	13.5
28	103	15.0	2.4	85	216	11.0	5.3
29	104	3.5	1.2	86	217	25.5	12.8
30	106	16.0	9.7	87	223	15.5	1.8
31	107	11.5	6.2	88	237	10.0	3.1
32	108	6.5	3.9	89	240	17.5	6.9
33	109	8.0	3.8	90	241	19.0	9.7
34	110	9.0	4.3	91	244	17.0	3.9
35	112	14.0	6.0	92	246	18.0	8.3
36	114	17.0	4.1	93	247	24.0	12.5
37	115	15.0	7.8	94	248	24.0	11.5
38	116	15.5	6.5	95	249	10.0	2.4
39	117	12.8	6.4	96	250	16.0	0.0
40	118	20.0	6.7	97	251	5.0	2.5

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program

(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data							
Item No.	Segment Number	Levee Height [1]	Reduction Height [2]		Item No.	Segment Number	Levee Height[1]	Reduction Height [2]
41	119	15.0	5.0		98	267	6.0	2.0
42	120	14.0	7.2		99	268	6.5	1.0
43	121	12.5	2.6		100	269	7.0	1.8
44	122	22.0	14.2		101	270	6.0	2.8
45	124	16.0	6.4		102	271	11.0	4.2
46	126	17.5	9.3		103	272	8.0	2.8
47	127	13.0	3.5		104	273	9.0	2.5
48	128	13.0	4.9		105	275	11.0	0.8
49	129	16.0	1.8		106	281	17.0	6.7
50	130	14.0	5.2		107	282	8.0	1.2
51	131	20.0	9.3		108	283	27.0	14.3
52	132	19.0	8.0		109	284	23.5	10.8
53	135	15.0	5.5		110	285	10.0	2.4
54	136	17.0	4.2		111	286	14.0	3.2
55	137	22.0	9.3		112	287	23.5	13.4
56	138	14.0	6.0		113	288	14.8	6.9
57	139	16.5	8.5		114	289	8.5	4.0
115	290	13.0	6.1		160	1046	23.0	8.9
116	291	16.5	5.0		161	1047	18.0	7.3
117	292	14.0	5.1		162	1048	20.0	2.4
118	293	21.0	10.0		163	1049	21.0	1.5
119	294	29.5	11.8		164	1050	21.0	10.0
120	295	24.0	10.8		165	1051	16.0	6.6
121	297	16.5	7.7		166	1052	18.0	0.4
122	303	17.0	3.9		167	1053	18.0	0.0
123	304	22.0	2.8		168	1054	18.0	7.3
124	305	19.0	5.5		169	2003	7.0	2.0
125	306	13.0	6.0		170	2005	13.0	5.7
126	307	18.0	10.7		171	1045-1	21.5	2.5
127	308	26.0	11.3		172	1045-2	15.0	1.5
128	309	26.0	8.0		173	113-1	18.5	7.0
129	310	21.0	8.1		174	113-2	18.5	11.2
130	311	8.0	1.2		175	123-1	18.0	1.8
131	312	16.0	7.0		176	123-2	22.0	11.4
132	313	17.5	8.5		177	151-1	15.2	5.8
133	314	15.4	0.8		178	151-2	14.5	4.7
134	315	15.0	7.7		179	153-1	20.2	7.5
135	378	16.0	11.6		180	153-2	23.0	11.3
136	379	8.5	0.5		181	156-1	19.0	6.0
137	380	17.0	9.0		182	156-2	15.0	5.6
138	382	7.0	5.0		183	263-1	11.0	4.5

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program

(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data							
Item No.	Segment Number	Levee Height [1]	Reduction Height [2]	Item No.	Segment Number	Levee Height[1]	Reduction Height [2]
139	385	17.0	8.8	184	263-2	9.5	2.5
140	386	19.5	4.8	185	274-1	10.5	7.2
141	387	23.0	7.6	186	274-2	3.0	0.0
142	388	27.0	15.1	187	316-1	27.0	5.9
143	390	17.0	7.8	188	316-2	20.0	3.6
144	392	18.5	2.3	189	381-1	8.0	2.7
145	393	23.0	8.4	190	381-2	13.0	0.0
146	1002	8.0	2.7	191	383-1	8.0	0.8
147	1006	11.0	1.8	192	383-2	9.0	6.4
148	1008	6.0	1.2	193	384-1	25.0	11.7
149	1010	6.0	2.1	194	384-2	14.8	8.3
150	1011	6.0	1.2	195	41a	18.0	10.0
151	1014	8.0	0.3	196	41b	7.0	4.0
152	1024	9.0	3.0	197	45-1	6.0	4.0
153	1025	8.0	1.5	198	45-2	7.5	2.4
154	1027	7.5	4.2	199	48-1	7.0	2.1
155	1036	15.0	0.0	200	48-2	7.2	2.4
156	1040	21.0	1.1	201	81-1	8.0	2.9
157	1041	18.5	4.3	202	81-2	10.0	4.5
158	1043	20.0	8.9	203	North NULE 108 (Cherokee Canal)	5.0	2.5
159	1044	21.0	6.7	204	North NULE 47 (Mud Creek and Sycamore Creek)	5.0	2.1
South NULE Locations							
1	10	5.3	1.8	13	177	7.5	4.2
2	11	5.7	1.5	14	178	10.2	4.9
3	12	6.1	2.9	15	179	11.2	2.1
4	22	3.3	1.3	16	180	9.0	2.4
5	23	5.2	1.8	17	181	8.8	4.5
6	27	8.1	4.4	18	182	11.2	6.6
7	28	8.1	4.9	19	183	7.0	4.5
8	73	12.1	0.6	20	184	11.4	3.6
9	74	4.9	1.8	21	185	19.4	13.0
10	75	6.0	1.2	22	188	17.7	8.1
11	76	4.6	2.1	23	189	21.5	12.4
12	176	9.5	2.3	24	190	11.4	6.1
25	191	10.3	5.0	70	349	6.6	0.9
26	192	21.8	12.9	71	350	6.3	1.2
27	193	16.8	3.4	72	351	8.7	4.5
28	194	14.6	7.6	73	352	11.2	5.8
29	195	10.6	5.8	74	353	9.4	2.4
30	196	19.9	9.6	75	354	9.6	4.6

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program

(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data							
Item No.	Segment Number	Levee Height (1)	Reduction Height (2)		Item No.	Segment Number	Levee Height(1)	Reduction Height (2)
31	197	12.6	6.0		76	355	9.4	1.8
32	198	14.0	8.9		77	356	6.5	2.9
33	199	12.9	6.2		78	357	12.5	7.1
34	200	12.5	2.6		79	358	7.0	2.8
35	201	14.3	1.6		80	359	9.0	2.7
36	202	18.3	9.8		81	360	6.0	1.2
37	203	8.9	2.7		82	5001	10.3	6.0
38	204	12.7	6.4		83	5002	5.6	2.1
39	205	13.3	6.8		84	5003	12.2	4.5
40	206	14.0	7.4		85	5004	11.4	0.3
41	207	14.6	4.3		86	5005	8.2	1.2
42	208	15.1	9.0		87	5006	6.7	3.5
43	218	10.6	3.6		88	5007	17.3	4.8
44	219	7.3	4.6		89	5008	11.4	7.7
45	220	6.9	4.4		90	5009	16.3	4.4
46	238	5.6	1.5		91	5010	14.8	11.7
47	252	13.2	7.4		92	5012	16.5	10.9
48	253	10.0	5.6		93	5013	14.0	6.9
49	254	10.0	2.7		94	5014	10.6	8.6
50	256	13.1	10.9		95	5015	15.2	10.0
51	257	13.5	7.5		96	5016	14.2	8.2
52	258	21.2	10.3		97	5017	16.8	8.6
53	259	11.4	4.6		98	5018	13.0	7.6
54	261	13.0	7.3		99	5019	14.2	6.0
55	332	4.2	2.2		100	5020	12.2	4.7
56	334	13.1	9.7		101	5021	7.7	5.6
57	335	9.5	5.4		102	5023	5.4	1.8
58	336	11.2	4.2		103	5024	5.6	1.5
59	337	10.5	0.0		104	5025	6.6	4.0
60	338	10.0	0.0		105	5026	7.7	4.6
61	339	10.5	0.0		106	5027	6.7	1.8
62	340	11.0	0.0		107	5028	5.7	2.1
63	341	16.5	8.2		108	5029	8.0	3.8
64	343	8.8	0.9		109	5030	7.6	1.8
65	344	9.1	0.9		110	5031	6.4	3.9
66	345	7.7	2.1		111	5032	7.2	4.5
67	346	7.5	1.9		112	5033	8.2	3.9
68	347	8.4	1.2		113	5034	7.4	4.7
69	348	8.6	0.9		114	5035	8.0	4.3

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program
(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
ULE Locations				
1	American River	A	11	0
2	American River	AA	8	0
3	American River	AB	8	0
4	American River	AC	8	0
5	American River	AD	8	0
6	American River	AE	8	0
7	American River	AF	7	0
8	American River	AG	5	0
9	American River	AH	2	0
10	American River	AI	2	0
11	American River	AJ	4	0
12	American River	B	11	0
13	American River	BA	17	8
14	American River	BB	15	7
15	American River	BC	15	7
16	American River	BD	15	7
17	American River	BE	20	7
18	American River	BF	20	7
19	American River	BG	17	7
20	American River	BH	8	6
21	American River	BI	8	6
22	American River	BJ	9	7
23	American River	BK	9	7
24	American River	BL	9	7
25	American River	BM	9	7
26	American River	BN	9	7
27	American River	BO	9	7
28	American River	BP	9	7
29	American River	BQ	10	7
30	American River	BR	10	7
31	American River	BS	10	7
32	American River	BT	10	7
33	American River	BU	10	7
34	American River	BV	8	6
35	American River	BW	8	6

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
ULE Locations				
36	American River	BX	5	3
37	American River	C	14	1
38	American River	D	10	0
39	American River	E	13	0
40	American River	F	2	0
41	American River	G	6	0
42	American River	H	0	0
43	American River	I	9	0
44	American River	J	14	0
45	American River	K	14	0
46	American River	L	14	0
47	American River	M	14	0
48	American River	N	14	0
49	American River	O	6	0
50	American River	P	13	0
51	American River	Q	13	0
52	American River	R	13	0
53	American River	S	13	0
54	American River	T	12	0
55	American River	U	12	0
56	American River	V	12	0
57	American River	W	12	0
58	American River	X	8	0
59	American River	Y	8	0
60	American River	Z	8	0
61	Davis	A	12	5
62	Davis	B	8	5
63	Davis	C	6	4
64	Davis	D	11	5
65	Davis	E	10	5
66	Davis	F	13	5
67	Davis	G	17	5
68	Davis	G1	19	5
69	Davis	G2	19	5
70	Davis	G3	19	5

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program

(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data					Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)	Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
71	Davis	H	17	6	107	Natomas Sac River East	1	15	0
72	Davis	I	19	8	108	Natomas Sac River East	13	17	10
73	Davis	J	11	5	109	Natomas Sac River East	14	17	10
74	Davis	K	12	5	110	Natomas Sac River East	15	17	10
75	Davis	L	9	5	111	Natomas Sac River East	16	17	10
76	Davis	M	10	5	112	Natomas Sac River East	11a	18	0
77	Davis	M1	10	5	113	Natomas Sac River East	11b	17	0
78	Davis	N	8	5	114	Natomas Sac River East	18b	18	11
79	Davis	N1	8	5	115	Natomas Sac River East	19a	16	9
80	Marysville	A	14	9	116	Natomas Sac River East	19b	18	11
81	Marysville	B	19	14	117	Natomas Sac River East	20a	18	11
82	Marysville	C1	16	11	118	Natomas Sac River East	20b	18	11
83	Marysville	C2	7	2	119	Natomas Sac River East	4a	19	0
84	Marysville	C3	16	11	120	Natomas Sac River East	5b	15	0
85	Marysville	D	28	21	121	Natomas Sac River East	6a	15	0
86	Marysville	E	16	11	122	Natomas Sac River East	6b	15	0
87	Marysville	F	24	19	123	Natomas Sac River East	9a	15	0
88	Marysville	G	23	18	124	Natomas Sac River East	9b	15	0
89	Marysville	H	19	14	125	Natomas American River No.	1	21	14
90	Marysville	I	24	22	126	Natomas North Cross Canal	1	20	5
91	Natomas American River No.	2	21	14	127	Natomas North Cross Canal	2	15	0
92	Natomas American River No.	3	21	14	128	Natomas North Cross Canal	3	15	0
92	Natomas American River No.	3	21		129	Natomas North Cross Canal	4	14	0
93	Natomas American River No.	4	21	5	130	Natomas North Cross Canal	5	14	0
94	Natomas	NCC Gap 1 2	16	9	131	Natomas North Cross Canal	6	14	0
95	Natomas Sac River East	17	18	14	132	NEMDC East	A	25	17
96	Natomas Sac River East	18a	18	11	133	NEMDC East	A1	18	7
97	Natomas Sac River East	4b	15	2	134	NEMDC East	A2	19	5
98	Natomas Sac River East	5a	15	11	135	NEMDC East	A3	12	5
99	Natomas	NCC Gap 2 2	20	21	136	NEMDC East	A4	11	3
100	Natomas Sac River East	2	15	11	137	NEMDC East	B	22	0
101	Natomas Sac River East	3	21	0	138	NEMDC East	B1	11	7
102	Natomas Sac River East	7	19	0	139	NEMDC East	B2	8	5
103	Natomas Sac River East	8	19	5	140	NEMDC East	B3	8	5
104	Natomas Sac River East	10	19	0	141	NEMDC East	C	16	0
105	Natomas Sac River East	12	17	10	142	NEMDC West	A	15	8
106	Natomas	NCC Gap 3 2	17	2	143	NEMDC West	B	16	9

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program

(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
144	NEMDC West	C	16	9
145	NEMDC West	D	14	7
146	NEMDC West	E	12	5
147	NEMDC West	F	10	5
148	NEMDC West	G	9	5
149	NEMDC West	H	8	5
150	NEMDC West	I	9	5
151	NEMDC West	J	9	5
152	NEMDC West	K	8	5
153	NEMDC West	L	6	4
154	NEMDC West	M	6	4
155	NEMDC West	N	9	5
156	NEMDC West	O	10	5
157	RD 17	A	9	5
158	RD 17	B	10	5
159	RD 17	C	11	5
160	RD 17	D	12	5
161	RD 17	E	15	5
162	RD 17	F	15	5
163	RD 17	G	25	6
164	RD 17	H	13	5
165	RD 17	I	16	14
166	RD 17	J	16	14
167	RD 17	K	15	13
168	RD 17	L	15	13
169	RD 17	M 1	16	5
170	RD 17	N 1	15	5
171	RD 404	A	7	5
172	RD 404	B	13	5
173	RD 404	C	11	5
174	RD 404	D1	11	9
175	RD 404	D2	9	7
176	RD 404	E	13	7
177	RD 404	F	10	7
178	RD 784	Dantoni Rd. to Griffith Rd.	14	0

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
179	RD 784	Hwy 70 to South Pacific Railroad	15	0
180	RD 784	Linda Break Sub-Reach	12	0
181	RD 784	Non-Setback Patrol Rd. (Griffith Rd.) to LM 3.91	16	5
182	RD 784		13	0
183	RD 784	Setback Levee Simpson Lane to Dantoni Rd.	16	1
184	RD 784		15	0
185	RD 784	So Pacific RR to Simpson Ln	16	1
186	RD 784	TRLIA -Setback Reach 2A	28	3
187	RD 784	TRLIA -WPIC-B	20	5
188	RD 784	TRLIA-1	24	3
189	RD 784	TRLIA-10	21	3
190	RD 784	TRLIA-11	21	3
191	RD 784	TRLIA-12	20	3
192	RD 784	TRLIA-19	23	3
193	RD 784	TRLIA-2	20	3
194	RD 784	TRLIA-3	20	3
195	RD 784	TRLIA-4	20	3
196	RD 784	TRLIA-5	20	3
197	RD 784	TRLIA-6	20	3
198	RD 784	TRLIA-7	20	3
199	RD 784	TRLIA-8	20	3
200	RD 784	TRLIA-9	21	3
201	RD 784	TRLIA-Best Slough Channel (C)	18	5
202	RD 784	TRLIA-KB-26 and KB-27 Area (E)	13	5
203	RD 784	TRLIA-Leach Rd. Channel (A)	20	5
204	RD 784	TRLIA-Setback Reach 1	28	3

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program

(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
205	RD 784	TRLIA-Setback Reach 2B	28	3
206	RD 784	TRLIA-Setback Reach 3	23	3
207	RD 784	TRLIA-Setback Reach 4	25	3
208	RD 784	TRLIA-Setback Reach 5	23	5
209	RD 784	TRLIA-Setback Reach 6	19	5
210	RD 784	TRLIA-Setback Reach 7	19	5
211	RD 784	TRLIA-Setback Reach 8	19	5
212	RD 784	TRLIA-WPIC-D	14	5
213	RD 784	TRLIA-WPIC-F	19	5
214	RD 784	TRLIA-WPIC-G	19	5
215	RD 784	TRLIA-WPIC-H1	7	5
216	RD 784	TRLIA-WPIC-H2	19	5
217	Sacramento River	A	5	3
218	Sacramento River	B	7	5
219	Sacramento River	C	18	5
220	Sacramento River	D	16	5
221	Sacramento River	E	13	7
222	Sacramento River	F	17	7
223	Sacramento River	G	19	7
224	Sacramento River	H	15	12
225	Sacramento River	I	13	5
226	Sacramento River	J	15	5
227	Sacramento River	K	14	5
228	Sacramento River	L	16	5
229	Sacramento River	M	16	5
230	Sacramento River	N	16	5
231	Sacramento River	O	15	5
232	Sacramento River	P	14	5
233	Sacramento River	Q	14	5
234	SJAFCA Bear Creek	A	9	1

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
235	SJAFCA Bear Creek	B	8	1
236	SJAFCA Bear Creek	C	8	4
237	SJAFCA Bear Creek	D	8	1
238	SJAFCA Bear Creek	E	8	1
239	SJAFCA Bear Creek	F	7	1
240	SJAFCA Bear Creek	G	9	1
241	SJAFCA Bear Creek	H	7	1
242	SJAFCA Bear Creek	I	4	1
243	SJAFCA Bear Creek	J	10	1
244	SJAFCA Bear Creek	K	7	1
245	SJAFCA Bear Creek	L	6	1
246	SJAFCA Bear Creek	M	10	5
247	SJAFCA Bear Creek	N	8	6
248	SJAFCA Bear Creek	O	7	1
249	SJAFCA Bear Creek	P	6	1
250	SJAFCA Bear Creek	Q	4	1
251	SJAFCA Bear Creek	R	4	1
252	SJAFCA Bear Creek	S	5	1
253	SJAFCA Bear Creek	T	3	1
254	SJAFCA Bear Creek	U	3	1
255	SJAFCA Bear Creek	V	3	1
256	SJAFCA Calaveras River	A	10	5
257	SJAFCA Calaveras River	AA	14	2
258	SJAFCA Calaveras River	AB	12	2
259	SJAFCA Calaveras River	AC	10.5	2
260	SJAFCA Calaveras River	AD	11	2
261	SJAFCA Calaveras River	AE	11	2
262	SJAFCA Calaveras River	AF	11.6	2
263	SJAFCA Calaveras River	AG	14	2
264	SJAFCA Calaveras River	AH	11	2
265	SJAFCA Calaveras River	AI	7.7	2
266	SJAFCA Calaveras River	AJ	7	2
267	SJAFCA Calaveras River	AK	4.3	2
268	SJAFCA Calaveras River	AL	4.3	2
269	SJAFCA Calaveras River	B	14.6	5
270	SJAFCA Calaveras River	C	14	5
271	SJAFCA Calaveras River	D	13.7	5

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program

(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
272	SJAFCA Calaveras River	E	11	6.2
273	SJAFCA Calaveras River	F	11	6.2
274	SJAFCA Calaveras River	G	14	6.2
275	SJAFCA Calaveras River	H	7.2	3.3
276	SJAFCA Calaveras River	H-1	10	3.3
277	SJAFCA Calaveras River	H-2	6	3.3
278	SJAFCA Calaveras River	H-3	6	3.3
279	SJAFCA Calaveras River	J	6	2
280	SJAFCA Calaveras River	K	10	5
281	SJAFCA Calaveras River	L	13.5	5
282	SJAFCA Calaveras River	M	13.4	6.2
283	SJAFCA Calaveras River	N	8.2	3.7
284	SJAFCA Calaveras River	O	10	3.7
285	SJAFCA Calaveras River	P	7.6	3.7
286	SJAFCA Calaveras River	Q	6.5	3.7
287	SJAFCA Calaveras River	R	10	6.2
288	SJAFCA Calaveras River	S	10.7	6.2
289	SJAFCA Calaveras River	T	8	2
290	SJAFCA Calaveras River	U	6	2
291	SJAFCA Calaveras River	V	6	2
292	SJAFCA Calaveras River	W	18	2
293	SJAFCA Calaveras River	X	15	2
294	SJAFCA Calaveras River	Y	16	2
295	SJAFCA Calaveras River	Z	15	2
296	Sutter	A	13	7
297	Sutter	AA	21	16
298	Sutter	B1	14	8
299	Sutter	B2	18	12
300	Sutter	BB	20	15
301	Sutter	C	14	5
302	Sutter	CC	18	15
303	Sutter	D	19	10
304	Sutter	DD	16	13
305	Sutter	EE	15	12
306	Sutter	FF	12	9
307	Sutter	GG	10	8
308	Sutter	HH	11	6

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
309	Sutter	II	11	6
310	Sutter	JJ	9	4
311	Sutter	KK	9	4
312	Sutter	LL	7	2
313	Sutter	LL-1	7	2
314	Sutter	M	24	22
315	Sutter	MM	12	7
316	Sutter	N	25	23
317	Sutter	NN	11	6
318	Sutter	O	23	21
319	Sutter	OO	13	9
320	Sutter	P	23	21
321	Sutter	PP	15	11
322	Sutter	Q	25	23
323	Sutter	QQ	13	9
324	Sutter	R	25	23
325	Sutter	R1	22	20
326	Sutter	RR	15	11
327	Sutter	S	23	21
328	Sutter	SS	15	11
329	Sutter	T1	23	21
330	Sutter	T2	23	21
331	Sutter	U	22	20
332	Sutter	U1	22	20
333	Sutter	V	25	23
334	Sutter	W	23	21
335	Sutter	X	26	24
336	Sutter	Y	28	26
337	Sutter	Z1	18	13
338	Sutter	Z2	20	15
339	Sutter	Z3	23	18
340	Sutter	Z4	23	18
341	West Sacramento	A	26	19
342	West Sacramento	AA	20	13
343	West Sacramento	AB	20	13
344	West Sacramento	AC	24	17
345	West Sacramento	AD	30	23

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program

(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
346	West Sacramento	AE	28	21
347	West Sacramento	AF	24	17
348	West Sacramento	B	23	16
349	West Sacramento	C	19	12
350	West Sacramento	D	20	13
351	West Sacramento	E	19	12
352	West Sacramento	F	14	7
353	West Sacramento	G	15	8
354	West Sacramento	H	17	10
355	West Sacramento	I	19	12
356	West Sacramento	J	19	10
357	West Sacramento	K1	14	7
358	West Sacramento	K2	14	7
359	West Sacramento	L	13	6
360	West Sacramento	M	3	0
361	West Sacramento	N	20	13
362	West Sacramento	O	20	18
363	West Sacramento	P	20	13
364	West Sacramento	Q	23	16
365	West Sacramento	R	20	13

Appendix A - CVFED Levee Reliability Data				
Item No.	Study Area	Reach ID	Levee Height (1)	Reduction Height (2)
366	West Sacramento	S	21	14
367	West Sacramento	T	21	14
368	West Sacramento	X	20	3
369	West Sacramento	Y	18	11
370	West Sacramento	Z	17	10
371	Woodland	A	19	13
372	Woodland	B	17	3
373	Woodland	C	16	8
374	Woodland	D	19	11
375	Woodland	E	21	13
376	Woodland	F	22	14
377	Woodland	G	19	15
378	Woodland	H	16	12
379	Woodland	I	5	1
-	-	-	-	-
381	ULE Chico (Mud Creek and Sycamore Creek)		9	4
382	ULE - Chico (Sycamore Creek)		9	4
383	ULE - Upper Feather River		15	11

NOTE: (1) Approximate height above landside toe in feet using date from the ULE/NULE Program
(2) Distance from Top of Levee down to the Reliable Levee Height Elevation

APPENDIX B

CVFED Through Seepage Estimation Procedure

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Technical Memorandum

Prepared For	Atkins North America, Inc.
Date	May 10, 2012
Project	California Department of Water Resources Task Order No. 68 - Work Order No. 2, CVFED Levee Reliability Study
Subject	CVFED Through-seepage Estimation Procedure
Prepared By	Loren Murray (URS)
Reviewed By	Richard Millet (URS)

SUMMARY

DWR has requested a detailed written explanation as to the derivation of through-seepage probability of failure ($P(f)_{TS}$) and subsequent representation of levee reliability in support of the CVFED Program's development of hydrologic and hydraulic models covering major watercourses in the Central Valley.

This Technical Memorandum (TM) describes the process applied in deriving estimated levee performance with respect to the through-seepage geotechnical failure mechanism. This process was developed and approved under the DWR Urban (ULE) and Non-urban (NULE) Levee Evaluation Programs. The TM presents procedures administered for both ULE levee reaches and NULE levee segments (the two procedures are different).

BACKGROUND

This TM supports Atkins' Task Order No. 68 and the development of riverine hydraulic models under the Central Valley Floodplain Evaluation and Delineation (CVFED) Program. This TM supports DWR's development of levee reliability data for Project and some limited and specific non-Project levees in the Central Valley. The levee reliability data has been based on existing geotechnical information and fragility curves developed under DWR's Urban and Non-Urban Levee Evaluation (ULE and NULE) Programs. The data set is consistent with that used in the development of the existing set of fragility curves (as of July 20, 2011). Probability of levee failure attributable to through-seepage and associated levee reliability (as used by DWR for the CVFED program) are explained at a fairly basic level in this TM; refer to cited references for more detailed explanations.

THROUGH-SEEPAGE DERIVATION

Urban Levees

Unlike procedures or protocols for analyzing levee under-seepage or levee stability, there isn't currently a U.S. Army Corps of Engineers or DWR-prescribed guideline document or procedure for the analyses of through-seepage conditions in levee easements. Thus, a procedure to aid DWR's CVFMP program required DWR to develop an analytical procedure to assess the Urban Levee through-seepage hazard potential. This procedure was reviewed and approved for use by an independent panel of experts in the geotechnical field (URS TM, 11/28/11). *Figure 1* depicts a process diagram of the through-seepage procedure for urban project levees.

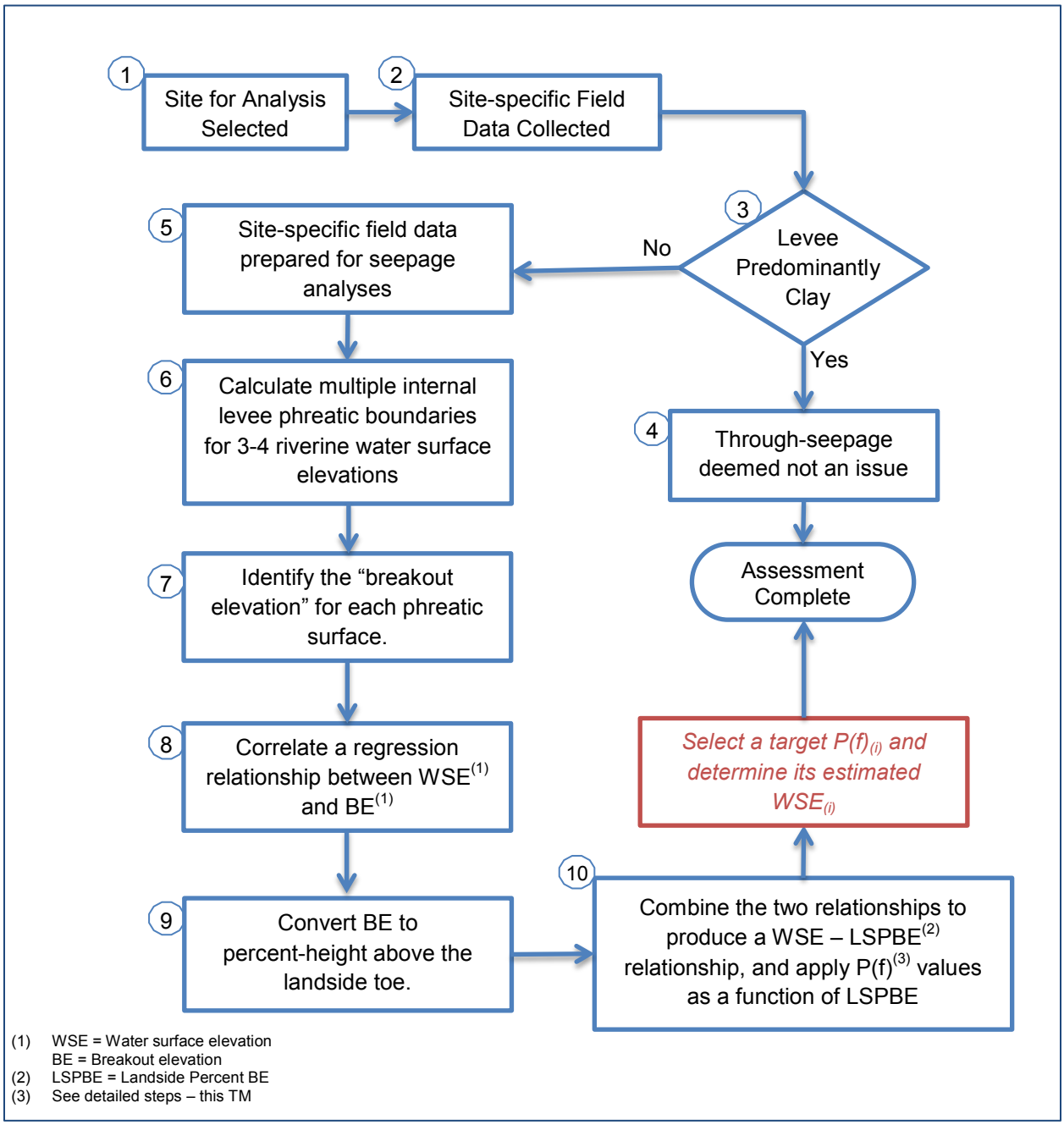


Figure 1 – Urban levee through-seepage computation process.

The following description is a series of steps followed in performing through-seepage analyses on Urban flood control levees throughout the Central Valley of California.

(1) – Site selection for analysis is based on a variety of indicators including, but not limited to, past performance (based on maintenance records; flood fight actions; etc.), known defects, preliminary field data assessment results, potential underlain hazards (i.e. – buried defects based on surficial geology mapping), or atypical levee geometry changes (settling; slumping; etc.).

(2) – Upon site selection and review of existing data, supplemental geotechnical data may be collected (borings; lab results; CPTs; vane shear testing; geophysical testing; etc.).

(3) – Assess the constituent properties of the levee body and determine dominant material representing the levee prism. If the levee prism is dominated by low-erosion soils (clays), then the likelihood of through-seepage is very low due to the low permeability of the soil mass.

(4) – If the levee prism is dominated by clays and clayey soils exhibiting a resistance or retardation of erosion potential, a decision of no through-seepage issue is rendered, and the analysis focuses on other potential failure modes.

(5) – If the levee prism is dominated by erodible materials, then seepage models are prepared incorporating levee materials and stratigraphy, levee geometry, hydraulic loading conditions, etc.

(6) Perform 3-4 analyses to identify the phreatic surface within the modeled levee prism associated with multiple WSEs selected and placed against the water-side levee slope. For these analyses, a steady-state condition is assumed.

(7) Identify the "breakout elevation" (BE) for each phreatic surface analyzed. The breakout elevation is that elevation on the landside slope of the levee above the toe where the phreatic boundary "daylights" or intersects the landside slope.

(8) Plot the WSEs versus BEs and compute a linear regression relationship between these two variables.

(9) Convert the BEs to percentages of the total levee height (defined as the difference between crest and landside toe). Establish the relationship between the WSEs and landside percent breakout elevations (LSPBE).

(10) Correlate the WSE-vs-LSPBE relationship against a prescribed LSPBE-$P(f)_i$ relationship to produce a WSE-$P(f)_{TS}$ curve.

The prescribed LSPBE-$P(f)_i$ relationship was reviewed and approved by the independent expert panel, and established as: $1\%_{LSPBE} = P(f)_{TS} = 1\%$; $20\%_{LSPBE} = P(f)_{TS} = 50\%$. The rationale being that a minimal landside slope exposure of the phreatic surface poses a low potential of failing the infrastructure; a moderate exposure (20 percent or one-fifth of the overall levee's height) of the phreatic surface and the landside slope has poses a heightened potential of failure of the infrastructure. A full range probability P(f) curve versus WSE was then developed by using a standard curve fitting function with a concavity factor "c" of 0.5.

Once this probability curve is developed, a water surface can be chosen for the analysis site and a corresponding through-seepage probability of failure derived. Likewise, choosing a target probability of failure for through-seepage results in an estimated not-to-exceed water surface elevation for the analysis site.

Figure 2 depicts the overall relationship between WSE, BE, LSPE, and $P(f)_{TS}$ for urban levee evaluation assessment of through-seepage failure potential.

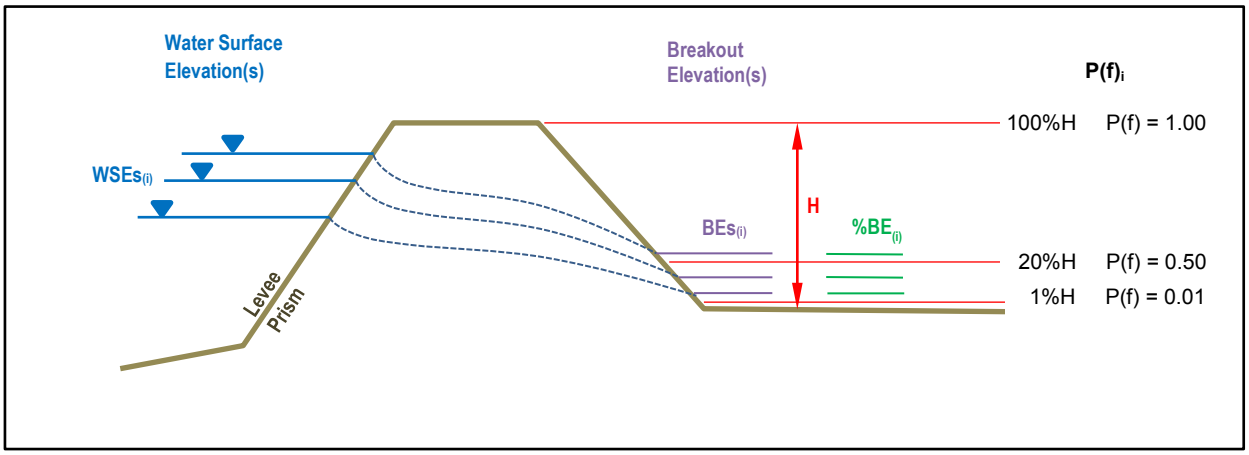


Figure 2 – Relationship between $WSE_{(i)}$, $BE_{(i)}$, $\%BE_{(i)}$, $P(f)_i$

Non-urban Levees

For non-urban levees, through-seepage hazard level was based on a qualitative appraisal as to the potential for through-seepage. The range of hazard level values are:

- Hazard Level A. When water reaches the assessment water surface elevation, there is a low likelihood of either levee failure or the need to flood-fight to prevent levee failure.
- Hazard Level B. When water reaches the assessment water surface elevation, there is a moderate likelihood of either levee failure or the need to flood-fight to prevent levee failure.
- Hazard Level C. When water reaches the assessment water surface elevation, there is a high likelihood of either levee failure or the need to flood-fight to prevent levee failure.
- Lacking Sufficient Data (LD): Currently lacking sufficient data regarding past performance or hazard indicators.

For non-urban levee segments being analyzed, the assessment water surface elevation is the '55/'57 design water surface for which many flood control levees throughout the Central Valley were designed and constructed.

Upon selecting a hazard level (A, B or C), a probability of failure P(f) is applied to that elevation. (A P(f) is not established for the LD hazard level.) The respective P(f) values at the '55/'57 water surface elevation for A, B and C are: $P(f)_A$=0.5%, $P(f)_B$ =2%, and $P(f)_C$=16%. The other two key elevations that establish the shape of the probability of failure curve are the elevation of the landside levee toe, and the levee crest. Probabilities of failure for the landside toe and the crest are set as: $P(f)_{toe}$ = 0%, and $P(f)_{crest}$ = 100%, respectively. The resultant P(f) versus WSE relationship again developed using curve fitting functions appears as depicted in Figure 3.

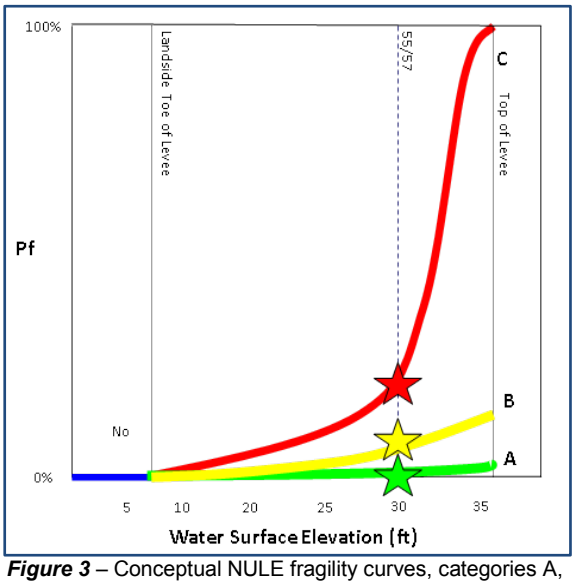


Figure 3 – Conceptual NULE fragility curves, categories A, B and C.

(More detailed discussion of the hazard levels is found in the Fragility Curve Development TM; see references.)

LIMITATIONS

This technical memorandum is for the use and benefit of DWR. Use by any other party is at their own discretion and risk.

This technical memorandum should not to be used as a basis for design, construction, remedial action or major capital spending decisions.

REFERENCE

A. Atkins Work Order No. 2, DWR MSC – TO #68 (Atkins Job No. 100025430) dated December 15, 2011.

B. URS Technical Memorandum – Fragility Curve Development, Non-Urban Levee Evaluations Project Task Order No. U108, November 28, 2011.

Appendix D
Construction Cost Development

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2302-0010

TECHNICAL MEMORANDUM

August 5, 2019

Subject: Preliminary Construction Cost Estimate

Project: Small Communities Flood Risk Reduction Program Feasibility Study for the City of Colusa

1.0 Background and Purpose

The purpose of this memo is to provide a basis for the preliminary quantities and costs associated with each measure and alternative developed in the Small Communities Flood Risk Reduction Program Feasibility Study for the City of Colusa (Feasibility Study).

2.0 Preliminary Cost Estimate Approach

This section summarizes the approach used to prepare quantities and cost estimates for each flood risk management measure considered. All measure costs were developed using the Department of Water Resources (DWR) Preliminary Cost Estimating Tool (PCET). PCET unit prices were updated based upon recent bid results from similar projects within the region. Unit costs were adjusted for inflation from 2017 to 2019 using ENR CCI factors. Then, costs were escalated to an assumed January 2025 start date using a 28.5% escalation factor. Quantities were developed using AutoCAD Civil 3D, ArcGIS, and typical cross sections of average levee heights and geometry. Construction cost estimates include a 30% contingency factor given the preliminary nature of the evaluations undertaken with this feasibility study.

2.1 Typical Geometry and Assumptions of Structural and Non-Structural Measures

Colusa has six reaches that were identified as needing improvement in the geotechnical analysis included in Appendix B of the Feasibility Study, and in the alternatives identified in the Feasibility Study. The geotechnical analysis recommends different measures for repairing each reach, and each may have different geometries depending on the extent of the deficiencies.

2.1.1 Drained Stability Berm

The typical geometry of the drainage stability berm (berm) is based on the geotechnical analysis. The berm is assumed to have a base width of 20 feet, and a height equal to half of the existing SPFC levee height. The existing levee height ranges from an average of 10 feet to 19.5 feet as provided in the geotechnical analysis. The cut slope is assumed to be 2:1, and the fill slope is assumed to be 2.5:1. Construction equipment will damage the existing levee road, so a gravel road will be replaced on the top of the levee.

2.1.1 Drained Seepage Berm

The drained seepage berm typical geometry is also based on the geotechnical analysis. The seepage berm is 5 feet in height at the toe of the existing levee, and 3 feet at the end of the berm. Each reach

has a different recommended geometry due to differing conditions. The recommended width of the seepage berm ranges from 70 to 105 feet along the existing levee. Construction equipment will damage the existing levee road, so a gravel road will be replaced on the top of the levee.

2.1.2 Soil-Bentonite Slurry Cutoff Wall

The typical characteristics and geometries of the soil-bentonite cutoff wall (cutoff wall) are also based on the geotechnical analysis (see Appendix B). The cost of the wall was estimated by assuming that the wall is to be constructed by degrading the existing levee by 1/2 of its height, and installing a foot soil-bentonite slurry wall. The depth of the wall is approximately 20 feet below the degrade. The existing SPFC levee's average height ranges from 10 to 18 feet, 15 to 24 feet in average width, 3:1 waterside slope, and 2.6:1 landside slope are also based on the geotechnical analysis. When the levee is degraded, it is assumed that 50% of the material will be reused and the gravel road on top of the levee will be replaced. Where the wall would interrupt a pipe crossing, it is assumed that the crossing will be rerouted or replaced.

2.1.2 Deep Soil Mixing Cutoff Wall

The deep soil mixing cutoff wall is similar to the soil-bentonite slurry cutoff wall in terms of typical characteristics. The difference is material and depth of the cutoff wall. The deep cutoff depth is 85 feet.

2.1.2 Rock Slope Protection

The rock slope protection costs assumes 18-inch minus quarry stone riprap is used to control erosion sites as identified in the geotechnical analysis (see Appendix B).

2.1.3 New Levee

The new levee has a typical cross section with a 20 foot crown width, and a 3:1 slope on the landward side and 2:1 slope on the waterside as described in Section 4.3.3 of the Feasibility Study. The height of the new levee in each alternative is an average of 5.2 feet. This height includes a freeboard allowance of four feet above the anticipated 100-year water surface elevations calculated from the hydraulic analyses and floodplain mapping (See Appendix C).

A 6 foot deep inspection trench would also need to be excavated along the new levee alignment to identify any shallow utilities or soil issues. It is assumed that 90% of the material excavated from the trench will be reusable. An aggregate base levee road will be installed on top of the levee to provide year round vehicle access.

Where the new alignment crosses a road or highway, it was assumed that the road or highway would be raised and a flood closure device would not be utilized. The length of the road elevation is a total of 2,800 feet where the speed limit is 55 mph or above. Where the speed limit is below 55 mph, the extent of the road elevation from the center of the levee alignment is 500 feet in each direction. The raised road was assumed to consist of imported fill with 4-inch asphalt concrete on top of 12-inch of aggregate base. A 4 foot gravel shoulder was assumed to be placed on each side of the impacted road reach, and existing travel lane width were maintained.

Where the new alignment crosses overhead utility lines, the poles are assumed to be relocated. Any utility poles in conflict with road elevation as a result of the new alignment utility poles would also have to be relocated. Where the alignment crosses an irrigation ditch, a low-head irrigation siphon is

assumed to be installed. If the alignment runs along an existing irrigation ditch, the ditch would need to be relocated.

2.1.4 Right-of-Way

Required right-of-way easements were based on the estimated footprint of each remediation measure or new levee plus a 20 foot easement on each side, or landside of the existing levee for the stability or seepage berm. In the case of a soil-bentonite cutoff wall remediation, a 30 foot easement was assumed to be required on the landside of the existing levee. If the footprint of a new facility is in conflict with a building, the building is assumed to be removed.

2.1.4 Operations and Maintenance

New levee alignments and new berms along existing levees, would require new operations and maintenance costs. Assuming that the new levees would be maintained by Sacramento River West Side Levee District, the approximate annual cost for maintenance would be $10,000 per mile. This unit cost was provided by SRWSLD and is based upon their existing levee system maintenance costs on a per mile basis. New berms would require $1,000 per mile in new maintenance costs.

2.1.8 Planning and Design Costs

As part of the project process, planning, design, and engineering costs were also considered. This cost was estimated to be approximately 17.5% of the construction cost.

2.1.9 Environmental Mitigation and Permit Fees

Most of the alternatives involve the need for environmental mitigation and permit application. The PCET identifies different levels of mitigation and associated environmental fees. Based on identified environmental constraints the mid-tier level of 12.5% of construction cost was used to price the estimated environmental costs of each alternative. Permit and legal fees were estimated to be 7.5% of construction costs.

2.1.10 Multi-Benefit Costs

The multi-benefit costs involve the excavation and revegetation costs associated with creating a river migration corridor as identified in Section 4.4 of the main report. Permitting, planning, design, and engineering costs are calculated similarly to the above sections.

2.1.11 Regional Non-Structural Costs

The regional non-structural costs involve actions that are in junction with each alternative to mitigate risks. Specifically, these strategies help meet flood emergency flood preparedness goals. The Grimes Emergency Operation Plan, Flood Contingency Map, City of Colusa Special Case Map, and Colusa Basin Unified Command Map will all need to be updated to accommodate changes in the region due to the implementation of an alternative. A new, shelter-in-place map would also be created, and a table top exercise would be completed every two years. The estimated cost of these items is $82,000.

In addition, replenishing flood fight supplies, assuming everything in their existing flood fight containers are used up, would cost approximately $18,000.

3.0 Preliminary Alternative Costs

The Feasibility Study evaluated in detail, four alternatives that combined various measures. All alternatives share the same multi-benefit projects and associated costs. Table 1 presents relevant quantities for each alternative.

Table 1 - Preliminary Alternative Quantities

Alternative	SPFC Repair Length (miles)	New Levee Length (miles)[(a)]	Existing Levee Repairs (miles)[(b)]	Powell Slough Alternative 7 Length (miles)	Total levee length (miles)
1	4.7	6.7	3.1 / 0.5	3.0	18.0
2	6.0	6.1	3.1 / 0.5	3.0	18.7
3	6.0	4.1	3.1 / 0.5	3.0	16.7
4	4.2	6.2	3.1 / 0.5	3.0	17.0
5	5.5	5.6	3.1 / 0.5	3.0	17.7
6	5.5	3.6	3.1 / 0.5	3.0	15.7

(a) Does not include the Powell Slough Feasibility Study Alternative 7 Levee
(b) Existing Powell Slough Levee / Existing MA 12 Levee respectively

(c) The preliminary construction costs for each alternative based on the assumptions above are summarized in Table 2 and 3 below. The total present worth of each alternative was calculated using an interest rate of 3% and at an infinite term.

Table 2 - Preliminary Alternative Costs

Alternative	SPFC Repair Cost	New Levee[1]	Powell Slough Alt 7	Repair Existing Powell Slough	Repair MA12
1	$74,015,283	$53,455,273	$37,528,771	$16,418,565	$1,707,111
2	$106,895,775	$47,125,256	$37,528,771	$16,418,565	$1,707,111
3	$106,895,775	$36,791,021	$37,528,771	$16,418,565	$1,707,111
4	$71,143,263	$48,737,104	$37,528,771	$16,418,565	$1,707,111
5	$104,023,755	$42,407,087	$37,528,771	$16,418,565	$1,707,111
6	$104,023,755	$32,072,852	$37,528,771	$16,418,565	$1,707,111

[1] Does not include the Powell Slough Feasibility Study Alternative 7 Levee

Table 3 - Preliminary Alternative Costs (continued)

Real Estate Management	Multi-Benefit	Regional Non-Structural	Total Cost (2025)	O&M[1]
$2,450,000	$2,356,799	$100,000	**$188,031,802**	$69,751
$2,575,000	$2,356,799	$100,000	**$214,707,277**	$65,109
$2,325,000	$2,356,799	$100,000	**$204,123,042**	$45,880
$2,225,000	$2,356,799	$100,000	**$180,216,613**	$64,633
$2,350,000	$2,356,799	$100,000	**$206,892,088**	$60,595
$2,100,000	$2,356,799	$100,000	**$196,307,853**	$41,367

[1] Operations & Maintenance Costs are increased annual costs (Year 2025) to the levee maintaining agencies.

Appendix E
Environmental Constraints Analysis

Environmental Constraints Analysis

Department of Water Resources

City of Colusa Flood Risk Reduction Feasibility Study

Colusa, Colusa County, California
September 30, 2019

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Acronyms and Abbreviations

APE	Area of Potential Effects
BFE	base flood evaluation
BMP	Best Management Practice
CalFire	California Department of Forestry and Fire Protection
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CNPS	California Native Plant Society
County	Colusa County
CRHR	California Register of Historical Resources
CVFPP	Central Valley Flood Protection Plan
CWA	Clean Water Act
DWR	Department of Water Resources
EIR	Environmental Impact Report
ESA	Endangered Species Act
GHG	Greenhouse Gas
MND	Mitigated Negative Declaration
MOU	Memorandum of Understanding
NAHC	California Native American Heritage Commission
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NULE	Non-Urban Levee Evaluation
NWIC	Northwest Information Center
proposed project	City of Colusa Flood Risk Reduction Feasibility Study
quad	quadrangle
RWQCB	Regional Water Quality Control Board
SHPO	State Historic Preservation Officer
SPFC	State Plan of Flood Control
SRWSLD	Sacramento River West Side Levee District
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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1 Introduction

Colusa County is initiating the City of Colusa Flood Risk Reduction Feasibility Study (proposed project). Colusa County has entered into an agreement with the City of Colusa, and the Sacramento River West Side Levee District (SRWSLD) to be the lead agency for the feasibility study. The County is proposing to study the feasibility of providing flood damage reduction for the City of Colusa, including portions of unincorporated Colusa County.

The Feasibility Study identifies preferred structural and non-structural elements, multi-benefits, and constraints. The Feasibility Study also compares implementation costs and schedules and identifies local funding requirements to assess options which will reduce the flood risk to the City of Colusa while sustaining agriculture and the regional economy, providing safe access to the river, improving the riverine habitat viability, and regional levee maintenance governance.

1.1 Purpose and Scope of a Feasibility Study

During the planning phase of a proposed project, a feasibility study is prepared to provide a description of the existing conditions and associated deficiencies, as well as an evaluation of alternative solutions to correct identified problems. A feasibility study report typically includes a framing of the feasibility study objectives, a discussion of the project area and background, an identification of problems and opportunities, and defining potential project constraints. Constraints are restrictions that limit the planning process, such as resource constraints (i.e. biological, cultural, etc.); legal and policy constraints (i.e. laws, applicable policies, regulations, etc.); and permit requirements. The purpose of including a constraints analysis within the feasibility study is to assist with the identification of key environmental issues that should be given due consideration during the planning and design phase of the project.

The analysis of constraints is intended to facilitate the project planning process, assist with the evaluation of various alternatives, define a preferred project, and assess potential permitting and mitigation requirements. This environmental constraints analysis focuses on the six alternatives described in **Section 1.4** since these alternatives have been developed to the point that a useful evaluation of environmental constraints is warranted and will be informative for planning purposes. Specifically, the environmental constraints analysis identifies potential constraints based on the anticipated presence or absence of environmental resources; describes the consistency and/or compliance of each alternative with existing policies; and identifies potential environmental mitigation costs for each alternative site. This report also provides basic permit information. Attachment B provides a detailed analysis of the potential impacts/constraints as a result of implementation of the proposed alternatives.

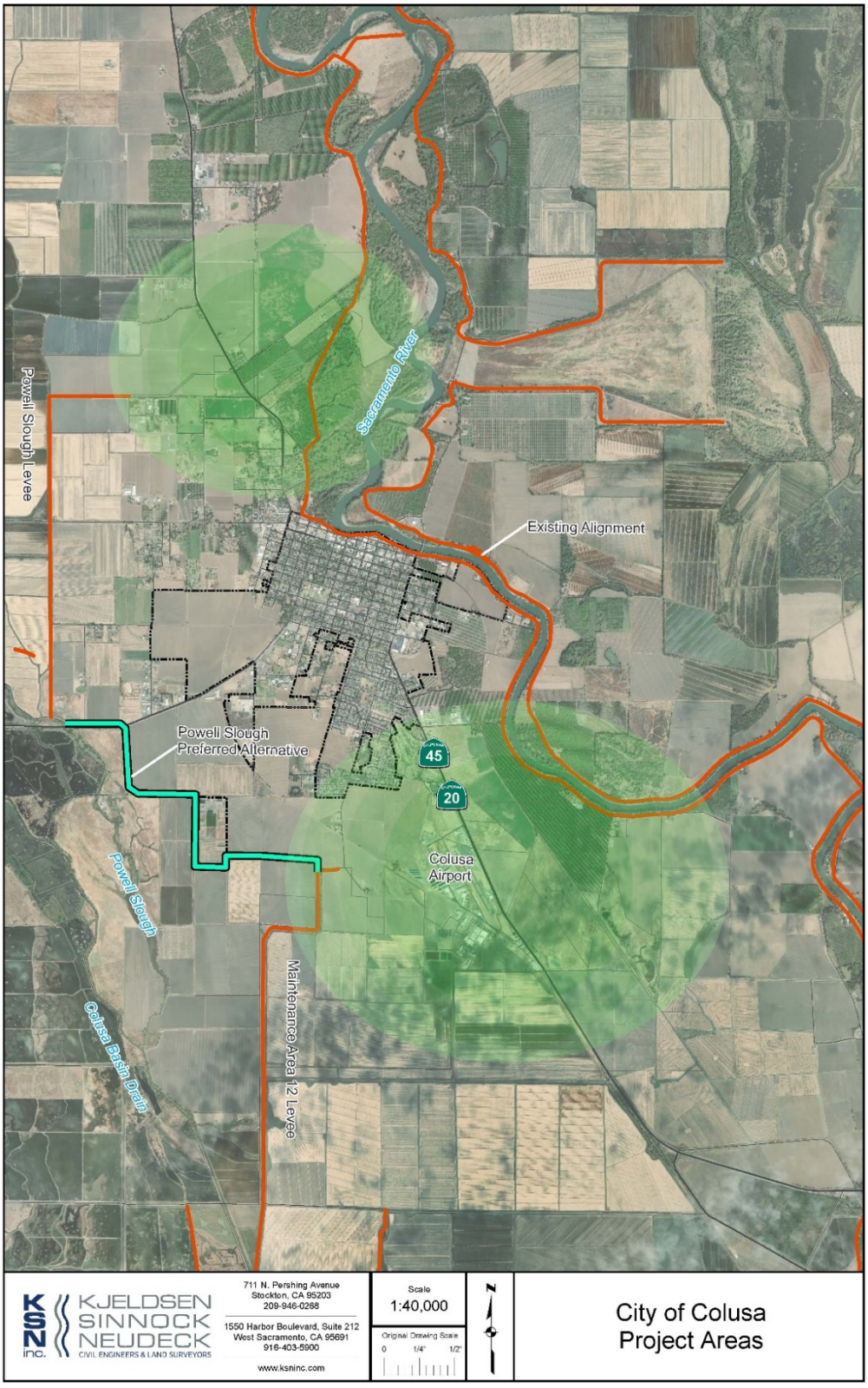
The California Environmental Quality Act (CEQA) Guidelines Section 15262 states that a project involving only feasibility or planning studies for possible future actions which an agency, board, or commission has not approved, adopted, or funded does not require the preparation of an Environmental Impact Report or a Negative Declaration. Section 15262 of the CEQA Guidelines does not apply to the adoption of a plan that will have a

legally binding effect on later activities. Therefore, no documentation under CEQA has been prepared for the Feasibility Study. In addition, the multi-benefit concepts identified in the Feasibility Study and summarized in this report are presented solely for planning purposes at this time. Their inclusion herein does not commit the County to any specific future actions and has no legally binding effect. An analysis of potential impacts from the multi-benefit concept are provided in Attachment E.

1.2 Project Area Location

The proposed project is located in the city of Colusa in Colusa County, California. **Figure 1-1** below provides an overview of the project area. The city of Colusa covers an area of approximately 1.83 square miles and had a population of approximately 5,963 people as of 2017 (US Census Bureau 2019). Colusa is located along the west bank of the Sacramento River approximately 13 miles downstream of the city of Princeton. According to the Colusa County General Plan Land Use Map, predominant land uses in Colusa include industrial, urban residential, rural residential, urban reserve area, commercial, and parks and recreation. Land within the project area immediately surrounding Colusa to the north, west, south, and east are designated for general agricultural purposes (Colusa County 2012). The Sacramento River to the east is a designated floodway (Colusa County 2012). Colusa National Wildlife Refuge is located one mile southwest of the city of Colusa. The Colusa National Wildlife Refuge is a part of the Sacramento National Wildlife Refuge Complex and consists of approximately 5,077 acres consisting primarily of wetlands, grasslands and riparian habitats (USFWS 2016).

Figure 1-1. City of Colusa Project Areas



1.3 Need for the Proposed Project

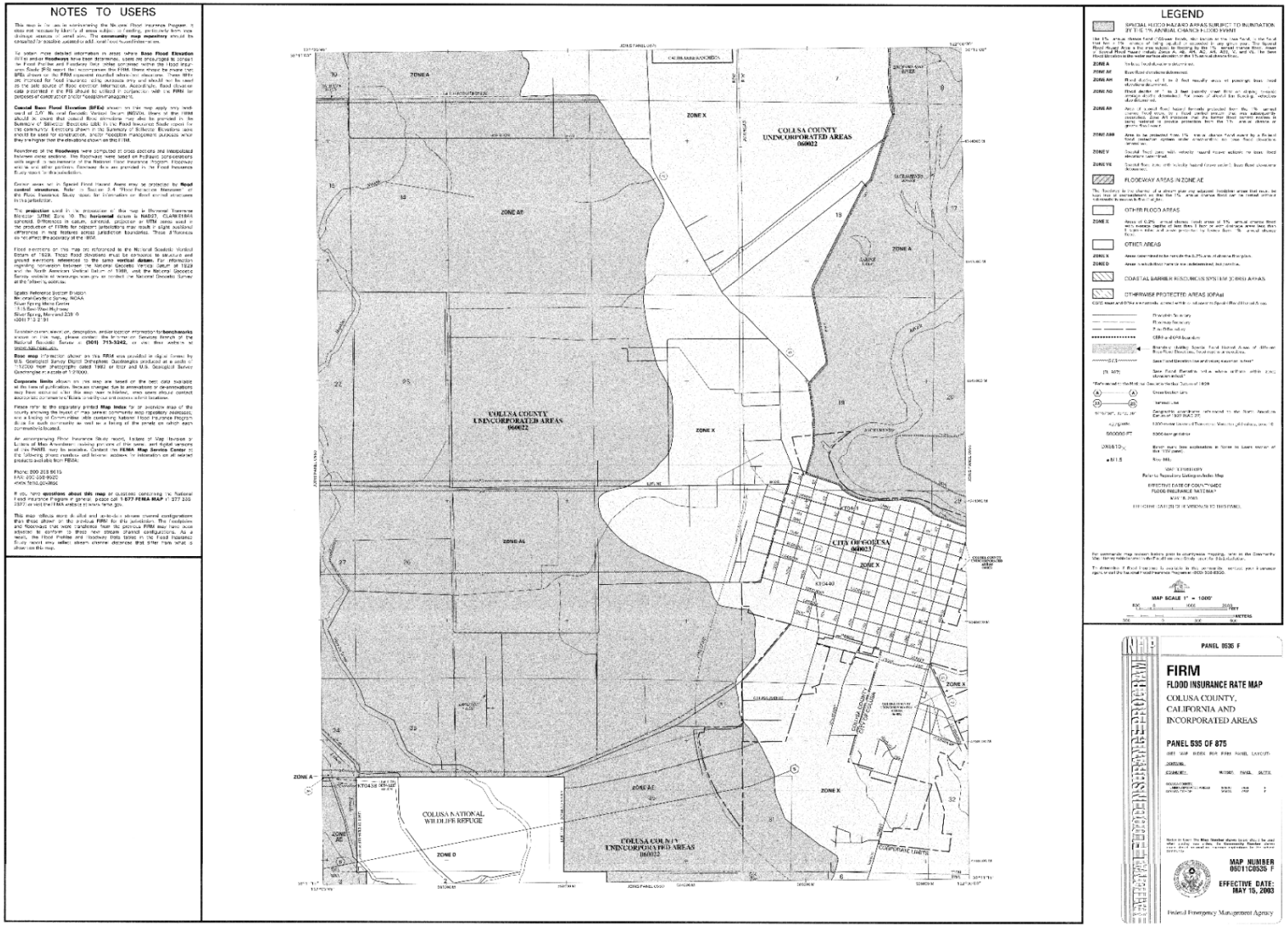
The proposed project is located in the Central Valley of California which faces significant flood risk. According to the Department of Water Resources (DWR), “approximately 1 million Californians live and work in the floodplains of the valley, which contain approximately $80 billion worth of infrastructure, buildings, homes, and prime agricultural land” (DWR 2018). As a result, a major flood in the Central Valley could result in devastating loses, both financially and otherwise (DWR 2018). Therefore, the proposed project is being studied to address the need for flood protection in this high flood risk region of California.

Portions of Colusa County are currently mapped as Zone AE on the 2003 FEMA Flood Insurance Rate Map (FIRM), meaning they are in the identified 100-year floodplain, and those living within the zone must have flood insurance. The city of Colusa is located in Zone X, Other Flood Areas, which is defined as, “Areas of 0.2% annual chance of flood; areas of 1% annual chance of flood with average depths of less than 1 foot or draining areas less than 1 square mile; and areas protected by levees from 1% annual chance of flood”. Other portions of the project area are located in Zone A, indicating special flood hazard areas subject to inundation by the 1 percent annual chance of flood event (see **Figure 1-2**). The proposed project is needed to provide increased flood protection for the city of Colusa and unincorporated portions of Colusa County and would help meet DWR’s Central Valley Flood Protection Plan (CVFPP) Conservation Strategy goals. The goals of the CVFPP Conservation Strategy include: improved flood risk management, the promotion of multi-benefit concepts, increased operational and regulatory efficiency, and the promotion and restoration of ecosystem function in the Central Valley (DWR 2016). The proposed project is needed because:

1. The city of Colusa is threatened from flooding from the Sacramento River to the east and the Colusa Basin Drain, which runs to the west.

2. Previous investigations by DWR, through the Non-Urban Levee Evaluation (NULE) program, showed that levees protecting the city of Colusa suffer from underseepage, through seepage, and erosion.

Figure 1-2. City of Colusa Flood Insurance Rate Map (FIRM)



1.4 Alternatives

Based on the goals and objectives of the proposed project to improve flood risk management, enhance habitat restoration, provide recreational benefits, and support agricultural sustainability in the city of Colusa, a wide array of alternatives were evaluated. Structural, nonstructural, and multi benefit concepts were formulated and screened. The structural alternatives consist of levee fix-in-place elements and new levee options and generally met the criteria established in the Feasibility Study. The six alternative alignments that are carried forward are summarized below (see **Figures 1-3** through **1-8**).

For each of the six alternative alignments, the regulatory setting and regulatory consistency analysis are provided for each resource area (**Attachment A**). An analysis of environmental resources, which includes the existing conditions, such as the anticipated presence or absence of environmental resources, and the key environmental constraints is provided in **Attachment B**. A summary of the six alternatives is provided below, followed by a description of construction methods and equipment in **Section 1.4.2**.

Alternative 1: Remediate SPFC Levee, Complete Ring Levee

- Remediate approximately 4.7 miles of existing Sacramento River SPFC Levee for through seepage, underseepage, and erosion;
- Construct a new, 2.1 mile levee from the existing Powell Slough Levee to connect with the SPFC Levee north of the city;
- Remediate the existing Powell Slough Levee to meet freeboard criteria;
- Construct the levee identified as the Powell Slough Feasibility Study Alternative 7 Levee;
- Remediate the Maintenance Area 12 (MA12) levee for geometry and freeboard deficiencies; and
- Construct a new, 4.6 mile levee from the SPFC levee to the existing MA12 levee along the south end of the City.

Alternative 2: Remediate SPFC Levee, Complete Ring Levee

- Remediate approximately six miles of the existing Sacramento River SPFC Levee for through seepage, underseepage, and erosion;
- Construct a new, 2.1 mile levee on the north end of the City of Colusa, connecting the SPFC levee to the existing Powell Slough Levee;
- Remediate the existing Powell Slough Levee to meet freeboard criteria;
- Construct the Powell Slough Feasibility Study Alternative 7 Levee;
- Remediate the MA12 levee for geometry and freeboard deficiencies; and
- Construct a new, four-mile levee alignment to connect the MA12 levee to the SPFC levee south of the city.

Alternative 3: Remediate SPFC levee, Construct North and South Levees

- Remediate approximately six miles of the Sacramento River SPFC levee for through seepage, underseepage, and erosion;
- Construct a new, 2.1 mile levee alignment from the existing Powell Slough Levee to connect with the SPFC Levee north of the city;
- Remediate the existing Powell Slough Levee to meet freeboard criteria;
- Construct the Powell Slough Feasibility Study Alternative 7 Levee;
- Remediate the MA12 levee for geometry and freeboard deficiencies; and
- Construct a new, two-mile levee alignment south of the city.

Alternative 4: Remediate SPFC levee, Complete Ring Levee

- Remediate approximately 4.2 miles of the Sacramento River SPFC levee for through seepage, underseepage, and erosion;
- Construct a new, 1.6 mile levee alignment from the existing Powell Slough Levee to connect with the SPFC Levee north of the city;
- Remediate the existing Powell Slough Levee to meet freeboard criteria;
- Construct the Powell Slough Feasibility Study Alternative 7 Levee;
- Remediate the MA12 levee for geometry and freeboard deficiencies; and
- Construct a new, 4.6 mile levee alignment to connect the MA12 levee to the SPFC levee south of the city.

Alternative 5: Remediate SPFC levee, Complete Ring Levee

- Remediate approximately 5.5 miles of the Sacramento River SPFC levee for through seepage, underseepage, and erosion;
- Construct a new, 1.6 mile levee alignment from the existing Powell Slough Levee to connect with the SPFC Levee north of the city;
- Remediate the existing Powell Slough Levee to meet freeboard criteria;
- Construct the Powell Slough Feasibility Study Alternative 7 Levee;
- Remediate the MA12 levee for geometry and freeboard deficiencies; and
- Construct a new, four-mile levee alignment to connect the MA12 levee to the SPFC levee south of the city.

Alternative 6: Remediate SPFC levee, Alternative North and South Levees

- Remediate approximately 5.5 miles of the Sacramento River SPFC levee for through seepage, underseepage, and erosion;
- Construct a new, 1.6 mile levee alignment from the existing Powell Slough Levee to connect with the SPFC Levee north of the city;

- Remediate the existing Powell Slough Levee to meet freeboard criteria;
- Construct the Powell Slough Feasibility Study Alternative 7 Levee;
- Remediate the MA12 levee for geometry and freeboard deficiencies; and
- Construct a new, two-mile levee alignment south of the city.

Regional Non-structural Strategies

Regional non-structural strategies that are a component of each of the six alternatives include updating the region's Emergency Operations Plans, Flood Contingency Maps, and Unified Command Map. Also included are developing a Shelter-in-Place Map, conducting tabletop exercises, and replenishing flood fight supplies.

1.4.2 Construction Methods and Equipment

Construction Equipment

Construction equipment used during the implementation of the proposed project would include excavators, scrapers, water trucks, rollers, pickup trucks, cranes, dump trucks and large flatbread trucks.

Sacramento River SPFC West Levee Remediation

During the remediation of the Sacramento River SPFC levee under Alternatives 1 through 6, the levee adjacent to the developed portions of Colusa would be remediated using a soil-bentonite cut-off wall. Portions of the levee not adjacent to Colusa would be remediated using a seepage berm. Installation of the soil-bentonite cut-off wall and seepage berm would require vegetation removal. In both cases, revegetation of the areas surrounding the levee would be carried out in accordance with the Sacramento River West Side Levee District (SRWSLD) Vegetation Management Plan. Remediation of the Sacramento River SPFC west levee would not require in-water work.

Remediation of the Existing Powell Slough Levee

The remediation of the existing Powell Slough levee would involve the placement and compaction of levee fill material to raise the crest elevation to provide sufficient freeboard to protect against flooding originating from the Sacramento River. The areas surrounding the levee would be revegetated with grasses to minimize erosion.

Extension of the Powell Slough Levee east and south and Construction of New Levees

In order to extend the existing Powell Slough levee to the east to connect to the Sacramento River levee north of the city, an exploratory trench would be dug, filled with soil, and compacted. These steps would be repeated until the levee is of sufficient height. The areas surrounding the levee would be revegetated with grasses to minimize erosion.

Construction of new levees south of Colusa to connect the Sacramento River SPFC west levee to the MA 12 levee would involve similar construction techniques as stated above.

The construction technique for the extended Powell Slough levee south by constructing a new 3 mile long levee to connect with the MA 12 levee would follow similar methodologies as those described in the preceding paragraph.

Figure 1-3. City of Colusa Proposed Alternative 1

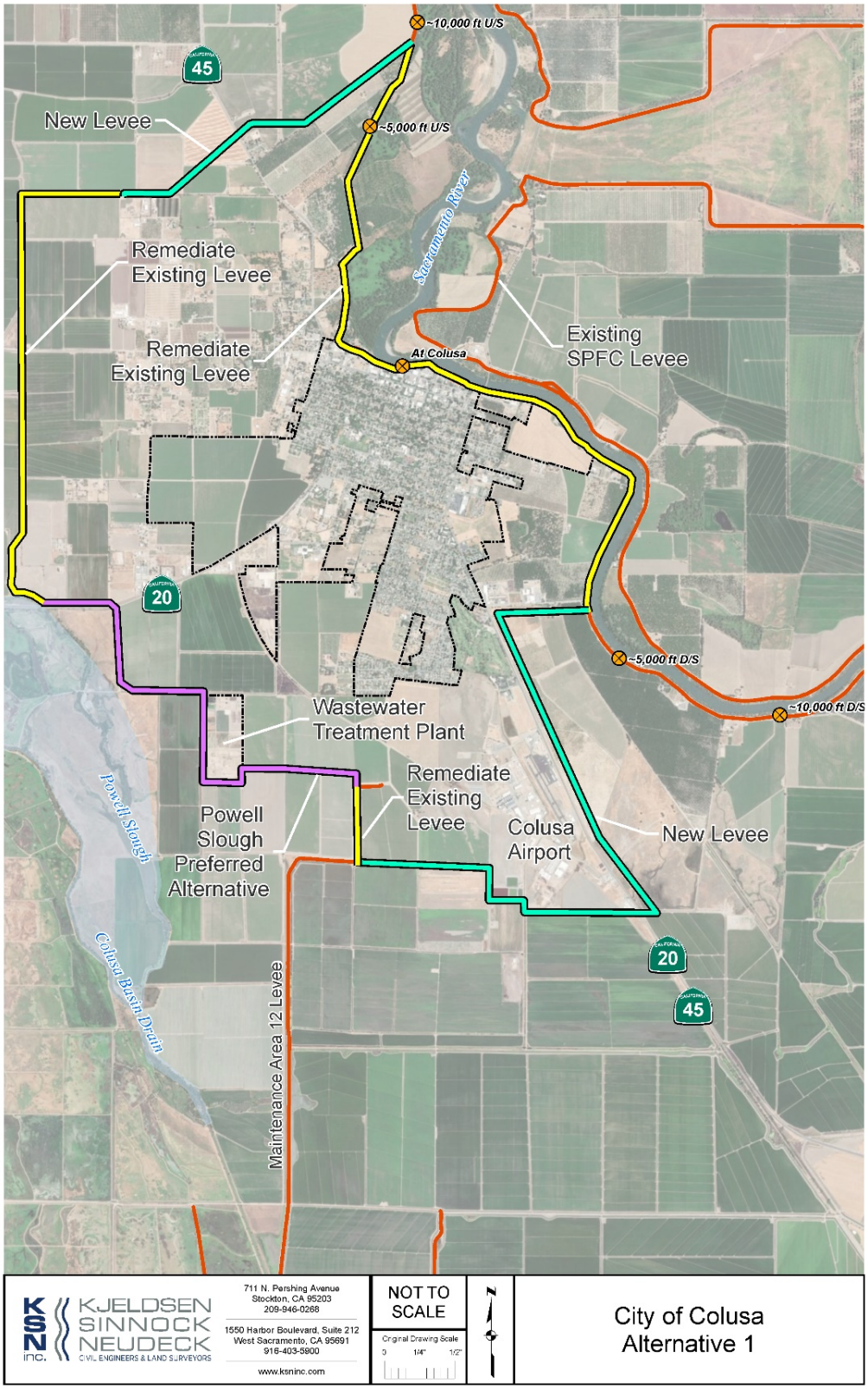


Figure 1-4. City of Colusa Proposed Alternative 2

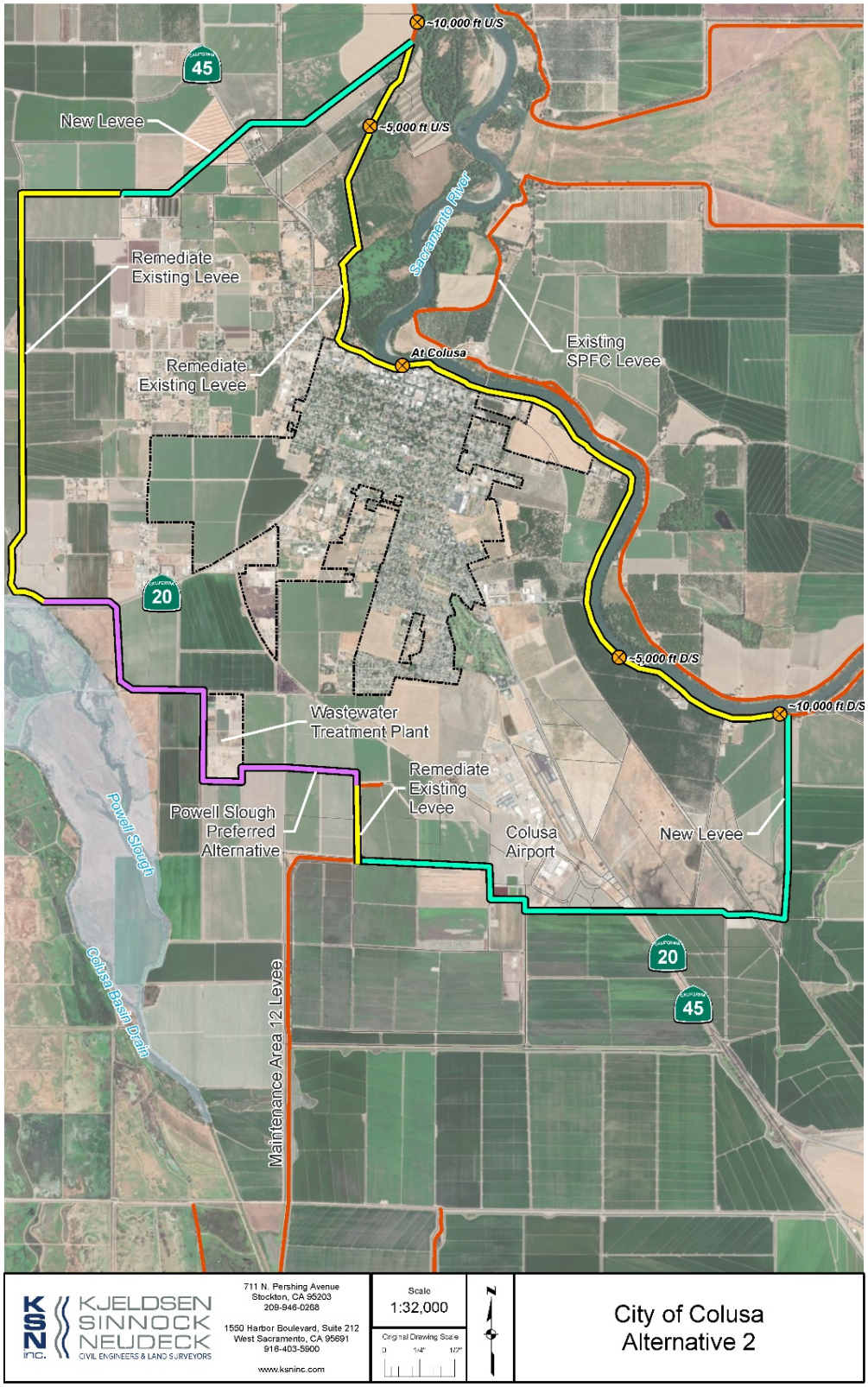


Figure 1-5. City of Colusa Proposed Alternative 3

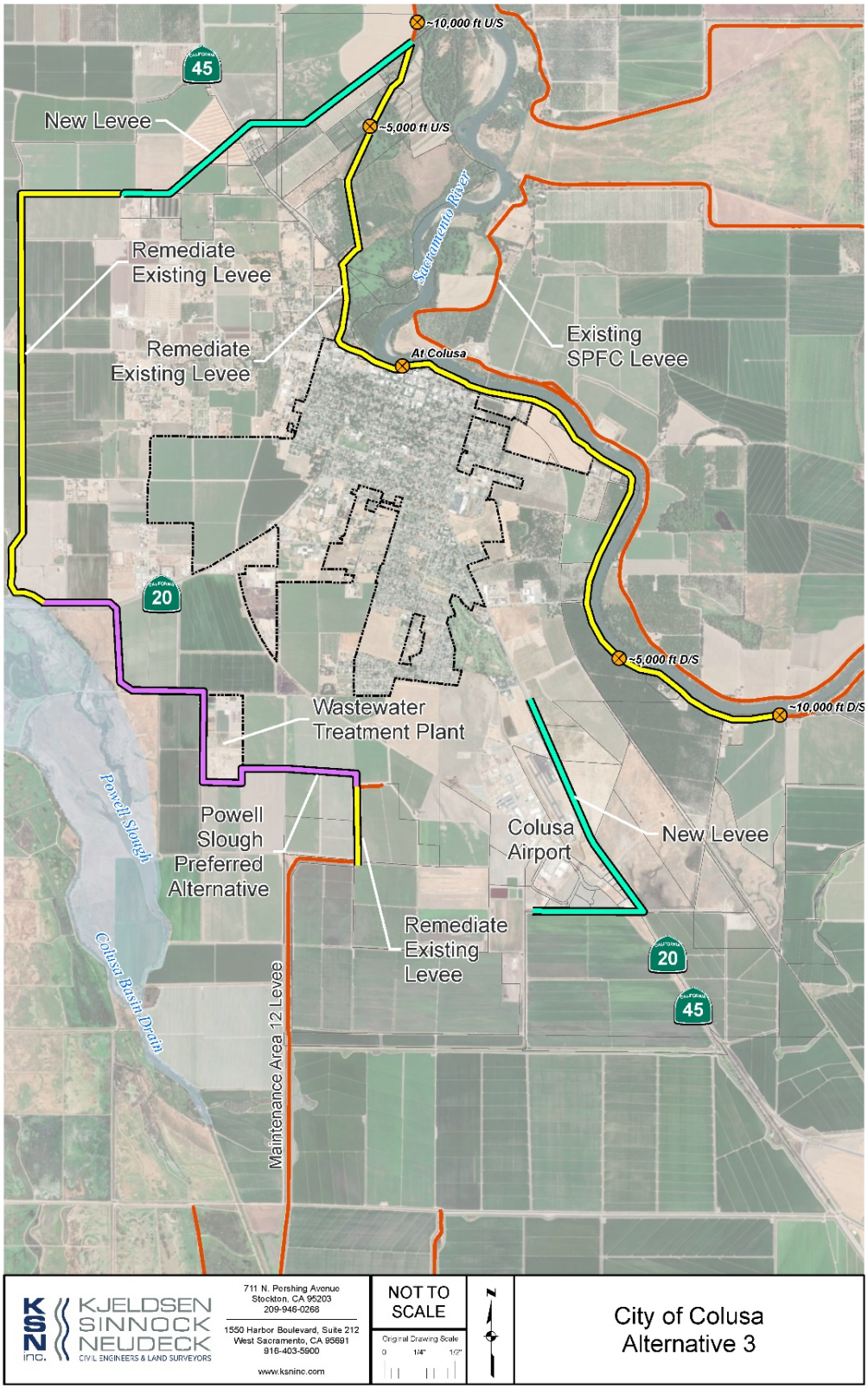


Figure 1-6. City of Colusa Proposed Alternative 4

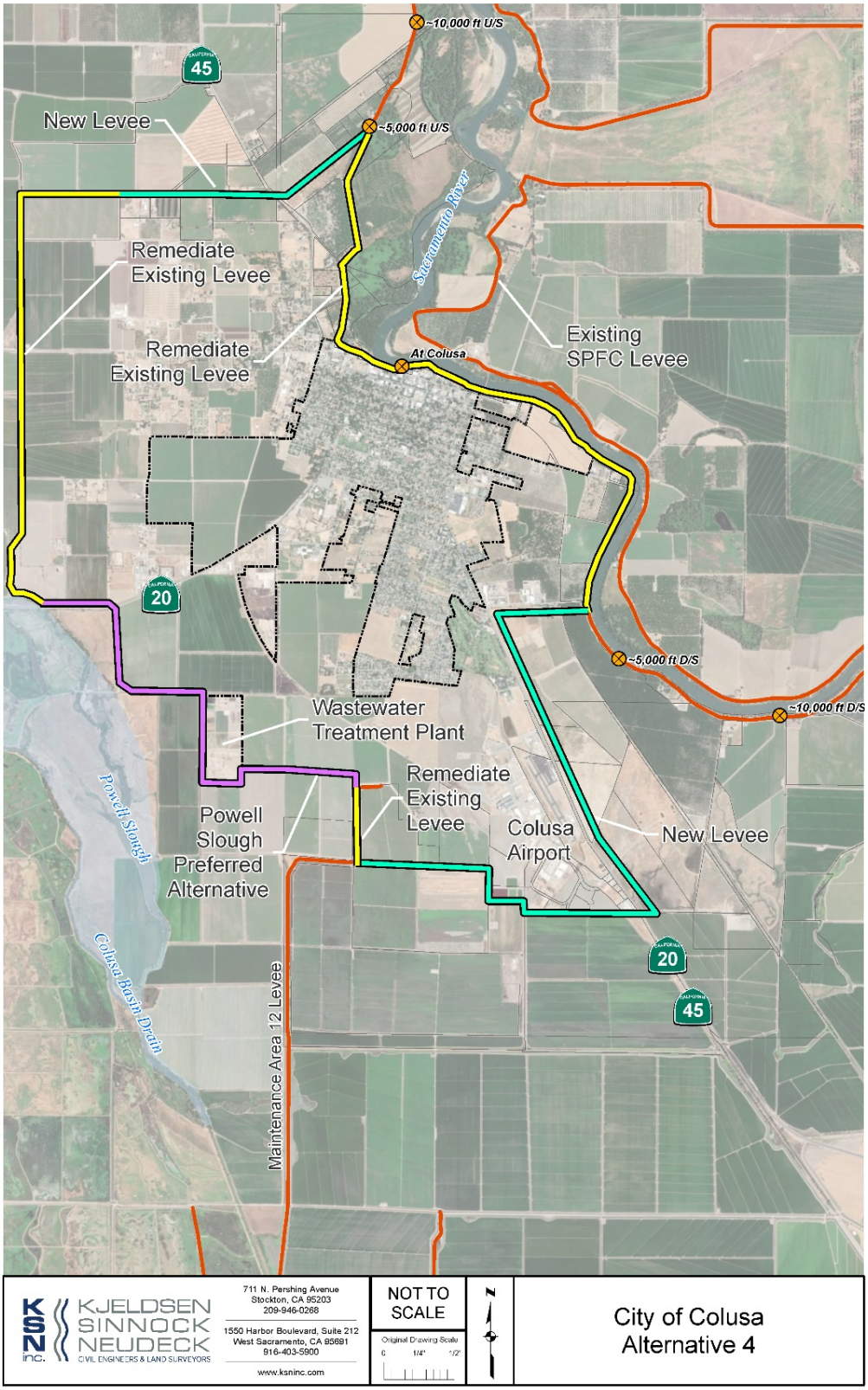


Figure 1-7. City of Colusa Proposed Alternative 5

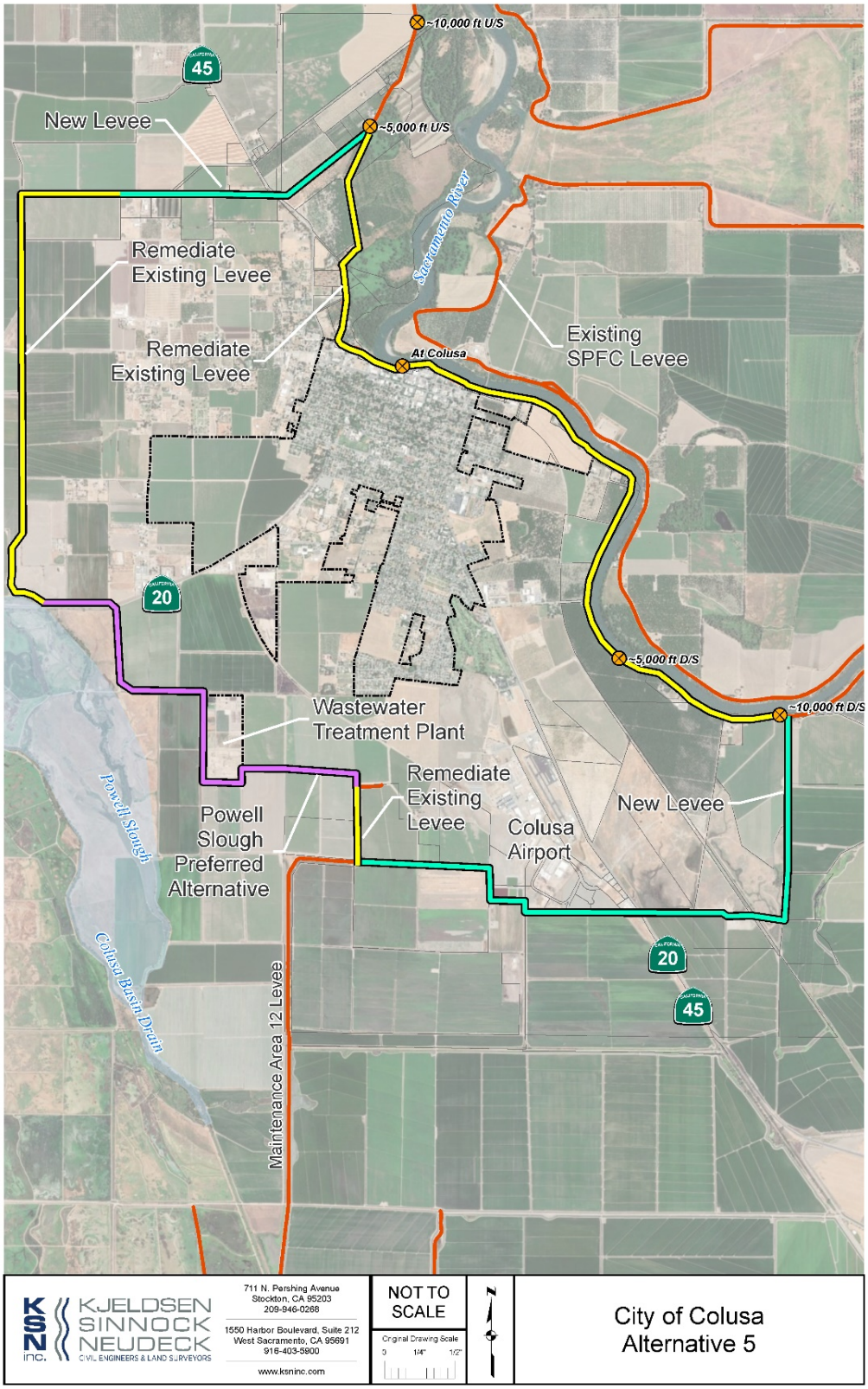
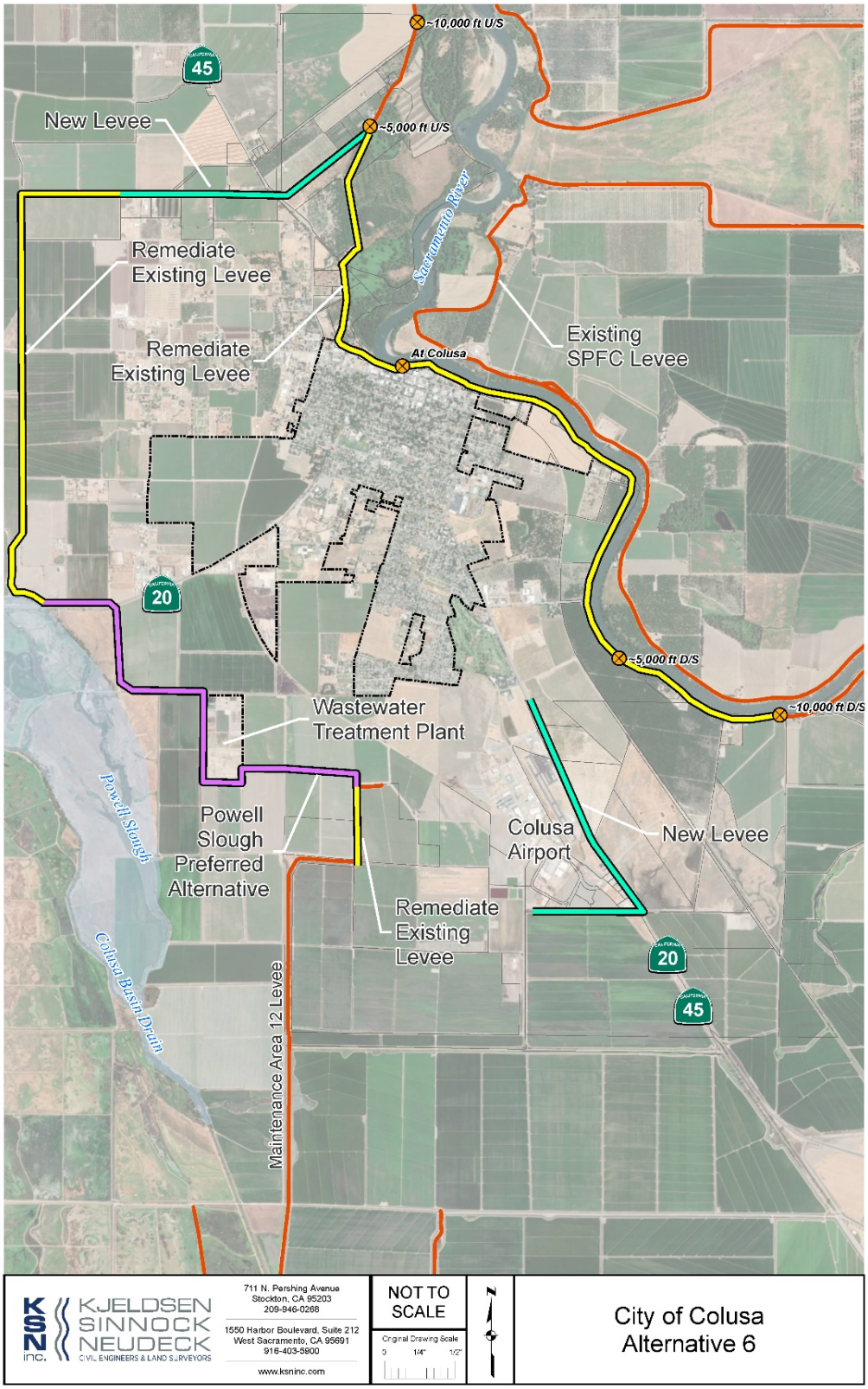


Figure 1-8. City of Colusa Proposed Alternative 6



2 Research Methods

2.1 Environmental Constraints Analysis Methodology

A desktop analysis was performed in order to determine potential environmental constraints associated with the implementation of each of the six alternatives. Criteria from Appendix G of the California Environmental Quality Act (CEQA) Guidelines was used as a framework to determine potentially significant impacts on different resource areas, and was also used as a means to determine if CEQA documentation would be required for any of the alternatives. The resource areas evaluated include the following:

- Agriculture and Forestry Resources
- Air Quality and Greenhouse Gas (GHG) Emissions
- Biological Resources
- Cultural and Tribal Cultural Resources
- Energy
- Geology, Soils, and Mineral Resources
- Hazards and Hazardous Materials
- Hydrology and Water Quality
- Land Use and Planning
- Noise
- Public Services and Recreation
- Traffic and Transportation
- Utilities and Service Systems

The results of that analysis are provided in **Attachment B** of this report, and a summary of potential environmental constraints is provided in **Section 3.2**. A regulatory consistency analysis was also performed for the proposed project to determine the alternatives' conformance to relevant federal, state, and local regulations under each of the evaluated resource areas **(Attachment A).** Primary data sources used during the desktop analysis include the following:

- Colusa County General Plan (Colusa County 2012);
- California Geologic Survey Farmland Mapping and Monitoring Program (DOC 2016);
- California Department of Conservation;
- California Department of Forestry and Fire Protection (CalFire) Hazard Severity Zone Maps (Cal Fire 2007);
- California Department of Transportation;

- California State Water Resources Control Board GeoTracker Database (SWRCB 2015);
- DTSC EnviroStor Database (DTSC 2018); and,
- Natural Resource Conservation Service (NRCS) Web Soil Survey (NRCS 2015).

In addition to the Environmental Constraints and the Regulatory Consistency analyses, separate in-depth Biological Resources, Cultural Resources, and Multi-Benefit Analyses were conducted to support the environmental constraints analysis, as described in further detail below. The Biological Resources Analysis is provided in **Attachment C**, the Cultural Resources Analysis is located in **Attachment D,** and the Multi-Benefit Analysis is provided in **Attachment E**.

2.2 Biological Resources Analysis Methodology

The Biological Resources Analysis is provided in **Attachment C**. The methodology for the Biological Resources Analysis is described below.

2.2.1 Desktop Review

A desktop review was undertaken to assess potential biological constraints in the city of Colusa project area (**Attachment C, Figure 1**), which included two steps to collect data on special-status species, vegetation communities, sensitive communities, protected lands, and federally-protected aquatic resources with the potential to occur in the project area. First, preliminary database searches were performed to identify aquatic resources and special-status species with the potential to occur in the project area. Second, a preliminary review of recent aerial imagery and land use maps was conducted to collect site-specific data regarding habitat suitability for special-status species, and to see if any protected lands overlap with the project area.

Database searches were performed on the following websites:

- U.S. Fish and Wildlife Service's (USFWS) Information Planning and Consultation (IPaC) System (2018a);
- USFWS Critical Habitat Portal (2018b);
- California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB) in BIOS 5 (2018);
- California Native Plant Society (CNPS) Inventory of Rare, Threatened, and Endangered Plants of California (2018);
- USFWS National Wetland Inventory (2018c); and,
- U.S. Geological Survey (USGS) topographical map.

A query of the USFWS's IPaC system was performed to identify federally listed species that may occur in or adjacent to the project area. A review of the USFWS's Critical Habitat portal was also conducted to identify designated critical habitat units that fall within the project area. A query of the CNDDB provided a list of processed and unprocessed special-status species occurrences within the Colusa US Geological Survey 7.5 minute quadrangle (quad), as well as all adjacent quads. Additionally, the

CNPS database was queried to identify special-status plant species with the potential to occur in the aforementioned quads. Finally, USFWS National Wetland Inventory data and USGS topographical maps were used to aid in the digitization of vegetation communities and potential aquatic resources within the project area. The raw data returned from the database queries is provided in **Attachment C, Attachment C-1**.

2.2.2 Reconnaissance Survey

A reconnaissance level survey was conducted on December 17, 2018, to verify the results of the desktop review. HDR biologists drove on publicly accessible roads throughout the project area in order to record existing vegetation communities, aquatic resources, and species observed. All portions of the project area were directly observed.

2.3 Cultural Resources Analysis Methodology

2.3.1 Records Search and Historic Map Review

A records search request for the project area was submitted on December 14, 2018 to the Northwest Information Center (NWIC) of the California Historical Resources Information System, located at Sonoma State University. The search area for which data was requested included all alternatives in the project area, plus a 0.25-mile buffer. Search results were received from the NWIC on January 24, 2019. The information request included a search of previous cultural resources investigations, and previously recorded archaeological sites and built environment resources. To gather these data the records search reviewed the following:

- NWIC Resource Database (database query dated January 24, 2019);
- NWIC Report Database (database query dated January 24, 2019);
- Office of Historic Preservation (OHP) Historic Properties Directory for Colusa County (directory last updated April 5, 2012);
- OHP Archaeological Determinations of Eligibility for Colusa County;
- California Inventory of Historical Resources (OHP 1976); and
- General Land Office (GLO) and/or Rancho Plat Maps.

Information was also requested on the Caltrans Bridge Survey, ethnographic information, and local inventories, where present. Historic USGS topographic maps and GLO survey plats were also reviewed in order to track land-use and historic-era development.

2.3.2 Reconnaissance Survey

A field reconnaissance of the project area was conducted on January 22, 2019 by John “Jay” Lloyd, M.A. Linguistics, who meets the Secretary of the Interior’s Qualification Standards for archaeology and is a Registered Professional Archaeologist. Methods included reviewing the results of the records search, confirming the absence/presence of previously recorded (and accessible) resources, generally driving across the breadth of the project area on publicly accessible roads, and assessing major topographical

differences between the historic and modern landscape using historic-era maps for comparison.

A summary of the results of the records search, historic map review, and the reconnaissance survey are provided in a technical memorandum located in **Attachment D**. The technical memorandum includes technical data review and discussion of cultural resources and potential sensitivity. The findings of the technical memorandum have been incorporated into **Section 3.2**.

1.1 Multi-Benefit Analysis

The multi-benefit analysis is provided in **Attachment E**. As a part of the DWR Small Communities Flood Risk Reduction Program, projects are expected to make significant progress towards the improvement and advancement of flood protection for small communities while also considering multi-benefit concepts that integrate other biological and environmental resource needs and promoting ecosystem function. Several multi-benefit concept options were analyzed to determine feasibility, potential impacts, and benefits. These results are provided in the Feasibility Study. Based on these results, floodplain restoration by lowering of the floodplain proved to be the most feasible multi-benefit concept capable of both improving flood management and supporting conservation efforts.

Consistent with the Environmental Constraints Analysis (ECA), provided in **Attachment B**, a desktop analysis was also performed in order to determine potential environmental constraints associated with the implementation of the preferred multi-benefit concept. Criteria from Appendix G of the CEQA Guidelines was used as a framework to determine potentially significant impacts on different resource areas, and was also used as a means to determine if CEQA documentation would be required. As a result, potential environmental constraints from the preferred multi-benefit concept were analyzed using the same criteria as the proposed project, located in **Attachment B.**

The results of the multi-benefit analysis are summarized in **Attachment E**, **Table E-1,** followed by recommendations for environmental documentation, permits and approvals.

3 Results

3.1 Regulatory Setting and Consistency

Agricultural Resources

All six alternatives would potentially conflict with the Farmland Mapping and Monitoring Program and Colusa County General Plan Agriculture Element. According to the Department of Conservation Farmland Mapping and Monitoring Program, the proposed project includes Prime Farmland, Unique Farmland, and Farmland of Local Importance and has the potential to disturb such land uses during construction and ground disturbing activities (DOC 2018). The proposed project would also potentially conflict with the Williamson Act Program. According to the Department of Conservation Colusa County Williamson Act FY 2013/14 Map, the Williamson Act Prime Agricultural Land is located within the proposed project area (DOC 2013) and ground disturbing activities or work

within these areas has the potential to disturb a property under the Williamson Act Contract.

Biological Resources

The proposed project could potentially conflict with biological resource regulations. Based on this preliminary review of biological resources databases and the site reconnaissance, the project area appears to contain suitable habitat for several special-status species; and includes various sensitive communities and aquatic resources. Proposed project activities have the potential to impact any of the biological resources listed in **Attachment C, Table 1**, should they be present in the vicinity of the proposed work area. Prior to project implementation, consultation with resource agencies and acquisition of permits may be necessary.

Cultural Resources

Based on the review of the records search results, historic maps, and the site reconnaissance presented in **Attachment D**, the project area contains 105 built environment resources eligible for listing on the California Register of Historical Resources (CRHR) and/or National Register of Historic Places (NRHP). The prehistoric, ethnographic, and historical contexts indicate a low to moderate sensitivity of the Project area for unrecorded surficial archaeological sites with a high potential for those sites, when identified, to have buried components. Further, the Project exhibits a high sensitivity for historical features and buildings in the vicinity of known historical resources. Construction of the proposed project would require ground disturbance, excavations, implementation of fill, compaction, and use of heavy equipment. These activities have the potential to result in impacts to the cultural resources listed in **Attachment D**, should the resources be identified within, or potentially in the vicinity of, a proposed work area. Any newly discovered archaeological site which cannot be avoided by the proposed project must be evaluated for eligibility to the CRHR and/or NRHP. If eligible, additional mitigation may be required if significant impacts/adverse effects cannot be avoided.

Air Quality, GHG Emissions, and Noise

During construction, the six alternatives would require the use of construction vehicles and equipment on a temporary basis. Significant air quality impacts could result from particulate matter generated during construction activities, such as dust and equipment exhaust on a short-term basis. The proposed project would also generate GHG emissions during the operation of construction vehicles and equipment. The proposed project would adhere to Best Management Practices (BMP) in an effort to minimize air quality and GHG emissions impacts, but there is potential that the proposed project would not conform to the Clean Air Act and relevant GHG regulations.

The proposed project would generate increased noise conditions during proposed project construction activities. With noise sensitive receptors in close proximity (schools, residents, etc.), there is a potential that the proposed project would not adhere to noise thresholds outlined in the Colusa County General Plan.

Other Resources

Based on the Regulatory Consistency Analysis provided in **Attachment A**. The proposed project would conform to all federal, state and local regulations under aesthetics; geology, soils and seismicity; hazards and hazardous materials; hydrology and water quality; land use and planning; public services and utilities; recreation; traffic and transportation; and energy. In many cases, regulatory compliance is contingent upon implementation of appropriate BMPs and proper permitting, such as those required to protect water quality. Potential required permits and approvals are provided in **Table 4-1.**

3.2 Summary of Potential Environmental Constraints

Resources with No Impacts

Based on the Existing Conditions and Environmental Constraints Analysis, environmental constraints would not occur under the following resources:

- Aesthetics
- Energy
- Land Use and Planning
- Mineral Resources
- Public Services and Recreation

Table 3-1 presents a summary of potential environmental constraints by alternative. Only the resource areas with potential constraints are included in **Table 3-1**. Yellow highlighted cells indicate the greatest potential for impacts based on the location of the alternative, the size of the project footprint, or proposed project activities. Green highlighted cells indicate the next greatest potential for impacts. The full analysis is provided in **Attachment B,** Existing Conditions and Environmental Constraints.

Table 3-1. Summary of Potential Environmental Constraints by Alternative

Potential Environmental Constraints	Alternative					
Agriculture and Forestry Resources	**1**	**2**	**3**	**4**	**5**	**6**
Would the project result in the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance?	✓	✓	✓	✓	✓	✓
Is the project located on a Williamson Act Contract property, or would it disturb a property under the Williamson Act Contract?	✓	✓	✓	✓	✓	✓
Air Quality and GHG Emissions						
Would project result in substantial emissions?	✓	✓	✓	✓	✓	✓
Would the project expose sensitive receptors to substantial pollutant concentrations?	✓	✓	✓	✓	✓	✓
Would the project generate GHG emissions either directly or indirectly?	✓	✓	✓	✓	✓	✓

Potential Environmental Constraints	Alternative					
Biological Resources						
Is the Project located adjacent to terrestrial or aquatic habitat areas for state or federally listed endangered, threatened, or candidate species?	✓	✓	✓	✓	✓	✓
Would the Project have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	✓	✓	✓	✓	✓	✓
Would the Project have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	✓	✓	✓	✓	✓	✓
Would the Project have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	✓	✓	✓	✓	✓	✓
Cultural and Tribal Cultural Resources						
Do known historical, archaeological, or tribal sites resources occur in the Project Area?	✓	✓	✓	✓	✓	✓
Does the Project require excavations or ground disturbance that could inadvertently impact known or unknown cultural, historical, or archaeological resources?	✓	✓	✓	✓	✓	✓
Would the Project disturb human remains, including those encountered outside of dedicated cemeteries?	✓	✓	✓	✓	✓	✓
Geology and Soils						
Would the project require excavations, grading, or other ground disturbing activities capable of causing erosion or loss of topsoil?	✓	✓	✓	✓	✓	✓
Hazards and Hazardous Materials						
Be located on a site which is included on a list of hazardous materials sites compiles pursuant to Government Code Section 65962.5 and, as a result, would it	✓	✓	✓	✓	✓	✓

Potential Environmental Constraints	Alternative					
create a significant hazard to the public or the environment?						
Would the Project emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	✓	✓	✓	✓	✓	✓
For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	✓	✓	✓	✓	✓	✓
Hydrology and Water Quality						
Would the project alter the drainage pattern of the site or area in a manner which would result in substantial erosion or siltation?	✓	✓	✓	✓	✓	✓
Noise						
Would the project generate noise in excess of thresholds outlined in the county noise ordinance or general plan?	✓	✓	✓	✓	✓	✓
Would the Project generate excessive ground borne vibration or ground borne noise levels?	✓	✓	✓	✓	✓	✓
Traffic and Transportation						
Would the project result in disruptions to traffic or the circulation system?	✓	✓	✓	✓	✓	✓
Utilities and Service Systems						
Would the Project require or result in the relocation or construction of new or expanded water, or wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities or expansion of existing facilities, the construction or relocation of which could cause significant environmental effects?	✓	✓	✓	✓	✓	✓

As shown in **Table 3-1** above, each alternative would result in impacts on agriculture and forestry resources; air quality and GHG emissions; biological resources; cultural and tribal cultural resources; geology and soils; hazards and hazardous materials; hydrology and water quality; noise, traffic and transportation; and utilities and service systems. Alternative 2 (approximately 12.1 miles) comprises the largest footprint of the six alternatives, followed by Alternative 1 (11.4 miles). As a result, Alternative 2 would result in a greater area of disturbance during construction to agriculture and forestry resources (see **Attachment F**, Land Use Maps), biological resources, cultural resources, geology

and soils, and hydrology and water quality, followed by Alternative 1. Alternatives 1 and 4 would have a higher potential for impacts on traffic and transportation given that improvements in the southeastern portion of the project area would occur along a longer span of State Route-20, which is a primary transportation corridor. Alternatives 1, 3, 4 and 6 are adjacent to Colusa County airport and would therefore result in a greater potential for impacts on hazards and hazardous materials. Based on these results, Alternative 1 has the greatest potential for impacts across resource areas, followed by Alternatives 2, 4, 3 and 6, and 5 in that respective order.

1.1.1 Multi-Benefit Analysis Results Summary

Impacts from the preferred multi-benefit concept would not differ substantially from impacts of the proposed project given that similar construction methods and equipment would be used, and because the proposed project and multi-benefit concept area are located in the same geographic area (see **Attachment E** for summary of impacts). As a result, potential environmental permits and approvals discussed in **Section 4** below would also apply to and be recommended for the preferred multi-benefit concept.

4 Environmental Documentation, Permits and Approvals

4.1 California Environmental Quality Act

Based on the results of the environmental constraints analysis, it is likely that the proposed alternatives would result in a potential impact on the environment and therefore, compliance with CEQA would be required. CEQA requires that all state and local government agencies consider the environmental consequences of projects they propose to carry out, or over which they have discretionary authority, before implementing or approving those projects. As specified in Section 15367 of the State CEQA Guidelines, the public agency that has the principal responsibility for carrying out or approving a project, as defined above and as described in more detail below, is the lead agency for purposes of CEQA. As specified in Section 15064(a) of the state CEQA Guidelines, if there is substantial evidence (such as the results of an Initial Study (IS)) that a project, either individually or cumulatively, could have a significant effect on the environment that cannot effectively be mitigated to a less-than-significant level, the lead agency must prepare an Environmental Impact Report (EIR). The lead agency may instead prepare an IS if it determined that there is no substantial evidence that the project could cause a significant impact to the environment. The lead agency may prepare a Mitigated Negative Declaration (MND), if in the course of the IS analysis, the agency recognizes that the project could have a significant impact to the environment but that implementing specific mitigation measures would reduce any such impacts to a less-than-significant level (state CEQA Guidelines, Section 15064[f]).

4.2 National Environmental Policy Act

Based on the results of the ECA, it is likely that the project would require compliance with federal regulations, such as the Clean Water Act, Section 404; National Historic

Preservation Act, Section 106; and Endangered Species Act (ESA), Section 7, as described in **Section 4.3, Permits**, below. As a result, of seeking these federal permits and consultations, compliance with the National Environmental Policy Act (NEPA) could also be triggered. In addition, the Sacramento River west levee is a part of the SPFC and thus is considered a state/federal facility, therefore any modifications to the levee would also trigger the need for NEPA compliance as well as a Rivers and Harbors Act, Section 408 approval. The level of NEPA documentation that could be required for the proposed project would likely be determined during the permitting process.

4.3 Permits and Approvals

Several Federal, state, and local permits and/or authorizations are anticipated for the proposed project. **Table 4-1** summarizes the potential permits and approvals that may be associated with the proposed project. The regulations and ordinances listed below represent a preliminary assessment of permitting requirements, which would be refined through subsequent project design and preparation of a detailed project description.

All of the proposed alternatives would directly and indirectly affect sensitive natural resources, including waters of the U.S. All potential waters of the U.S., including wetlands, identified within the study area may be regulated by the U.S. Army Corps of Engineers (USACE) through section 404 of the Clean Water Act (CWA) and by the Regional Water Quality Control Board (RWQCB) as waters of the State through Section 401. All ecological systems associated with drainages (i.e. potential waters of the U.S.), and drainage features with bed and bank topography may also be regulated by Sections 1600-1616 of the California Fish and Game Code. In conjunction with the USACE Section 404 permit, impacts on wetlands and waters would likely require a Section 401 Water Quality Certification or Waste Discharge Requirement from RWQCB and CDFW Section 1602 Streambed Alteration Agreement. Also, for all alternatives, the proposed project has the potential to affect more than 1.0 acre of soil, triggering the requirement of a National Pollutant Discharge Elimination System (NPDES) General Permit from the RWQCB.

The proposed project has the potential to adversely affect special-status species. Direct and/or indirect impact to federal and state listed species and their habitat would require formal consultation with the USFWS (Biological Opinion/Take Statement) and CDFW (2081 Incidental Take Permit) to determine the levels of take.

Table 4-1. Potential Environmental Permits and Approvals

Agency	Type of Permit or Approval	Regulated Activity
Federal		
U.S. Army Corps of Engineers	Clean Water Act, Section 404 Permit	Discharges of dredged or fill material into waters of the U.S., including wetlands
State Historic Preservation Officer (SHPO)	National Historic Preservation Act, Section 106 Consultation	Consultation and coordination regarding potential effects on properties listed in, or eligible for listing in the National Register of Historic Places
U.S. Fish and Wildlife Service (USFWS),	Endangered Species Act (ESA), Section 7 Consultation	Section 7 Consultation and coordination regarding potential effects to federally protected species

Agency	Type of Permit or Approval	Regulated Activity
National Marine Fisheries Service (NMFS)		
State		
California Department of Fish and Wildlife (CDFW)	California ESA, California Fish and Game Code, Section 2081 Consultation	Consultation and take authorization
CDFW	California Fish and Game Code, Section 1602	Streambed Alteration Agreement
California Native American Heritage Commission (NAHC)	NAHC Consultation	Consultation and coordination regarding potential effects on Native American burials or artifacts
Local		
Regional Water Quality Control Board (RWQCB)	CWA, Section 402	Section 402 National Pollutant Discharge Elimination System (NPDES) Construction General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities, Waste Discharge Requirements for Dewatering and Other Low Threat Discharges to Surface Waters
RWQCB	CWA, Section 401	Section 401 Water Quality Certification for discharge of dredged or fill material into Waters of the U.S. and State
Air Pollution Control District	Authority to Construct/ Permit to Operate	Certification that construction emissions will meet all applicable requirements and will not interfere with air quality standards Certification that equipment complies with applicable rules and regulations

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Attachment A. Regulatory Consistency Analysis

Regulatory Consistency Analysis

Introduction

The Regulatory Consistency Analysis provides an overview of the federal, state and local regulations, policies and plans applicable to the proposed project and includes a discussion of whether proposed project activities would conflict with these regulations, policies and plans. **Table B-1** includes a summary of potential consistency conflicts by regulatory area.

Table B-1. Regulatory Consistency Table

Regulatory Area	Potential Consistency Conflict? Yes/No (Y/N)
Aesthetics	N
Agricultural Resources	Y
Air Quality	Y
Biological Resources	Y
Cultural Resources	Y
Energy	N
Geology and Soils	N
Hazards and Hazardous Materials	N
Hydrology and Water Quality	N
Land Use and Planning	N
Noise	Y
Public Services and Utilities	N
Recreation	N
Traffic and Transportation	N

The sections below describe the relevant regulatory setting and regulatory consistency analysis for each resource area.

Aesthetics

State

California Scenic Highway Program. California's Scenic Highway Program was created by the Legislature in 1963 to preserve and protect scenic highway corridors from change, which would diminish the aesthetic value of lands adjacent to highways (Caltrans 2018). The state laws governing the Scenic Highway Program are found in the Streets and Highways Code (Section 260, et seq.).

Local

***Colusa County General Plan*.** The Community Character Element of the Colusa County General Plan includes policies intended to maintain and enhance the aesthetic beauty of the County, including the preservation and enhancement of the rural landscape and the protection of the County's scenic beauty (Colusa County 2012).

CONSISTENCY ANALYSIS

No conflict. The six alternatives would not conflict with the California Scenic Highway Program. There are no officially designated state or county scenic highways in Colusa County. The only eligible state scenic highway in the county is located outside of the project area.

The proposed project would conform to policies outlined in the Colusa County General Plan. The project area is located in rural Colusa County and is primarily dominated by lands under agricultural use. Proposed project activities would be consistent with the current uses and visual quality of the project area, and would not impact visual resources in Colusa County.

Agricultural Resources

State

***Farmland Mapping and Monitoring Program*.** The California Department of Conservation, Division of Land Resource Protection works with landowners, local governments, and researchers to conserve the state's farmland and open space, and maintains a statewide inventory of farmlands. These lands are mapped as part of the Farmland Mapping and Monitoring Program (FMMP), which is based on a classification system that rates agricultural land according to soil quality and irrigation status. Agricultural lands are divided and mapped into the following eight categories:

- *Prime Farmland*—Farmland with the best combination of physical and chemical features able to sustain long-term agricultural production. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields. Land must have been used for irrigated agricultural production at some time during the 4 years before the mapping date.
- *Farmland of Statewide Importance*—Farmland similar to Prime Farmland but with minor shortcomings, such as greater slopes or less ability to store soil moisture. Land must have been used for irrigated agricultural production at some time during the 4 years before the mapping date.
- *Unique Farmland*—Farmland of lesser quality soils used for the production of the state's leading agricultural crops. This land is usually irrigated, but may include non-irrigated orchards or vineyards as found in some climatic zones in California. Land must have been cropped at some time during the 4 years before the mapping date.
- *Farmland of Local Importance*—Land of importance to the local agricultural economy as determined by each county's board of supervisors and a local advisory committee.
- *Grazing Land*—Land on which the existing vegetation is suited to the grazing of livestock.
- *Urban and Built-up Land*—Land occupied by structures with a building density of at least one unit to 1.5 acres, or approximately six structures to a 10-acre parcel.
- *Other Land*—Land not included in any other mapping category. Common examples include low-density rural developments; brush, timber, wetland, and riparian areas not suitable for livestock grazing; confined livestock, poultry, or aquaculture facilities; strip mines; borrow pits; and water bodies smaller than 40 acres. Vacant and nonagricultural

land surrounded on all sides by urban development and greater than 40 acres is mapped as Other Land.
- *Water*—Perennial water bodies with an extent of at least 40 acres.

Williamson Act Program. The California Land Conservation Act of 1965, commonly referred to as the Williamson Act, enables local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open space use. In return, landowners receive reduced property tax assessments. Williamson Act categories include:

- Williamson Act – Non-Prime Agricultural Land: Land which is enrolled under California Land Conservation Act contract and does not meet any of the criteria for classification as Prime Agricultural Land.
- Williamson Act – Farmland Security Zone: Enrolled parcels containing either Prime or Non-Prime agricultural land restricted by a 20 year contract pursuant to Government Code Section 51296.

Local

Colusa County General Plan Agriculture Element. The Agriculture Element of the Colusa County General Plan includes goals, objectives, policies and action items geared towards the protection of agricultural lands, the expansion of agricultural operations, and the reduction of conflicts between agricultural and non-agricultural land uses (Colusa County 2012).

CONSISTENCY ANALYSIS

Potential conflict. The six alternatives would potentially conflict with the Farmland Mapping and Monitoring Program and the Colusa County General Plan Agriculture element. The project area includes Prime Farmland, Farmland of Local Importance, and Unique Farmland and has the potential to disturb or convert such land uses during construction and ground disturbing activities (DOC 2013; DOC 2018). To the extent possible, these areas would be avoided and BMPs would be employed to reduce impacts on agricultural lands.

Air Quality

Federal

Clean Air Act. The Clean Air Act (CAA) was first enacted in 1963 and has since been amended (1965, 1967, 1970, 1977, and 1990). Under the CAA, the U.S. Environmental Protection Agency (USEPA) developed the National Ambient Air Quality Standards (NAAQS), or numerical concentration-based standards, for six criteria pollutants that have been determined to affect human health and the environment. The NAAQS represent the maximum allowable concentrations for O3 - measured as either volatile organic compounds (VOCs) or total oxides of nitrogen (NOx), carbon monoxide (CO), nitrogen dioxide (NO2), sulfur oxides (SOx), respirable particulate matter (including PM10 and PM2.5), and lead (Pb).

USEPA classifies the air quality in an Air Quality Control Region (AQCR), or in subareas of an AQCR, according to whether the concentrations of criteria pollutants in ambient air exceed the NAAQS. Areas within each AQCR are therefore designated as either “attainment,”

"nonattainment," "maintenance," or "unclassified" for each of the six criteria pollutants. Attainment means that the air quality within an AQCR is better than the NAAQS; nonattainment indicates that criteria pollutant levels exceed NAAQS; maintenance indicates that an area was previously designated nonattainment but is now attainment; and an unclassified air quality designation by USEPA means that there is not enough information to appropriately classify an AQCR, so the area is considered attainment. The CAA also mandates that each state implement a State Implementation Plan (SIP) for local areas not meeting those standards, and the SIP must include pollution control measures outlining how the standards will be met.

State

California Clean Air Act. The CAA gives the authority to states to establish air quality rules and regulations. Air quality in California is governed by the California Clean Air Act (CCAA). The State of California has adopted the NAAQS and promulgated additional California Ambient Air Quality Standards (CAAQS) for criteria pollutants. The CAAQS are more stringent than the Federal primary standards. The CCAA requires all air districts in the state to endeavor to meet the CAAQS by the earliest practical date.

In California, the USEPA has delegated the authority for ensuring compliance with the NAAQS to the California Air Resources Board (CARB). CARB has delegated responsibility for implementation of the CAA and CCAA to local air pollution control agencies.

Greenhouse Gas Regulation. California has adopted statewide legislation addressing various aspects of climate change and mitigation for greenhouse gas (GHG) emissions. This legislation establishes a broad framework for meeting the state's long-term GHG reduction goals. The Governor of California has also issued several orders related to the state's evolving climate change policy. Of particular importance is the Global Warming Solutions Act of 2006, also commonly referred to as Assembly Bill (AB) 32, which establishes a statewide GHG reduction goal of achieving 1990 emissions levels by 2020.

Local

Colusa County Air Pollution Control District (CCAPD). The project area is located within the jurisdictional boundaries of the Colusa County Air Pollution Control District (CCAPCD) and is subject to rules and regulations developed by the CCAPCD. The CCAPCD is responsible for implementing and enforcing State and Federal air quality regulations within Colusa County.

Colusa County General Plan Conservation Element. The Conservation Element of the Colusa County General Plan includes policies intended for the conservation, protection, and enhancements of the County's air quality, including the minimization of air pollutant emissions (Colusa County 2012).

CONSISTENCY ANALYSIS

Potential conflict. The proposed project would require the use of construction vehicles and equipment on a temporary basis during construction. Air quality impacts could result from particulate matter generated during construction activities, such as dust and equipment exhaust. Operation of construction vehicles and equipment could generate GHG emissions on a short term, intermittent basis. The proposed project would implement BMPs during construction in an

effort to minimize air quality and GHG impacts, but there is potential that the Project would not conform to CAA, GHG regulations and the CCAPD rules and regulations.

Biological Resources

Federal

Endangered Species Act of 1973. The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) enforce the provisions stipulated within the Federal Endangered Species Act of 1973 (hereafter, "FESA," 16 United States Code [USC] §1531 et seq.). Threatened and Endangered species on the Federal list (50 Code of Federal Regulations [CFR] § 17.11 and 17.12) are protected from take, defined as direct or indirect harm or harassment, unless a Section 10 permit is granted to an entity other than a Federal agency, or a Biological Opinion with incidental take provisions is rendered to a Federal lead agency via a Section 7 consultation. Pursuant to the requirements of FESA, an agency reviewing a Proposed Project within its jurisdiction must determine whether any federally listed or proposed species may be present in the study area and determine whether the Proposed Project is likely to jeopardize the continued existence of the species, or result in the adverse modification or destruction of habitat for said species. Under FESA, habitat loss is considered to be an impact to a species, thus related impacts to these species or their habitats would be considered significant and would require mitigation.

Wetlands and Other Waters of the U.S. Any person, firm, or agency planning to perform work that involves the discharge of dredged or fill material into "waters of the U.S.", must first obtain authorization from the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (33 USC §1344). Permits, licenses, variances, or similar authorizations may also be required by other Federal, State, and local statutes. Waters of the U.S. are defined as: all waters used in interstate or foreign commerce; all interstate waters including interstate wetlands; all other waters such as intrastate lakes, rivers, streams (including intermittent and ephemeral streams), mudflats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes or natural ponds, where the use, degradation, or destruction of which could affect interstate commerce; impoundments of these waters; tributaries of these waters; or wetlands adjacent to these waters (33 CFR Part 328). With non-tidal waters, in the absence of adjacent wetlands, the extent of USACE jurisdiction extends to the ordinary high water mark (OHWM) – the line on the shore established by fluctuations of water and indicated by a clear, natural line impressed on the bank, shelving, changes in soil character, destruction of terrestrial vegetation, or the presence of litter and debris. Wetlands are defined as: "… those areas that are inundated or saturated by surface or ground water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions".

In addition, the Regional Water Quality Control Board (RWQCB) may require a State Water Quality Certification (CWA, Section 401 permit) before other permits are issued.

In California, the USEPA has delegated the authority for ensuring compliance with the NAAQS to the California Air Resources Board (CARB). CARB has delegated responsibility for implementation of the CAA and CCAA to local air pollution control agencies.

U.S. Fish and Wildlife Service Colusa National Wildlife Refuge Comprehensive Conservation Plan. The Sacramento, Delevan, Colusa, and Sutter National Wildlife Refuges Comprehensive Conservation Plan is a document that guides the management of the Sacramento National Wildlife Refuge Complex over a period of 15 years. Each of the separate regions within the National Wildlife Refuge Complex also contains its own Refuge Management Plan, including the Colusa National Wildlife Refuge Comprehensive Conservation Plan. The National Wildlife Refuge System Improvement Act of 1997 (16 United States Code [USC] 668dd-668ee) (Improvement Act) required that all refuges be managed in accordance with an approved CCP by 2012. The Comprehensive Conservation Plan contains goals, objectives and strategies to help manage and improve habitat quality, visitor experiences, and partnership opportunities (USFWS 2009).

State

California Endangered Species Act (CESA). The California Endangered Species Act (CESA) is similar to the FESA in that it contains a process for listing species and regulating potential impacts to listed species. Section 2081 of the CESA authorizes the California Department of Fish and Wildlife (CDFW) to enter into a memorandum of agreement for take of listed species for scientific, educational or management purposes.

CDFW also requires notification prior to commencement, and may require a Streambed Alteration Agreement, pursuant to California Fish and Game Code (Subsections 1601-1603), if a proposed project would result in the alteration or degradation of a stream, river, or lake in California.

Colusa County General Plan Conservation Element. The Conservation Element of the Colusa County General Plan includes policies intended for the conservation and protection of the County's ecosystem, habitats, and special status species (Colusa County 2012).

CONSISTENCY ANALYSIS

Potential conflict. Based on a preliminary review of biological resources databases and a site reconnaissance, the project area appears to contain suitable habitat for several special-status species. The proposed project area also includes several aquatic resources and vegetation communities that are considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. Proposed project activities have the potential to impact biological resources listed in **Attachment C Table 1**, should they be present in the vicinity of the proposed work area. Prior to project implementation, consultation with resource agencies and acquisition of permits may be necessary.

Cultural Resources

Federal

Section 106 of the National Historic Preservation Act (NHPA). Section 106 of the National Historic Preservation Act (NHPA) requires that, before beginning any undertaking, a federal agency must take into account the potential for effects on historic properties and offer the Advisory Council on Historic Preservation (ACHP) and other interested parties an opportunity to comment on the Proposed Project. Specific regulations regarding compliance with Section 106 state that, although the tasks necessary to comply with Section 106 may be delegated to others, the federal agency is ultimately responsible for ensuring that the Section 106 process is completed. Upon initiation of the Section 106 process, the lead federal agency is required to invite the appropriate State Historic Preservation Office (SHPO) or appropriate Tribal Historic Preservation Office (required only if the undertaking would occur on land owned by a federally recognized Indian tribe) to participate in the process.

Section 106 also requires federal agencies, or those they fund or permit, to consider the effects of their actions on properties that are determined eligible for listing or are listed in the National Register of Historic Places (NRHP). To determine whether an undertaking could affect NRHP-eligible properties, cultural resources (archaeological, historical, architectural, and traditional cultural properties) must be inventoried and evaluated for the NRHP. To be listed in the NRHP, a property must be at least 50 years old (or be of exceptional historic significance if less than 50 years old) and meet one or more of the NRHP criteria. To qualify for listing, a historic property must represent a significant theme or pattern in history, architecture, archaeology, engineering, or culture at the local, state, or national level, and must meet specific significance criteria.

State

California Office of Historic Preservation. The State of California implements the NHPA through its statewide comprehensive cultural resource preservation programs. The California Office of Historic Preservation (OHP), an office of the California Department of Parks and Recreation, implements the policies of the NHPA on a statewide level. The OHP also maintains the California Historical Resources Inventory. The SHPO is an appointed official who implements historic preservation programs within the State's jurisdiction.

The California Native American Heritage Commission (NAHC) identifies and catalogs cultural resources (i.e., places of special religious or social significance to Native Americans, and known graves and cemeteries of Native Americans on private lands) in California. The NAHC is charged with preserving and ensuring accessibility of sacred sites and burials, the disposition of Native American human remains and burial items, maintain an inventory of Native American sacred sites located on public lands, and review current administrative and statutory protections related to these sacred sites.

Local

The Conservation Element of the Colusa General Plan includes policies intended to conserve and protect cultural and historical resources (Colusa County 2012).

CONSISTENCY ANALYSIS

Potential conflict. Based on the review of the records search results, historic maps, and the site reconnaissance presented in Attachment D, the project area contains 105 built environment resources eligible for listing on the CRHR/NRHP. The prehistoric, ethnographic, and historical contexts indicate a low to moderate sensitivity of the Project area for unrecorded surficial archaeological sites with a high potential for those sites, when identified, to have buried components. Further, the Project exhibits a high sensitivity for historical features and buildings in the vicinity of known historical resources. Construction of the proposed project would require ground disturbance, excavations, implementation of fill, compaction, and use of heavy equipment. These activities have the potential to result in impacts to the cultural resources listed in **Attachment D**, should the resources be identified within, or potentially in the vicinity of, a proposed work area. Any newly discovered archaeological site which cannot be avoided by the proposed project must be evaluated for eligibility to the CRHR and/or NRHP. If eligible, additional mitigation may be required if significant impacts/adverse effects cannot be avoided.

Energy

State

Senate Bill 350. SB 350 (Chapter 547, Statutes of 2015) was signed into law in September 2015. SB 350 establishes tiered increases to the Renewables Portfolio Standard of 40 percent by 2024, 45 percent by 2027, and 50 percent by 2030. The former target was 33 percent by 2020. SB 350 also set a new goal to double the electricity and natural gas savings for existing buildings through energy efficiency and conservation measures.

CONSISTENCY ANALYSIS

No conflict. The six alternatives would conform to Senate Bill 350. The proposed project would use limited amounts of energy during construction during the operation of construction equipment. Regular energy usage would not be required during operation of the proposed project.

Geology and Soils

State

Alquist-Priolo Earthquake Fault Zoning Act. California's Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) (Public Resources Code [PRC] Section 2621 et seq.) is intended to reduce risks to life and property from surface fault rupture during earthquakes. Under the Alquist-Priolo Act, faults are zoned, and construction along or across them is strictly regulated if they are "sufficiently active" and "well defined." A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the act as referring to approximately the last 11,000 years). A fault is considered well-defined if its trace can be clearly identified by a trained geologist at the ground surface, or in the shallow subsurface using standard professional techniques, criteria, and judgment.

Seismic Hazards Mapping Act. Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC Sections 2690–2699.6) is intended to reduce damage resulting from earthquakes.

While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other seismic hazards, including strong ground shaking, liquefaction, and seismically induced landslides, and cities and counties are required to regulate development within mapped seismic hazard zones.

Local

Colusa County General Plan Safety Element. The Safety Element of the Colusa County General Plan addresses a range of natural and human-caused hazards that may pose a risk to life and property, and includes policies intended to protect residents and land from hazards (Colusa County 2012).

CONSISTENCY ANALYSIS

No conflict. The project area is in a region of California characterized as having relatively low seismic activity. No Alquist-Priolo Earthquake Fault Zones and no Seismic Hazard Zones are identified within the County. Therefore, the proposed project would conform to the Alquist-Priolo Earthquake Fault Zoning Act and Seismic Hazards Mapping Act. The proposed project would adhere to grading and erosion control measures during ground disturbing activities and would not conflict with local regulations and policies.

Hazards and Hazardous Materials

State

California Environmental Protection Agency (Cal/EPA) and the State Office of Emergency Services. The California Environmental Protection Agency (Cal/EPA) and the State Office of Emergency Services establish rules governing the use of hazardous substances. The SWRCB has primary responsibility to protect water quality and supply. The Cal/EPA was created to better coordinate state environmental programs, reduce administrative duplication, and address the greatest environmental and health risks. The agency also unifies the California's environmental authority under a single Cabinet-level agency. The Secretary for Environmental Protection oversees the following agencies: CARB, Integrated Waste Management Board, Department of Pesticide Regulation, SWRCB, Department of Toxic Substances Control (DTSC), and the Office of Environmental Health Hazard Assessment.

Hazardous Waste Control Law. California requirements and statutory responsibilities are outlined in the statute implemented by the California DTSC in Health and Safety Code, Division 20, Chapter 6.5, Hazardous Waste Control Law. Regulations adopted from the Statute are found in Title 22 of the California Code of Regulations. The Hazardous Waste Control Law is similar to RCRA in that it regulates the identification, generation, transportation, storage, and disposal of materials deemed hazardous by the State.

Local

Colusa County General Plan Safety Element. The Safety Element of the Colusa County General Plan addresses a range of natural and human-caused hazards that may pose a risk to life and property, and includes policies intended to protect residents and land from hazards (Colusa County 2012).

CONSISTENCY ANALYSIS

No conflict. The proposed project would conform to federal, state and local hazardous waste regulations. Construction vehicles and equipment containing grease and oils would be utilized during the construction phase. Implementation of spill prevention measures to address the accidental or inadvertent release of oil, grease, or fuel into adjacent waterways would further help minimize potential construction-related water quality impacts. No hazardous materials would be used post construction and no hazardous waste would be generated.

Hydrology and Water Quality

Federal

The Clean Water Act: Section 401—Water Quality Certification. Section 401 of the CWA requires that an applicant pursuing a federal permit to conduct an activity that may result in a discharge of a pollutant obtain a Water Quality Certification. A Water Quality Certification requires the evaluation of water quality considerations associated with dredging or placement of fill materials into waters of the U.S. Water Quality Certifications are issued by one of the nine geographically separated Regional Water Quality Control Boards (Regional Boards) in California. Under the CWA, the relevant Regional Board must issue a Section 401 Water Quality Certification for a project to be permitted under CWA Section 404.

The Clean Water Act: Section 402—NPDES Permit Program. NPDES Permit Program: CWA Section 402 establishes the NPDES, a permitting system for the discharge of any pollutant (except for dredged or fill material) into waters of the U.S. The Central Valley Regional Water Quality Control Board (Central Valley Water Board) is delegated with the responsibility of protecting the quality of surface and ground waters of the state in Proposed Project area.

The Clean Water Act: Section 404—Dredge/Fill Permitting. The discharge of dredged or fill material into waters of the U.S. is subject to permitting specified under Title IV (Permits and Licenses) of the CWA and specifically under Section 404 (Discharges of Dredge or Fill Material) of the CWA. Section 404 of the CWA regulates placement of fill materials into the waters of the U.S. Section 404 permits are administered by the USACE.

State

Porter-Cologne Act. The Porter-Cologne Act authorizes the state to implement the provisions of the CWA and establishes a regulatory program to protect the water quality and beneficial uses of waters of the state. The act requires projects that are discharging, or proposing to discharge, wastes that could affect the quality of the state's waters to file a report of waste discharge with the appropriate Regional Board.

Local

Colusa County General Plan Conservation Element. The Conservation Element of the Colusa County General Plan includes policies intended for the protection of the County's surface water quality (Colusa County 2012).

CONSISTENCY ANALYSIS

No conflict. Each of the six alternatives would involve work along the Sacramento River. The proposed project would conform to all federal, state and local water quality, waste discharge, and reporting requirements. Further the proposed project, if applicable, would obtain all necessary permits issued under CWA, including Section 401, Section 404, and NPDES permitting, and would implement a project SWPPP, and grading and erosion control BMPs to reduce water quality impacts.

Land Use and Planning

Local

Colusa County General Plan. Land use designations for the County are outlined in the General Plan and General Plan Land Use Map (Colusa County 2012). Zoning classifications, allowed uses, and development standards are outlined in the Colusa County Zoning Code (Colusa County 2014).

CONSISTENCY ANALYSIS

No conflict. Land use zoning would not change or be impacted by the implementation of the six alternatives. The proposed project would not require the development of new roads or structures that have the potential to divide an established community and would adhere to the land use designations in the Colusa County General Plan.

Noise

Local

Colusa County General Plan. The Noise Element of the Colusa County General Plan includes policies that seek to reduce community exposure to excessive noise levels through the establishment of noise level standards for a variety of land uses (Colusa County 2012). Noise standards specific to construction are not included in the Noise Element.

CONSISTENCY ANALYSIS

Potential conflict. The six alternatives would generate altered noise conditions only during project construction activities. With noise sensitive receptors in close proximity (schools, residents, etc.), there is a potential that the proposed project would temporarily not adhere to noise constraints outlined in the Colusa County General Plan.

Public Services and Utilities

Local

Colusa County General Plan. The Colusa County General Plan includes policies intended to address the following public services and facilities: water, wastewater, solid waste, fire protection and emergency medical services, law enforcement, and schools (Colusa County, 2012).

CONSISTENCY ANALYSIS

No conflict. The proposed project would not result in an increase in population that could result in an increased demand on public services, levels of service or service ratios. Therefore, the six

alternatives would adhere to public service guidelines outlined in the Colusa County General Plan.

Recreation

Local

Colusa County General Plan Open Space Element. The Open Space and Recreation Element of the Colusa County General Plan includes policies intended to govern the preservation of open space and the maintenance, expansion, and creation of recreational resources and amenities to maintain a high quality of life for the County's citizens (Colusa County 2012).

CONSISTENCY ANALYSIS

No conflict. The six alternatives would adhere to recreation guidelines outlined in the Colusa County General Plan. The proposed project would not permanently disturb recreational facilities and the proposed project would not result in increased population growth resulting in the need for additional recreational facilities.

Traffic and Transportation

State

Caltrans Transportation Corridor Concept Report – State Route 20. The Transportation Corridor Concept Report is a system planning document developed by Caltrans, as the owner and operator of the State Highway System, that identifies the existing and future route conditions as well as future needs for each route on the State Highway System. System planning is a statutory responsibility of Caltrans under Gov. Code §65086. It involves the evaluation of conditions and proposed enhancements to the State Highway System in order to meet Caltrans' goals of increasing safety, improving mobility, providing excellent stewardship, and meeting community and environmental needs along the corridor through integrated management of the transportation network (Caltrans 2015).

Local

Colusa County General Plan. The Circulation Element of the Colusa County General Plan provides the framework for decisions concerning the countywide transportation system, and includes policies intended to provide an efficient multi-modal road and highway system that meets the needs of its users (Colusa County, 2012).

CONSISTENCY ANALYSIS

No conflict. During construction, the proposed project would involve work within roadways and highways which would result in temporary disruptions to traffic and the circulation system. Prior to construction activities, a traffic management plan and a traffic safety plan would be developed in coordination with Colusa County. Upon completion of construction, vehicle traffic would return to pre-construction levels. Therefore, the six alternatives would adhere to traffic guidelines outlined in the Colusa County General Plan.

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Attachment B. Existing Conditions and Environmental Constraints

	Alternative 1 Impact Analysis	Alternative 2 Impact Analysis	Alternative 3 Impact Analysis	Alternative 4 Impact Analysis	Alternative 5 Impact Analysis	Alternative 6 Impact Analysis	Alternatives with Potential for Environmental Constraints
Impact Criteria and Existing Conditions							
Aesthetics							
Existing Conditions: There are no officially designated state or county highways in Colusa County. The only eligible state scenic highway in the county is located south of Williams along State Routes 20 and 16 (Caltrans 2018). The project area is located in rural Colusa County and is primarily dominated by lands under agricultural use. According to the Colusa County General Plan, the County is largely defined by its rural agricultural setting (Colusa County 2012). According to the Colusa County General Plan Conservation Element, the County is home to a wide variety of natural resources, waterways, wildlife habitat and historical resources (Colusa County 2012). The County is also home to three National Wildlife Refuges, two National Wildlife Management Areas, one State Recreation Area, two State Wildlife Areas, three Land Conservancy Areas, and a wide variety of habitat types and surface water resources that contribute to the scenic beauty and quality of life.							
Would the project create a substantial source of light or glare?	No. The proposed project does not include any permanent stationary sources of light. Light would be associated with the operation of construction vehicles and equipment. However, use of construction vehicles and equipment would occur on a temporary basis, primarily during daylight hours and would not substantially impact surrounding communities.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Is the Project located near a scenic highway?	No. There are no officially designated state or county highways in Colusa County. The only eligible state scenic highway in the county is located south of Williams along State Routes 20 and 16, which is outside of the project area.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project interfere with public views in the area?	No. The proposed project would involve the extension and construction of new levees. These levees would be consistent with the visual character of the area and would not substantially affect public views given that the project area is predominantly agricultural. Additionally, construction equipment would be used on a temporary basis and would be staged when not in use.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project damage scenic resources?	No. The proposed project involves levee improvement and construction and the implementation of ancillary flood control features. These activities would be consistent with the current uses and visual quality of the project area, and would not impact visual resources in Colusa County.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Agriculture and Forestry Resources							
Existing Conditions: According to the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP), Colusa is predominantly designated as Urban and Built-Up Land, with smaller parcels designated as grazing land. The Sacramento River is designated as Other Land. Outside of these areas, the project area includes Prime Farmland, Farmland of Local Importance, and Unique Farmland (DOC 2018). According to the Department of Conservation Colusa County Williamson Act FY 2013/14 Map, Williamson Act Prime Agricultural Land, Non-Prime Agricultural Land, and Farmland Security Zone properties are located within and adjacent to the project area (DOC 2013). According to the Colusa County General Plan Land Use Map, the proposed project is not located in areas designated for forest land (Colusa County 2012).							
Would the project result in the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance?	Yes. According the DOC FMMP, Colusa is designated as Urban and Built-Up Land and the Sacramento River is designated as Other Land. Outside of these areas, the proposed project includes Prime Farmland, Farmland of Local Importance, and Unique Farmland and has the potential to disturb or convert such land uses during construction and ground disturbing activities (DOC 2018).	Same as Alternative 1. The six alternatives have similar footprints; however, Alternative 2 comprises a larger footprint, followed by Alternative 1. Therefore Alternative 2 has the potential to disturb more Farmland of Local Importance, Prime Farmland and Unique Farmland.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6 Alternative 2 has the greatest potential for impacts, followed by Alternative 1.

Is the project located on a Williamson Act Contract property, or would it disturb a property under the Williamson Act Contract?	Yes. According to the Department of Conservation Colusa County Williamson Act FY 2013/14 Map, properties under Williamson Act contracts are located in the project area (DOC 2013). Ground disturbing activities have the potential to impact surrounding Williamson Act Properties.	Same as Alternative 1. The six alternatives have similar footprints; however, Alternative 2 comprises a larger footprint, followed by Alternative 1. Therefore, Alternative 2 has the potential to disturb more Williamson Act properties.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6 Alternative 2 has the greatest potential for impacts, followed by Alternative 1.
Would the Project result in the loss of forest land or conversion of forest land to non-forest use?	No. The proposed project would not result in the loss of forest land or conversion of forest land to non-forest use. According to the Colusa County General Plan Land Use Map, the proposed project is not located in areas designated for forest land (Colusa County 2012).	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Air Quality and GHG Emissions							
Existing Conditions: The project area is located within the jurisdictional boundaries of the Colusa County Air Pollution Control District (CCAPCD) and is subject to rules and regulations developed by the CCAPCD. The CCAPCD is responsible for implementing and enforcing State and Federal air quality regulations within Colusa County. Under the Federal NAAQS, the air quality within the CCAPCD has been characterized by the USEPA as unclassified/attainment for all criteria pollutants. However, under the State CAAQS, California Air Resources Board (CARB) has designated the CCAPCD as a nonattainment area for PM10 (CARB 2016). The proposed project is located in the Sacramento Valley Air Basin (SVAB). The SVAB is a broad, flat valley bounded by the Coastal Range to the west, the Sierra Nevada to the east, the Cascade Range to the north, and the San Joaquin Valley Air Basin to the south. The SVAB consists of 13 counties and is split into two planning sections based on the degree of pollutant transport and the level of emissions. Colusa County belongs to the Northern Sacramento Valley Air Basin. <u>Sensitive Receptors</u> Schools within the project area include Colusa Alternative Home School, James M. Burchfield Primary Elementary School, George T Egling Middle School, Colusa High School, Our Lady of Lourdes School, Colusa Community School, Charity Baptist Academy, and Union High School. Colusa Children's Services and Education Village is located approximately 0.25 mile southwest of the Sacramento River. Medical facilities in the City of Colusa include Colusa Medical Center, Colusa Health Clinic and Internal Medicine, Ampla Health Colusa Medical and Dental, and Riverside Health Clinic.						
Would project result in substantial emissions?	Yes. During construction the project would require the use of construction vehicles and equipment on a temporary basis. Significant air quality impacts could result from particulate matter generated during construction activities, such as dust and equipment exhaust. However, the proposed project would not create emissions post construction and no new stationary emissions sources are proposed.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
Would the project create objectionable odors?	No. The proposed project involves implementation of flood protection and remediation measures and does not involve activities that involve the long term creation of objectionable odors during construction or post construction.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project expose sensitive receptors to substantial pollutant concentrations?	Yes. Sensitive receptors nearest the proposed project include Colusa County Community School, located approximately .30 mile southwest of the Sacramento River and Colusa Children's Services and Education Village, located approximately 0.25 mile southwest of the Sacramento River. Colusa Medical Center and Colusa Health Clinic and Internal Medicine are located within a 0.5 mile radius of the proposed project. Operation of construction vehicles and equipment could result in increased emissions on a short term basis and impacts on sensitive receptors would not be substantial.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
Would the project generate GHG emissions either directly or indirectly?	Yes. Operation of construction vehicles and equipment could generate GHG emissions on a short term, intermittent basis.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6

Biological Resources							
Existing Conditions: See Attachment C, Biological Resources Analysis, for existing conditions and detailed analysis.							
Is the Project located adjacent to terrestrial or aquatic habitat areas for state or federally listed endangered, threatened, or candidate species?	Yes. Database query results returned a large number of special-status species with a potential to occur in the vicinity of the project area (Attachment C, Attachment C-1). Attachment C Table 1 provides a description of the special-status species that have the potential to occur in each of the delineated vegetation communities. Several aquatic resources and vegetation communities in the project area would be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. These areas include the following communities: riparian, agricultural ditches, open water, and other potential aquatic resources. It is recommended that a formal delineation of aquatic resource be completed prior to any work in order to determine the level of impact on sensitive communities. Depending on the project alternative chosen and the biological resources that may be affected, there are numerous agencies that may need to be consulted with and/or permits completed (See Section 4, *Environmental Documentation, Permits and Approvals*).	Same as Alternative 1. However, Alternative 2 has the highest potential for impacts given that it comprises the largest construction footprint, followed by Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Alternatives 1, 2, 3, 4, 5 and 6 Alternative 2 would have the highest potential for impacts, followed by Alternative 1.
Would the Project have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	Yes. There are two critical habitat units that are within or adjacent to the project area. The designated final critical habitat unit for vernal pool tadpole shrimp (Lepidurus packardi), VERTS 6, is located in the southern portion of the project area (USFWS 2018b). This area is largely delineated as annual grassland and orchard with areas of open water and numerous potential wetlands. The proposed critical habitat unit for western yellow-billed cuckoo (Coccyzus americanus), CA Unit 2, extends along the Sacramento River from Red Bluff south to Colusa (USFWS 2014). This unit is largely outside of the project area, however narrow portions of CA Unit 2 overlap with the project area, specifically with the riparian corridor along the Sacramento River levee. In addition, the Sacramento River immediately adjacent to the project area is designated critical habitat for multiple runs of the chinook salmon (Oncorhynchuys tshawytscha) as well as steelhead (Oncorhynchys mykiss) (USFWS 2018b). Database query results returned a large number of special-status species with a potential to occur in the vicinity of the project area (Attachment C, Attachment C-1). Several aquatic resources and vegetation communities in the project area would also be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. Proposed project activities would require ground disturbance and vegetation removal in the levee footprint and the right of way, which could impact associated special-status species, should they be present, and these species should be considered when consulting with the appropriate agencies.	Same as Alternative 1. However, Alternative 2 has the highest potential for impacts given that it comprises the largest construction footprint, followed by Alternative 1.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6 Alternative 2 would have the highest potential for impacts, followed by Alternative 1.

Would the Project have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	Yes. Several aquatic resources and vegetation communities in the project area would be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. These areas include the following communities: riparian, agricultural ditches, open water, and other potential aquatic resources. It is recommended that a formal delineation of aquatic resource be completed prior to any work in order to determine the level of impact on sensitive communities. Proposed project activities would require ground disturbance and vegetation removal in the levee footprint and the right of way, which could impact associated special-status species, should they be present, and these species should be considered when consulting with the appropriate agencies.	Same as Alternative 1. However, Alternative 2 has the highest potential for impacts given that it comprises the largest construction footprint, followed by Alternative 1.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6 Alternative 2 would have the highest potential for impacts, followed by Alternative 1.
Does the project conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	No. No Habitat Conservation Plans, Natural Community Conservation Plans, or other approved conservation plans were identified in the project area and none would be impacted by proposed project activities.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the Project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	No. The Sutter Bypass is located approximately 2 miles east of the project area. The bypass is part of a large, engineered floodway that runs adjacent to the Sacramento River from north of the Sutter Buttes, south to the Sacramento-San Joaquin Delta. The bypass acts as a wildlife movement corridor for numerous terrestrial and aquatic species. Given the distance from the project area, impacts to the Sutter Bypass are not likely to occur. However, aquatic resources provide a variety of functions for plants and wildlife including habitat, foraging, cover, migration, and movement corridors. Several aquatic resources and vegetation communities were identified in the project area. It is recommended that a formal delineation of aquatic resource be completed prior to any work in order to determine the level of impact on sensitive communities and wildlife corridors.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the Project have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	Yes. The Wildlife Heritage Foundation operates the Dolan Preserve in the southeast portion of the project area, within an area delineated as annual grassland and potential wetlands (CCED 2018). Additionally, the designated final critical habitat unit for vernal pool tadpole shrimp (Lepidurus packardi), VERTS 6, is located in the southern portion of the project area (USFWS 2018b). This area is largely delineated as annual grassland and orchard with areas of open water and numerous potential wetlands. Agricultural ditches identified in the project area also have the potential to fall under state or federal jurisdiction, however a formal aquatic resources delineation would need to be conducted to verify the jurisdiction of these features.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
Cultural and Tribal Cultural Resources							

Existing Conditions: See Attachment D, Cultural Resources Analysis, for existing conditions and detailed analysis.							
Do known historical, archaeological, or tribal sites resources occur in the Project Area?	Yes. Based on the review of the records search results, historic maps, and the site reconnaissance presented in Attachment D, the project area contains 105 built environment resources eligible for listing on the CRHR/NRHP. The prehistoric, ethnographic, and historical contexts indicate a low to moderate sensitivity of the Project area for unrecorded, surficial archaeological sites with a high potential for those sites, when identified, to have buried components. Further, the Project exhibits a high sensitivity for historical features and buildings in the vicinity of known historical resources.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
Does the Project require excavations or ground disturbance that could inadvertently impact known or unknown cultural, historical, or archaeological resources?	Yes. Construction of the proposed project would require ground disturbance, excavations, implementation of fill, compaction, and use of heavy equipment. These activities have the potential to result in impacts to the cultural resources listed in Attachment D, should the resources be identified within, or potentially in the vicinity of, a proposed work area. Any newly discovered archaeological site which cannot be avoided by the proposed project must be evaluated for eligibility to the CRHR and/or NRHP. If eligible, additional mitigation may be required if significant impacts/adverse effects cannot be avoided.	Same as Alternative 1. However, Alternative 2 has the highest potential for impacts given that it comprises the largest construction footprint, followed by Alternative 1.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6 Alternative 2 would have the highest potential for impacts, followed by Alternative 1.
Would the project disturb any human remains, including those interred outside of dedicated cemeteries?	Yes. Based on the records search, one potentially significant prehistoric site just north of Colusa, P-06-00032 (CA-COL-008), was first recorded in 1949 and was likely an extensive habitation site located adjacent to the Sacramento River and included human remains and beads. The site was presumed to have been mostly destroyed by levee construction. However, identification efforts in 2009 and 2010 identified sparse to moderate quantities of prehistoric material (freshwater clam shell, obsidian and basalt flaked stone, groundstone, clam shell beads, an olivella shell bead, faunal bone) and human bone; suggesting that the prehistoric deposit may be more extensive (and potentially intact) than what had been previously noted. However, these areas would be avoided during proposed project activities. In the event that human remains are inadvertently discovered outside of dedicated cemeteries, work would stop immediately and the County Coroner would be contacted for consultation.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
Energy							
Existing Conditions: Pacific Gas and Electric (PG&E) provides energy services to Colusa County. The following is a breakdown of PG&E's primary energy sources (PG&E 2018): • Non-emitting nuclear generation (27 percent) • Large hydroelectric facilities (18 percent) • Eligible renewable resources, such as wind, geothermal, biomass, solar and small hydro (33 percent). • Natural gas/other (20 percent) • Unspecified power (2 percent). This electricity is not traceable to specific sources by any auditable contract trail. According to the California Energy Commission, Colusa County consumed 296 GWh of energy in 2017 (California Energy Commission 2016).							

Would the project result in a potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy, or wasteful use of energy resources, during project construction or operation?	No. The proposed project would use limited amounts of energy during construction through the operation of construction equipment. Regular energy usage would not be required post construction of the proposed project. PG&E would have the capacity to support the project's energy needs. Therefore, impacts on energy resources would not be substantial.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the Project conflict with or obstruct a state or local plan for renewable energy or energy efficiency?	No. The proposed project would comply with state and local plans for renewable energy and energy efficiency.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Geology, Soils and Mineral Resources							
Existing Conditions: According to the Colusa County General Plan and EIR, the project area is in a region of California characterized by relatively low seismic activity (Colusa County, 2011, 2012). No Alquist-Priolo Earthquake Fault Zones and no Seismic Hazard Zones are identified within the County. According to the Natural Resource Conservation Service (NRCS) Web Soil Survey for Colusa County, the project area contains mainly Willows silty clay and Scribner silt loam soils (NRCS, 2015). The Willows series consists of very deep, poorly to very poorly drained sodic soils formed in alluvium from mixed rock sources. According to the Colusa County General Plan and EIR, much of the County's land surface is comprised of soils that would require special design considerations due to shrink-swell potentials (Colusa County, 2011, 2012). According to the University of California Museum of Paleontology at Berkeley and the 2016 PaleoDatabase, paleontological resources are known to exist in Colusa County (Bureau of Reclamation 2017). According to USGS Mineral Resources Online Spatial Data map, a mineral resources mine, past or present producer is located approximately 0.25 mile west of the project area, west of Princeton Road in the northwest portion of the City (USGS 2018).							
Would the project require excavations, grading, or other ground disturbing activities capable of causing erosion or loss of topsoil?	Yes. The proposed project would require ground disturbance, excavations, implementation of fill, compaction, and use of heavy construction equipment. These, and other activities with the potential to result in erosion and loss of topsoil under the proposed project include remediation of the Sacramento River SPFC west and Powell Slough levees, extension of the Powell Slough levee, levee construction, and non-structural improvements. The proposed project would adhere to erosion and grading control ordinances within the Colusa County General Plan and impacts would not be substantial.	Same as Alternative 1. However, Alternative 2 would involve the largest footprint compared to the other alternatives, followed by Alternative 1. Therefore Alternatives 1 and 2 consist of the greatest area of disturbance. and would have a higher potential for impacts on erosion and loss of topsoil.	Same as Alternative 1.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6 Alternative 2 would have the highest potential for impacts, followed by Alternative 1.
Is the Project located in a seismically active area?	No. According to the Colusa County General Plan and EIR, the project area is in a region of California characterized by relatively low seismic activity (Colusa County, 2011, 2012). No Alquist-Priolo Earthquake Fault Zones and no Seismic Hazard Zones are identified within the County.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Are new permanent structures proposed that could expose people to seismic related hazards such as landslides, liquefaction, ground failure, strong seismic ground shaking?	No. The project area is in a region of California characterized by relatively low seismic activity. Although the proposed project would involve the construction and extension of levees, no impacts would occur because seismic hazards are lacking in the project area (Colusa County, 2011, 2012).	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None

Is the Project located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	No. The project area is not located on a geologic unit or soil(s) that are unstable, or that would become unstable as a result of the proposed project, thereby resulting in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. According to the Colusa County General Plan and EIR, much of the County's land surface is comprised of soils that would require special design considerations due to shrink-swell potentials (Colusa County, 2011, 2012), however, these considerations would be factored into the project design.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Are mineral resources present in the project area?	According to USGS Mineral Resources Online Spatial Data map, a "mineral resources mine, past or present producer" is located approximately 0.25 mile west of the project area, west of Princeton Road in the northwest portion of the City (USGS 2018). However, proposed improvements would not extend to these areas. As a result, there would be no impact.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Do known paleontological resources exist in the Project Area?	Yes. According to the University of California Museum of Paleontology at Berkeley and the 2016 PaleoDatabase, paleontological resources are known to exist in Colusa County (Bureau of Reclamation 2017). If paleontological resources are identified in the project area during construction, the proposed project would follow policies outlined in the Colusa County General Plan Conservation Element and the Society of Vertebrate Paleontology's standard procedures for the assessment and mitigation of adverse impacts on paleontological resources. With these measures in place, impacts on paleontological resources would not be substantial.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None

Hazards and Hazardous Materials

Existing Conditions:

According to Cal/EPA, the provisions in Government Code Section 65962.5 are commonly referred to as the "Cortese List." A site's presence on the list has bearing on the local permitting process. The Cortese list, which includes the resources listed below, was reviewed for references to the project area and vicinity:

- List of Hazardous Waste and Substances sites from the DTSC EnviroStor database;
- List of Leaking Underground Storage Tank Sites from the SWRCB GeoTracker database;
- List of solid waste disposal sites identified by SWRCB with waste constituents above hazardous waste levels outside the waste management unit;
- List of "active" Cease and Desist Orders and Cleanup and Abatement Orders from SWRCB; and
- List of hazardous waste facilities subject to corrective action identified by DTSC.

Noteworthy Database Listings

According to the DTSC EnviroStor Database, a number of LUST Cleanup sites are located in the vicinity of the proposed alternatives, south of the Sacramento River and along the northern border of the City of Colusa. These include I.G. Zumalt (850 Market Street; gasoline contamination in soil); Jackpot SS (809 Market Street; gasoline contamination in soil); PG&E (105 2nd Street; gasoline contamination in soil); Circle-K (11 Market Street; gasoline contamination in an aquifer used for drinking water supply). Each of these LUST cases has been closed.

The former PG&E Manufactured Gas Plant (MGP) is located at 105 2nd Street, less than 350 feet from the proposed project. According to EnviroStor, the site is an open cleanup site. Contaminants of concern include arsenic, polynuclear aromatic hydrocarbons (PAHS), waste oil (motor, hydraulic, and lubricating). The potential media of concern in an aquifer used for drinking water supply (Colusa Basin -Sycamore-Sutter). The site was the location of a manufactured gas plant that operated from 1886 to 1940. PG&E bought the plant in 1906 and continued using the plant until 1940. The site is currently used by PG&E as a service center for gas and electric work crews, a substation and poleyard. The site comprises of 1.4 acres.

Tri County Petroleum is located at 1630 East Clay Street, approximately 200 feet from the Sacramento River. The site is a an open cleanup program site that has operated as a bulk plant since 1951. Potential contaminants of concern include petroleum from automotive gasolines and diesel fuels. The potential media of concern is groundwater (Colusa Basin - Sycamore-Sutter).

River Ranch, located on River Ranch Road less than 500 feet north of the proposed project is an open cleanup program site for potential gasoline contamination in the soils onsite. According to EnviroStor, in 1993, a Phase I environmental assessment was conducted at the property. The Site contained a fruit dehydrator facility which contained a 10,000 gallon vertical above ground storage tank (AGT), a 10,000 gallon horizontal AGT, small building next to a potable water supply well, metal shed used for storing oil drums, and other facilities. Heavy oil staining was observed at the base of the two AGTs and the metal shed used for drum storage. Later in 1993 and 1994, contaminated soil was excavated from around the AGTs and drum storage area.

Other Hazards

According to the California Department of Forestry and Fire Protection (Cal Fire) Fire Hazard Severity Zone Map for Colusa County, the proposed project is located in an "LRA Unzoned" area. The City of Colusa is outside of areas zoned for Very High and High fire hazard severity; however, portions of the project area are within a Moderate fire hazard severity zone (Cal Fire 2007).

The nearest airport is Colusa County Airport, located at 100 Sunrise Blvd. The airport is adjacent to Alternatives 2 and 3 and approximately 0.62 mile north of Alternative 1. Schools within the project area include Colusa Alternative Home School, James M. Burchfield, Primary Elementary School, George T Egling Middle School, Colusa High School, Our Lady of Lourdes School, Colusa Community School, and Union High School.

Be located on a site which is included on a list of hazardous materials sites compiles pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	Yes. According to the DTSC EnviroStor database, the proposed project is located less than 500 feet from three open program cleanup sites, including the former PG&E MGP, Tri County Petroleum, and River Ranch. Ground disturbing activities and excavations associated with the proposed project within the direct vicinity of these listings have the potential result in hazards to the public and environment. Work on these sites is not anticipated; however, it is possible that contamination from these sites has spread to the project area.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
Would the project impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	No. Implementation of the proposed project is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Does the Project require the use or routine transport of hazardous materials?	Yes. Construction vehicles and equipment containing grease and oils would be utilized during the construction phase. Implementation of spill prevention measures to address the accidental or inadvertent release of oil, grease, or fuel into adjacent waterways would further help minimize potential construction-related water quality impacts. Impacts would not be substantial with the implementation of BMPs.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the Project emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	Yes. Most of the schools near the project area are located directly in the City of Colusa, outside of where proposed project activities would occur. The nearest school is Colusa County Community School, located approximately 0.30 mile south of the Sacramento River. However, it is possible that construction vehicles and equipment would be operated in the vicinity of or use streets adjacent to schools for site access. As a result, operation of construction vehicles and equipment in the vicinity of these schools, although temporary, could expose sensitive receptors to emissions. To the extent possible, emissions would be controlled and contained through the implementation of BMPs.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	Yes. The nearest airport is Colusa County Airport, located at 100 Sunrise Blvd, adjacent to Alternatives 1, 3, 4 and 6. Work within this span of the project area could result in a safety hazard or excessive noise during construction. When working in the vicinity of the airport, construction workers would be required to wear personal protective equipment (PPE), such as hearing protection, to minimize impacts. Alternatives 1, 3, 4 and 6 would have the greatest potential for impacts given that they are located adjacent to the airport.	Yes. The nearest airport is Colusa County Airport, located at 100 Sunrise Blvd, approximately 0.50 mile north of Alternatives 2 and 5. Work within this span of the project area could result in safety hazards or excessive noise during construction. When working in the vicinity of the airport, construction workers would be required to wear personal protective equipment (PPE), such as hearing protection, to minimize impacts.	Same as Alternative 1. Alternatives 1, 3, 4 and 6 would have the greatest potential for impacts given that they are located adjacent to the airport.	Same as Alternative 1. Alternatives 1, 3, 4 and 6 would have the greatest potential for impacts given that they are located adjacent to the airport.	Same as Alternative 2	Same as Alternative 1. Alternatives 1, 3, 4 and 6 would have the greatest potential for impacts given that they are located adjacent to the airport.	Alternatives 1, 2, 3, 4, 5 and 6 Alternatives 1, 3, 4 and 6 would have the greatest potential for impacts

Would the Project expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires?	No. According to the Cal Fire Fire Hazard Severity Zone Map for Colusa County, the proposed project is located in an "Local Responsibility Area Unzoned" area. Colusa is outside of areas zoned for Very High and High fire hazard severity. Therefore, it is unlikely that the proposed project would lead to a significant risk of loss, injury or death involving wildland fires.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Hydrology and Water Quality							
Existing Conditions: According to the Colusa County General Plan and EIR, water is supplied to the County from both groundwater, used mainly for domestic water systems, and surface water, such as the Colusa Drain, used mainly for irrigation systems (Colusa County 2011, 2012). The County is subject to flooding problems due to its poorly drained valley floor.According to the County of Colusa Flood Safety Plan Map, the proposed project is located within both the 100-year and 500-year flood zones (Colusa County 2018). <u>Groundwater</u> The project area is located in the Sacramento Valley Groundwater Basin, a large basin which covers over 5,900 square miles and 10 counties. This basin is divided into several smaller subbasins, and the County overlies portions of two subbasins: the Colusa (project area) and West Butte Subbasins. <u>Surface Water</u> The majority of the County is considered part of the Sacramento River Hydrologic Region. The Sacramento River is the only major naturally occurring water body in the County, running north to south through the eastern portion of the County. There are also four major man-made water bodies in the County: Colusa Basin Drainage Canal, Tehama Colusa Canal, Princeton-Codora-Glenn Irrigation Canal (also referred to as River Branch Canal), and East Park Reservoir.						
Would the project alter the drainage pattern of the site or area in a manner which would result in substantial erosion or siltation?	Yes. Construction activities associated with the proposed project could potentially cause or result in erosion and/or siltation. Erosion of onsite soils can lead to increased levels of suspended sediments and turbidity in receiving waters, and could potentially impact water quality and result in a violation of water quality standards during construction.	Same as Alternative 1. However, Alternative 2 comprises a larger footprint than the other alternatives, followed by Alternative 1. Therefore there is a greater potential for impacts on erosion and siltation under Alternative 2.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Alternatives 1, 2, 3, 4, 5 and 6. Alternative 2 would have the highest potential for impacts, followed by Alternative 1.
Would the project alter the drainage pattern of the site or area or result in an increase in surface runoff in a manner which would result in flooding on- or off-site?	No. Proposed project activities would alter the drainage pattern of the area; however, the project is intended to provide flood damage reduction and would therefore result in beneficial impacts on flooding.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project conform to water quality standards and waste discharge requirements?	Yes. During construction, the proposed project has the potential to result in erosion, which could lead to increased levels of suspended sediments and turbidity in receiving waters. However, the proposed project would conform to water quality standards during construction through the implementation of BMPs, such as grading and erosion control measures, as well as the implementation of a project SWPPP to reduce polluted storm water runoff.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Is the Project located within a 100-year flood hazard area?	Yes. According to the County of Colusa Flood Safety Plan Map, the proposed project is located within both the 100-year and 500-year flood zones (Colusa County 2018). However, flood risks in the project area are not considered a restraint to project implementation, as the purpose of the proposed project is to provide flood damage reduction.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project require the use of groundwater or hinder groundwater recharge?	No. The proposed project would not require the use of groundwater and would not involve the implementation of impervious surfaces to the extent that groundwater recharge would be hindered. Therefore, impacts on groundwater would not be substantial.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None

Would the project create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff?	No. Construction, ground disturbing activities and work along the Sacramento River have the potential to contribute to increased runoff on a temporary basis. However, the proposed project would include a Stormwater Pollution Prevention Plan (SWPPP) and would not exceed the capacity of existing or planned storm water drainage or provide substantial additional sources of polluted runoff.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Land Use and Planning							
Existing Conditions: The proposed project is located in the City of Colusa, an unincorporated community in Colusa County, California. The City of Colusa covers an area of approximately 1.83 square miles and is located along the west bank of the Sacramento River approximately 13 miles downstream of the city of Princeton. According to the Colusa County General Plan Land Use Map, predominant land uses in the city of Colusa include industrial, urban residential, rural residential, urban reserve area, commercial, and parks and recreation. Land within the project area immediately surrounding Colusa to the north, west, south, and east are designated for general agricultural purposes (Colusa County 2012). The Sacramento River to the east is a designated floodway (Colusa County 2012). According to the Colusa County Zoning Map, predominant zonings in the City include commercial, agricultural, residential, public facilities, and airport (Colusa County 2014). The area along the Sacramento River within the proposed project area is zoned as F-M: Flood Management. Colusa National Wildlife Refuge is located one mile southwest of the City of Colusa in Colusa County. The Colusa National Wildlife Refuge is a part of the Sacramento National Wildlife Refuge Complex and consists of approximately 5,077 acres consisting primarily of wetlands, grasslands and riparian habitats (USFWS 2016).							
Is the proposed action consistent with the predominant character of the existing built or natural landscape?	Yes. The area along the Sacramento River within the project area is zoned as F-M: Flood Management. Residential, commercial, public uses, and agricultural zonings are also predominant in the project area (Colusa County 2014). Flood improvement measures under the proposed project are consistent with these zonings and would not preclude current land uses.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Is the proposed action permitted under zoning regulations?	Yes. The area along the Sacramento River within the proposed project area is zoned as F-M: Flood Management. Residential, commercial, public uses, and agricultural zonings are also predominant in the project area (Colusa County 2014). Flood improvement measures under the proposed project are consistent with these zonings and would not preclude current land uses.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the Project physically divide an established community?	No. The proposed project would not require the development of new roads or structures that have the potential to divide an established community. The newly proposed levees, levee extensions, and other ancillary flood control features are predominantly located outside of the City of Colusa in agricultural areas and would not divide an established community. Therefore, no impact would occur.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Noise							
Existing Conditions: Land uses typically considered sensitive to noise include hospitals, parks, churches, schools, libraries, and other uses where low interior noise levels are essential. Noise sensitive receptors in the vicinity of the project area include Colusa Levee Scenic Park, located adjacent to the Sacramento River; Sacramento State Park and Colusa-Sacramento River State Recreation Area, located approximately 0.12 mile west of the Sacramento River; Colusa County Library, located approximately 0.11 mile south of the Sacramento River; Colusa County Community School, located approximately 0.30 mile southwest of the Sacramento River; Colusa Children's Services and Education Village, located approximately 0.25 mile southwest of the Sacramento River; Colusa Medical Center and Colusa Health Clinic and Internal Medicine, located within a 0.5 mile radius of the proposed project; Christian Church, First Presbyterian Church, located less than 0.25 mile from the proposed project; and Assembly of God, located adjacent to Alternatives 2 and 3 along State Route 20. Noise standards specific to construction are not included in the Noise Element. The Colusa County General Plan establishes exterior and interior noise level performance standards for projects affected by, or including, non-transportation noise sources. These are as follows (Colusa County 2012): •All sensitive land uses have an interior noise level standard of 45dB Lmax; a daytime (7am to 10pm) exterior noise level of 55dB, and a nighttime (10pm to 7am) exterior noise level of 45 dB Lmax. •New residential affected by existing seasonal agricultural noise has an interior noise level standard of 40 dB Ldn. No exterior noise level thresholds exist under this category. *Note: *Exterior noise level standard to be applied at the property line of the receiving land use or at a designated outdoor activity area (at the discretion of the Planning Director) of the new development. For mixed-use type projects, the exterior noise level standard may be waived (at the discretion of the Planning Director) if the project does not include a designated activity area and mitigation of property line noise is not practical. In this case, the interior standard would still apply.* *Terms:* *Decibel, or dB: A unitless measure of sound on a logarithmic scale, defined as ten times the logarithm of the ratio of the sound pressure squared over the reference pressure squared.* *Ldn:L Day/Night average sound level* *Leq: Equivalent or energy-averaged sound level.* *Lmax: The highest root-mean-square (RMS) sound level measured over a given period of time.*							

Would the project generate noise in excess of thresholds outlined in the county noise ordinance or general plan?	Yes. Sensitive receptors in the project area are discussed in Existing Conditions above. The proposed project has the potential to generate noise in excess of local thresholds during the operation of construction vehicles and equipment. Construction activities would primarily consist of excavation, fill and compaction, which would not substantially increase noise levels. However, soil bentonite cut-off wall construction along the Sacramento River West SPFC Levee in areas adjacent to developed Colusa would generate higher noise levels than typical excavation, fill, and compaction activities. Generally, construction activities would not occur in the direct vicinity of sensitive receptors. Construction would be temporary and intermittent and therefore, noise levels would return to pre-construction levels once construction is completed.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
Would the Project generate excessive ground borne vibration or ground borne noise levels?	Yes. Operation of construction equipment and ground disturbing activities would result in ground borne vibration and ground borne noise. However, ground borne noise and vibration impacts would occur on a short term, intermittent basis and would not be substantial.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6
Public Services and Recreation							
Existing Conditions: Police services in the unincorporated areas of the County, which include the project area, are provided by the Colusa County Sheriff's Department. The Sheriff's Department is responsible for law enforcement patrol services. Colusa Police Department also provide police services for the City of Colusa and is located at 260 6th Street in Colusa. Fire protection services in the project area are provided by the Sacramento River Fire Protection District, which also provides emergency medical services, rescue, and hazardous materials response services to the eastern portion of the unincorporated County. Colusa Fire Department also provides fire services for the City of Colusa and is located at 750 Market Street in Colusa. The department is made up of 5 paid staff and 25 volunteer personnel. Colusa Parks and Community Services Department (Recreation Department) is responsible for an aquatics complex, softball facility and 10 existing parks within the City of Colusa. Parks and reaction areas nearest the proposed alternatives include Colusa Levee Scenic Park and the Colusa-Sacramento River State Recreation Area, which are both located adjacent to the Sacramento River along the proposed levee improvements. Wildlife Heritage Foundation operates the Dolan Preserve in the southeast portion of the project area. Schools within the project area include Colusa Alternative Home School, James M. Burchfield, Primary Elementary School, George T Egling Middle School, Colusa High School, Our Lady of Lourdes School, Colusa Community School, Charity Baptist Academy, and Union High School.						
Would the project result in an increase in response times for public services such as police and fire protection?	No. The proposed project would not result in an increase in population that could result in an increased demand on public services or response times. Further, the proposed project would not interfere with emergency routes and would implement a traffic safety plan. As a result there would be no impact on public services response times.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services: Fire protection, police protection, schools, parks, other public facilities?	No. The proposed project would not result in an increase in population that could result in an increased demand on public services, levels of service or service ratios. As it relates to emergency response times, the proposed project would not interfere with emergency routes and would implement a traffic safety plan. As a result there would be no impact on public services.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project damage parks or other public facilities?	No. The proposed project would not damage parks or public facilities. The proposed project would involve remediation of the Sacramento River SPFC west levee which is located in the vicinity of the Colusa Levee Scenic Park and the Colusa-Sacramento River State Recreation Area. Proposed project activities could result in temporary disruptions or closures to these recreation areas during construction, particularly Colusa Levee Scenic Park; however, access and conditions would return once construction is complete.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None

Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	No. The proposed project does not include recreational facilities and would require expansion of recreational facilities. Further, the proposed project would not result in increased population growth resulting in the need for additional recreational facilities. Therefore, there would be no impact.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	No. The proposed project would not result in increased population growth resulting in the increased use of parks and recreational facilities. The proposed project would involve remediation of the Sacramento River SPFC west levee which is located in the vicinity of the Colusa Levee Scenic Park and the Colusa-Sacramento River State Recreation Area. Proposed project activities could result in temporary disruptions or closures to these recreation areas during construction, particularly Colusa Levee Scenic Park; however, access and conditions would return once construction is complete. Therefore, there would be no impact.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Traffic and Transportation							
Existing Conditions: According to the Colusa County General Plan and EIR, the roadway network within the unincorporated parts of the County is rural in character and mainly serves small communities and agriculture uses (Colusa County, 2011, 2012). Interstate 5 (I-5), SR 20 and SR 45 are the primary transportation corridors extending through the County; other County arterials and a network of local public and private roads make up the remainder of the roadway system.							
Would the proposed action result in a substantial increase in traffic above present levels?	No. The proposed project has the potential to temporarily increase the volume of traffic present on local roads and highways during construction. However, any long-term effect of the proposed project on transportation and circulation issues would be negligible.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project conflict with a plan, ordinance or policy addressing the circulation system, including transit, roadways, bicycle lanes and pedestrian paths?	No. The proposed project would conform to relevant plans, ordinances and policies addressing the circulation system. Construction vehicles and equipment would utilize local roads and highways on a temporary basis. Construction equipment would be staged to the extent possible when not in use. Prior to proposed project activities, a Traffic Management Plan would be developed in coordination with Colusa County and the City of Colusa. Additionally, implementation of the proposed project is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g. farm equipment)?	No. The proposed project involves levee remediation and construction, and extension of the Powell Slough. These activities would be consistent with the current uses and would not create traffic or transportation hazards due to a geometric design feature.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project result in inadequate emergency access?	No. Implementation of the proposed project is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities. The proposed project would adhere to the traffic safety plan and would not interfere with emergency access routes.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None

Would the project result in disruptions to traffic or the circulation system?	Yes. The proposed project would involve work within roadways and highways which would result in temporary disruptions to traffic and the circulation system. Roads, highways and lanes through which the alignment passes could be blocked on a temporary basis. Construction equipment would be staged to the extent possible when not in use. Prior to proposed project activities, a Traffic Management Plan would be developed in coordination with Colusa County and the City of Colusa. Additionally, implementation of the proposed project is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities. However, temporary disruptions to traffic would still occur. Alternatives 1 and 4 would have a higher potential for impacts given that improvements in the southeastern portion of the project area would occur along a longer span of SR-20, which is a primary transportation corridor.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1. Alternatives 1 and 4 would have a higher potential for impacts given that improvements in the southeastern portion of the project area would occur along a longer span of SR-20, which is a primary transportation corridor.	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6 Alternatives 1 and 4 would have a higher potential for impacts
Utilities and Service Systems							
Existing Conditions: Water service in the project area is supplied from groundwater and surface water. All domestic water systems in the County are supplied with groundwater (private wells), and most irrigation systems are supplied with surface water. Wastewater in the project area is treated and disposed of using onsite disposal, such as for much of the unincorporated County. Solid waste disposal in the project area, for residential or commercial garbage, is provided by Recology Butte Colusa Counties. Landfills serving the project area include the Maxwell Transfer Station and the Stonyford Disposal Site. Stonyford Disposal Site has a remaining capacity of 55,683 cubic yards per day and a maximum permitted throughput of 10 tons per day. Maxwell Transfer Facility has a max permitted throughput of 180 tons per day (remaining capacity not available) (CalRecycle 2018).							
Would the proposed Project connect to an existing public/private water supply?	No. The proposed project would not require connection to an existing public or private water supply.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	No. The proposed project would not generate wastewater that would need to be treated by a local wastewater treatment provider.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the project have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?	Yes. Limited amounts of water would be used during construction; however, no water would be required post construction. Therefore, no impacts on water supply would result from the proposed project.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?	Yes. The proposed project would generate limited amounts of solid waste during construction. No solid waste would be generated post construction. The proposed project would comply with federal, state and local regulations on solid waste.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None

Generate solid waste in excess of State or local standards or in excess of the capacity of local infrastructure?	No. Limited amounts of solid waste such as construction debris, municipal waste and green waste would be generated during construction. Solid waste would not be generated post construction. Stonyford Disposal Site and Maxwell Transfer Station serve the project area. Stonyford Disposal Site has a remaining capacity of 55,683 cubic yards per day and a maximum permitted throughput of 10 tons per day. Maxwell Transfer Facility has a max permitted throughput of 180 tons per day (remaining capacity not available). The proposed project would not generate waste in excess of state or local standards and could be accommodated by local infrastructure.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	None
Would the Project require or result in the relocation or construction of new or expanded water, or wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities or expansion of existing facilities, the construction or relocation of which could cause significant environmental effects?	Yes. The proposed project would not increase demand for solid waste disposal, water service, wastewater treatment, electric power, natural gas or telecommunications facilities, and would not require service by local utility providers. However, overhead utility lines are present along surface streets and highways in the project area, and there is potential that unseen underground utility infrastructure exists in the project area. Therefore, utility infrastructure would need to be relocated as a result of the proposed project.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Alternatives 1, 2, 3, 4, 5 and 6

Attachment C. Biological Resources Analysis

Memo

Date:	Friday, January 11, 2019
Project:	Colusa Flood Risk Reduction Feasibility Study
To:	Colusa County
From:	Scott Tidball, Biologist (HDR)
Reviewed:	Summer Pardo, Senior Biologist (HDR)
Subject:	Colusa – Biological Constraints Analysis

Introduction

This memo presents a preliminary review of potential biological constraints for the Colusa Flood Risk Reduction Feasibility Study project. Potential constraints are described below.

Methodology

Desktop Review

A desktop review was undertaken to assess potential biological constraints in the Colusa project area (Figure 1), which included two steps to collect data on special-status species, vegetation communities, sensitive communities, protected lands, and federally-protected aquatic resources with the potential to occur in the project area. First, preliminary database searches were performed to identify aquatic resources and special-status species with the potential to occur in the project area. Second, a preliminary review of recent aerial imagery and land use maps was conducted to collect site-specific data regarding habitat suitability for special-status species, and to see if any protected lands overlap with the project area.

Database searches were performed on the following websites:

- U.S. Fish and Wildlife Service's (USFWS) Information Planning and Consultation (IPaC) System (2018a);
- USFWS Critical Habitat Portal (2018b);
- California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB) in BIOS 5 (2018);
- California Native Plant Society (CNPS) Inventory of Rare, Threatened, and Endangered Plants of California (2018);
- USFWS National Wetland Inventory (2018c); and,
- U.S. Geological Survey (USGS) topographical map.

A query of the USFWS's IPaC system was performed to identify federally listed species that may occur in or adjacent to the project area. A review of the USFWS's Critical Habitat portal was also conducted to identify designated critical habitat units that fall within the project area. A query of the CNDDB provided a list of processed and unprocessed special-status species occurrences within the

Colusa and Meridian USGS 7.5 minute quadrangles (quads), as well as all adjacent quads. Additionally, the CNPS database was queried to identify special-status plant species with the potential to occur in the aforementioned quads. Finally, USFWS National Wetland Inventory data and USGS topographical maps were used to aid in the digitization of vegetation communities and potential aquatic resources within the project area. The raw data returned from the database queries is provided in Attachment A.

Reconnaissance Survey

A reconnaissance level survey was conducted on December 17, 2018, to verify the results of the desktop review. HDR biologists drove on publically accessible roads throughout the project area in order to record existing vegetation communities, aquatic resources, and species observed. Portions of the project area were not directly observed during the field visit due to limited public access. The southeast corner of the project area east of State Highway 20 was not accessible, as were portions of the southern and western edges of the project area. All areas that were not directly observed were delineated and evaluated using aerial imagery, publically available geographic information system (GIS) databases, and USGS topological maps.

Results

The desktop and reconnaissance survey mapped seven vegetation communities in the project area including annual grassland, irrigated agriculture, open water, orchard, pasture, riparian, and urban. Agricultural ditches and potential aquatic resources were also recorded in the project area. These resources are described in detail below and are shown on Figure 1. The review of the project area also evaluated the potential for special-status species to occur in the project area. Table 1 provides a summary of special-status species with the potential to occur and their associated vegetation communities. Several special-status species included in the database query results were ruled-out due to absence of suitable habitat in the project area or being located outside of known species ranges. These species are not included in Table 1, but can be referenced in Attachment A. Additionally, USFWS designated critical habitat units, conservation easements, and other protected areas located in or adjacent to the project area are described in greater detail below.

Vegetation Communities

ANNUAL GRASSLAND

Annual grasslands consist of a dense to sparse cover of annual grasses with flowering culms 0.5-1.5 feet high. They are often associated with numerous species of showy-flowered, native annual forbs, especially in years of favorable rainfall. Germination occurs with the onset of the late fall rains; growth, flowering, and seed-set occur from winter through spring. With a few exceptions, the plants are dead through the summer-fall dry season, persisting as seeds. Due to the timing of the site visit (December 17, 2018), biologists were not able to identify the majority of species within these non-native grasslands. Typical species found within annual grasslands include wild oat (*Avena fatua*), ripgut brome (*Bromus diandrus*), soft brome (*Bromus hordeaceus*), and Italian rye grass (*Festuca perennis*). Areas of annual grassland are found scattered throughout the project area.

IRRIGATED AGRICULTURE

Irrigated agriculture in the project area includes field and row crops. These are dryland crops that are irrigated throughout the growing season and can often have multiple harvests during the year. No crops were planted during the December 17, 2018 site visit, however typical agriculture crops in this part of the Sacramento Valley include rice (*Oryza* spp.), corn (*Zea mays*), tomatoes (*Solanum*

lycopersicum), and other grain and vegetable crops. While grape (*Vitis* spp.) vineyards are another abundant Central Valley crop, none were observed within the project area. Irrigated agriculture is found throughout the project area and is considered one of the dominant cover types.

OPEN WATER

Open water consists of small, isolated, permanent water features that support little to no vegetation. Areas of open water include artificial agriculture ponds, golf course water features, and a small pond in the southeast corner of the project area that is part of a larger wetland complex. The Sacramento River bounds the eastern edge of the project area, but does not overlap.

ORCHARD

Orchard crops consist of various tree grown agriculture products. Species observed during the December 17, 2018 survey included walnut (*Juglans* spp.), persimmons (*Diospyros* spp.), olives (*Olea europaea*), pomegranates (*Punica granatum*), and various citrus such as mandarins (*Citrus reticulata*), oranges (*Citrus* c.f. x *sinensis*), and lemons (*Citrus* c.f. x *limon*). Orchards are located throughout the project area.

PASTURE

Pastures within the project area include undeveloped areas vegetated with herbaceous plants and primarily nonnative grasses that are regularly grazed or mowed. A site-specific list of plant species found in pastures was not compiled during the site visit due to lack of access; however, common species associated with pasture communities typically include annual grasses such as wild oat, ripgut brome, medusahead (*Elymus caput-medusae*), as well as herbaceous species such as filaree (*Erodium* spp.), blue dicks (*Dichelostemma capitatum*), clover (*Trifolium* spp.), and lupines (*Lupinus* spp.). Pastures are located along the northern edge of the city of Colusa and a small patch in the southwest corner of the project area.

RIPARIAN

Riparian communities in the project area consists of multilayered woodlands with a tree overstory and a diverse shrub layer. During the December 17, 2018 field visit riparian areas were not directly observed due to limited access. However, typical riparian species in the Sacramento Valley include an overstory of cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*), Northern California black walnut (*Juglands hindsii*), and willows (*Salix* sp.). The understory is typically composed of California grape (*Vitis californica*), Himalayan blackberry (*Rubus armeniacus*), poison oak (*Toxicodendron diversilobum*), elderberry (*Sambucus* spp.), and a variety of herbaceous species. Riparian communities are found on the east side of the levee bounding the Sacramento River as well as along two small hydrologically isolated areas in the project area.

URBAN

Urban areas mapped in the project area include the dense residential portions of the city of Colusa, semi-rural residential areas, as well as the Colusa County Airport, the industrial park corridor along State Highway 20, and a water treatment plant in the southern portion of the project area. Urban cover is also associated with paved roads and rural residences scattered throughout the project area, however, these were not mapped in detail on Figure 1. Vegetation is characterized as either landscaped areas or non-native herbaceous species growing in and around paved and developed features.

AGRICULTURAL DITCHES

Agricultural ditches are narrow, freshwater, linear features that can be either channelized natural features or anthropologically created. These features are typically unvegetated or support emergent, hydrophytic plants that are adapted to regular inundation. Agricultural ditches have the potential to fall under state or federal jurisdiction, however a formal aquatic resources delineation would need to be conducted to verify the jurisdiction of these features. Agriculture ditches are typically found adjacent to irrigated agriculture fields or orchards. In the project area, several ditches bisect other vegetation communities such as annual grasslands, pastures, and urban areas.

AQUATIC RESOURCES

Aquatic resources mapped in the project area are areas that were identified as having the potential to be categorized as vernal pools or wetlands, including areas prone to seasonal flooding or topographic depressions. These features are typically seasonally pooled or saturated areas fed by precipitation or flooding from adjacent rivers, and can be either natural or anthropologically created. Aquatic resources typically consist of hydrophytic plants that are adapted to regular inundation, and have the potential to fall under state and/or federal jurisdiction; however, a formal wetland delineation would need to occur to verify jurisdiction. Aquatic resources shown on **Figure 1** were identified by a combination of aerial review, National Wetlands Inventory, and field verification. Not all features were field verified and the mapped extent of potential aquatic resources is based on aerial interpretation and their presence, location, or extent should not be considered final.

Wildlife Observed

Wildlife observed during the December 17, 2018, site visit included numerous bird species such as black-billed magpie (*Pica hudsonia*), common raven (*Corvus corax*), European starling (*Sturnus vulgaris*), coot (*Fulica* sp.), great egret (*Ardea alba*), mourning dove (*Zenaida macroura*), California scrub jay (*Aphelocoma californica*), finches (Fringillidae), killdeer (*Charadrius vociferus*), and other various shore birds, in addition to raptors such as red-tailed hawk (*Buteo jamaicensis*), turkey vulture (*Cathartes aura*), and American kestrel (*Falco zoniventris*). A Swainson's hawk (*Buteo swainsoni*) was observed perching in a large oak tree amidst irrigated agriculture land in the northwest corner of the project area. While no other special status species or elderberry shrubs were observed during the survey they still have the potential to occur in the project area (Table 1), and are discussed in more detail below.

Special-Status Species

Database query results returned a large number of special-status species with a potential to occur in the vicinity of the project area (Attachment A). Through review of these results, many species were determined to not have the potential to occur in the project area due to absence of suitable habitat or the project area being located outside of known species ranges. Table 1 provides a description of the special-status species that have the potential to occur in each of the delineated vegetation communities.

Any potential project related effects on these species or their habitats would require compliance with the California Environmental Quality Act as well as permits/authorizations from the appropriate state or federal agencies; as a result, a site-specific biological resources assessment would need to be conducted prior to project implementation to assess impacts on special-status species and their habitats.

Critical Habitat

There are two critical habitat units that are within or adjacent to the project area. The designated final critical habitat unit for vernal pool tadpole shrimp (*Lepidurus packardi*), VERTS 6, is located in the southern portion of the project area (USFWS 2018b). This area is largely delineated as annual grassland and orchard with areas of open water and numerous potential wetlands. The proposed critical habitat unit for western yellow-billed cuckoo (*Coccyzus americanus*), CA Unit 2, extends along the Sacramento River from Red Bluff south to Colusa (USFWS 2014). This unit is largely outside of the project area, however narrow portions of CA Unit 2 overlap with the project area, specifically with the riparian corridor along the Sacramento River levee. In addition, the Sacramento River immediately adjacent to the project area is designated critical habitat for multiple runs of the chinook salmon (*Oncorhynchuys tshawytscha*) as well as steelhead (*Oncorhynchys mykiss*) (USFWS 2018b).

Critical habitat data was acquired using the USFWS IPaC on December 10, 2018 which includes all critical habitat units that occur within in the project area, however it does not provide any search radius or critical habitat units potentially adjacent to the project area. Due to the federal government shut down taking place at the time of the writing of this memo, the USFWS Critical Habitat Portal was not available for viewing and it is unknown if additional critical habitat units exist adjacent to the project area.

Sensitive Habitats and Aquatic Resources

Sensitive habitats included are those that are of special concern to resource agencies or those that are protected under various state or federal regulations. Aquatic resources provide a variety of functions for plants and wildlife including habitat, foraging, cover, migration, and movement corridors. In addition to habitat functions, these features provide physical conveyance of surface water flows capable of handling large stormwater events.

Several aquatic resources and vegetation communities in the project area would be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. These areas include the following communities: riparian, agricultural ditches, open water, and other potential aquatic resources. It is recommended that a formal delineation of aquatic resource be completed prior to any work in order to determine the level of impact on sensitive communities.

Depending on the project alternative chosen and the biological resources that may be affected, there are numerous agencies that may need to be consulted with and/or permits completed. It is likely that the project would require consultation with or completion of some or all of the following:

- US Army Corps of Engineers (USACE) Section 404 consultation – covers any impacts to waters of the U.S.
- USACE Section 408 consultation – covers any project work in or around federally managed levees
- USFWS Section 7 consultation – covers any potential impacts to federally listed species managed by the USFWS
- National Marine Fisheries Service (NMFS) Section 7 consultation – covers any potential impacts to federally listed species managed by the NMFS
- CDFW Section 1602 permit – covers any alteration below the top-of-bank of a river channel or within the riparian corridor

- CDFW Incidental Take Permit (ITP) – covers any potential impacts to state listed species
- RWQCB Section 401 permit – covers any discharge of dredge or fill into waters of the State

Protected Areas, Conservation Easements, and Wildlife Movement Corridors

There are multiple protected areas and easements within and surrounding the project area. The City of Colusa operates many small public parks scattered throughout the urban portions of the project area. The California Department of Parks and Recreation operates the Sacramento River State Recreation Area – Colusa, along the northeast portion of the project area adjacent to the Sacramento River (CPAD 2017). Additionally, the Wildlife Heritage Foundation operates the Dolan Preserve in the southeast portion of the project area, within an area delineated as annual grassland and potential wetlands (CCED 2018).

Within one mile of the project area there are many additional protected areas and conservations easements. Protected areas include the Sacramento River Wildlife Area operated by the CDFW, the Colusa Bypass Wildlife Area operated by the Central Valley Flood Protection Board, the Colusa National Wildlife Refuge operated by the USFWS, and a portion of the Sacramento River riparian area owned by The Nature Conservancy (CPAD 2017). Easement lands include the Sacramento River Conservation Easement owned by the CDFW, Wetlands Reserve Program holdings by the US Natural Resources Conservation Service, and the North Central Valley Wildlife Management Area owned by the USFWS (CCED 2018).

The Sutter Bypass is located approximately 2 miles east of the project area. The bypass is part of a large engineered floodway that runs adjacent to the Sacramento River from north of the Sutter Buttes, south to the Sacramento-San Joaquin Delta. The bypass acts as a wildlife movement corridor for numerous terrestrial and aquatic species.

Local Ordinances

There are no county or local ordinances that affect this project area.

Table 1. Special-Status Species with the Potential to Occur in the Project Area

Scientific Name	Common Name	Federal Listing[1]	State Listing[2]/CRPR[3]	Vegetation Community Description
Plants				
Atriplex cordulata var. *cordulata*	heartscale	--	1B.2	potential wetlands, annual grassland
Atriplex depressa	brittlescale	--	1B.2	potential wetlands, annual grassland
Atriplex persistens	vernal pool smallscale	--	1B.2	potential wetlands
Chloropyron palmatum	palmate-bracted bird's-beak	--	1B.1	potential wetlands
Extriplex joaquinana	San Joaquin spearscale	--	1B.2	potential wetlands, annual grassland
Heteranthera dubia	water star-grass	--	2B.2	potential wetlands
Hibiscus lasiocarpos var. *occidentalis*	woolly rose-mallow	--	1B.2	potential wetlands, riparian
Lasthenia glabrata ssp. *coulteri*	Coulter's goldfields	--	1B.1	potential wetlands
Invertebrates				
Branchinecta conservatio	Conservancy fairy shrimp	FE	--	potential wetlands
Branchinecta lynchi	vernal pool fairy shrimp	FT	--	potential wetlands
Desmocerus californicus dimorphus	valley elderberry longhorn beetle	FT	--	throughout the project area wherever elderberry host plant occurs, but most likely to occur in riparian areas
Lepidurus packardi	vernal pool tadpole shrimp	FE	--	potential wetlands
Reptiles				
Emys marmorata	western pond turtle	--	SSC	open water, agricultural ditches
Thamnophis gigas	giant garter snake	FT	ST	open water, riparian, agricultural ditches
Birds				

[1] FT = Federally Threatened, FE = Federally Endangered
[2] SSC = Species of Special Concern, ST = State Threatened, SE = State Endangered, FP = Fully Protected, CE = Candidate for Endangered
[3] CRPR (California Rare Plant Ranking); 1B.1 = Seriously rare, threatened, or endangered in CA and elsewhere, 1B.2 = Moderately rare, threatened, or endangered in CA and elsewhere, 2B.2 = Moderately rare, threatened, or endangered in CA but more common elsewhere

Scientific Name	Common Name	Federal Listing[1]	State Listing[2]/CRPR[3]	Vegetation Community Description
Agelauis tricolor	tricolored blackbird	--	ST/SSC	open water, riparian, agricultural ditches, irrigated agriculture
Antigone canadensis tabida	greater sandhill crane	--	ST/FP	wintering: irrigated agriculture
Athene cunicularia	burrowing owl	--	SSC	annual grassland, pasture, urban
Buteo swainsoni	Swainson's hawk	--	ST	foraging: orchard, irrigated agriculture, annual grassland, pasture nesting: riparian and other large trees throughout project area
Circus hudsonius	northern harrier	--	SSC	foraging: orchard, irrigated agriculture, annual grassland, pasture
Coccyzus americanus occidentalis	western yellow-billed cuckoo	FT	SE	riparian
Elanus leucurus	white-tailed kite	--	FP	foraging: irrigated agriculture, annual grassland, pasture nesting: riparian and other large trees throughout project area
Icteria virens	yellow-breasted chat	--	SSC	riparian
Ixobrychus exilis	least bittern	--	SSC	riparian
Lanius ludovicianus	loggerhead shrike	--	SSC	foraging: irrigated agriculture, annual grassland, pasture nesting: shrubs and trees throughout project area
Laterallus jamaicensis coturniculus	California black rail	--	ST/FP	potential wetlands, open water
Melospiza melodia	song sparrow (Modesto population)	--	SSC	riparian
Riparia riparia	bank swallow	--	ST	riparian
Mammals				
Lasiurus blossevillii	western red bat	--	SSC	riparian, orchard
Taxidea taxus	American badger	--	SSC	irrigated agriculture, annual grassland, pasture

Conclusion

The findings in this memo represent a preliminary, high-level review of potential biological constraints in the project area and should not be considered final and all-encompassing. Based on this preliminary review of biological resources databases and the site reconnaissance, the project area appears to contain suitable habitat for several special-status species; and includes various sensitive communities and aquatic resources. Proposed project activities have the potential to impact any of the aforementioned biological resources, should they be present in the vicinity of the proposed work area. Prior to project implementation, consultation with resource agencies and acquisition of permits may be necessary.

Literature Cited

CCED (California Conservation Easement Database). 2017. Data is available for viewing, exploration, and download at http://calands.org. Accessed December 19, 2018.

CPAD (California Protected Areas Database). 2018. Data is available for viewing, exploration, and download at http://calands.org. Accessed December 19, 2018.

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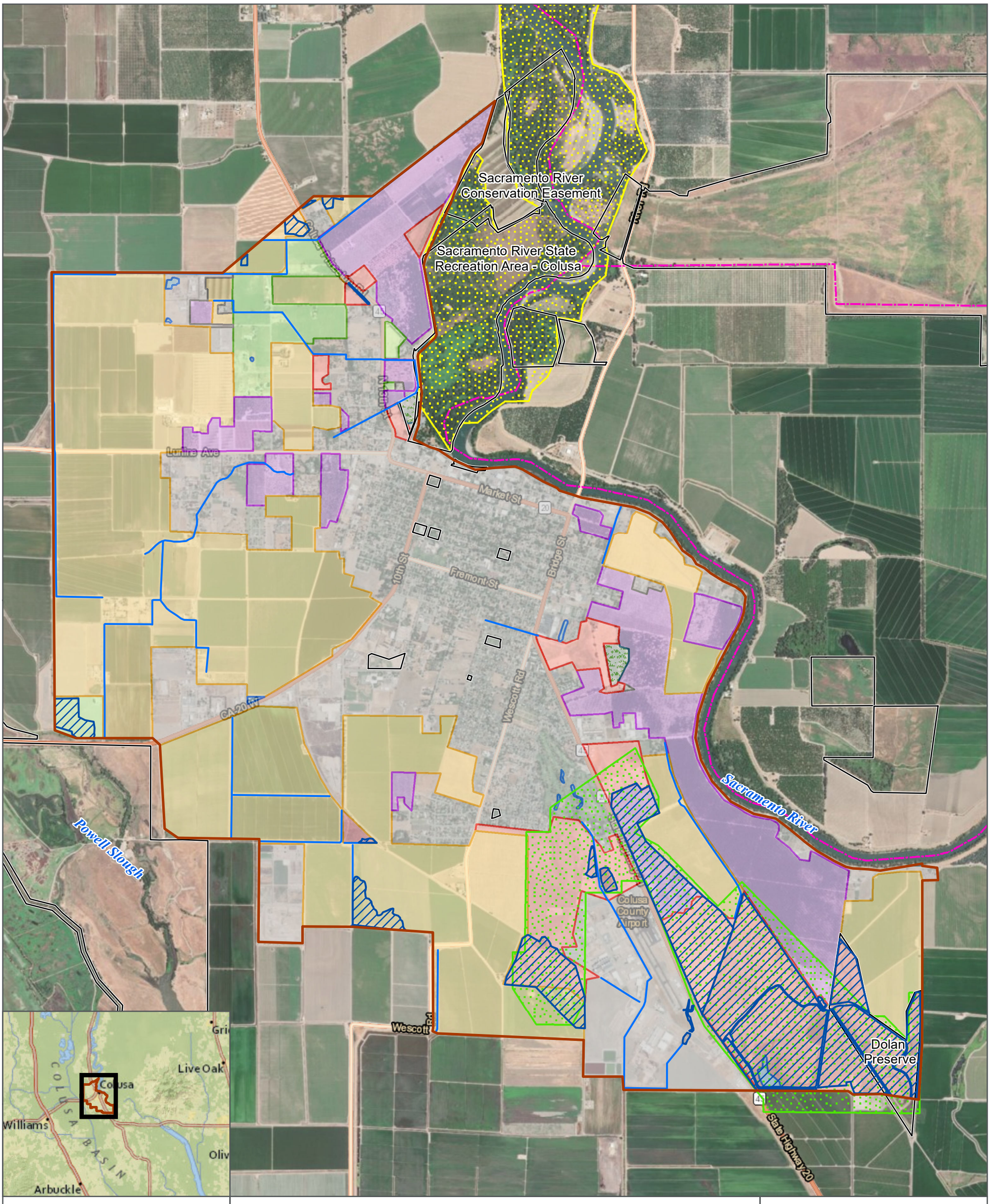
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----. 2018b. Critical Habitat Mapper. https://fws.maps.arcgis.com/home/webmap/viewer.html Accessed December 19, 2018.

----. 2018c. “National Wetlands Inventory Wetlands Mapper.” https://www.fws.gov/wetlands/ Accessed December 19, 2018.

----. 2014. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Western Distinct Population Segment of the Yellow-Billed Cuckoo; Proposed Rule, August 15, 2014. 50 CFR Pt 17



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MILES

SOURCES: Aerial Imagery - ESRI; Critical Habitat - USFWS; CPAD and CCED - GreenInfo Network;

Project Area, Potential Wetlands, Agriculture Ditches, Vegetation Communities - HDR Inc.

This map product was compiled from the best available sources. No warranty is made for its accuracy or completness. Projection: State Plane California Zone II 0402 US Feet.

- Project Area
- Potential Wetlands
- Agriculture Ditches
- California Protected Areas Database (CPAD) and California Conservation Easement Database (CCED) Units
- Final Critical Habitat for Chinook Salmon *(Oncorhynchus tshawytscha)* and Steelhead *(Oncorhynchus mykiss)*
- Final Critical Habitat - Vernal Pool Tadpole Shrimp *(Lepidurus packardi)*
- Proposed Critical Habitat - Western Yellow-Billed Cuckoo *(Coccyzus americanus)*

Vegetation Communities

- Annual Grassland
- Irrigated Agriculture
- Open Water
- Orchard
- Pasture
- Riparian
- Urban

COLUSA FLOOD RISK REDUCTION FEASIBILITY STUDY

FIGURE 1

PATH: H:\GIS_PROJECTS\COLUSA SMALL COMMUNITIES\MXD\ATTACHMENT_COLUSA_COUNTY_COLUSA_11X17_07222019.MXD - USER: STIDBALL - DATE: 7/22/2019

Attachment C-1. Database Results

IPaC **U.S. Fish & Wildlife Service**

Last login December 10, 2018 10:36 AM MST

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

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Project information

NAME

Colusa Small Communities

LOCATION

Colusa County, California



Local office

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

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Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Log in to IPaC.
2. Go to your My Projects list.
3. Click PROJECT HOME for this project.
4. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS

Northern Spotted Owl Strix occidentalis caurina — Threatened
There is **final** critical habitat for this species. Your location is outside the critical habitat.
https://ecos.fws.gov/ecp/species/1123

Yellow-billed Cuckoo Coccyzus americanus — Threatened
There is **proposed** critical habitat for this species. Your location overlaps the critical habitat.
https://ecos.fws.gov/ecp/species/3911

Reptiles

NAME	STATUS
Giant Garter Snake Thamnophis gigas No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4482	Threatened

Amphibians

NAME	STATUS
California Red-legged Frog Rana draytonii There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander Ambystoma californiense There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/321	Threatened

Insects

NAME	STATUS
Valley Elderberry Longhorn Beetle Desmocerus californicus dimorphus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/7850	Threatened

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Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp Branchinecta conservatio There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/8246	Endangered
Vernal Pool Fairy Shrimp Branchinecta lynchi There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/498	Threatened
Vernal Pool Tadpole Shrimp Lepidurus packardi There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/2246	Endangered

Flowering Plants

NAME	STATUS
Palmate-bracted Bird's Beak Cordylanthus palmatus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1616	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Vernal Pool Tadpole Shrimp Lepidurus packardi https://ecos.fws.gov/ecp/species/2246#crithab	Final
Yellow-billed Cuckoo Coccyzus americanus https://ecos.fws.gov/ecp/species/3911#crithab	Proposed

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

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Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

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NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)

Bald Eagle Haliaeetus leucocephalus — Breeds Jan 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1626

Burrowing Owl Athene cunicularia — Breeds Mar 15 to Aug 31
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9737

California Thrasher Toxostoma redivivum — Breeds Jan 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Common Yellowthroat Geothlypis trichas sinuosa — Breeds May 20 to Jul 31
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/2084

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Lewis's Woodpecker Melanerpes lewis — Breeds Apr 20 to Sep 30
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9408

Long-billed Curlew Numenius americanus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5511

Marbled Godwit Limosa fedoa — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Nuttall's Woodpecker Picoides nuttallii — Breeds Apr 1 to Jul 20
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9410

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Oak Titmouse Baeolophus inornatus — Breeds Mar 15 to Jul 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9656

Rufous Hummingbird selasphorus rufus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8002

Song Sparrow Melospiza melodia — Breeds Feb 20 to Sep 5
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Spotted Towhee Pipilo maculatus clementae — Breeds Apr 15 to Jul 20
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/4243

Tricolored Blackbird Agelaius tricolor — Breeds Mar 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3910

Whimbrel Numenius phaeopus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9483

Willet Tringa semipalmata — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Yellow-billed Magpie Pica nuttalli — Breeds Apr 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9726

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Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (▪)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

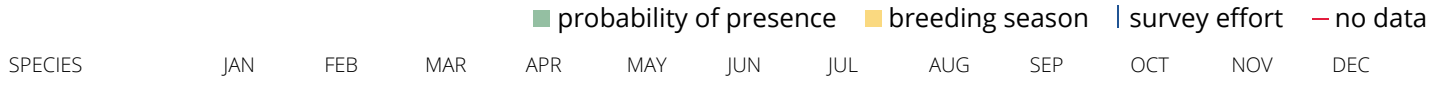
Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

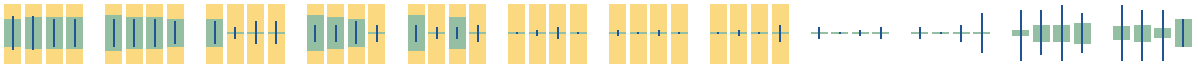
No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

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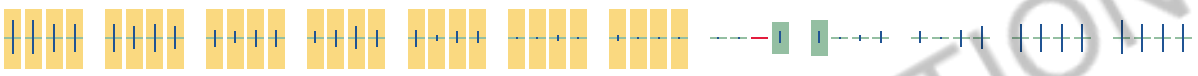
Bald Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



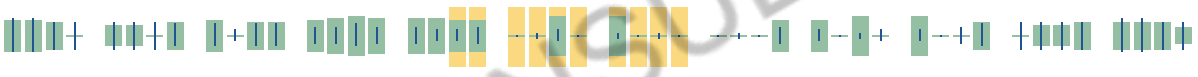
Burrowing Owl
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



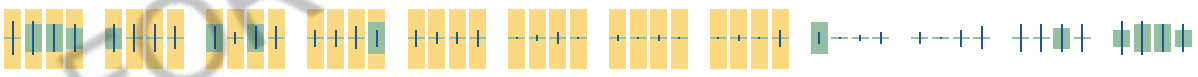
California Thrasher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Common Yellowthroat
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



Golden Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



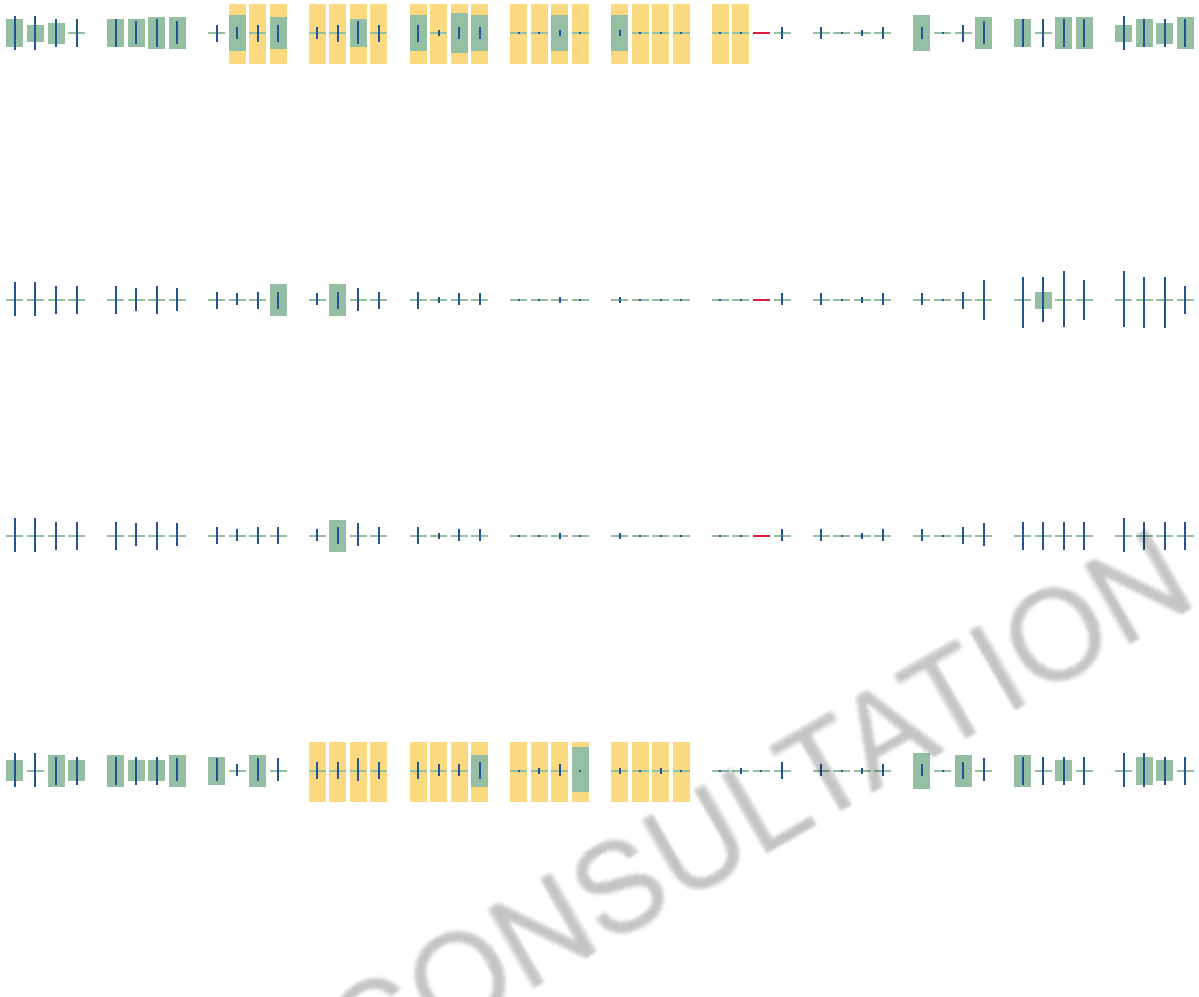
Lewis's Woodpecker
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



NOT FOR CONSULTATION



NOT FOR CONSULTATION



Tricolored Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Whimbrel
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Willet
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Yellow-billed Magpie
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

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Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

NOT FOR CONSULTATION

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
Colusa National Wildlife Refuge	4,079.79 acres

(530) 458-2666
(530) 458-2666

MAILING ADDRESS
C/o Sacramento Nwr Complex
752 County Road 99w
Willows, CA 95988-9639

PHYSICAL ADDRESS
2180 Highway 20
Colusa, CA 95932

https://www.fws.gov/refuges/profiles/index.cfm?id=81621

Fish hatcheries

NOT FOR CONSULTATION

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND

- PEM1Ei
- PEM1K
- PEM1A
- PEM1Ci
- PEM1C
- PEM1F

FRESHWATER FORESTED/SHRUB WETLAND

- PSS1A
- PFO1A

FRESHWATER POND

- PUBKx
- PUBF
- PAB4Kx
- PUBHx
- PUBH
- PUBFx

RIVERINE

- R2AB3Hx
- R2AB4Hx
- R2UBHx
- R4SBCx
- R2UBF

A full description for each wetland code can be found at the National Wetlands Inventory website

Data limitations

NOT FOR CONSULTATION

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

NOT FOR CONSULTATION

CNDDB 9-Quad Species List 215 records.

Element Type	Scientific Name	Common Name	Element Code	Federal Status	State Status	CDFW Status	CA Rare Plant Rank	Quad Code	Quad Name	Data Status	Taxonomic Sort
Animals - Amphibians	Rana boylii	foothill yellow-legged frog	AAABH01050	None	Candidate Threatened	SSC	-	3912212	Cortina Creek	Mapped	Animals - Amphibians - Ranidae - Rana boylii
Animals - Amphibians	Spea hammondii	western spadefoot	AAABF02020	None	None	SSC	-	3912212	Cortina Creek	Mapped and Unprocessed	Animals - Amphibians - Scaphiopodidae - Spea hammondii
Animals - Amphibians	Spea hammondii	western spadefoot	AAABF02020	None	None	SSC	-	3912211	Arbuckle	Mapped and Unprocessed	Animals - Amphibians - Scaphiopodidae - Spea hammondii
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912211	Arbuckle	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912212	Cortina Creek	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912221	Colusa	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912118	Grimes	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912222	Williams	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912231	Moulton Weir	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912232	Maxwell	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Circus hudsonius	northern harrier	ABNKC11011	None	None	SSC	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Accipitridae - Circus hudsonius
Animals - Birds	Elanus leucurus	white-tailed kite	ABNKC06010	None	None	FP	-	3912221	Colusa	Unprocessed	Animals - Birds - Accipitridae - Elanus leucurus
Animals - Birds	Haliaeetus leucocephalus	bald eagle	ABNKC10010	Delisted	Endangered	FP	-	3912231	Moulton Weir	Mapped	Animals - Birds - Accipitridae - Haliaeetus leucocephalus
Animals - Birds	Branta hutchinsii leucopareia	cackling (=Aleutian Canada) goose	ABNJB05035	Delisted	None	-	-	3912138	Sanborn Slough	Mapped and Unprocessed	Animals - Birds - Anatidae - Branta hutchinsii leucopareia
Animals - Birds	Branta hutchinsii leucopareia	cackling (=Aleutian Canada) goose	ABNJB05035	Delisted	None	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Birds - Anatidae - Branta hutchinsii leucopareia
Animals - Birds	Branta hutchinsii leucopareia	cackling (=Aleutian Canada) goose	ABNJB05035	Delisted	None	-	-	3912118	Grimes	Mapped	Animals - Birds - Anatidae - Branta hutchinsii leucopareia
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Birds - Ardeidae - Ardea alba

Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912211	Arbuckle	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Botaurus lentiginosus	American bittern	ABNGA01020	None	None	-	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Ardeidae - Botaurus lentiginosus
Animals - Birds	Botaurus lentiginosus	American bittern	ABNGA01020	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Botaurus lentiginosus
Animals - Birds	Botaurus lentiginosus	American bittern	ABNGA01020	None	None	-	-	3912232	Maxwell	Unprocessed	Animals - Birds - Ardeidae - Botaurus lentiginosus
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912232	Maxwell	Mapped and Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Ixobrychus exilis	least bittern	ABNGA02010	None	None	SSC	-	3912232	Maxwell	Unprocessed	Animals - Birds - Ardeidae - Ixobrychus exilis
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912232	Maxwell	Mapped and Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax

Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912211	Arbuckle	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912221	Colusa	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912128	Meridian	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912231	Moulton Weir	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Falco peregrinus anatum	American peregrine falcon	ABNKD06071	Delisted	Delisted	FP	-	3912128	Meridian	Unprocessed	Animals - Birds - Falconidae - Falco peregrinus anatum
Animals - Birds	Falco peregrinus anatum	American peregrine falcon	ABNKD06071	Delisted	Delisted	FP	-	3912221	Colusa	Unprocessed	Animals - Birds - Falconidae - Falco peregrinus anatum
Animals - Birds	Antigone canadensis tabida	greater sandhill crane	ABNMK01014	None	Threatened	FP	-	3912128	Meridian	Mapped	Animals - Birds - Gruidae - Antigone canadensis tabida
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912118	Grimes	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912221	Colusa	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912231	Moulton Weir	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912231	Moulton Weir	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912222	Williams	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912232	Maxwell	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912221	Colusa	Mapped	Animals - Birds - Icteridae - Agelaius tricolor

Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912211	Arbuckle	Mapped and Unprocessed	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912118	Grimes	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912128	Meridian	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Icteria virens	yellow-breasted chat	ABPBX24010	None	None	SSC	-	3912211	Arbuckle	Unprocessed	Animals - Birds - Icteriidae - Icteria virens
Animals - Birds	Lanius ludovicianus	loggerhead shrike	ABPBR01030	None	None	SSC	-	3912232	Maxwell	Unprocessed	Animals - Birds - Laniidae - Lanius ludovicianus
Animals - Birds	Pandion haliaetus	osprey	ABNKC01010	None	None	WL	-	3912231	Moulton Weir	Mapped and Unprocessed	Animals - Birds - Pandionidae - Pandion haliaetus
Animals - Birds	Pandion haliaetus	osprey	ABNKC01010	None	None	WL	-	3912128	Meridian	Unprocessed	Animals - Birds - Pandionidae - Pandion haliaetus
Animals - Birds	Setophaga petechia	yellow warbler	ABPBX03010	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Birds - Parulidae - Setophaga petechia
Animals - Birds	Melospiza melodia	song sparrow (-inModesto-in population)	ABPBXA3010	None	None	SSC	-	3912221	Colusa	Mapped	Animals - Birds - Passerellidae - Melospiza melodia
Animals - Birds	Melospiza melodia	song sparrow (-inModesto-in population)	ABPBXA3010	None	None	SSC	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Passerellidae - Melospiza melodia
Animals - Birds	Melospiza melodia	song sparrow (-inModesto-in population)	ABPBXA3010	None	None	SSC	-	3912128	Meridian	Mapped	Animals - Birds - Passerellidae - Melospiza melodia
Animals - Birds	Phalacrocorax auritus	double-crested cormorant	ABNFD01020	None	None	WL	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Phalacrocoracidae - Phalacrocorax auritus
Animals - Birds	Phalacrocorax auritus	double-crested cormorant	ABNFD01020	None	None	WL	-	3912221	Colusa	Unprocessed	Animals - Birds - Phalacrocoracidae - Phalacrocorax auritus
Animals - Birds	Laterallus jamaicensis coturniculus	California black rail	ABNME03041	None	Threatened	FP	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Rallidae - Laterallus jamaicensis coturniculus
Animals - Birds	Asio flammeus	short-eared owl	ABNSB13040	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Birds - Strigidae - Asio flammeus
Animals - Birds	Asio otus	long-eared owl	ABNSB13010	None	None	SSC	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Strigidae - Asio otus
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3912212	Cortina Creek	Mapped	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912211	Arbuckle	Mapped	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912221	Colusa	Mapped	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912118	Grimes	Unprocessed	Animals - Birds - Threskiornithidae - Plegadis chihi

Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912231	Moulton Weir	Mapped and Unprocessed	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912232	Maxwell	Mapped	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912222	Williams	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912231	Moulton Weir	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Fish	Lavinia exilicauda exilicauda	Sacramento hitch	AFCJB19012	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Cyprinidae - Lavinia exilicauda exilicauda
Animals - Fish	Lavinia exilicauda exilicauda	Sacramento hitch	AFCJB19012	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Cyprinidae - Lavinia exilicauda exilicauda
Animals - Fish	Mylopharodon conocephalus	hardhead	AFCJB25010	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Cyprinidae - Mylopharodon conocephalus
Animals - Fish	Mylopharodon conocephalus	hardhead	AFCJB25010	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Cyprinidae - Mylopharodon conocephalus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3912118	Grimes	Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii
Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii
Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii

Animals - Fish	Spirinchus thaleichthys	longfin smelt	AFCHB03010	Candidate	Threatened	SSC	-	3912221	Colusa	Mapped	Animals - Fish - Osmeridae - Spirinchus thaleichthys
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912221	Colusa	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912138	Sanborn Slough	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912118	Grimes	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912231	Moulton Weir	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3912118	Grimes	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30
Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3912118	Grimes	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30
Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3912128	Meridian	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6

Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3912118	Grimes	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3912221	Colusa	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3912221	Colusa	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3912118	Grimes	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3912128	Meridian	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Insects	Bombus crotchii	Crotch bumble bee	IIHYM24480	None	None	-	-	3912118	Grimes	Mapped	Animals - Insects - Apidae - Bombus crotchii
Animals - Insects	Cicindela hirticollis abrupta	Sacramento Valley tiger beetle	IICOL02106	None	None	-	-	3912128	Meridian	Mapped	Animals - Insects - Carabidae - Cicindela hirticollis abrupta
Animals - Insects	Cicindela hirticollis abrupta	Sacramento Valley tiger beetle	IICOL02106	None	None	-	-	3912221	Colusa	Mapped	Animals - Insects - Carabidae - Cicindela hirticollis abrupta
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912221	Colusa	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912128	Meridian	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912118	Grimes	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912231	Moulton Weir	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3912222	Williams	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3912211	Arbuckle	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin

Animals - Mammals	Perognathus inornatus	San Joaquin Pocket Mouse	AMAFD01060	None	None	-	-	3912128	Meridian	Mapped	Animals - Mammals - Heteromyidae - Perognathus inornatus
Animals - Mammals	Taxidea taxus	American badger	AMAJF04010	None	None	SSC	-	3912211	Arbuckle	Unprocessed	Animals - Mammals - Mustelidae - Taxidea taxus
Animals - Mammals	Taxidea taxus	American badger	AMAJF04010	None	None	SSC	-	3912212	Cortina Creek	Unprocessed	Animals - Mammals - Mustelidae - Taxidea taxus
Animals - Mammals	Taxidea taxus	American badger	AMAJF04010	None	None	SSC	-	3912222	Williams	Mapped	Animals - Mammals - Mustelidae - Taxidea taxus
Animals - Mammals	Lasiurus blossevillii	western red bat	AMACC05060	None	None	SSC	-	3912221	Colusa	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus blossevillii
Animals - Mammals	Lasiurus blossevillii	western red bat	AMACC05060	None	None	SSC	-	3912128	Meridian	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus blossevillii
Animals - Mammals	Lasiurus cinereus	hoary bat	AMACC05030	None	None	-	-	3912128	Meridian	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus cinereus
Animals - Mammals	Lasiurus cinereus	hoary bat	AMACC05030	None	None	-	-	3912221	Colusa	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus cinereus
Animals - Mammals	Myotis ciliolabrum	western small-footed myotis	AMACC01140	None	None	-	-	3912221	Colusa	Mapped	Animals - Mammals - Vespertilionidae - Myotis ciliolabrum
Animals - Mammals	Myotis yumanensis	Yuma myotis	AMACC01020	None	None	-	-	3912128	Meridian	Mapped	Animals - Mammals - Vespertilionidae - Myotis yumanensis
Animals - Mollusks	Anodonta oregonensis	Oregon floater	IMBIV04110	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Mollusks - Unionidae - Anodonta oregonensis
Animals - Mollusks	Gonidea angulata	western ridged mussel	IMBIV19010	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Mollusks - Unionidae - Gonidea angulata
Animals - Reptiles	Masticophis flagellum ruddocki	San Joaquin coachwhip	ARADB21021	None	None	SSC	-	3912212	Cortina Creek	Unprocessed	Animals - Reptiles - Colubridae - Masticophis flagellum ruddocki
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912138	Sanborn Slough	Mapped	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912222	Williams	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912222	Williams	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912231	Moulton Weir	Mapped	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912232	Maxwell	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas

Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912221	Colusa	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912138	Sanborn Slough	Mapped	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912211	Arbuckle	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912118	Grimes	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Community - Terrestrial	Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	CTT52410CA	None	None	-	-	3912128	Meridian	Mapped	Community - Terrestrial - Coastal and Valley Freshwater Marsh
Community - Terrestrial	Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	CTT52410CA	None	None	-	-	3912138	Sanborn Slough	Mapped	Community - Terrestrial - Coastal and Valley Freshwater Marsh
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912138	Sanborn Slough	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912221	Colusa	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912128	Meridian	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912118	Grimes	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912231	Moulton Weir	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912231	Moulton Weir	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912118	Grimes	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912128	Meridian	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912221	Colusa	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912138	Sanborn Slough	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Willow Scrub	Great Valley Willow Scrub	CTT63410CA	None	None	-	-	3912118	Grimes	Mapped	Community - Terrestrial - Great Valley Willow Scrub
Community - Terrestrial	Great Valley Willow Scrub	Great Valley Willow Scrub	CTT63410CA	None	None	-	-	3912231	Moulton Weir	Mapped	Community - Terrestrial - Great Valley Willow Scrub

Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912231	Moulton Weir	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912222	Williams	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912232	Maxwell	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912128	Meridian	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912211	Arbuckle	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912221	Colusa	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Lasthenia ferrisiae	Ferris' goldfields	PDAST5L070	None	None	-	4.2	3912221	Colusa	Unprocessed	Plants - Vascular - Asteraceae - Lasthenia ferrisiae
Plants - Vascular	Lasthenia ferrisiae	Ferris' goldfields	PDAST5L070	None	None	-	4.2	3912128	Meridian	Unprocessed	Plants - Vascular - Asteraceae - Lasthenia ferrisiae
Plants - Vascular	Lasthenia ferrisiae	Ferris' goldfields	PDAST5L070	None	None	-	4.2	3912232	Maxwell	Unprocessed	Plants - Vascular - Asteraceae - Lasthenia ferrisiae
Plants - Vascular	Lasthenia ferrisiae	Ferris' goldfields	PDAST5L070	None	None	-	4.2	3912222	Williams	Unprocessed	Plants - Vascular - Asteraceae - Lasthenia ferrisiae
Plants - Vascular	Lasthenia glabrata ssp. coulteri	Coulter's goldfields	PDAST5L0A1	None	None	-	1B.1	3912221	Colusa	Mapped	Plants - Vascular - Asteraceae - Lasthenia glabrata ssp. coulteri
Plants - Vascular	Layia septentrionalis	Colusa layia	PDAST5N0F0	None	None	-	1B.2	3912211	Arbuckle	Mapped	Plants - Vascular - Asteraceae - Layia septentrionalis
Plants - Vascular	Layia septentrionalis	Colusa layia	PDAST5N0F0	None	None	-	1B.2	3912118	Grimes	Mapped	Plants - Vascular - Asteraceae - Layia septentrionalis
Plants - Vascular	Trichocoronis wrightii var. wrightii	Wright's trichocoronis	PDAST9F031	None	None	-	2B.1	3912118	Grimes	Mapped	Plants - Vascular - Asteraceae - Trichocoronis wrightii var. wrightii
Plants - Vascular	Amsinckia lunaris	bent-flowered fiddleneck	PDBOR01070	None	None	-	1B.2	3912138	Sanborn Slough	Mapped	Plants - Vascular - Boraginaceae - Amsinckia lunaris
Plants - Vascular	Brasenia schreberi	watershield	PDCAB01010	None	None	-	2B.3	3912138	Sanborn Slough	Mapped	Plants - Vascular - Cabombaceae - Brasenia schreberi
Plants - Vascular	Atriplex cordulata var. cordulata	heartscale	PDCHE040B0	None	None	-	1B.2	3912128	Meridian	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex cordulata var. cordulata
Plants - Vascular	Atriplex depressa	brittlescale	PDCHE042L0	None	None	-	1B.2	3912211	Arbuckle	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex depressa
Plants - Vascular	Atriplex depressa	brittlescale	PDCHE042L0	None	None	-	1B.2	3912221	Colusa	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex depressa
Plants - Vascular	Atriplex depressa	brittlescale	PDCHE042L0	None	None	-	1B.2	3912231	Moulton Weir	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex depressa

Plants - Vascular	Atriplex persistens	vernal pool smallscale	PDCHE042P0	None	None	-	1B.2	3912221	Colusa	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex persistens
Plants - Vascular	Atriplex persistens	vernal pool smallscale	PDCHE042P0	None	None	-	1B.2	3912211	Arbuckle	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex persistens
Plants - Vascular	Extriplex joaquinana	San Joaquin spearscale	PDCHE041F3	None	None	-	1B.2	3912221	Colusa	Mapped	Plants - Vascular - Chenopodiaceae - Extriplex joaquinana
Plants - Vascular	Extriplex joaquinana	San Joaquin spearscale	PDCHE041F3	None	None	-	1B.2	3912222	Williams	Mapped	Plants - Vascular - Chenopodiaceae - Extriplex joaquinana
Plants - Vascular	Extriplex joaquinana	San Joaquin spearscale	PDCHE041F3	None	None	-	1B.2	3912232	Maxwell	Mapped	Plants - Vascular - Chenopodiaceae - Extriplex joaquinana
Plants - Vascular	Cuscuta obtusiflora var. glandulosa	Peruvian dodder	PDCUS01111	None	None	-	2B.2	3912138	Sanborn Slough	Mapped	Plants - Vascular - Convolvulaceae - Cuscuta obtusiflora var. glandulosa
Plants - Vascular	Astragalus tener var. ferrisiae	Ferris' milk-vetch	PDFAB0F8R3	None	None	-	1B.1	3912211	Arbuckle	Mapped	Plants - Vascular - Fabaceae - Astragalus tener var. ferrisiae
Plants - Vascular	Astragalus tener var. ferrisiae	Ferris' milk-vetch	PDFAB0F8R3	None	None	-	1B.1	3912118	Grimes	Mapped	Plants - Vascular - Fabaceae - Astragalus tener var. ferrisiae
Plants - Vascular	Astragalus tener var. ferrisiae	Ferris' milk-vetch	PDFAB0F8R3	None	None	-	1B.1	3912221	Colusa	Mapped	Plants - Vascular - Fabaceae - Astragalus tener var. ferrisiae
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912221	Colusa	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912231	Moulton Weir	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912232	Maxwell	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912118	Grimes	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912128	Meridian	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912211	Arbuckle	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912138	Sanborn Slough	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Fritillaria agrestis	stinkbells	PMLIL0V010	None	None	-	4.2	3912211	Arbuckle	Unprocessed	Plants - Vascular - Liliaceae - Fritillaria agrestis
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3912138	Sanborn Slough	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3912128	Meridian	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis

Plants - Vascular	Chloropyron palmatum	palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	-	1B.1	3912118	Grimes	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron palmatum
Plants - Vascular	Chloropyron palmatum	palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	-	1B.1	3912211	Arbuckle	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron palmatum
Plants - Vascular	Chloropyron palmatum	palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	-	1B.1	3912231	Moulton Weir	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron palmatum
Plants - Vascular	Chloropyron palmatum	palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	-	1B.1	3912221	Colusa	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron palmatum
Plants - Vascular	Puccinellia simplex	California alkali grass	PMPOA53110	None	None	-	1B.2	3912221	Colusa	Mapped	Plants - Vascular - Poaceae - Puccinellia simplex
Plants - Vascular	Puccinellia simplex	California alkali grass	PMPOA53110	None	None	-	1B.2	3912222	Williams	Mapped	Plants - Vascular - Poaceae - Puccinellia simplex
Plants - Vascular	Puccinellia simplex	California alkali grass	PMPOA53110	None	None	-	1B.2	3912211	Arbuckle	Mapped	Plants - Vascular - Poaceae - Puccinellia simplex
Plants - Vascular	Navarretia leucocephala ssp. bakeri	Baker's navarretia	PDPLM0C0E1	None	None	-	1B.1	3912211	Arbuckle	Mapped	Plants - Vascular - Polemoniaceae - Navarretia leucocephala ssp. bakeri
Plants - Vascular	Navarretia leucocephala ssp. bakeri	Baker's navarretia	PDPLM0C0E1	None	None	-	1B.1	3912118	Grimes	Mapped	Plants - Vascular - Polemoniaceae - Navarretia leucocephala ssp. bakeri
Plants - Vascular	Heteranthera dubia	water star-grass	PMPON03010	None	None	-	2B.2	3912138	Sanborn Slough	Mapped	Plants - Vascular - Pontederiaceae - Heteranthera dubia
Plants - Vascular	Heteranthera dubia	water star-grass	PMPON03010	None	None	-	2B.2	3912222	Williams	Mapped	Plants - Vascular - Pontederiaceae - Heteranthera dubia
Plants - Vascular	Myosurus minimus ssp. apus	little mousetail	PDRAN0H031	None	None	-	3.1	3912232	Maxwell	Unprocessed	Plants - Vascular - Ranunculaceae - Myosurus minimus ssp. apus

CNDDB 9-Quad Species List 215 records.

Element Type	Scientific Name	Common Name	Element Code	Federal Status	State Status	CDFW Status	CA Rare Plant Rank	Quad Code	Quad Name	Data Status	Taxonomic Sort
Animals - Amphibians	Rana boylii	foothill yellow-legged frog	AAABH01050	None	Candidate Threatened	SSC	-	3912212	Cortina Creek	Mapped	Animals - Amphibians - Ranidae - Rana boylii
Animals - Amphibians	Spea hammondii	western spadefoot	AAABF02020	None	None	SSC	-	3912212	Cortina Creek	Mapped and Unprocessed	Animals - Amphibians - Scaphiopodidae - Spea hammondii
Animals - Amphibians	Spea hammondii	western spadefoot	AAABF02020	None	None	SSC	-	3912211	Arbuckle	Mapped and Unprocessed	Animals - Amphibians - Scaphiopodidae - Spea hammondii
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912211	Arbuckle	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912212	Cortina Creek	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912221	Colusa	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912118	Grimes	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912222	Williams	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912231	Moulton Weir	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912232	Maxwell	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Circus hudsonius	northern harrier	ABNKC11011	None	None	SSC	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Accipitridae - Circus hudsonius
Animals - Birds	Elanus leucurus	white-tailed kite	ABNKC06010	None	None	FP	-	3912221	Colusa	Unprocessed	Animals - Birds - Accipitridae - Elanus leucurus
Animals - Birds	Haliaeetus leucocephalus	bald eagle	ABNKC10010	Delisted	Endangered	FP	-	3912231	Moulton Weir	Mapped	Animals - Birds - Accipitridae - Haliaeetus leucocephalus
Animals - Birds	Branta hutchinsii leucopareia	cackling (=Aleutian Canada) goose	ABNJB05035	Delisted	None	-	-	3912138	Sanborn Slough	Mapped and Unprocessed	Animals - Birds - Anatidae - Branta hutchinsii leucopareia
Animals - Birds	Branta hutchinsii leucopareia	cackling (=Aleutian Canada) goose	ABNJB05035	Delisted	None	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Birds - Anatidae - Branta hutchinsii leucopareia
Animals - Birds	Branta hutchinsii leucopareia	cackling (=Aleutian Canada) goose	ABNJB05035	Delisted	None	-	-	3912118	Grimes	Mapped	Animals - Birds - Anatidae - Branta hutchinsii leucopareia
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Birds - Ardeidae - Ardea alba

Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912211	Arbuckle	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Botaurus lentiginosus	American bittern	ABNGA01020	None	None	-	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Ardeidae - Botaurus lentiginosus
Animals - Birds	Botaurus lentiginosus	American bittern	ABNGA01020	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Botaurus lentiginosus
Animals - Birds	Botaurus lentiginosus	American bittern	ABNGA01020	None	None	-	-	3912232	Maxwell	Unprocessed	Animals - Birds - Ardeidae - Botaurus lentiginosus
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912232	Maxwell	Mapped and Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Ixobrychus exilis	least bittern	ABNGA02010	None	None	SSC	-	3912232	Maxwell	Unprocessed	Animals - Birds - Ardeidae - Ixobrychus exilis
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912232	Maxwell	Mapped and Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax

Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3912211	Arbuckle	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912221	Colusa	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912128	Meridian	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912231	Moulton Weir	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Falco peregrinus anatum	American peregrine falcon	ABNKD06071	Delisted	Delisted	FP	-	3912128	Meridian	Unprocessed	Animals - Birds - Falconidae - Falco peregrinus anatum
Animals - Birds	Falco peregrinus anatum	American peregrine falcon	ABNKD06071	Delisted	Delisted	FP	-	3912221	Colusa	Unprocessed	Animals - Birds - Falconidae - Falco peregrinus anatum
Animals - Birds	Antigone canadensis tabida	greater sandhill crane	ABNMK01014	None	Threatened	FP	-	3912128	Meridian	Mapped	Animals - Birds - Gruidae - Antigone canadensis tabida
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912118	Grimes	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912221	Colusa	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912231	Moulton Weir	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912231	Moulton Weir	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912222	Williams	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912232	Maxwell	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912221	Colusa	Mapped	Animals - Birds - Icteridae - Agelaius tricolor

Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912211	Arbuckle	Mapped and Unprocessed	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912118	Grimes	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912128	Meridian	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Icteria virens	yellow-breasted chat	ABPBX24010	None	None	SSC	-	3912211	Arbuckle	Unprocessed	Animals - Birds - Icteriidae - Icteria virens
Animals - Birds	Lanius ludovicianus	loggerhead shrike	ABPBR01030	None	None	SSC	-	3912232	Maxwell	Unprocessed	Animals - Birds - Laniidae - Lanius ludovicianus
Animals - Birds	Pandion haliaetus	osprey	ABNKC01010	None	None	WL	-	3912231	Moulton Weir	Mapped and Unprocessed	Animals - Birds - Pandionidae - Pandion haliaetus
Animals - Birds	Pandion haliaetus	osprey	ABNKC01010	None	None	WL	-	3912128	Meridian	Unprocessed	Animals - Birds - Pandionidae - Pandion haliaetus
Animals - Birds	Setophaga petechia	yellow warbler	ABPBX03010	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Birds - Parulidae - Setophaga petechia
Animals - Birds	Melospiza melodia	song sparrow (-inModesto-in population)	ABPBXA3010	None	None	SSC	-	3912221	Colusa	Mapped	Animals - Birds - Passerellidae - Melospiza melodia
Animals - Birds	Melospiza melodia	song sparrow (-inModesto-in population)	ABPBXA3010	None	None	SSC	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Passerellidae - Melospiza melodia
Animals - Birds	Melospiza melodia	song sparrow (-inModesto-in population)	ABPBXA3010	None	None	SSC	-	3912128	Meridian	Mapped	Animals - Birds - Passerellidae - Melospiza melodia
Animals - Birds	Phalacrocorax auritus	double-crested cormorant	ABNFD01020	None	None	WL	-	3912138	Sanborn Slough	Unprocessed	Animals - Birds - Phalacrocoracidae - Phalacrocorax auritus
Animals - Birds	Phalacrocorax auritus	double-crested cormorant	ABNFD01020	None	None	WL	-	3912221	Colusa	Unprocessed	Animals - Birds - Phalacrocoracidae - Phalacrocorax auritus
Animals - Birds	Laterallus jamaicensis coturniculus	California black rail	ABNME03041	None	Threatened	FP	-	3912138	Sanborn Slough	Mapped	Animals - Birds - Rallidae - Laterallus jamaicensis coturniculus
Animals - Birds	Asio flammeus	short-eared owl	ABNSB13040	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Birds - Strigidae - Asio flammeus
Animals - Birds	Asio otus	long-eared owl	ABNSB13010	None	None	SSC	-	3912231	Moulton Weir	Unprocessed	Animals - Birds - Strigidae - Asio otus
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3912212	Cortina Creek	Mapped	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912211	Arbuckle	Mapped	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912221	Colusa	Mapped	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912118	Grimes	Unprocessed	Animals - Birds - Threskiornithidae - Plegadis chihi

Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912231	Moulton Weir	Mapped and Unprocessed	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912232	Maxwell	Mapped	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912222	Williams	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912231	Moulton Weir	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Fish	Lavinia exilicauda exilicauda	Sacramento hitch	AFCJB19012	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Cyprinidae - Lavinia exilicauda exilicauda
Animals - Fish	Lavinia exilicauda exilicauda	Sacramento hitch	AFCJB19012	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Cyprinidae - Lavinia exilicauda exilicauda
Animals - Fish	Mylopharodon conocephalus	hardhead	AFCJB25010	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Cyprinidae - Mylopharodon conocephalus
Animals - Fish	Mylopharodon conocephalus	hardhead	AFCJB25010	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Cyprinidae - Mylopharodon conocephalus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3912118	Grimes	Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii
Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii
Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii

Animals - Fish	Spirinchus thaleichthys	longfin smelt	AFCHB03010	Candidate	Threatened	SSC	-	3912221	Colusa	Mapped	Animals - Fish - Osmeridae - Spirinchus thaleichthys
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912221	Colusa	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912138	Sanborn Slough	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912118	Grimes	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912231	Moulton Weir	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3912118	Grimes	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30
Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3912118	Grimes	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30
Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3912128	Meridian	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3912128	Meridian	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6

Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3912118	Grimes	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3912221	Colusa	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3912221	Colusa	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3912118	Grimes	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3912128	Meridian	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Insects	Bombus crotchii	Crotch bumble bee	IIHYM24480	None	None	-	-	3912118	Grimes	Mapped	Animals - Insects - Apidae - Bombus crotchii
Animals - Insects	Cicindela hirticollis abrupta	Sacramento Valley tiger beetle	IICOL02106	None	None	-	-	3912128	Meridian	Mapped	Animals - Insects - Carabidae - Cicindela hirticollis abrupta
Animals - Insects	Cicindela hirticollis abrupta	Sacramento Valley tiger beetle	IICOL02106	None	None	-	-	3912221	Colusa	Mapped	Animals - Insects - Carabidae - Cicindela hirticollis abrupta
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912221	Colusa	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912128	Meridian	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912118	Grimes	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912231	Moulton Weir	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3912222	Williams	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3912118	Grimes	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3912211	Arbuckle	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin

Animals - Mammals	Perognathus inornatus	San Joaquin Pocket Mouse	AMAFD01060	None	None	-	-	3912128	Meridian	Mapped	Animals - Mammals - Heteromyidae - Perognathus inornatus
Animals - Mammals	Taxidea taxus	American badger	AMAJF04010	None	None	SSC	-	3912211	Arbuckle	Unprocessed	Animals - Mammals - Mustelidae - Taxidea taxus
Animals - Mammals	Taxidea taxus	American badger	AMAJF04010	None	None	SSC	-	3912212	Cortina Creek	Unprocessed	Animals - Mammals - Mustelidae - Taxidea taxus
Animals - Mammals	Taxidea taxus	American badger	AMAJF04010	None	None	SSC	-	3912222	Williams	Mapped	Animals - Mammals - Mustelidae - Taxidea taxus
Animals - Mammals	Lasiurus blossevillii	western red bat	AMACC05060	None	None	SSC	-	3912221	Colusa	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus blossevillii
Animals - Mammals	Lasiurus blossevillii	western red bat	AMACC05060	None	None	SSC	-	3912128	Meridian	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus blossevillii
Animals - Mammals	Lasiurus cinereus	hoary bat	AMACC05030	None	None	-	-	3912128	Meridian	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus cinereus
Animals - Mammals	Lasiurus cinereus	hoary bat	AMACC05030	None	None	-	-	3912221	Colusa	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus cinereus
Animals - Mammals	Myotis ciliolabrum	western small-footed myotis	AMACC01140	None	None	-	-	3912221	Colusa	Mapped	Animals - Mammals - Vespertilionidae - Myotis ciliolabrum
Animals - Mammals	Myotis yumanensis	Yuma myotis	AMACC01020	None	None	-	-	3912128	Meridian	Mapped	Animals - Mammals - Vespertilionidae - Myotis yumanensis
Animals - Mollusks	Anodonta oregonensis	Oregon floater	IMBIV04110	None	None	-	-	3912221	Colusa	Unprocessed	Animals - Mollusks - Unionidae - Anodonta oregonensis
Animals - Mollusks	Gonidea angulata	western ridged mussel	IMBIV19010	None	None	-	-	3912128	Meridian	Unprocessed	Animals - Mollusks - Unionidae - Gonidea angulata
Animals - Reptiles	Masticophis flagellum ruddocki	San Joaquin coachwhip	ARADB21021	None	None	SSC	-	3912212	Cortina Creek	Unprocessed	Animals - Reptiles - Colubridae - Masticophis flagellum ruddocki
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912138	Sanborn Slough	Mapped	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912221	Colusa	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912222	Williams	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912222	Williams	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912231	Moulton Weir	Mapped	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912232	Maxwell	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas

Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912221	Colusa	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912138	Sanborn Slough	Mapped	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912211	Arbuckle	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912128	Meridian	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912118	Grimes	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Community - Terrestrial	Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	CTT52410CA	None	None	-	-	3912128	Meridian	Mapped	Community - Terrestrial - Coastal and Valley Freshwater Marsh
Community - Terrestrial	Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	CTT52410CA	None	None	-	-	3912138	Sanborn Slough	Mapped	Community - Terrestrial - Coastal and Valley Freshwater Marsh
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912138	Sanborn Slough	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912221	Colusa	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912128	Meridian	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912118	Grimes	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912231	Moulton Weir	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912231	Moulton Weir	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912118	Grimes	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912128	Meridian	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912221	Colusa	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912138	Sanborn Slough	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Willow Scrub	Great Valley Willow Scrub	CTT63410CA	None	None	-	-	3912118	Grimes	Mapped	Community - Terrestrial - Great Valley Willow Scrub
Community - Terrestrial	Great Valley Willow Scrub	Great Valley Willow Scrub	CTT63410CA	None	None	-	-	3912231	Moulton Weir	Mapped	Community - Terrestrial - Great Valley Willow Scrub

Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912231	Moulton Weir	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912222	Williams	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912232	Maxwell	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912128	Meridian	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912211	Arbuckle	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Centromadia parryi ssp. rudis	Parry's rough tarplant	PDAST4R0P3	None	None	-	4.2	3912221	Colusa	Unprocessed	Plants - Vascular - Asteraceae - Centromadia parryi ssp. rudis
Plants - Vascular	Lasthenia ferrisiae	Ferris' goldfields	PDAST5L070	None	None	-	4.2	3912221	Colusa	Unprocessed	Plants - Vascular - Asteraceae - Lasthenia ferrisiae
Plants - Vascular	Lasthenia ferrisiae	Ferris' goldfields	PDAST5L070	None	None	-	4.2	3912128	Meridian	Unprocessed	Plants - Vascular - Asteraceae - Lasthenia ferrisiae
Plants - Vascular	Lasthenia ferrisiae	Ferris' goldfields	PDAST5L070	None	None	-	4.2	3912232	Maxwell	Unprocessed	Plants - Vascular - Asteraceae - Lasthenia ferrisiae
Plants - Vascular	Lasthenia ferrisiae	Ferris' goldfields	PDAST5L070	None	None	-	4.2	3912222	Williams	Unprocessed	Plants - Vascular - Asteraceae - Lasthenia ferrisiae
Plants - Vascular	Lasthenia glabrata ssp. coulteri	Coulter's goldfields	PDAST5L0A1	None	None	-	1B.1	3912221	Colusa	Mapped	Plants - Vascular - Asteraceae - Lasthenia glabrata ssp. coulteri
Plants - Vascular	Layia septentrionalis	Colusa layia	PDAST5N0F0	None	None	-	1B.2	3912211	Arbuckle	Mapped	Plants - Vascular - Asteraceae - Layia septentrionalis
Plants - Vascular	Layia septentrionalis	Colusa layia	PDAST5N0F0	None	None	-	1B.2	3912118	Grimes	Mapped	Plants - Vascular - Asteraceae - Layia septentrionalis
Plants - Vascular	Trichocoronis wrightii var. wrightii	Wright's trichocoronis	PDAST9F031	None	None	-	2B.1	3912118	Grimes	Mapped	Plants - Vascular - Asteraceae - Trichocoronis wrightii var. wrightii
Plants - Vascular	Amsinckia lunaris	bent-flowered fiddleneck	PDBOR01070	None	None	-	1B.2	3912138	Sanborn Slough	Mapped	Plants - Vascular - Boraginaceae - Amsinckia lunaris
Plants - Vascular	Brasenia schreberi	watershield	PDCAB01010	None	None	-	2B.3	3912138	Sanborn Slough	Mapped	Plants - Vascular - Cabombaceae - Brasenia schreberi
Plants - Vascular	Atriplex cordulata var. cordulata	heartscale	PDCHE040B0	None	None	-	1B.2	3912128	Meridian	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex cordulata var. cordulata
Plants - Vascular	Atriplex depressa	brittlescale	PDCHE042L0	None	None	-	1B.2	3912211	Arbuckle	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex depressa
Plants - Vascular	Atriplex depressa	brittlescale	PDCHE042L0	None	None	-	1B.2	3912221	Colusa	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex depressa
Plants - Vascular	Atriplex depressa	brittlescale	PDCHE042L0	None	None	-	1B.2	3912231	Moulton Weir	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex depressa

Plants - Vascular	Atriplex persistens	vernal pool smallscale	PDCHE042P0	None	None	-	1B.2	3912221	Colusa	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex persistens
Plants - Vascular	Atriplex persistens	vernal pool smallscale	PDCHE042P0	None	None	-	1B.2	3912211	Arbuckle	Mapped	Plants - Vascular - Chenopodiaceae - Atriplex persistens
Plants - Vascular	Extriplex joaquinana	San Joaquin spearscale	PDCHE041F3	None	None	-	1B.2	3912221	Colusa	Mapped	Plants - Vascular - Chenopodiaceae - Extriplex joaquinana
Plants - Vascular	Extriplex joaquinana	San Joaquin spearscale	PDCHE041F3	None	None	-	1B.2	3912222	Williams	Mapped	Plants - Vascular - Chenopodiaceae - Extriplex joaquinana
Plants - Vascular	Extriplex joaquinana	San Joaquin spearscale	PDCHE041F3	None	None	-	1B.2	3912232	Maxwell	Mapped	Plants - Vascular - Chenopodiaceae - Extriplex joaquinana
Plants - Vascular	Cuscuta obtusiflora var. glandulosa	Peruvian dodder	PDCUS01111	None	None	-	2B.2	3912138	Sanborn Slough	Mapped	Plants - Vascular - Convolvulaceae - Cuscuta obtusiflora var. glandulosa
Plants - Vascular	Astragalus tener var. ferrisiae	Ferris' milk-vetch	PDFAB0F8R3	None	None	-	1B.1	3912211	Arbuckle	Mapped	Plants - Vascular - Fabaceae - Astragalus tener var. ferrisiae
Plants - Vascular	Astragalus tener var. ferrisiae	Ferris' milk-vetch	PDFAB0F8R3	None	None	-	1B.1	3912118	Grimes	Mapped	Plants - Vascular - Fabaceae - Astragalus tener var. ferrisiae
Plants - Vascular	Astragalus tener var. ferrisiae	Ferris' milk-vetch	PDFAB0F8R3	None	None	-	1B.1	3912221	Colusa	Mapped	Plants - Vascular - Fabaceae - Astragalus tener var. ferrisiae
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912221	Colusa	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912231	Moulton Weir	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912232	Maxwell	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912118	Grimes	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912128	Meridian	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912211	Arbuckle	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912138	Sanborn Slough	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Fritillaria agrestis	stinkbells	PMLIL0V010	None	None	-	4.2	3912211	Arbuckle	Unprocessed	Plants - Vascular - Liliaceae - Fritillaria agrestis
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3912138	Sanborn Slough	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3912128	Meridian	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis

Plants - Vascular	Chloropyron palmatum	palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	-	1B.1	3912118	Grimes	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron palmatum
Plants - Vascular	Chloropyron palmatum	palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	-	1B.1	3912211	Arbuckle	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron palmatum
Plants - Vascular	Chloropyron palmatum	palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	-	1B.1	3912231	Moulton Weir	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron palmatum
Plants - Vascular	Chloropyron palmatum	palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	-	1B.1	3912221	Colusa	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron palmatum
Plants - Vascular	Puccinellia simplex	California alkali grass	PMPOA53110	None	None	-	1B.2	3912221	Colusa	Mapped	Plants - Vascular - Poaceae - Puccinellia simplex
Plants - Vascular	Puccinellia simplex	California alkali grass	PMPOA53110	None	None	-	1B.2	3912222	Williams	Mapped	Plants - Vascular - Poaceae - Puccinellia simplex
Plants - Vascular	Puccinellia simplex	California alkali grass	PMPOA53110	None	None	-	1B.2	3912211	Arbuckle	Mapped	Plants - Vascular - Poaceae - Puccinellia simplex
Plants - Vascular	Navarretia leucocephala ssp. bakeri	Baker's navarretia	PDPLM0C0E1	None	None	-	1B.1	3912211	Arbuckle	Mapped	Plants - Vascular - Polemoniaceae - Navarretia leucocephala ssp. bakeri
Plants - Vascular	Navarretia leucocephala ssp. bakeri	Baker's navarretia	PDPLM0C0E1	None	None	-	1B.1	3912118	Grimes	Mapped	Plants - Vascular - Polemoniaceae - Navarretia leucocephala ssp. bakeri
Plants - Vascular	Heteranthera dubia	water star-grass	PMPON03010	None	None	-	2B.2	3912138	Sanborn Slough	Mapped	Plants - Vascular - Pontederiaceae - Heteranthera dubia
Plants - Vascular	Heteranthera dubia	water star-grass	PMPON03010	None	None	-	2B.2	3912222	Williams	Mapped	Plants - Vascular - Pontederiaceae - Heteranthera dubia
Plants - Vascular	Myosurus minimus ssp. apus	little mousetail	PDRAN0H031	None	None	-	3.1	3912232	Maxwell	Unprocessed	Plants - Vascular - Ranunculaceae - Myosurus minimus ssp. apus

CNPS California Native Plant Society

Plant List

Inventory of Rare and Endangered Plants

19 matches found. *Click on scientific name for details*

Search Criteria

Found in Quads 3912232, 3912231, 3912138, 3912222, 3912221, 3912128, 3912212 3912211 and 3912118;

Modify Search Criteria | Export to Excel | Modify Columns | Modify Sort | Display Photos

Scientific Name	Common Name	Family	Lifeform	Blooming Period	CA Rare Plant Rank	State Rank	Global Rank
Amsinckia lunaris	bent-flowered fiddleneck	Boraginaceae	annual herb	Mar-Jun	1B.2	S3	G3
Astragalus tener var. ferrisiae	Ferris' milk-vetch	Fabaceae	annual herb	Apr-May	1B.1	S1	G2T1
Atriplex cordulata var. cordulata	heartscale	Chenopodiaceae	annual herb	Apr-Oct	1B.2	S2	G3T2
Atriplex depressa	brittlescale	Chenopodiaceae	annual herb	Apr-Oct	1B.2	S2	G2
Atriplex persistens	vernal pool smallscale	Chenopodiaceae	annual herb	Jun,Aug,Sep,Oct	1B.2	S2	G2
Brasenia schreberi	watershield	Cabombaceae	perennial rhizomatous herb (aquatic)	Jun-Sep	2B.3	S3	G5
Centromadia parryi ssp. rudis	Parry's rough tarplant	Asteraceae	annual herb	May-Oct	4.2	S3	G3T3
Chloropyron palmatum	palmate-bracted bird's-beak	Orobanchaceae	annual herb (hemiparasitic)	May-Oct	1B.1	S1	G1
Cuscuta obtusiflora var. glandulosa	Peruvian dodder	Convolvulaceae	annual vine (parasitic)	Jul-Oct	2B.2	SH	G5T4T5
Extriplex joaquinana	San Joaquin spearscale	Chenopodiaceae	annual herb	Apr-Oct	1B.2	S2	G2
Grimmia torenii	Toren's grimmia	Grimmiaceae	moss		1B.3	S2	G2
Heteranthera dubia	water star-grass	Pontederiaceae	perennial herb (aquatic)	Jul-Oct	2B.2	S2	G5
Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	Malvaceae	perennial rhizomatous herb (emergent)	Jun-Sep	1B.2	S3	G5T3
Lasthenia glabrata ssp. coulteri	Coulter's goldfields	Asteraceae	annual herb	Feb-Jun	1B.1	S2	G4T2
Layia septentrionalis	Colusa layia	Asteraceae	annual herb	Apr-May	1B.2	S2	G2
Myosurus minimus ssp. apus	little mousetail	Ranunculaceae	annual herb	Mar-Jun	3.1	S2	G5T2Q
Navarretia leucocephala ssp. bakeri	Baker's navarretia	Polemoniaceae	annual herb	Apr-Jul	1B.1	S2	G4T2
Puccinellia simplex	California alkali grass	Poaceae	annual herb	Mar-May	1B.2	S2	G3
Trichocoronis wrightii var. wrightii	Wright's trichocoronis	Asteraceae	annual herb	May-Sep	2B.1	S1	G4T3

Suggested Citation

California Native Plant Society, Rare Plant Program. 2019. Inventory of Rare and Endangered Plants of California (online edition, v8-03 0.39). Website http://www.rareplants.cnps.org [accessed 09 January 2019].

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Plant List

Inventory of Rare and Endangered Plants

22 matches found. *Click on scientific name for details*

Search Criteria

Found in Quads 3912231, 3912138, 3912137, 3912221, 3912128, 3912127, 3912211 3912118 and 3912117;

Modify Search Criteria | Export to Excel | Modify Columns | Modify Sort | Display Photos

Scientific Name	Common Name	Family	Lifeform	Blooming Period	CA Rare Plant Rank	State Rank	Global Rank
Amsinckia lunaris	bent-flowered fiddleneck	Boraginaceae	annual herb	Mar-Jun	1B.2	S3	G3
Astragalus tener var. ferrisiae	Ferris' milk-vetch	Fabaceae	annual herb	Apr-May	1B.1	S1	G2T1
Atriplex cordulata var. cordulata	heartscale	Chenopodiaceae	annual herb	Apr-Oct	1B.2	S2	G3T2
Atriplex depressa	brittlescale	Chenopodiaceae	annual herb	Apr-Oct	1B.2	S2	G2
Atriplex minuscula	lesser saltscale	Chenopodiaceae	annual herb	May-Oct	1B.1	S2	G2
Atriplex persistens	vernal pool smallscale	Chenopodiaceae	annual herb	Jun,Aug,Sep,Oct	1B.2	S2	G2
Atriplex subtilis	subtle orache	Chenopodiaceae	annual herb	Jun,Aug,Sep(Oct)	1B.2	S1	G1
Brasenia schreberi	watershield	Cabombaceae	perennial rhizomatous herb (aquatic)	Jun-Sep	2B.3	S3	G5
Castilleja rubicundula var. rubicundula	pink creamsacs	Orobanchaceae	annual herb (hemiparasitic)	Apr-Jun	1B.2	S2	G5T2
Centromadia parryi ssp. parryi	pappose tarplant	Asteraceae	annual herb	May-Nov	1B.2	S2	G3T2
Centromadia parryi ssp. rudis	Parry's rough tarplant	Asteraceae	annual herb	May-Oct	4.2	S3	G3T3
Chloropyron palmatum	palmate-bracted bird's-beak	Orobanchaceae	annual herb (hemiparasitic)	May-Oct	1B.1	S1	G1
Cuscuta obtusiflora var. glandulosa	Peruvian dodder	Convolvulaceae	annual vine (parasitic)	Jul-Oct	2B.2	SH	G5T4T5
Extriplex joaquinana	San Joaquin spearscale	Chenopodiaceae	annual herb	Apr-Oct	1B.2	S2	G2
Heteranthera dubia	water star-grass	Pontederiaceae	perennial herb (aquatic)	Jul-Oct	2B.2	S2	G5
Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	Malvaceae	perennial rhizomatous herb (emergent)	Jun-Sep	1B.2	S3	G5T3
Lasthenia glabrata ssp. coulteri	Coulter's goldfields	Asteraceae	annual herb	Feb-Jun	1B.1	S2	G4T2
Layia septentrionalis	Colusa layia	Asteraceae	annual herb	Apr-May	1B.2	S2	G2
Navarretia leucocephala ssp. bakeri	Baker's navarretia	Polemoniaceae	annual herb	Apr-Jul	1B.1	S2	G4T2

Puccinellia simplex	California alkali grass	Poaceae	annual herb	Mar-May	1B.2	S2	G3
Trichocoronis wrightii var. wrightii	Wright's trichocoronis	Asteraceae	annual herb	May-Sep	2B.1	S1	G4T3
Wolffia brasiliensis	Brazilian watermeal	Araceae	perennial herb (aquatic)	Apr,Dec	2B.3	S2	G5

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Attachment D. Cultural Resources Analysis

Memo

Date:	Friday, March 01, 2019
Project:	Colusa Flood Risk Reduction Feasibility Study
To:	Colusa County
From:	John “Jay” Lloyd, Senior Archaeologist (HDR)
Reviewed:	Danielle Risse, Senior Archaeologist (HDR)
Subject:	Colusa – Cultural Resources Constraints Analysis

Introduction

This memo presents a preliminary review of potential cultural resources constraints for the Colusa Flood Risk Reduction Feasibility Study Project (Project). Potential constraints are described below.

Methodology

Records Search and Historic Map Review

A records search request for the Project area was submitted on December 14, 2018 to the Northwest Information Center (NWIC) of the California Historical Resources Information System, located at Sonoma State University. The search area for which data was requested included all alternatives for the Project footprint, plus a 0.25-mile buffer. Search results were received from the NWIC on January 24, 2019. The information request included a search of previous cultural resources investigations, and previously recorded archaeological sites and built environment resources. To gather these data the records search reviewed the following including the:

- NWIC Resource Database,
- NWIC Report Database,
- Office of Historic Preservation (OHP) Historic Properties Directory for Colusa County,
- OHP Archaeological Determinations of Eligibility for Colusa County,
- California Inventory of Historical Resources (1976), and
- GLO and/or Rancho Plat Maps.

Information was also requested on the Caltrans Bridge Survey, ethnographic information, and local inventories, where present. Historic United States Geological Service (USGS) topographic maps were also reviewed in order to track land-use and historic-era development.

Reconnaissance Survey

A field reconnaissance of the Project area was conducted on January 22, 2019 by John “Jay” Lloyd, M.A. Linguistics, who meets the Secretary of the Interior’s Qualification Standards for archaeology and is a Registered Professional Archaeologist (RPA). Methods included reviewing the results of the records search, confirming the absence/presence of previously recorded (and accessible) resources, generally driving across the breadth of the Project area on publicly accessible roads, and assessing major topographical differences between the historic and modern landscape using historic-era maps for comparison.

Results

Records Search

There have been 42 previous cultural resources investigations intersecting the Project area (**Attachment D-1**) with nine of these studies (S-002917, S-027163, S-034069, S-035456, S-043891, S-043845, S-044297, S-046926, and S-049309) producing multiple reports. Previous investigations were primarily archaeological or architectural/historical field studies and were conducted for a variety of projects including community infrastructure and management projects, levee improvements, transmission lines, fiber optic lines, and transportation projects. These studies documented more than 375 prehistoric and historical archaeological sites and historical built environment resources, although many of these were recorded outside of the Project area. An additional seven studies have been conducted within the 0.25-mile search radius – one examining various locations within two Sacramento River Bank Protection Units, a levee erosion repair project, boat launch and development projects, and an overview and management plan for the Sacramento River Conservation Area. The studies are summarized in **Attachment D-1**.

A total of 287 resources have been identified and recorded in the Project area and 0.25-mile search radius – including prehistoric and historical archaeological sites as well as built environment resources (**Table 1** and **Attachment D-2**). The vast majority of these (n=276) are the result of an extensive survey of historic buildings within the city of Colusa (Peterson and Carter 1980, Bunch 1980) and are discussed in more detail below.

The remaining 11 sites include a mix of prehistoric and historical archaeological sites, and built environment resources, most of which have not been evaluated for CRHR/NRHP eligibility. Two sites (P-06-00113 and P-06-00206) were subject to archaeological excavation in support of a Corps of Engineers levee project and recommended ineligible for listing on the National Register of Historic Places (NRHP) (Nadolski and Jackson 1997a, 1997b). These 11 resources are summarized in **Table 1**.

One potentially significant prehistoric site just north of Colusa, P-06-00032 (CA-COL-008), was first recorded in 1949 and was likely an extensive habitation site located adjacent to the Sacramento River and included human remains and beads. The site was presumed to have been mostly destroyed by levee construction. However, identification efforts in 2009 and 2010 identified sparse to moderate quantities of prehistoric material (freshwater clam shell, obsidian and basalt flaked stone, groundstone, clam shell beads, an olivella shell bead, faunal bone) and human bone; suggesting that the prehistoric deposit may be more extensive (and potentially intact) than what had been previously noted.

Finally, as noted above, the vast majority of previously documented resources in the Project area stem from an extensive historical building survey within the city of Colusa (Peterson and Carter 1980). In 1979-1980, the city of Colusa and the California Office of Historic Preservation jointly funded a historical building inventory which eventually covered more than 100 city blocks and examined more than 1,000 buildings (Bunch 1980). The NWIC database lists 275 historical built environment resources within the Project area and 1 within the search radius. Of the 276 buildings, 105 of the structures are considered CRHR/NRHP eligible, 39 are ineligible, 130 are unevaluated, and the status of 2 could not be determined. Additionally, five historical districts were also noted within Colusa – the Old Chinatown District, the 1000-1100 Blocks of Jay Street District, the 1100-

1200 Blocks of Oak Street District, the 100 Block of Clay Street District, and the Parkhill Street (between 5th and 8th streets) District. These resources are summarized in **Attachment D-2**.

Table 1: Previously recorded resources in NWIC database (excluding the Colusa Historic Resources Inventory [included as Attachment D-2])

Primary No.	Trinomial	Resource Type	NRHP[1] / CRHR[2] Status	Intersects Project Area?
P-06-00032	CA-COL-008	Prehistoric site	Unevaluated	No
P-06-00113	CA-COL-090H	Historical structure, site	Not Eligible	Yes
P-06-00206	CA-COL-221	Prehistoric site	Not Eligible	Yes
P-06-00276	CA-COL-245/H	Prehistoric and Historical Site		
P-06-000281	n/a	Prehistoric site	Unevaluated	Yes
P-06-000589	CA-COL-287H	Historical site	Unevaluated	Yes
P-06-000592	n/a	Historical site	Unevaluated	Yes
P-06-000619	CA-COL-286H	Colusa City Dump	Unevaluated	Yes
P-06-000657	CA-COL-339H	Sacramento Northern Railway	Unevaluated	Yes
P-06-000750	CA-COL-337/H	Prehistoric and historical site	Unevaluated	Yes
P-06-000756	n/a	PG&E gas plant	Unevaluated	Yes

[1]National Register of Historic Places
[2]California Register of Historical Resources

Historic Map Review

GLO survey plats were reviewed to identify potential historic-era resources within the Project area and 0.25-mile buffer (**Table 2**). Some resources depicted on historical maps may become archaeological sites as they disintegrate over time. The 1867 map makes multiple references to geographical locations (city of Colusa, ferry, roads, and fence lines) but does not note any structures. The map also notes property divisions within the Colus Rancho as well as its boundary with the Jimeno Rancho. Similar to other GLO maps from this time period, no landscape (sloughs, creeks, roads, ditches, etc.) or cartographic (township, range, or section lines) features are recorded within either of the ranchos. This may have been a function of the land office's initial focus on public lands. A subsequent 1892 map provides extensive parcel detail east of the Sacramento River but does not note any features on the west side of the river.

Table 2. Resources depicted on GLO survey plats

Date	Resource Type	Location	Intersects Project Area?
1867	Lot No. 38 – labelled as "Part of Colus Rancho" Town of Colusa (no structures plotted) Colusa Ferry Two fence lines Colusa Road Road from Colusa Boundary with Jimeno Rancho	Section 19; T16N, R1W	Yes
1892	Lot No. 37 – Part of Colus Rancho Boundary with Jimeno Rancho	Section 19; T16N, R1W	Yes

Early United States Geological Survey (USGS) topographic maps were also reviewed to identify potential areas where historical resources may be found (**Table 3**). The early 20th century 1:62500 Colusa map depict the town of Colusa in its present-day location (USGS 1907) approximately within

the modern alignments of Market Street, 10th Street, and Bridge Street. The map also depicts 100+ buildings within the city core as well as the "Colusa and Lake" railroad line coming in from the west (along the modern alignment of Lurline Avenue). The 1912 Meridian (USGS 1912) 1:31680 map shows the modern alignment of Clay Street, a bridge across the Sacramento River, and 10+ buildings southeast of the city core. The 1:31680 Powell Slough map (USGS 1918) maps shows the same features as the 1907 Colusa map. The first 1:24000 map of Colusa (USGS 1952) shows the development of the city into the county seat. The map shows two cemeteries, an airport, fairgrounds, the Sacramento River levee, and multiple canals and ditches. By 1952 the town was also served by the Southern Pacific railroad and a rail station.

Table 3. Resources depicted on historical USGS topographic maps

Date	Map (scale)	Resource Type	Intersects Project Area?
1907	Colusa (1:62500)	Modern alignments of city core laid out with 100+ structures (roughly bound by Market Street, 10th Street, and Bridge Street) Colusa and Lake Railroad	Yes
1912	Meridian (1:31680)	Sacramento River bridge Clay Street 10+ structures southeast of city core	Yes
1918	Powell Slough (1:31680)	Same features as 1907 Colusa map	Yes
1952	Colusa (1:24000)	Southern Pacific Railroad and Station Two cemeteries Colusa Airport Colusa Fairgrounds Levee Multiple canals/ditches	Yes

Reconnaissance Survey

Today the Project area is generally low and topographically flat and land use is predominantly rice fields, row-crop agriculture (alfalfa), and nut (walnut, almond) orchards. Irrigation water is provide by a network of canals and ditches. Historic-era farms and ranches – with their collection of associated barns, sheds, pump houses, silos, and other outbuildings – are scattered throughout the Project area, as well as newer homes and commercial buildings. Not surprisingly, considering the results of the records search, Colusa's central business district and the surrounding neighborhoods contain a large concentration of historical (and significant) industrial, commercial, and residential buildings dating to as early as the 1860s. The town of Colusa was founded within Rancho Colus, which had been granted to John Bidwell by Mexican Governor Pio Pico in 1845 (Hoffman 1862). Bidwell sold the rancho to Charles Semple in 1850 who, along with his brother Robert, built the first hotel and residences at the new town site. Steamboat service to and from Benicia soon followed and the new town became a popular stage stop on the way to mines near Shasta (Colusa County n.d.).

Historically, the land has been graded and levelled for agricultural purposes, obscuring much, if not all, of the original topography. In the general vicinity of the Sacramento River, prehistoric archaeological sites tended to be located on natural, high spots adjacent to the river. Often, early European settlers utilized the same locations, thus it is not uncommon for intact prehistoric site remnants to be present within historic-era settlements.

Conclusion

Archaeological and built environment sensitivity within the Project area and 0.25-mile buffer is variable and contingent on the type of resource (prehistoric vs. historical) and geography (proximity to the river and the town of Colusa). For most of the Project area, near-surface archaeological sites have likely been disturbed, and possibly destroyed, by decades of agricultural practices and levee construction. Most of the Project area has not been previously surveyed for archaeological sites and, accordingly, there is a low-to-moderate potential for near-surface unrecorded prehistoric or Native American sites within the unsurveyed portions of the Project area; as well as a moderate to high potential for buried archaeological sites throughout the entire Project area due to the flood plain along the Sacramento River where it is common to find archaeological sites that have been buried by alluvial sediment. Sensitivity for historic-era archaeological sites and historical built environment resources ranges from low to high throughout the Project area and is largely contingent on proximity to historic roadways, residences, and the town of Colusa. As evidenced by the records search, the community of Colusa has a very high percentage of structures significant at the local, state, and national level.

Summary

The findings in this memo represent a preliminary, high-level review of potential cultural resources constraints in the Project area and should not be considered an identification effort sufficient for complying with local, state, or federal laws. Based on this review of the records search results, historic maps, and the site reconnaissance, the Project area contains 105 built environment resources eligible for listing on the CRHR/NRHP. The prehistoric, ethnographic, and historical contexts indicate a low to moderate sensitivity of the Project area for unrecorded surficial archaeological sites with a high potential for those sites, when identified, to have buried components. Further, the Project exhibits a high sensitivity for historical features and buildings in the vicinity of known historical resources. Proposed Project activities have the potential to impact any of the aforementioned cultural resources, should they be identified within, or potentially in the vicinity of, a proposed work area.

Literature Cited

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ATTACHMENT D-1

Previous Cultural Resources Investigations

Attachment D-1: Previous cultural resources investigations identified by the NWIC

Author(s)	Date	Report Title	Study Type	IC File No.	Results
Intersects with project area					
M. Russo	1979	Cultural Resources Survey and Evaluation of 29 Sites in Sacramento Bank Protection Unit 35 Along the Sacramento River (From Millers Landing in Colusa County to Two Miles North of Glenn, Glenn County, California)	Field Study	S-002917	1 site
M. Russo	1979	Cultural Resources Survey and Evaluation of 31 Proposed Spoil Sites and Access Routes Associated with 29 Sites in Sacramento Bank Protection Unit 35 Along the Sacramento River (From Miller's Landing in Colusa County to Two Miles North of Glenn, Glenn County, California) and Cultural Resource Survey and Evaluation of a Borrow Site on the Sacramento Bypass Near Sacramento River Mile 63.0	Field Study	S-002917	Negative
M. Russo	1980	Sacramento River Bank Protection Unit 35 Supplemental Report: Preliminary Historic Investigations of CA-COL-90/H (Colusa County, California)	Management / Planning	S-002917	n/a
Peak & Associates	1977	Cultural Resource Assessment of the City of Colusa Wastewater Treatment Facilities Improvements, Colusa County, California	Field Study	S-002919	Negative
Peak & Associates	1978	Preliminary Case Report of the Colusa Bridge	Field Study	S-002922	Negative
J. Johnson	1974	Reconnaissance Archeological Survey of 151 Locations on the Sacramento River Drainage from Elder Creek in the North to Rio Vista in the South	Field Study	S-005062	6 sites

Author(s)	Date	Report Title	Study Type	IC File No.	Results
L.Glover	1992	Geotechnical Explorations Systems Phase V, Glenn, Colusa, Sutter, and Yolo Counties	Field Study	S-013593	Negative
J. Manning	1981	An archaeological reconnaissance of the proposed site for the Colusa Industrial Park (letter report)	Field Study	S-015790	Negative
L. Shapiro	1992	Cultural Resources Inventory for the Colusa Basin/Knights Landing Ridge Cut Levees Project, Colusa and Yolo Counties, California, Contract No. DACWO591P1469.	Field Study	S-017949	7 sites
J. Nadolski and T. Jackson	1997	Excavation and Evaluation of CA-COL-90H, Contract Number DACW05-97-P-0777	Excavation	S-020092	1 site
J. Nadolski and T. Jackson	1997	Excavation and Evaluation of CA-COL-221, Contract Number DACW05-97-P-0777	Excavation	S-020093	1 site
R. Cartier	1998	Cultural Resource Evaluation of the Colusa County Airport Project in the County of Colusa, California	Field Study	S-020426	Negative
N. Garr	2000	Cultural Resource Report for the Colusa County Behavioral Health Facility, Colusa County, California	Field Study	S-022686	3 sites
P. Jensen	2000	Archaeological Inventory Survey, Proposed Powell Slough Flood Control/Levee Project, c. 4.5 Miles of Linear Corridor, Located West of Colusa, Colusa County, California	Field Study	S-022858	Negative
A. Huberland and L. Westwood	2001	Cultural Resources Monitoring Report for the Level (3) Fiber Optic Project, Yolo, Colusa, Glenn, Tehama, and Shasta Counties, California	Field Study	S-024035	18 sites

Author(s)	Date	Report Title	Study Type	IC File No.	Results
R. Klemm, J. Morton, J. Brennan, D. Krause, R. Salveson, and L. Womble	2002	City of Colusa, Historic Resources Inventory	Field Study	S-026001	262 buildings
J. Haney	2003	Historic Property Survey Report, 03-COL-20, 52.79-R63.41 (P.M. 32.80-R39.40) 03-SUT-20, K.P. 0.00-4.02 (P.M. 0.00-2.50) EA 03-1A97V0	Management / Planning	S-027163	4 sites
J. Haney	2002	Negative Archaeological Survey Report; Roadway Widening and Rehabilitation on State Route 20 in Colusa and Sutter Counties, California	Field Study	S-027163	Negative
G. St. John	2002	Historical Resources Evaluation Report for Roadway Widening and Rehabilitation on State Route 20 in Colusa and Sutter Counties, California	Field Study	S-027163	Negative
J. Haney	2004	Supplemental Negative Historic Property Survey Report, 03-COL-20, K.P. 52.79-R63.41 (P.M. 32.80-R39.40), 03-SUT-20, K.P. 0.00-4.02 (P.M. 0.00-2.50), EA 03-1A97W0	Management / Planning	S-027163	Negative
J. Haney	2004	First Addendum Archaeological Survey Report, Roadway Widening and Rehabilitation on State Route 20 in Colusa and Sutter Counties, California	Field Study	S-027163	Negative
K. Mellon	2003	FHWA030205A: Determinations of Eligibility and Effect for the Proposed Widening and Rehabilitation of State Route 20, Colusa and Sutter Counties, CA [HAD-CA, File No. 03-COL-20, PM 33.1/39.4, 03-SUT-20, PM 0.0/2.5, Document No. P43387	Correspondence	S-027163	n/a
M. Peak and A. Peak	2005	Determination of Eligibility and Effect for the Dolan Preserve Project Area, Colusa County, California	Field Study	S-033072	Negative

Author(s)	Date	Report Title	Study Type	IC File No.	Results
C. Corey and N. Sikes	2007	Cultural Resources Inventory for the Proposed General Plan Amendment and Zoning Amendment, Colusa County, California	Field Study	S-033142	Negative
URS	2006	Cultural Resources Evaluation for the Emergency Levee-Banks Repairs of 16 Critical Erosion Sites	Field Study	S-034069	1 site
JRP Historical Consulting	2006	Architectural History and Levee Evaluations for the Proposed Levee Repair Project	Management / Planning	S-034069	n/a
URS	2006	Cultural Resources Evaluation for the Proposed Levee Repair Design Project at 16SAC145.9L	Field Study, Management / Planning	S-034069	n/a
ECORP Consulting	2008	Cultural Resources Survey Report, Riverbend Estates, City of Colusa, Colusa County, California, Project 2006-185	Field Study	S-034427	6 sites
L. Leach-Palm, P. Mikkelsen, P. Brandy, Jay King, L. Hartman, and B. Larson	2008	Cultural Resources Inventory of Caltrans District 3 Rural Conventional Highways in Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Sacramento, Sierra, Sutter, Yolo, and Yuba Counties	Field Study	S-035042	63 sites
M. Peak	2008	Historical Resources Evaluation Report for The State Route 20/45 Signal Project, City of Colusa, Colusa County, California	Field Study	S-035456	Negative
M. Peak	2008	Archaeological Survey Report for The State Route 20/45 Signal Project, City of Colusa, Colusa County, California	Field Study	S-035456	Negative
Tremaine & Associates, Inc.	2008	Cultural Resources Constraints Study for the Replacement of 30 Poles Along the Cortina #4 60kV Transmission Line	Field Study	S-035495	2 sites

Author(s)	Date	Report Title	Study Type	IC File No.	Results
B. Elliott	2010	Final Cultural Resources Technical Report, Levee Geotechnical Evaluation Program, Sacramento Ricer, Right Bank Levee, Glenn and Colusa Counties, California	Field Study	S-037119	5 sites
B. Elliott	2010	Final Cultural Resources Technical Report, Levee Geotechnical Evaluation Program, Sacramento River: Right Bank Levee, Colusa and Sutter Counties, California	Field Study	S-037248	2 sites
B. Elliott	2010	Final Cultural Resources Technical Report: Levee Geotechnical Evaluation Program, Addendum 5: Colusa Basin Drainage Canal, Colusa County, California	Field Study	S-038295	2 sites
B. Elliott	2010	Final Cultural Resources Technical Report, Levee Geotechnical Evaluation Program, Hopkins Slough, Colusa County, California	Field Study	S-038697	Negative
L. R. Steidl	2000	Archaeological Survey Report, Colusa- Sacramento River SRA (DPR #140), NBD 5024 Log #00/01-01, Riparian Forest Restoration	Field Study	S-039118	Negative
P. C. Riordan	2010	The Search for CA-COL-8	Field Study	S-039295	1 site
J. A. Coleman	2012	Cultural Resources Survey for The White Road Farms WRP Project, Colusa County, California	Field Study	S-039997	Negative
D. M. Davy, H. Calicher, W. Shapiro	2007	Cultural Resources Inventory for the North Area Right-of-Way Maintenance Environmental Assessment: CVP and Pacific AC Intertie	Field Study	S-043683	1 site
Peak & Associates, Inc.	2006	Cultural Resources Inventory for the Proposed City of Colusa Wastewater Treatment Plant Upgrade Project Area, Colusa County, California	Field Study	S-043801	Negative

Author(s)	Date	Report Title	Study Type	IC File No.	Results
C. Him and M. W. Donaldson	2007	Cultural Resources Inventory for the Proposed City of Colusa Wastewater Treatment Plant Upgrade Project Area, Colusa County, California: State Revolving Fund No. C-06-4438-110	Field Study	S-043801	Negative
B. Cox	2011	Cultural Resources Inventory Report for the Cortina #3 60kV Transmission Line Pole Replacement Project, Colusa County, California	Field Study	S-043845	Negative
N. A. Haley	2012	COE120117A: Transmission Line Maintenance for 7 Existing Wooden Transmission Poles	Field Study	S-043845	Negative
J. Grant	2013	Cultural Resources Constraints Report: Cortina No. 4 60 kV	Field Study	S-044047	1 site
L. Machado and E. Dwyer	2014	Historic Property Survey Report, proposed placement of three overhead signs at the intersection of State Routes 20 and 45 within the City of Colusa, in Colusa County, PM 31.16, 31.03/19.19	Field Study	S-044297	4 sites
L. Machado	2014	Archaeological Survey Report for the State Route 20/45 Overhead Sign Project, Colusa County, California 03-COL-20/45, PM Various, EA:03-2F3901	Field Study	S-044297	Negative
R. J. Jackson	2014	Colusa Signalization Project Colusa County, California	Archaeological Monitoring	S-044297	Negative
J. P. Glover	2008	Cultural Resources Constraints Study for the Replacement of 7 Poles on the Colusa Junction No. 1 High Voltage Transmission Line, Colusa and Sutter Counties, CA	Field Study	S-044864	2 sites
T. Fernandez	2015	Cultural Resources Inventory Report for the City of Colusa Wastewater Treatment Plant Improvements, Colusa California	Field Study	S-046926	2 sites

Author(s)	Date	Report Title	Study Type	IC File No.	Results
J. Saunders and S. Stewart	2015	EPA_2015_0223_001; Request Concurrence for Section 106 Compliance and a finding of No Historic Properties Affected for the Wastewater Treatment Plant Improvements Project; City of Colusa, Colusa County, California; California Clean Water State Revolving Fund Project No. C-06-7896-110 (your letter of February 18, 2015)	Correspondence	S-046926	N/A
L. Machado	2016	Historic Property Survey Report for the Colusa Pavement Rehabilitation Project in Colusa County, California, 03-COL-20, P.M. 31.8/32.8, EA: 03-2F980, E-FIS: 0312000026	Field Study	S-049309	Negative
L. Machado	2016	Archaeological Resources Management Plan for the Colusa Pavement Rehabilitation Project in Colusa County, California, 03-COL- 20, P.M. 31.8/32.8, EA: 03-2F980, E-FIS: 0312000026	Management / Planning	S-049309	Negative
L. Machado, K. Hobbs, J. Polanco, J. L. Brown, and J. Hupp	2016	FHWA_2016_0526_001: Historic Property Survey Report Transmittal for the Proposed Colusa Pavement Rehabilitation Project	Field Study	S-049309	Negative
R. McCann	2013	Cultural Resources Survey Report for NRCS Project #13FY06-0006: Proposed O'Connell Field Irrigation, Livestock Water System, Fence, Windbreak, and Management Practices (Grazing, Nutrient, and Irrigation) Project, Colusa County, California	Field Study	S-049982	Negative
Within 0.25-miles of the project area					
J.G. Maniery and M. L. Maniery	1986	Cultural Resources Inventory and Evaluation, Sacramento River Bank Protection (Unit 40) Project	Field Study	S-009666	Negative

Author(s)	Date	Report Title	Study Type	IC File No.	Results
P. Bouey	1989	Cultural Resources Inventory and Evaluation: Sacramento River Bank Protection (Unit 44) Project	Field Study	S-010741	Negative
G. White, J. Kraft, L. Harrington, D. Coleman, and R. Allen	2003	Cultural Resource Overview and Management Plan, Sacramento River Conservation Area, Tehama, Butte, Glenn and Colusa Counties, California	Management / planning	S-027658	1 site
L. Westwood and G. White	2005	Cultural Resource Investigation for the Colusa Subreach Planning, Volume I of II, Glenn and Colusa Counties, California	Field Study	S-029678	Sterile
S. Jensen	2006	Archaeological Survey, C. 40-Acre Moons Bend Development Project, Colusa County, California	Field Study	S-032570	Sterile
M. Bailey	2010	Cultural Resources Survey for the Colusa Boat Launch Ramp, Colusa, Colusa County, California	Field Study	S-037877	Sterile
W. Pierce	2016	Cultural Resources Inventory Report, Small Erosion Repair Project (SERP): East Levee Sacramento River at River Mile 4.6 (SERP_2016_ST03_SAC1_T2_LM4.6) Colusa County, California	Field Study	S-048572	1 Site
N. Haley and J. Polanco	2016	Sec 106 Consultation for the Small Erosion Repair Project (SERP): East Levee Sacramento River at River Mile 4.6, City of Colusa, Colusa County, California (SPK-2016-00495)	Correspondence	S-048572	n/a

ATTACHMENT D-2

Colusa City Historic Resources Inventory

Attachment D-2: Colusa City Historic Resources Inventory Summary

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
1.	P-06-000277	049851	Government Building	1861	Eligible (SHL #890)	Yes
2.	P-06-000286	049768	Single Family Property	1913 (Demolished)	Ineligible	Yes
3.	P-06-000287	049769	Single Family Property	1922	Eligible	Yes
4.	P-06-000288	049770	Single Family Property	1885	Eligible	Yes
5.	P-06-000289	--	Single Family Property	1919	Unevaluated	Yes
6.	P-06-000290	049915	Single Family Property	1919	Unevaluated	Yes
7.	P-06-000291	049916	Single Family Property	1919	Unevaluated	Yes
8.	P-06-000292	049771	Other	1912 (Demolished)	Ineligible	Yes
9.	P-06-000293	049772	Single Family Property	1890 (Demolished)	Ineligible	Yes
10.	P-06-000294	049772	Single Family Property	c. 1890	Ineligible	Yes
11.	P-06-000295	049732	Single Family Property	c. 1890	Eligible	Yes
12.	P-06-000296	049733	Single Family Property	c. 1890	Ineligible	Yes
13.	P-06-000297	049734	Single Family Property	c. 1890	Unevaluated	Yes
14.	P-06-000298	049773	Single Family Property	1897	Unevaluated	Yes
15.	P-06-000299	049774	Single Family Property	1878	Unevaluated	Yes
16.	P-06-000300	049775	Single Family Property	c. 1873	Eligible	Yes
17.	P-06-000301	049776	Single Family Property	c. 1886	Ineligible	Yes
18.	P-06-000302	049777	Single Family Property	1887	Eligible	Yes
19.	P-06-000303	049778	Single Family Property	1860	Unevaluated	Yes
20.	P-06-000304	049779	Single Family Property	c. 1875	Unevaluated	Yes
21.	P-06-000305	049780	Single Family Property	c. 1880	Eligible	Yes
22.	P-06-000306	049781	Single Family Property	c. 1880	Unevaluated	Yes
23.	P-06-000307	049782	Single Family Property	1882	Eligible	Yes
24.	P-06-000308	049783	Single Family Property	c. 1887	Eligible	Yes
25.	P-06-000309	049784	Single Family Property	1937	Eligible	Yes
26.	P-06-000310	049785	Single Family Property	c. 1869	Unevaluated	Yes
27.	P-06-000311	049786	Single Family Property	1916	Unevaluated	Yes
28.	P-06-000312	049787	Single Family Property	1919	Unevaluated	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
29.	P-06-000313	049788	Single Family Property	c. 1932	Unevaluated	Yes
30.	P-06-000314	049789	Single Family Property	1938	Unevaluated	Yes
31.	P-06-000315	049790	Single Family Property	1918	Eligible	Yes
32.	P-06-000316	049791	Single Family Property	1921	Eligible	Yes
33.	P-06-000317	049911	Single Family Property	1936	Eligible	Yes
34.	P-06-000318	049792	Single Family Property	1923	Eligible	Yes
35.	P-06-000319	--	Single Family Property	1926	Eligible	Yes
36.	P-06-000320	049793	Single Family Property	1920	Ineligible	Yes
37.	P-06-000321	--	Single Family Property	1935	Eligible	Yes
38.	P-06-000322	049793	Single Family Property	1925	Unevaluated	Yes
39.	P-06-000323	049794	Single Family Property	1940	Unevaluated	Yes
40.	P-06-000324	049698	Single Family Property	1886	Unevaluated	Yes
41.	P-06-000325	049722	Single Family Property	c. 1890	Eligible	Yes
42.	P-06-000326	049699	Single Family Property	c. 1890	Unevaluated	Yes
43.	P-06-000327	049661	Other	1948 (Demolished)	Ineligible	Yes
44.	P-06-000328	049662	1-3 Story Commercial Building	1907	Unevaluated	Yes
45.	P-06-000329	049663	Other	1867 (Demolished)	Ineligible	Yes
46.	P-06-000330	049664	1-3 Story Commercial Building	1889	Unevaluated	Yes
47.	P-06-000331	049665	1-3 Story Commercial Building	1888	Unevaluated	Yes
48.	P-06-000332	049666	1-3 Story Commercial Building	1870	Unevaluated	Yes
49.	P-06-000333	090693	1-3 Story Commercial Building	1892	Ineligible	Yes
50.	P-06-000334	049668	1-3 Story Commercial Building	1911	Eligible	Yes
51.	P-06-000335	049669	1-3 Story Commercial Building	1911	Unevaluated	Yes
52.	P-06-000336	049670	1-3 Story Commercial Building	1892	Unevaluated	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
53.	P-06-000337	049671	1-3 Story Commercial Building	1910	Unevaluated	Yes
54.	P-06-000338	049672	1-3 Story Commercial Building	1920	Eligible	Yes
55.	P-06-000339	049673	1-3 Story Commercial Building	1920	Ineligible	Yes
56.	P-06-000340	049674	Single Family Property	1900	Eligible	Yes
57.	P-06-000341	049675	Single Family Property	1881	Unevaluated	Yes
58.	P-06-000342	049676	Single Family Property	1888	Eligible	Yes
59.	P-06-000343	049677	Single Family Property	1882	Unevaluated	Yes
60.	P-06-000344	049678	Single Family Property	1891	Eligible	Yes
61.	P-06-000345	049679	Single Family Property	c. 1887	Eligible	Yes
62.	P-06-000346	049680	Single Family Property	1916	Eligible	Yes
63.	P-06-000347	--	Single Family Property	1896	Unevaluated	Yes
64.	P-06-000348	049682	Religious Building	1894	Unevaluated	Yes
65.	P-06-000349	049657	Religious Building	1875 (Reconstructed 1964)	Ineligible	Yes
66.	P-06-000350	049658	Single Family Property	c. 1875	Unevaluated	Yes
67.	P-06-000351	049659	Single Family Property	c. 1873	Unevaluated	Yes
68.	P-06-000352	049660	Single Family Property	1871	Unevaluated	Yes
69.	P-06-000353	049796	Single Family Property	c. 1885	Unevaluated	Yes
70.	P-06-000354	049744	Single Family Property	c. 1916	Ineligible	Yes
71.	P-06-000355	049745	Single Family Property	c. 1916	Unevaluated	Yes
72.	P-06-000356	049746	Single Family Property	c. 1919	Eligible	Yes
73.	P-06-000357	049797	Single Family Property	c. 1880	Eligible	Yes
74.	P-06-000358	049798	Single Family Property	1903	Unevaluated	Yes
75.	P-06-000359	049799	Single Family Property	c. 1922	Eligible	Yes
76.	P-06-000360	049800	Single Family Property	c. 1890	Unevaluated	Yes
77.	P-06-000361	049801	Single Family Property	c. 1886	Ineligible	Yes
78.	P-06-000362	049802	Single Family Property	c. 1871	Eligible	Yes
79.	P-06-000363	049803	Single Family Property	c. 1895	Eligible	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
80.	P-06-000364	049804	Single Family Property	1918	Eligible	Yes
81.	P-06-000365	049805	1-3 Story Commercial Building	1919	Eligible	Yes
82.	P-06-000366	049806	Other	1888 (Demolished)	Ineligible	Yes
83.	P-06-000367	049807	Other	1912 (Demolished)	Ineligible	Yes
84.	P-06-000368	049808	Single Family Property	1903	Eligible	Yes
85.	P-06-000369	049809	Single Family Property	1874	Eligible	Yes
86.	P-06-000370	049810	Single Family Property	1904	Eligible	Yes
87.	P-06-000371	049811	Single Family Property	1870	Eligible	Yes
88.	P-06-000372	049812	Religious	1869	Eligible	Yes
89.	P-06-000373	049813	Single Family Property	1909	Unevaluated	Yes
90.	P-06-000374	049814	Single Family Property	c. 1875	Eligible	Yes
91.	P-06-000375	049815	Single Family Property	c. 1875	Unevaluated	Yes
92.	P-06-000376	049816	Single Family Property	1922	Unevaluated	Yes
93.	P-06-000377	049917	Single Family Property	1904	Eligible	Yes
94.	P-06-000378	049918	Single Family Property	1904	Eligible	Yes
95.	P-06-000379	049817	Single Family Property	c. 1875	Eligible	Yes
96.	P-06-000380	049818	Single Family Property	c. 1873	Unevaluated	Yes
97.	P-06-000381	049740	Single Family Property	c. 1920	Unevaluated	Yes
98.	P-06-000382	049739	Single Family Property	c. 1920	Unevaluated	Yes
99.	P-06-000383	049736	Single Family Property	c. 1920	Unevaluated	Yes
100.	P-06-000384	049819	Single Family Property	1924	Eligible	Yes
101.	P-06-000385	049737	Single Family Property	c. 1920	Unevaluated	Yes
102.	P-06-000386	049738	Single Family Property	c. 1920	Unevaluated	Yes
103.	P-06-000387	049820	Single Family Property	1897	Unevaluated	Yes
104.	P-06-000388	049821	Single Family Property	1898	Unevaluated	Yes
105.	P-06-000389	049822	Single Family Property	1903	Unevaluated	Yes
106.	P-06-000390	049823	Single Family Property	1852	Eligible	Yes
107.	P-06-000391	049824	Single Family Property	1912	Unevaluated	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
108.	P-06-000392	049825	Hotel/Motel; 1-3 Story Commercial Building	1937	Unevaluated	Yes
109.	P-06-000393	049826	Single Family Property	1894	Unevaluated	Yes
110.	P-06-000394	049827	1-3 Story Commercial Building	c. 1872	Eligible	Yes
111.	P-06-000395	049828	1-3 Story Commercial Building	1889 (Demolished)	Ineligible	Yes
112.	P-06-000396	049829	1-3 Story Commercial Building	1857	Unevaluated	Yes
113.	P-06-000397	049830	1-3 Story Commercial Building	1859 (Demolished)	Ineligible	Yes
114.	P-06-000398	049831	1-3 Story Commercial Building	1909 (Demolished)	Ineligible	Yes
115.	P-06-000399	049832	1-3 Story Commercial Building	1906	Eligible	Yes
116.	P-06-000400	049833	1-3 Story Commercial Building	1918	Unevaluated	Yes
117.	P-06-000401	049728	1-3 Story Commercial Building	1976	Ineligible	Yes
118.	P-06-000402	049727	1-3 Story Commercial Building	c. 1890	Eligible	Yes
119.	P-06-000403	049726	1-3 Story Commercial Building	c. 1890	Eligible	Yes
120.	P-06-000404	049725	1-3 Story Commercial Building	c. 1890	Eligible	Yes
121.	P-06-000405	049724	1-3 Story Commercial Building	c. 1890	Eligible	Yes
122.	P-06-000406	049723	1-3 Story Commercial Building	c. 1890	Eligible	Yes
123.	P-06-000407	049721	1-3 Story Commercial Building	c. 1890	Eligible	Yes
124.	P-06-000408	049720	1-3 Story Commercial Building	c. 1890	Eligible	Yes
125.	P-06-000409	049719	1-3 Story Commercial Building	c. 1890	Eligible	Yes
126.	P-06-000410	049834	Public Utility Building	1926	Eligible	Yes
127.	P-06-000411	049835	Single Family Property	c. 1915	Unevaluated	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
128.	P-06-000412	049836	Urban Open Space	1919 (Demolished)	Ineligible	Yes
129.	P-06-000413	049837	Single Family Property	1882	Unevaluated	Yes
130.	P-06-000414	049838	Single Family Property	c. 1895	Unevaluated	Yes
131.	P-06-000415	049839	Single Family Property	1904	Unevaluated	Yes
132.	P-06-000416	049840	Single Family Property; Multiple Family Property	1902	Unevaluated	Yes
133.	P-06-000417	049841	Other	1947 (Demolished)	Ineligible	Yes
134.	P-06-000418	049842	1-3 Story Commercial Building	1909 (Demolished)	Ineligible	Yes
135.	P-06-000419	049843	1-3 Story Commercial Building	1910 (Demolished)	Ineligible	Yes
136.	P-06-000420	049844	1-3 Story Commercial Building	1889	Eligible	Yes
137.	P-06-000421	049845	1-3 Story Commercial Building	1909	Unevaluated	Yes
138.	P-06-000422	049846	1-3 Story Commercial Building	1909	Unevaluated	Yes
139.	P-06-000423	049847	1-3 Story Commercial Building	1947	Eligible	Yes
140.	P-06-000424	049848	1-3 Story Commercial Building	1870	Eligible	Yes
141.	P-06-000425	049849	1-3 Story Commercial Building	1881	Unevaluated	Yes
142.	P-06-000426	049850	1-3 Story Commercial Building	1879	Unevaluated	Yes
143.	P-06-000428	049852	1-3 Story Commercial Building	1936	Unevaluated	Yes
144.	P-06-000429	049853	1-3 Story Commercial Building	1936	Eligible	Yes
145.	P-06-000430	049854	1-3 Story Commercial Building	1916	Eligible	Yes
146.	P-06-000431	049855	1-3 Story Commercial Building	1928	Unevaluated	Yes
147.	P-06-000432	049856	1-3 Story Commercial Building	1934	Eligible	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
148.	P-06-000433	049857	1-3 Story Commercial Building	1928	Unevaluated	Yes
149.	P-06-000434	049858	Other	c. 1885 (Demolished)	Ineligible	Yes
150.	P-06-000435	049859	1-3 Story Commercial Building	1919	Eligible	Yes
151.	P-06-000436	049860	Other	c. 1890	Ineligible	Yes
152.	P-06-000437	049861	Unknown	c. 1892 (Demolished)	Ineligible	Yes
153.	P-06-000438	049862	Multiple Family Property	1925	Unevaluated	Yes
154.	P-06-000439	049863	Single Family Property	c. 1887	Unevaluated	Yes
155.	P-06-000440	049700	Educational Building	c. 1900 (Demolished)	Ineligible	Yes
156.	P-06-000442	049701	Single Family Property	c. 1894	Unevaluated	Yes
157.	P-06-000443	049702	Single Family Property	1920	Eligible	Yes
158.	P-06-000444	049742	Single Family Property	c. 1918	Eligible	Yes
159.	P-06-000445	049743	Single Family Property	c. 1909	Eligible	Yes
160.	P-06-000446	049864	Single Family Property	c. 1897	Eligible	Yes
161.	P-06-000447	049865	Single Family Property	1937	Eligible	Yes
162.	P-06-000448	049866	Single Family Property	1937	Unevaluated	Yes
163.	P-06-000449	049867	Single Family Property	1917	Unevaluated	Yes
164.	P-06-000450	049868	Religious Building	1880	Unevaluated	Yes
165.	P-06-000451	049869	Single Family Property	c. 1870	Unevaluated	Yes
166.	P-06-000452	049870	Single Family Property	c. 1878	Unevaluated	Yes
167.	P-06-000453	049871	Religious Building	1942	Eligible	Yes
168.	P-06-000454	049872	Women's Property	1923	Unevaluated	Yes
169.	P-06-000455	049873	Educational Building	1914	Unevaluated	Yes
170.	P-06-000456	049874	Single Family Property	1915	Eligible	Yes
171.	P-06-000457	049875	Single Family Property	c. 1868	Unevaluated	Yes
172.	P-06-000458	049876	Single Family Property	1869	Eligible	Yes
173.	P-06-000459	049877	Single Family Property	1917	Eligible	Yes
174.	P-06-000460	049878	Single Family Property	1874	Eligible	Yes
175.	P-06-000461	049879	Single Family Property	1904	Eligible	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
176.	P-06-000462	049880	Single Family Property	1909	Eligible	Yes
177.	P-06-000463	049881	Multiple Family Property	c. 1882	Unevaluated	Yes
178.	P-06-000464	049882	Single Family Property	1921	Unevaluated	Yes
179.	P-06-000465	049883	Single Family Property	1914	Eligible	Yes
180.	P-06-000466	049884	Single Family Property	1908	Eligible	Yes
181.	P-06-000467	049885	Single Family Property	1908	Eligible	Yes
182.	P-06-000468	049886	Single Family Property	1910	Eligible	Yes
183.	P-06-000469	049887	Single Family Property	1909	Unevaluated	Yes
184.	P-06-000470	049888	Single Family Property	1906	Unevaluated	Yes
185.	P-06-000471	049889	Single Family Property	1919	Unevaluated	Yes
186.	P-06-000472	049747	Single Family Property	1920	Unevaluated	Yes
187.	P-06-000473	049748	Single Family Property	1920	Unevaluated	Yes
188.	P-06-000474	049749	Single Family Property	1923	Unevaluated	Yes
189.	P-06-000475	049761	Single Family Property	1935	Unevaluated	Yes
190.	P-06-000476	049762	Single Family Property	1922	Unevaluated	Yes
191.	P-06-000477	049763	Single Family Property	1926	Unevaluated	Yes
192.	P-06-000478	049750	Single Family Property	c. 1923	Eligible	Yes
193.	P-06-000479	049751	Single Family Property	c. 1923	Unevaluated	Yes
194.	P-06-000480	049890	Single Family Property	1902	Unevaluated	Yes
195.	P-06-000481	049891	Single Family Property	1923	Unevaluated	Yes
196.	P-06-000482	049892	Other	c. 1910 (Demolished)	Ineligible	Yes
197.	P-06-000483	049893	Single Family Property	c. 1908	Unevaluated	Yes
198.	P-06-000484	049894	Single Family Property	c. 1872	Eligible	Yes
199.	P-06-000485	049895	Single Family Property	c. 1881	Unevaluated	Yes
200.	P-06-000486	049896	Single Family Property	1871	Eligible	Yes
201.	P-06-000487	049897	Single Family Property	1872	Eligible	Yes
202.	P-06-000488	049898	Single Family Property	c. 1888	Unevaluated	Yes
203.	P-06-000489	049899	Single Family Property	1812	Eligible	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
204.	P-06-000490	049900	Single Family Property	c. 1880	Unevaluated	Yes
205.	P-06-000491	049753	Single Family Property	1918	Eligible	Yes
206.	P-06-000492	049754	Single Family Property	1923	Unevaluated	Yes
207.	P-06-000493	049755	Single Family Property	c. 1922	Unevaluated	Yes
208.	P-06-000494	049756	Multiple Family Property	1914	Eligible	Yes
209.	P-06-000495	049757	Multiple Family Property	1932	Unevaluated	Yes
210.	P-06-000496	049758	Single Family Property	c. 1927	Unevaluated	Yes
211.	P-06-000497	049759	Single Family Property	1925	Unevaluated	Yes
212.	P-06-000498	049921	Single Family Property	c. 1923	Unevaluated	Yes
213.	P-06-000499	049922	Single Family Property	1922	Unevaluated	Yes
214.	P-06-000500	049692	Single Family Property	c. 1900	Eligible	Yes
215.	P-06-000501	049693	Single Family Property	1912	Unevaluated	Yes
216.	P-06-000502	049694	Single Family Property; Educational Building	c. 1875	Unevaluated	Yes
217.	P-06-000503	049695	Single Family Property	1917	Eligible	Yes
218.	P-06-000504	049696	Single Family Property	c. 1890	Unevaluated	Yes
219.	P-06-000505	046997	Single Family Property	1940	Eligible	Yes
220.	P-06-000506	049683	1-3 Story Commercial Building	1869	Eligible	Yes
221.	P-06-000507	049684	Single Family Property	1868	Eligible	Yes
222.	P-06-000508	049685	Government Building	1906	Eligible	Yes
223.	P-06-000509	049686	Other	1917 (Demolished)	Ineligible	Yes
224.	P-06-000510	049687	Single Family Property	1881	Unevaluated	Yes
225.	P-06-000511	049688	Single Family Property	c. 1880	Unevaluated	Yes
226.	P-06-000512	049919	Single Family Property	c. 1892	Unevaluated	Yes
227.	P-06-000513	049920	Single Family Property	c. 1892	Unevaluated	Yes
228.	P-06-000514	049689	Single Family Property	1893	Unevaluated	Yes
229.	P-06-000515	049690	Religious Building	1894	Unevaluated	Yes
230.	P-06-000516	049691	1-3 Story Commercial Building	1882 (Demolished)	Ineligible	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
231.	P-06-000517	049703	Single Family Property	1882	Eligible	Yes
232.	P-06-000518	049704	Single Family Property	1919	Eligible	Yes
233.	P-06-000519	049705	Single Family Property	1905	Eligible	Yes
234.	P-06-000520	049706	Single Family Property	1898	Eligible	Yes
235.	P-06-000521	049707	Single Family Property	1898	Eligible	Yes
236.	P-06-000522	049708	Single Family Property	1905	Eligible	Yes
237.	P-06-000523	049709	Single Family Property	1900	Eligible	Yes
238.	P-06-000524	049710	Single Family Property	1916	Eligible	Yes
239.	P-06-000525	049711	Single Family Property	1926	Unevaluated	Yes
240.	P-06-000526	049712	Single Family Property	1938	Unevaluated	Yes
241.	P-06-000527	049713	Educational Building	1926	Eligible	Yes
242.	P-06-000528	049714	Single Family Property	1896	Eligible	Yes
243.	P-06-000529	049715	Single Family Property	c. 1866	Eligible	Yes
244.	P-06-000530	049655	Single Family Property	c. 1900	Unevaluated	Yes
245.	P-06-000531	049656	Single Family Property	c. 1890	Unevaluated	Yes
246.	P-06-000532	049717	Rural Open Space	1889 (Demolished)	Ineligible	Yes
247.	P-06-000533	049716	Single Family Property	1923	Unevaluated	Yes
248.	P-06-000534	049923	Single Family Property	1924	Unevaluated	Yes
249.	P-06-000535	049924	Single Family Property	1924	Unevaluated	Yes
250.	P-06-000536	049764	Single Family Property	1928	Unevaluated	Yes
251.	P-06-000537	049901	Single Family Property	c. 1875 (Demolished)	Ineligible	Yes
252.	P-06-000538	049902	Single Family Property	1912	Eligible	Yes
253.	P-06-000539	049903	Single Family Property	1897	Unevaluated	Yes
254.	P-06-000540	049904	Single Family Property	1892	Unevaluated	Yes
255.	P-06-000541	049905	Single Family Property	1893	Unevaluated	Yes
256.	P-06-000542	049906	Single Family Property	1918	Eligible	Yes
257.	P-06-000543	049907	Government Building; Educational Building	1918	Eligible	Yes

	Primary No.	OHP Property No.	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
258.	P-06-000544	049908	Single Family Property	c. 1900	Unevaluated	Yes
259.	P-06-000545	049909	Single Family Property	c. 1883	Eligible	Yes
260.	P-06-000546	049910	Single Family Property	1870	Ineligible	Yes
261.	P-06-000548	--	Industrial Building	c. 1925	Ineligible	Yes
262.	P-06-000561	--	Ancillary Building	c. 1930	Ineligible	Yes
263.	P-06-000562	--	Single Family Property	1952	Ineligible	Yes
264.	P-06-000563	--	Single Family Property	1952	Ineligible	Yes
265.	P-06-000590	--	Ancillary Building; Farm/Ranch	c. 1957	Unevaluated	Yes
266.	P-06-000591	--	Farm/ Ranch	Unknown	Unevaluated	Yes
267.	P-06-000593	--	Bridge	Unknown	Unevaluated	Yes
268.	P-06-000634	--	Ancillary Building	Unknown	Unevaluated	Yes
269.	P-06-000715	--	Engineering Structure	1958	Ineligible	No
270.	P-06-000746	049730	Single Family Property; 3+ Story Commercial Building; Canal/Aqueduct; Landscape Architecture	c. 1890	Eligible	Yes
271.	P-06-000747	049718	Engineering Structure; Urban Open Space	Unknown	Unknown	Yes
272.	P-06-000748	049729	Unknown	Unknown	Unknown	Yes
273.	P-06-000749	049741	Single Family Property	c. 1920	Unevaluated	Yes
274.	P-06-000751	049752	Single Family Property	c. 1923	Unevaluated	Yes
275.	P-06-000762	049735	Single Family Property	c. 1890	Unevaluated	Yes
276.	P-06-000763	049760	Single Family Property; Multiple Family Property	c. 1923	Unevaluated	Yes

Attachment E. Multi-Benefit Analysis

Memo

Date:	Thursday, March 14, 2019
Project:	Colusa Flood Risk Reduction Feasibility Study
To:	Colusa County
From:	Natalie Bogan, Environmental Planner (HDR)
Reviewed:	Linda Fisher, Environmental Project Manager (HDR); Leslie Parker, Biologist (HDR)
Subject:	Colusa – Multi-benefit Concept Environmental Constraints Analysis: Floodplain Restoration by Lowering the Floodplain

Introduction

As a part of the Department of Water Resources (DWR) Small Communities Flood Risk Reduction Program, projects are expected to make significant progress towards the improvement and advancement of flood protection for small communities while also considering multi-benefit concepts that integrate other biological and environmental resource needs and promote ecosystem function. The 2017 Central Valley Flood Protection Plan (CVFPP) Update defines multi-benefit concepts as concepts that are "designed to reduce flood risk and enhance fish and wildlife habitat, as well as create additional public benefits such as sustaining agricultural production, improving water quality and water supply reliability, increasing groundwater recharge, supporting commercial fisheries, and providing public recreation and educational opportunities, or any combination thereof" (DWR 2017).

Section 4.4.9 of the Feasibility Study provides a definition of multi-benefit concepts; explains the need for such concepts; describes potential options for regional multi-benefit concepts that would align with the Mid & Upper Sacramento River Regional Flood Management Plan (DWR 2014) and the CVFPP Conservation Strategy Goals; and summarizes the feasibility, impacts and benefits of each option. Multi-benefit concepts evaluated include revetment removal to support restoration of the riverine processes, recreational bike paths, and floodplain restoration by lowering the floodplain. After a review of these options, floodplain restoration by lowering of the floodplain proved to be the most feasible multi-benefit concept capable of both improving flood management and supporting conservation efforts.

The potential multi-benefit area is located immediately north of the city of Colusa, as shown in **Figure 1** below. This memo presents a preliminary review of potential environmental constraints for floodplain restoration by lowering the floodplain as a part of the multi-benefit component of the Colusa Flood Risk Reduction Feasibility Study project. The multi-benefit concepts identified in the Feasibility Analysis have been developed to a conceptual level and they do not meet the definition of a "project" as defined by CEQA (California Public Resources Code [PRC], Division 13, Section 21000 et seq.). The 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). As mentioned previously, the 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. Therefore, the ecosystem and multi-benefit concepts are presented solely for planning purposes. Potential constraints are described below.



Figure 1. City of Colusa Potential Multi-Use (Multi-Benefit) Areas

Methodology

A desktop analysis was performed in order to determine potential environmental constraints associated with the implementation of the multi-benefit concept. Criteria from **Appendix G** of the California Environmental Quality Act (CEQA) Guidelines was used as a framework to determine potentially significant impacts on different resource areas and was also used as a means to determine if CEQA documentation would be required. Potential environmental constraints from the multi-benefit concept were analyzed using the same criteria as the proposed project in **Attachment B**, *Existing Conditions and Environmental Constraints*, and are summarized in **Table 1** below. Given the proximity of the multi-benefit concept to the proposed project, the regulatory and environmental settings for each of the resource areas listed in **Attachments A** and **B** be can be applied to the multi-benefit concept.

Results

Based on a summary of the multi-benefit concept environmental impacts, provided in **Table 1**, floodplain restoration by lowering of the floodplain could result in impacts on the following resource areas:

- Air Quality and Greenhouse Gas (GHG) Emissions
- Biological Resources
- Cultural and Tribal Resources
- Geology, Soils and Mineral Resources
- Hazards and Hazardous Materials
- Hydrology and Water Quality
- Noise
- Traffic and Transportation
- Utilities and Service Systems

No impacts would occur under the following resource areas:

- Aesthetics
- Agriculture and Forestry Resources
- Energy
- Land Use and Planning
- Public Services and Recreation

As discussed, in addition to potential adverse impacts, floodplain restoration by lowering the floodplain would create a variety of beneficial impacts including the following:

- Increase seasonal flooding and create a floodplain swale or side channel
- Increase the frequency and duration of flooding to provide for a resting or rearing area for migrating fish
- Increase the frequency and duration of flooding to allow riparian vegetation and habitat to be established
- Increase riparian vegetation to help dissipate energy and combat erosion
- Increase riparian vegetation to allow shaded riverine aquatic habitat cover to establish

- Minimize impacts to existing farming operations
- Improve flood management support and conservation efforts

Table E-1. Summary of Multi-benefit Concept Environmental Impacts

Resource Area	Potential for Impacts (Yes/No)	Discussion
Aesthetics	No	The multi-benefit concept is consistent with the aesthetics alternatives analysis for the proposed project, presented in Attachment B. No impact on aesthetics would occur.
Agriculture and Forestry Resources	No	According to the California Important Farmland Finder, the multi-benefit concept is located in an area designated as "other land," and does not contain Important Farmland (DOC 2016). No Williamson Act Contract properties or lands designated as forest land is located within the multi-benefit concept area (DOC 2013; Colusa County 2012). As a result, no important farmland, Williamson Act Contract properties, or forest lands would be converted or disturbed and no impact to agriculture and forestry resources would occur. Post construction, lowering of the floodplain is expected to minimize impacts on existing farming operations by reducing the risk of flooding occurrence, and therefore is expected to provide beneficial impacts.
Air Quality and GHG Emissions	Yes	The multi-benefit concept would generate GHG emissions through the operation of construction vehicles and equipment on a short-term intermittent basis. Sensitive receptors, such as residences are located less than 0.25 mile south of the multi-benefit concept area. The closest school, Colusa Community School, is located approximately 0.40 mile south of the multi-benefit concept area. These sensitive receptors have the potential to be exposed to emissions from construction vehicles and equipment on a short-term intermittent basis and impacts would not be substantial. The multi-benefit concept would not involve the long-term creation of objectionable odors.

Biological Resources	Yes	A biological survey for the multi-benefit concept area was not included in the biological survey for the proposed project conducted on December 17, 2018; however, given the proximity of the multi-benefit concept area to the proposed project, many of the results from the survey are considered relevant and can be applied to this analysis. A review of aerial imagery shows the multi-benefit concept area is likely characterized as a mix of annual grassland and riparian woodland. These vegetation communities generally described in the Biological Resources Analysis (Attachment C) as similar areas were observed in the surveyed project area. Trees may require removal during lowering of the floodplain. Potential avoidance measures could include limiting tree removal to outside the nesting season and/or conducting preconstruction surveys for nesting birds and other special-status species prior to implementation of the multi-benefit concept. Any potential effects on these species or their habitats would require compliance with the California Environmental Quality Act as well as permits/authorizations from the appropriate state or federal agencies; as a result, a site-specific biological resources assessment would need to be conducted prior to implementation of the multi-benefit concept to assess impacts on special-status species and their habitats. Database query results returned a large number of special-status species with a potential to occur in the vicinity of the multi-benefit concept area (Attachment C, Attachment C-1). A few of the species included in this table have the potential to occur in riparian habitat located along the levee of the Sacramento River. These are likely the species that would have the greatest potential to be impacted by the multi-benefit concept. Aquatic resources in the vicinity of the multi-benefit concept area could be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. These areas include the following communities: riparian, agricultural ditches, open water, and other potential aquatic resources. It is recommended that a formal delineation of aquatic resource be completed prior to any work in order to determine the level of impact on sensitive communities in the multi-benefit concept area. The riparian corridor associated with the Sacramento River near the multi-benefit concept area is designated critical habitat for western yellow-billed cuckoo (*Coccyzus americanus*). In addition, the Sacramento River immediately adjacent to the multi-benefit concept area is designated final critical habitat for multiple runs of chinook salmon (*Oncorhynchus tshawytscha*) as well as steelhead (*Oncorhynchus mykiss*). Construction activities such as excavations, vegetation removal, in-water work, and implementation of fill could impact the biological resources discussed above. As a result, appropriate agencies should be contacted prior to construction. However, lowering of the floodplain would result in beneficial impacts post construction, as this action could increase the frequency and duration of flooding to provide for a resting or rearing area for migrating fish,

		and allow riparian vegetation and habitat to be established. The riparian vegetation could also dissipate energy to combat erosion, and allow shaded riverine aquatic habitat cover to establish.
Cultural and Tribal Cultural Resources	Yes	A cultural resources analysis was not performed specifically for the multi-benefit concept area; however, results from the cultural resources analysis for the proposed project are considered relevant to this analysis based on the proposed project's proximity to the multi-benefit concept area. The records search results, historic map review, and site reconnaissance (provided in Attachment D) performed for the proposed project in the vicinity of the multi-benefit concept area indicate a low to moderate sensitivity in the vicinity of the multi-benefit concept area for unrecorded surficial archaeological sites with a high potential for those sites, when identified, to have buried components. Furthermore, the area exhibits a potentially elevated sensitivity for historical features and buildings in the vicinity of known historical resources. Based on the records search, one potentially significant prehistoric site just north of Colusa, P-06-00032 (CA-COL-008), was first recorded in 1949 and was likely an extensive habitation site located adjacent to the Sacramento River and included human remains and beads. These areas would

		be avoided during implementation of the multi-benefit concept. In the event that human remains are inadvertently discovered outside of dedicated cemeteries, work would stop immediately and the County Coroner would be contacted for consultation. The multi-benefit concept would require ground disturbance, excavations, implementation of fill, compaction, vegetation removal, in-water work, and use of heavy construction equipment. These activities have the potential to result in impacts to any of the cultural resources listed above, should they be identified within, or potentially in the vicinity of, a proposed work area. Any newly discovered archaeological site which cannot be avoided by the multi-benefit concept must be evaluated for eligibility to the California Register of Historical Resources (CRHR) and/or National Register of Historic Places (NRHP). If eligible, additional mitigation may be required if significant impacts/adverse effects cannot be avoided.
Energy	No	The multi-benefit concept is consistent with the energy alternatives analysis for the proposed project, presented in Attachment B. No impact on energy would occur.
Geology, Soils and Mineral Resources	Yes	The multi-benefit concept would require ground disturbance, excavations, implementation of fill, compaction, and use of heavy construction equipment, which have the potential to result in erosion and loss of topsoil during construction. The multi-benefit concept would adhere to erosion and grading control ordinances within the Colusa County General Plan and impacts would not be substantial. Post construction, beneficial impacts on erosion and loss of topsoil would occur as lowering of the floodplain would allow riparian vegetation and habitat to be established, which would dissipate energy to combat erosion. Consistent with the proposed project, the multi-benefit concept is in a region of California characterized by relatively low seismic activity. No Alquist-Priolo Earthquake Fault Zones and no Seismic Hazard Zones are identified within the County. No mineral resources are present in the multi-benefit concept area.

Hazards and Hazardous Materials	Yes	Residences are located less than 0.25 mile south of the multi-benefit concept area. Other sensitive receptors, such as Colusa Community School are located within 0.40 mile of the multi-benefit concept area. These sensitive receptors have the potential to be exposed to emissions from construction vehicles and equipment on a short-term intermittent basis during construction activity. To the extent possible, emissions would be controlled and contained through the implementation of BMPs and impacts from emissions would not be substantial. The multi-benefit concept is not located on a site which is included on a list of hazardous materials sites compiles pursuant to Government Code Section 65962.5 (DTSC 2018). Implementation of the multi-benefit concept is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities. No airports are within 2 miles of the multi-benefit concept area. The multi-benefit concept is also located outside of areas zoned for Very High and High fire hazard severity. Portions of the multi-benefit concept area are located adjacent to Moderate fire hazard severity zones.
Hydrology and Water Quality	Yes	Construction activities including excavations, ground disturbance, implementation of fill, compaction, in-water work and the use of heavy construction equipment have the potential to result in erosion and siltation. Erosion of onsite soils can lead to increased levels of suspended sediments and turbidity in receiving waters, and could potentially impact water quality and result in a violation of water quality standards during construction. Impacts would be temporary and increased erosion and siltation is not anticipated post construction. Post construction, lowering of the floodplain could increase the frequency and duration of flooding to provide for a resting or rearing area for migrating fish, and allow riparian vegetation and habitat to be established. The riparian vegetation could also dissipate energy to combat erosion, and allow shaded riverine aquatic habitat cover to establish. As a result, beneficial impacts on erosion and siltation would occur post construction. In addition to beneficial impacts from erosion and siltation, implementation of the multi-benefit concept would result in beneficial impacts on flooding in the area. While in-water work is anticipated, the multi-benefit concept would conform to all federal, State and local water quality and waste discharge requirements, such as Section 401 and 404 of the Clean Water Act, if applicable. BMPs such as grading and erosion control measures would be implemented during construction to reduce potential water quality impacts. Consistent with the proposed project, the multi-benefit concept would not require the use of groundwater, nor would it involve the implementation of impervious surfaces to the extent that ground water recharge would be hindered. Construction and ground disturbing activities and work along the Sacramento River have the potential to contribute to increased runoff on a temporary basis. However, the multi-benefit concept would include a Stormwater Pollution Prevention Plan (SWPPP) and would not

		exceed the capacity of existing or planned storm water drainage or provide substantial additional sources of polluted runoff.
Land Use and Planning	No	The multi-benefit concept is consistent with the land use and planning alternatives analysis for the proposed project, presented in Attachment B. No impact on land use and planning would occur.
Noise	Yes	The use of heavy construction equipment associated with lowering of the floodplain could result in increased noise levels and ground borne vibrations, which could impact sensitive receptors within 0.25 mile of the multi-benefit concept area on a temporary and intermittent basis. Impacts from noise and ground borne vibration would be minimal and would return to pre-construction conditions once construction activities are complete.
Public Services and Recreation	No	The multi-benefit concept is consistent with the public services and recreation alternatives analysis for the proposed project, presented in Attachment B. No impact on public services and recreation would occur.

Traffic and Transportation	Yes	The multi-benefit concept has the potential to temporarily increase the volume of traffic present on local roads and highways during constriction. However, the multi-benefit concept is not located adjacent to a major road or highway, and upon completion of construction, traffic would return to pre multi-benefit concept conditions. To the extent possible, construction vehicles and equipment would be staged when not in use. A Traffic Management Plan would be developed in coordination with Colusa County. Additionally, implementation of the multi-benefit concept is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities.
Utilities and Service Systems	Yes	The multi-benefit concept would not require connection to an existing public or private water supply. Lowering of the floodplain would not generate wastewater that would need to be treated by a local wastewater treatment provider. Limited amounts of water would be used during construction; however, no water would be required once construction is completed. Therefore, no impact to water supply would occur. The multi-benefit concept would generate limited amounts of solid waste during construction. No solid waste would be generated post construction. The multi-benefit concept would comply with federal, state and local regulations on solid waste and multi-benefit concept waste could be accommodated by local infrastructure. Lowering of the floodplain would not increase demand for solid waste disposal, water service, wastewater treatment, electric power, natural gas, or telecommunications facilities, and would not require service by local utility providers. However, while unlikely given its location along the Sacramento River, it is possible that overhead or unseen underground utility infrastructure would need to be relocated as a result of implementation of the multi-benefit concept.

Conclusion

Impacts from the multi-benefit concept would not differ substantially from impacts of the proposed project given that similar construction methods and equipment would be used, and because the proposed project and multi-benefit concept area are located in the same geographic area (see **Figure 1**). As a result, potential environmental permits and approvals discussed in **Section 4,** *Environmental Documentation, Permits and Approvals,* of the Environmental Constraints Analysis – Flood Risk Reduction Feasibility Study report would also apply to and be recommended for the multi-benefit concept.

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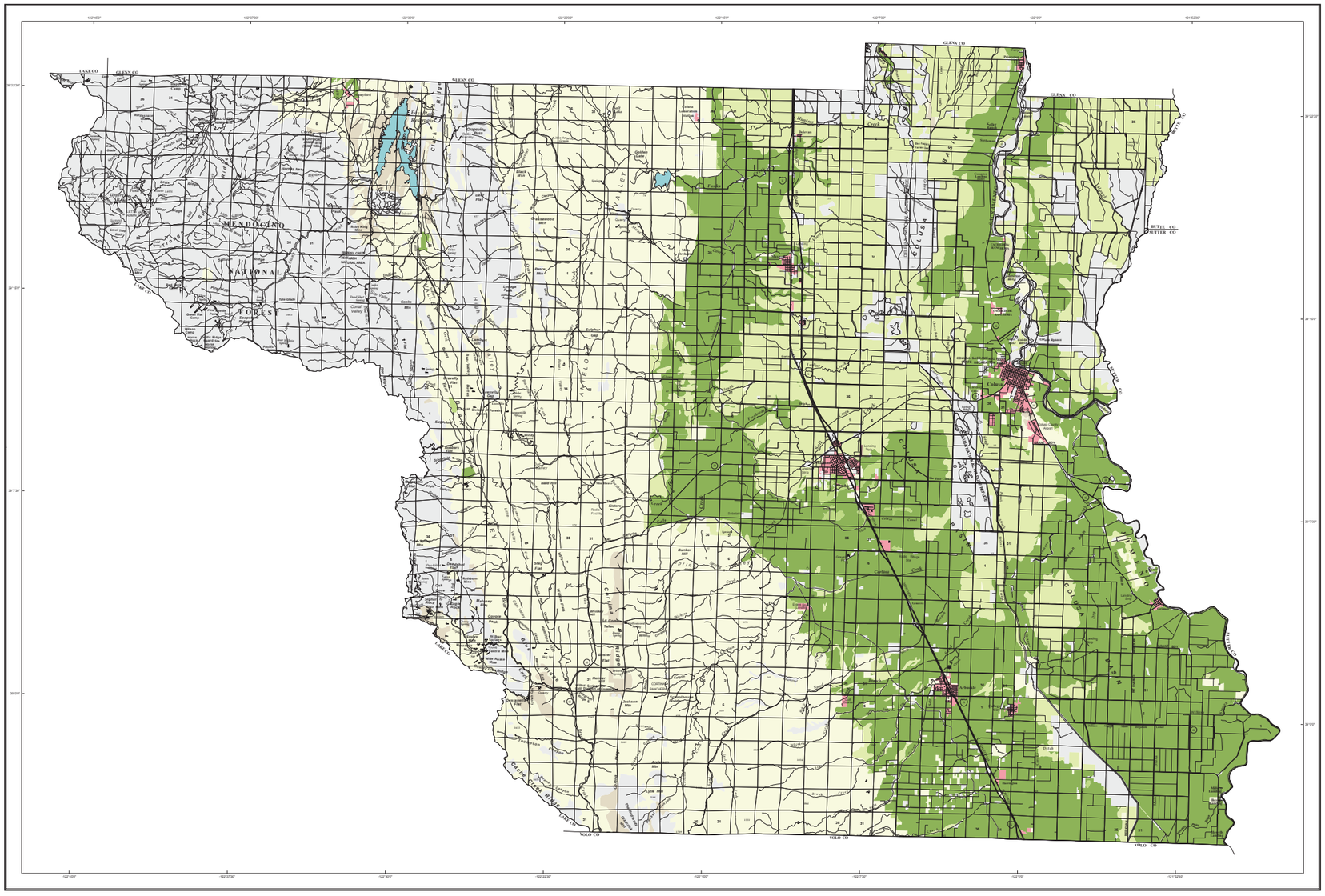
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Attachment F. Land Use Maps

STATE OF CALIFORNIA
Edmund G. Brown, Jr., *Governor*
THE NATURAL RESOURCES AGENCY
John Laird, *Secretary*
DEPARTMENT OF CONSERVATION
Mark Nechodom, *Director*

COLUSA COUNTY IMPORTANT FARMLAND 2012

CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF LAND RESOURCE PROTECTION
FARMLAND MAPPING AND MONITORING PROGRAM



PRIME FARMLAND

PRIME FARMLAND HAS THE BEST COMBINATION OF PHYSICAL AND CHEMICAL FEATURES ABLE TO SUSTAIN LONG-TERM AGRICULTURAL PRODUCTION. THIS LAND HAS THE SOIL QUALITY, GROWING SEASON, AND MOISTURE SUPPLY NEEDED TO PRODUCE SUSTAINED HIGH YIELDS. LAND MUST HAVE BEEN USED FOR IRRIGATED AGRICULTURAL PRODUCTION AT SOME TIME DURING THE FOUR YEARS PRIOR TO THE MAPPING DATE.

FARMLAND OF STATEWIDE IMPORTANCE

FARMLAND OF STATEWIDE IMPORTANCE IS SIMILAR TO PRIME FARMLAND BUT WITH MINOR SHORTCOMINGS, SUCH AS GREATER SLOPES OR LESS ABILITY TO STORE SOIL MOISTURE. LAND MUST HAVE BEEN USED FOR IRRIGATED AGRICULTURAL PRODUCTION AT SOME TIME DURING THE FOUR YEARS PRIOR TO THE MAPPING DATE.

UNIQUE FARMLAND

UNIQUE FARMLAND CONSISTS OF LESSER QUALITY SOILS USED FOR THE PRODUCTION OF THE STATE'S LEADING AGRICULTURAL CROPS. THIS LAND IS USUALLY IRRIGATED, BUT MAY INCLUDE NONIRRIGATED ORCHARDS OR VINEYARDS AS FOUND IN SOME CLIMATIC ZONES IN CALIFORNIA. LAND MUST HAVE BEEN CROPPED AT SOME TIME DURING THE FOUR YEARS PRIOR TO THE MAPPING DATE.

FARMLAND OF LOCAL IMPORTANCE

THE FOLLOWING LANDS ARE TO BE INCLUDED IN THE FARMLAND OF LOCAL IMPORTANCE CATEGORY: ALL FARMABLE LANDS WITHIN COLUSA COUNTY THAT DO NOT MEET THE DEFINITIONS OF PRIME, STATEWIDE, OR UNIQUE, BUT ARE CURRENTLY IRRIGATED PASTURE OR NONIRRIGATED CROPS; OR NONIRRIGATED LAND WITH SOILS QUALIFYING FOR PRIME FARMLAND OR FARMLAND OF STATEWIDE IMPORTANCE; OR LANDS THAT WOULD HAVE PRIME OR STATEWIDE DESIGNATION AND HAVE BEEN IMPROVED FOR IRRIGATION BUT ARE NOW IDLE; OR LANDS WITH A GENERAL PLAN LAND USE DESIGNATION FOR AGRICULTURAL PURPOSES, AND LANDS THAT ARE LEGISLATED TO BE USED ONLY FOR AGRICULTURAL (FARMLAND) PURPOSES.

GRAZING LAND

GRAZING LAND IS LAND ON WHICH THE EXISTING VEGETATION IS SUITED TO THE GRAZING OF LIVESTOCK.

URBAN AND BUILT-UP LAND

URBAN AND BUILT-UP LAND IS OCCUPIED BY STRUCTURES WITH A BUILDING DENSITY OF AT LEAST 1 UNIT TO 1.5 ACRES, OR APPROXIMATELY 6 STRUCTURES TO A 10-ACRE PARCEL. COMMON EXAMPLES INCLUDE RESIDENTIAL, INDUSTRIAL, COMMERCIAL, INSTITUTIONAL FACILITIES, CEMETERIES, AIRPORTS, GOLF COURSES, SANITARY LANDFILLS, SEWAGE TREATMENT, AND WATER CONTROL STRUCTURES.

OTHER LAND

OTHER LAND IS LAND NOT INCLUDED IN ANY OTHER MAPPING CATEGORY. COMMON EXAMPLES INCLUDE LOW DENSITY RURAL DEVELOPMENTS, BRUSH, TIMBER, WETLAND, AND RIPARIAN AREAS NOT SUITABLE FOR LIVESTOCK GRAZING, CONFINED LIVESTOCK, POULTRY, OR AQUACULTURE FACILITIES, STRIP MINES, BORROW PITS, AND WATER BODIES SMALLER THAN 40 ACRES. VACANT AND NONAGRICULTURAL LAND SURROUNDED ON ALL SIDES BY URBAN DEVELOPMENT AND GREATER THAN 40 ACRES IS MAPPED AS OTHER LAND.

WATER

PERENNIAL WATER BODIES WITH AN EXTENT OF AT LEAST 40 ACRES.

SCALE: 1:100,000
1 inch equals approximately 1.6 miles







Total County Area - 740,393 acres
Mapped Area - 740,393 acres

Important Farmland Maps are compiled by the Farmland Mapping and Monitoring Program (FMMP) pursuant to Section 65570 of the California Government Code. To create the maps, FMMP combines current land use information with U.S. Department of Agriculture-Natural Resources Conservation Service (NRCS) soil survey data. Soil units qualifying for Prime Farmland and Farmland of Statewide Importance are determined by the NRCS. Changes to soil profiles subsequent to publication of NRCS soil surveys are not reflected on this map. This map was developed using NRCS digital soil data (SSURGO) and may contain individual soil units as small as one acre.

Land use status is determined using current and historic aerial imagery, supplemental GIS data, and field verification. Imagery sources may include public domain datasets, web-based information, and commercially purchased data, depending on data availability. Supplemental data on land management status is obtained from federal, state, and local governments. Map reviewers at the local level contribute valuable information with their comments and suggestions. Please refer to FMMP field analyst reports for each county to obtain specific citations.

Cultural base information for the Important Farmland Maps was derived from public domain data sets, based upon design of the U.S. Geological Survey, with updates generated by digitizing over current imagery.

This map should be used within the limits of its purpose – as a current inventory of agricultural land resources. This map does not necessarily reflect general plan or zoning designations, city limit lines, changing economic or market conditions, or other factors which may be taken into consideration when land use policies are determined. This map is not designed for parcel-specific planning purposes due to its scale and the ten-acre minimum land use mapping unit. Classification of important farmland and urban areas on this map is based on best available data. The information has been delineated as accurately as possible at 1:24,000-scale, but no claim to meet 1:24,000 National Map Accuracy Standards is made due to variations in the quality of source data.

The Department of Conservation makes no warranties as to the suitability of this product for any particular purpose.

Additional data is available at www.conservation.ca.gov/dlrp/fmmp, including detail on the program, full size PDF maps, map categories, statistics, field summaries, and GIS data for download. Contact the:

Farmland Mapping and Monitoring Program
801 K Street, MS 18-01
Sacramento, CA 95814
Phone: (916) 324-0859
e-mail: fmmp@conservation.ca.gov

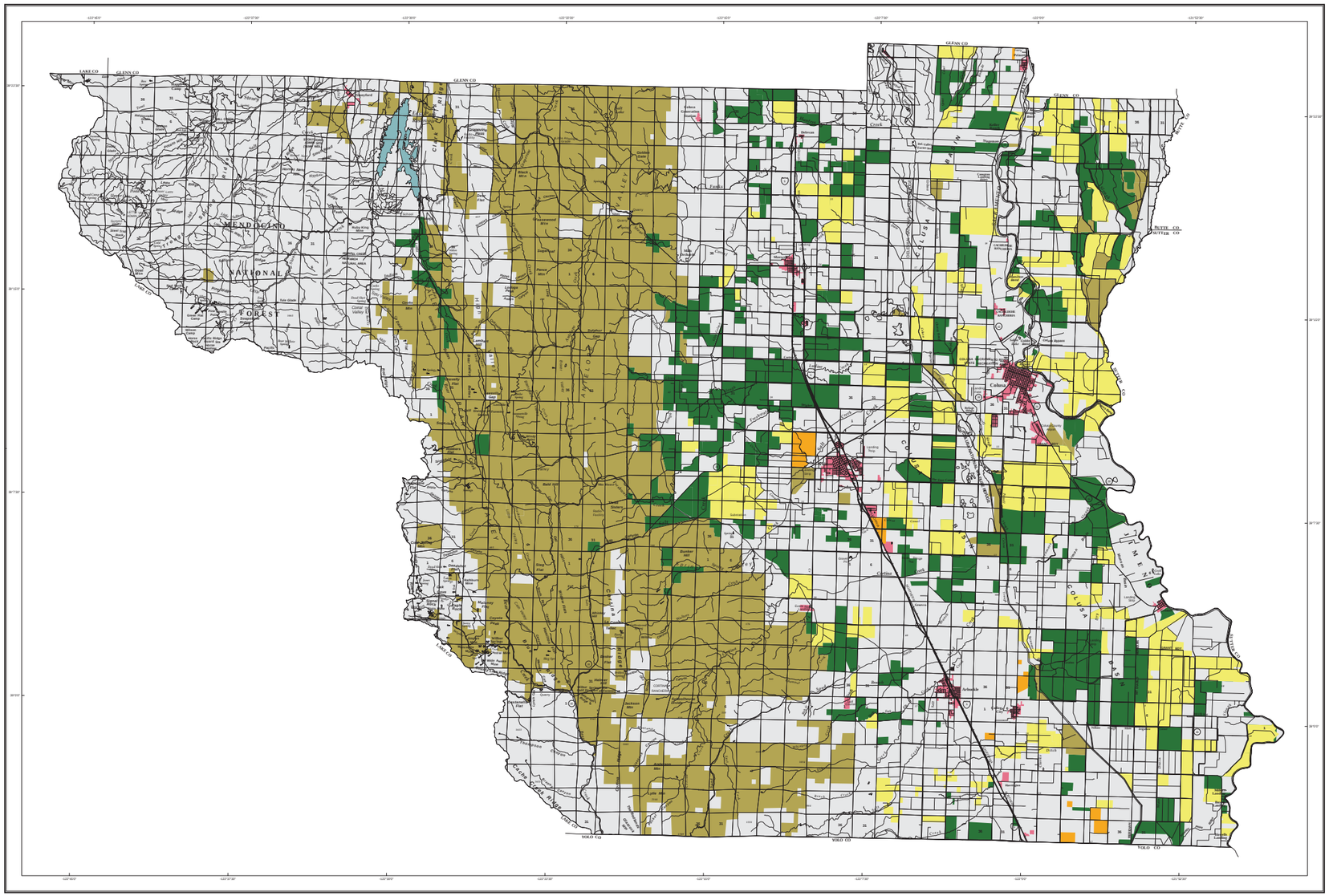
© California Department of Conservation, Division of Land Resource Protection, 2014.

Map published November 2014.

STATE OF CALIFORNIA
Edmund G. Brown, Jr., *Governor*
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John Laird, *Secretary*
DEPARTMENT OF CONSERVATION
Mark Nechodom, *Director*

COLUSA COUNTY WILLIAMSON ACT FY 2013/2014

CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF LAND RESOURCE PROTECTION
CONSERVATION PROGRAM SUPPORT



WILLIAMSON ACT- PRIME AGRICULTURAL LAND

Land which is enrolled under California Land Conservation Act contract and meets any of the following criteria (as set forth under California Government Code Section 51201):
1: Land which qualifies for rating as class I or class II in the Natural Resources Conservation Service land use capability classifications;
2: Land which qualifies for rating 80 to 100 in the Storie Index Rating;
3: Land which supports livestock used for the production of food and fiber and which has an annual carrying capacity equivalent to at least one animal unit per acre as defined by the United States Department of Agriculture;
4: Land planted with fruit or nut-bearing trees, vines, bushes or crops which have a nonbearing period of less than five years and which will normally return during the commercial bearing period on an annual basis from the production of unprocessed agricultural plant production not less than two hundred dollars per acre;
5: Land which has returned from the production of unprocessed agricultural plant production and has an annual gross value of not less than two hundred dollars per acre for three of the previous five years.

WILLIAMSON ACT- NON - PRIME AGRICULTURAL LAND

Land which is enrolled under California Land Conservation Act contract and does not meet any of the criteria for classification as Prime Agricultural Land. Non-Prime Land is defined as Open Space Land of Statewide Significance under the California Open Space Subvention Act (see California Government Code Section 16143), and may be identified as such in other documents. Most Non-Prime Land is in agricultural uses such as grazing or non-irrigated crops. However, Non-Prime Land may also include other open space uses which are compatible with agriculture and consistent with local general plans.

WILLIAMSON ACT- FARMLAND SECURITY ZONE

Enrolled parcels containing either Prime or Non-Prime agricultural land restricted by a 20 year contract pursuant to Government Code Section 51296. According to Colusa County's 2007 Open Space Subvention submissions, the percentage of reported Farmland Security Zone Prime agricultural land constitutes 17.75 percent of the total Williamson Act enrollment for the County whereas the Farmland Security Zone Non-prime agricultural land constitutes only 0.97 percent of the total Williamson Act enrollment.

WILLIAMSON ACT- NON-RENEWAL

Enrolled lands for which non-renewal has been filed pursuant to Government Code Section 51245. Upon the filing of non-renewal, the existing contract remains in effect for the balance of the period remaining on the contract. During the non-renewal process, the annual tax assessment gradually increases. At the end of the 9 year non-renewal period, the contract expires and the land is no longer enforceably restricted.

NON-WILLIAMSON ACT LAND

NON-ENROLLED LAND

Land not enrolled in a Williamson Act contract and not mapped by Farmland Mapping & Monitoring Program (FMMP) as Urban and Built-Up Land or Water.

URBAN AND BUILT-UP LAND

Urban and Built-Up Land is occupied by structures with a building density of at least 1unit to 1.5 acres, or approximatley 6 structures to a 10-acre parcel. Common examples include residential, industrial, commercial, institutional facilities, cemeteries, airports, golf courses, sanitary landfills, sewage treatment, and water control structures. This definition and extent of mapping is derived from the latest Farmland Mapping and Monitoring Program Important Farmland Maps.

WATER

Perennial water bodies with an extent of at least 40 acres. This definition and extent of mapping is derived from the latest Farmland Mapping and Monitoring Program Important Farmland Maps.

SCALE: 1:100,000
1 inch equals approximately 1.6 miles

1 square mile = 640 acres.



Total County Area - 740,393 acres
Total Enrolled: 318,673 acres

The California Land Conservation Act of 1965 - commonly referred to as the Williamson Act - is the State's primary program for the conservation of private land in agricultural and open space use. It is a voluntary, locally administered program that offers preferential property taxes on lands which have enforceable restrictions on their use via contracts between individual landowners and local governments. For more information on the Williamson Act please contact:

Department of Conservation
Division of Land Resource Protection
801 K Street, MS18-01
Sacramento, CA 95814

Phone (916) 324-0850;
email: dlrp@conservation.ca.gov;
web page: www.conservation.ca.gov/dlrp/lca

Maps depicting Williamson Act enrollment are produced in cooperation with the participating counties and the California Department of Conservation's Division of Land Resource Protection using Geographic Information Systems. The information used to create these maps is provided by county planning agencies and/or assessor offices. For the most accurate and up to date information regarding the status of specific contracted lands, contact the county assessor or planning agency office as the status of enrolled lands may change throughout the year.

Cultural base information was derived from public domain data sets, based upon design of the U.S. Geological Survey, with updates generated by digitizing over current imagery.

The Department of Conservation makes no warranties as to suitability of this map for any particular purpose.

Copyright: California Department of Conservation, Division of Land Resource Protection, 2013.

General Plan Land Use Map

- URA - Urban Reserve Area
- AG - Agricultural General
- AU - Agricultural Upland
- AT - Agricultural Transition
- PR - Parks & Recreation
- RSC - Rural Service Center
- PS - Public/Semi-Public Services
- C - Commercial
- DF - Designated Floodway
- I - Industrial
- RC - Resource Conservation
- TL - Tribal Lands
- FL - Forest Lands
- RR - Rural Residential
- UR - Urban Residential
- MU - Mixed Use

- State, Federal, or Other Agency Lands
- Specific or Master Plan Areas
- City Boundaries
- Spheres of Influence
- Bureau of Reclamation Lands
- Wildlife Refuges
- County Boundaries
- Bodies of Water

N

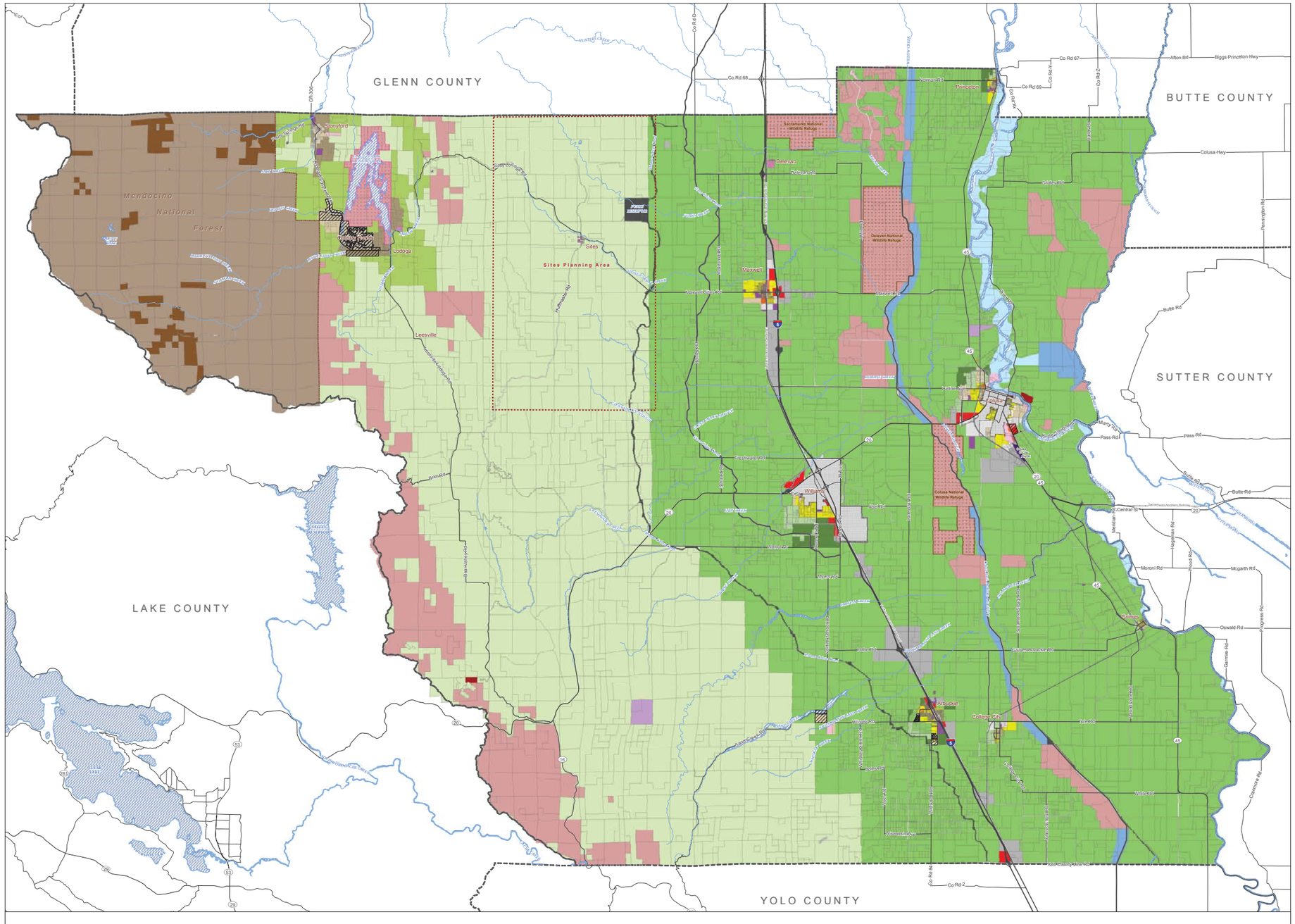
0 1 2 4 Miles

1:220,000

De Novo Planning Group
A Land Use Planning, Design, and Environmental Firm

General plan and parcel boundary data developed by the Geographical Information Center, California State University, Chico, for the DeNovo Planning Group and Colusa County. Other data sources: Colusa County GIS, ESRI StreetMap North America, US Forest Service. Map date: July 31, 2012.

GLENN COUNTY
BUTTE COUNTY
SUTTER COUNTY
LAKE COUNTY
YOLO COUNTY
Stonyford
East Park Reservoir
Century Ranch
Lodoga
Leesville
Sites
Sites Planning Area
Princeton
Sacramento Nat'l Wildlife Refuge
Delevan
Delevan Nat'l Wildlife Refuge
Maxwell
Colusa
Colusa Nat'l Wildlife Refuge
Williams
Arbuckle
College City
Grimes
CR 306
Co.Rd.68
Norman Rd
Co Rd 69
Co Rd Y
Co Rd Z
Butte Rd
Colusa Hwy
Gridley Rd
Remington Rd
Sites Lodoga Rd
Delevan Rd
Funks Creek
Stone Corral Creek
Maxwell Sites Rd
Maxwell Rd
McDermott Rd
Dunnigan Slough
Logan Creek
Little Stony Creek
Indian Creek
Leesville Lodoga Rd
Diabelo Rd
Freshwater Rd
Schaad Rd
Abel Rd
Walnut Dr
Myers Rd
Bartlett Springs Rd
Brim Rd
Bear Valley Rd
Salt Creek
Spring Creek
Cortina Creek
Hahn Rd
Grimes Arbuckle Rd
Sycamore Slough Rd
Sand Creek
Hillgate Rd
Tule Rd
Boles Rd
Wilkerson Creek
Whitehurst Creek
Saucy Creek Rd
Cortina School Rd
Whiskey Creek Rd
Wilkerson Rd
Wiley Rd
Wisconsin Ave
College Glen Rd
Jehlis Cheek Rd
Yolo County Line Rd
Co Rd 2
Lurline Ave
Pass Rd
Marty Rd
Meridian Rd
Hageman Rd
Wood Rd
Moroni Rd
Mcgarth Rd
Oswald Rd
Progress Rd
Garmire Rd
Carmore Rd
Rowdstone Rd
White Rd
Butte Rd
Butte City Rd
Sutter Bypass
Butte Creek
Colusa Basin Drain
Main Canal
Glenn Valley Slough
Sycamore Slough
Logan Creek
Funks Creek
Stone Corral Creek
Freshwater Creek
Salt Creek
Cortina Creek
Sand Creek
Whitehurst Creek
Wilkerson Creek
Colusa Basin Drain
Sacramento River
Butte Creek
Sutter Bypass
Sycamore Slough
Main Canal
Glenn Valley Slough
Dunnigan Slough
Little Stony Creek
Indian Creek
Salt Creek
Spring Creek
Cortina Creek
Sand Creek
Whitehurst Creek
Wilkerson Creek
Freshwater Creek
Logan Creek
Funks Creek
Stone Corral Creek
Sites Planning Area
20
16
5
45



- F-A: Foothill Agriculture
- E-A: Exclusive Agriculture
- UC-10: Upland Conservation <20ac
- UC-80: Upland Conservation >20 ac
- AT-10: Ag Transition <20ac
- AT-20: Ag Transition >20ac
- RR-2: Rural Residential, 2-acre min. lot
- RR-5: Rural Residential, 5-acre min. lot
- U-T: Upland Transition
- R-1: Residential Single-Family
- R-1-6: Residential Single-Family, 6,000-s.f. min. lot
- R-1-8: Residential Single-Family, 8,000-s.f. min. lot
- R-2: Residential Two-Family
- R-3: Residental Multiple Family
- R-4: Apartment-Professional
- C-1: Neighborhood Commercial
- C-2: Community Commercial
- C-H: Highway Service Commercial
- C-R: Commercial Resort
- MU: Mixed Use
- M-1: Light Industrial
- M-2: Heavy Industrial
- RD: Research and Development
- R-F: River Frontage
- F-M: Flood Management
- FM-R: Forest Management and Recreation
- F-R: Forest Residential
- R-M: Resource Management
- G-R: General Recreation
- A-V: Airport
- P-F: Public Facilities
- R-S: Rural Services
- T-L: Tribal Lands
- State, Federal, and Other Agency Land
- Planned Development Overlay
- City Boundaries
- Spheres of Influence
- Sites Plannning Area
- Bureau of Reclamation Lands
- Wildlife Refuges
- County Boundaries
- Bodies of Water

Parcel boundary data developed by the Geographical Information Center, California State University, Chico, for DeNovo Planning Group and Colusa County.
Other data sources: Colusa County GIS; ESRI StreetMap North America; US Forest Service. Map date: April 27, 2015. M:\Colusa\GIS_ZONING_FINAL_ONLINE_150427\

Colusa County Zoning Map

Adopted August 26, 2014

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W E
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Miles

1:75,000

De Novo Planning Group
A Land Use Planning, Design, and Environmental Firm

Appendix F
Financial Analyses

LWA
LARSEN WURZEL
& Associates, Inc.
2450 Venture Oaks Way, Suite 240 • Sacramento, CA 95833
www.larsenwurzel.com

Final Technical Memorandum

Colusa Flood Risk Reduction Feasibility Study
Small Communities Flood Risk Reduction Program

Financial Feasibility *October 25, 2019*

Prepared by: David Lee
Reviewed by: Seth Wurzel, CGFM & Derek Larsen, P.E., CFM

1. Purpose

This memorandum has been prepared by Larsen Wurzel & Associates, Inc. (LWA) in support of the Colusa Flood Risk Reduction Feasibility Study under the Department of Water Resources Small Communities Flood Risk Reduction Program. LWA expects that the conclusions presented within this memorandum will be utilized during the alternatives evaluation phase, particularly to help screen the alternatives that would not be financially feasible for the local community. LWA prepared a separate funding sources memorandum that provides a summary of available State and federal funding sources to advance flood risk reduction projects.

This memorandum and the funding sources memorandum were used to develop a conceptual financial plan for implementation of the preferred alternative. The conceptual finance plan and funding sources memorandum are presented separately as part of a final Feasibility Study Report.

Organization

This memorandum is divided into six sections. This section provides the purpose of the memorandum; Sections 2 and 3 outline the approach and methodology used to analyze the financial feasibility of the proposed alternatives; Section 4 describes the constraints facing flood risk reduction projects; Section 5 outlines the alternative analysis screening constraints in determining the capacity of the local community to generate revenue for Operations and Maintenance (O&M) and capital improvement projects; and section 6 provides recommendations for the alternatives evaluated.

Attachment 1 Provides a summary of the local funding methods used by local agencies in California to fund flood risk reduction improvements and services. The table describes the general uses of the funding source and the attributes and applicability of the mechanism for flood control and management projects. In addition to these sources, many local agencies supplement funding for flood risk reduction through enterprise revenues related to storm water management and general fund revenues (primarily property tax revenue).
Attachment 2 Provides the series of tables referenced throughout this memorandum.

2. Approach

Multiple local funding mechanisms are available to fund flood risk reduction efforts as shown in Attachment 1. Flood risk reduction projects provide a special benefit to property owners and are most commonly funded by property-based assessment districts. Therefore, the primary approach for analyzing financial feasibility starts with the assumption that the local funding required for a flood risk reduction project will be raised through a property-based special benefit assessment. As a result, the requirements associated with imposing a benefit assessment would apply. These requirements, primarily those associated with Proposition 218, are discussed further below.

The next assumption is that the local beneficiaries would be solely responsible for long-term ongoing O&M of any improvements. Therefore, locally generated annual assessment revenue would first be utilized to pay for the on-going O&M of the project. Any remaining annual revenue would then be allocated toward the local share of the capital cost either on a pay-go basis or to service debt.

LWA's analysis starts by determining the proportionality of assessment revenue between land uses and applying the following approaches to gauge feasibility:

1) Estimate the assessment rates required to generate, on an aggregate basis, $100,000 of annual revenue and review the resulting rates to determine whether any land use assessment rate exceeds a level that could preclude approval of the assessment;
2) Establish the O&M funding requirements based on project team input and determine whether there is sufficient revenue to fund adequate levee maintenance;
3) Estimate the amount of annual revenue that could be generated from benefiting properties given the special benefit proportionality requirements of Proposition 218 and an assumed feasible single-family residence assessment rate developed by the project team.
4) Screen and rank alternatives based on criteria established by the project team.

The information will be utilized during the alternatives evaluation phase to assess the feasibility of the local community to fund annual O&M and cost share implementation of the preferred alternative.

3. Methodology

Special benefit assessments for flood control projects have historically utilized the following parcel attributes to apportion benefit:

- Land use;
- Parcel size;
- Parcel improvements;
    - Permanent Crop Type; and/or
    - Structure type and size; and
- Relative Damage

Proposition 218 requires first; that parcels only be assessed for the special benefits received by the service; meaning that all general benefits provided by the service and available to the public at large be excluded from the assessment, and second; that a property only be assessed for its proportionate share of the special benefits received. Given this, once the special benefits received by all parcels have been quantified, each individual parcel would be assessed based on its proportionate share of the total special benefits.

Benefit Area

LWA was provided GIS shape files generated from the hydraulic analyses showing the post project reduction in flood depths. The extents of these areas were considered the preliminary benefit areas for the alternatives evaluated in the feasibility study. **Figure 1** and **Figure 2** show the alternatives and benefit areas considered in this evaluation. All parcels within this benefit area were utilized in the analysis.[1]

Land Use

Land uses for properties within the benefit area were compiled from Colusa County Assessor's data obtained from ParcelQuest. Each land use code was evaluated and assigned to a generalized Land Use Category (e.g.: Agricultural, Single-Family Residential, Commercial, etc.) to identify the category for use in apportioning special benefit. A table presenting the County's use type code and the associated land use category is displayed in **Table 1** of **Attachment 2**.

Parcel Size

The Colusa County Assessor's data obtained from ParcelQuest included the acreage of each parcel. This data was reviewed for completeness. Where data was missing, the parcel size was estimated using parcel GIS data also obtained from the County. For this feasibility level analysis, no effort was made to verify or reconcile the GIS data or County Assessor data.

Structure Type and Size

The Colusa County Assessor's data obtained from ParcelQuest also included structure size data. Structures on a parcel were assumed to be consistent with the Land Use Category assigned to the property for the purposes of this analysis. For example, all structures on a parcel with a Commercial land use category designation by the County Assessment were analyzed as Commercial structures. Agricultural and vacant land uses assume no structural damage. **Table 2** provides a summary of the total acreage of parcels with structures, total structure size, and the average structure size per acre for each land use category within the benefit area.

[1] Where only a portion of a parcel was included in a benefit area, a percentage of the parcel within the benefit area was used to determine the benefit received by the parcel.

Relative Damage Rate

The special benefits received from flood control projects are assumed to be proportional to the amount of flood damage avoided by implementing the projects and/or performing O&M services. For the purpose of this analysis, a simplified approach has been used to quantify the flood damages avoided for each Land Use Category.

Composite structure depth-damage values were prepared for each Land Use Category based on the U.S. Army Corps of Engineers (USACE) guidance. The composite structure damage values consider the structure replacement value, the contents-to-structure ratio and the percentage of damage to the structure and contents at an average flood depth. The flood depth for each parcel was provided to LWA to calculate the average flood depth per land use.

Agricultural land was assigned a crop damage value of $300/acre based on data provided in the 2010 Central Valley Flood Protection Plan.

Vacant land was assigned a damage value of $100/acre to reflect minor damage to infrastructure and/or damage from site erosion.

Table 3 provides the structure replacement value, the contents-to-structure ratios and the composite damage values for each Land Use Category, excluding agricultural and vacant land uses across a range of flood depths.

The average damage per acre for each Land use Category was calculated using the following formula:

$$\begin{bmatrix} Average \\ Damage \\ per\ Acre \end{bmatrix} = \begin{bmatrix} Composite \\ Damage\ Value \\ (Table\ 3) \end{bmatrix} \times \begin{bmatrix} Average \\ SF\ per\ Acre \\ (Table\ 2) \end{bmatrix}$$

A Relative Damage Factor was calculated by normalizing the average damage per acre to the Agricultural Land Use (i.e., Agricultural = 1.0). The normalization does not change the proportionality and maintains compliance with Proposition 218.

Alternatives

Six alternatives were evaluated for Colusa. Assessment ranks for each alternative were developed and estimated for potential local revenue. Tables 4 through 7 were developed for each alternative and are labeled by the table number followed by the alternative reference.

Assessment Rate

The special benefit for each parcel was determined by calculating the amount of Equivalent Benefit Units (EBU) using the following formula:

$$EBU_{parcel} = \begin{bmatrix} Parcel \\ Acreage \end{bmatrix} \times \begin{bmatrix} Relative \\ Damage\ Factor \\ (Table\ 4) \end{bmatrix}_{\substack{Based\ on \\ Parcel\ Land \\ Use\ Category}}$$

The Assessment Rate is equal to the amount of revenue required divided by the sum of EBUs from all benefitting parcels.

The assessment for a particular parcel is equal to the quantity of EBUs for that parcel multiplied by the resulting Assessment Rate per EBU. **Table 4** (A-F) summarizes these EBU and Assessment rate calculations.

In order to generate an estimated range of maximum revenue, **Table 5** (A-F) summarizes the aggregate assessment amount, the average assessment per parcel, and the average assessment per acre, required to generate $100,000 in annual assessment revenue

4. Financial Feasibility Constraints

Demonstrating Federal Interest

The USACE; planning process has a defined approach to determine flood risk reduction benefits. The USACE analysis is based on the value of damageable property and the projected reduction in flood damages once flood risk reduction measures are implemented. Less densely populated areas with agricultural land produce lower benefits than densely populated areas. This makes demonstrating a federal interest in small communities in agricultural areas very difficult.

Securing federal funding for flood risk reduction projects will continue to become more competitive. In the past, funding for authorized projects has relied heavily on prioritizing appropriations based on a project's Benefit to Cost Ratio (BCR). This approach limits federal investments to areas that can achieve a very robust BCR and generally these projects are in urban areas where significant flood damage reduction benefits exist. In FY 2019 budget requests, the current administration sought to limit funding to ongoing flood risk reduction projects with a BCR greater than 2.5 to 1. While the BCRs for projects vary each year, the competition for limited federal funding also increases as authorizations continue to outpace appropriations.

Limited Availability of Federal Funding

The USACE has historically been a major financial contributor in the development of flood risk reduction infrastructure in California. It is estimated the USACE has a backlog of authorized projects higher than $96 billion.[2] Annual appropriations for construction funding in FY 2018 and FY 2019 were $2.1 billion and $2.2 respectively, or just over 2% of the total backlog of authorized projects. However, some of the backlogged appropriations are

[2] Carter, N. (2018). *Army Corps of Engineers Annual and Supplemental Appropriations: Issues for Congress.* Congressional Research Service.

related to projects that are unlikely to be constructed, as throughout the nation they are not competitive when compared against other projects.

There are multiple factors contributing to the growth of the USACE's backlog; authorizations have outpaced appropriations, aging infrastructure requires more significant financial investments, and construction related costs continue to escalate.

Availability of State Funds

Following the passage of the Water Resources Development Act of 1986, non-federal interests were required to share more of the financial and management burdens. These new requirements, coupled with more stringent environmental regulations, resulted in further reduction in the federal share of spending for flood and water management projects. With the reduction in federal authorizations and the more stringent conditions on State and local financing of flood management projects, the State turned to general obligation (GO) bonds.

In 2006, the State passed water management bond propositions 84 and 1E. The Disaster Preparedness and Flood Protection Bond Act of 2006 (Proposition 1E) authorized $4.09 billion in general obligation bonds to rebuild and repair California's most vulnerable flood control structures to protect homes and prevent loss of life from flood-related disasters, including levee failures, flash floods, and mudslides and to protect California's drinking water supply system by rebuilding delta levees that are vulnerable to earthquakes and storms. Proposition 84 enhanced these efforts with an additional $800 million for flood projects. Proposition 1 was passed on November 4, 2014 and included $395 million for flood projects. Proposition 68 was passed on June 5, 2018 and included another $550 million for flood projects.

Proposition 1E funds have been allocated to conduct Feasibility Study investigations that are consistent with DWR's SCFRR Program Guidelines (2016) and support the (2012 and 2017) Central Valley Flood Protection Plan goals of promoting flood risk management actions to reduce flood risk to people and property protected by State Plan of Flood Control facilities. The study objectives include assessing a community's existing flood hazards, evaluating structural, non-structural and multi-benefit projects, and making recommendations to implement a flood risk protection project that integrates other resources' needs, as much as feasible.

Limited Local Funding Sources/Proposition 218 Assessments

Funding local infrastructure and services, including flood and water management projects, became more difficult when voters in California passed Proposition 13 in 1978, Proposition 62 in 1986, and Proposition 218 in 1996. Proposition 13 limited ad valorem taxes on California properties. The proposition limited the amount of tax that could be collected based on the assessed value of private property, including real estate, to 1 percent of the assessed value of the property. Proposition 13 also decreased the assessed value of the properties to 1975 values (negating three years of increased value), and limited increases of assessed value to a maximum of 2 percent per year. Property that is sold or declines in value after an initial purchase may be reassessed. The enactment of Proposition 13 cut local property tax revenue significantly, causing cities and counties to raise user fees and other local taxes. In response, voters approved Proposition 62, the Voter Approval of Taxes Act, in 1986. This proposition

required that new general taxes be approved by two-thirds of the local agency's governing body and a majority of voters, and new special taxes be approved by a two-thirds majority of voters. This led local agencies and communities to use assessments and property-related fees (among other fees) to pay for government services. Proposition 218 was passed by voters in 1996 and added requirements and limits on local governments' ability to impose or increase assessments and fees.

Proposition 26, which was passed in 2010, redefined many existing fees as taxes. The impacts of institutional and legal constraints associated with raising local funding for flood infrastructure and services is described in greater detail in a 2014 Public Policy Institute of California's report ("Paying for Water in California," 2014). Constraints from Proposition 218 and 13 have been thoroughly documented by the State and also highlighted as a major challenge in DWR's January 2005 White Paper, "Responding to California's Flood Crisis."

Tax Rate and Infrastructure Burden Considerations

In order to consider an area's ability to generate new revenue through special taxes and assessments, the uses of taxing capacity for all infrastructure and services should be considered. The California Debt and Investment Advisory Commission (CDIAC) promulgates guidelines with respect to land secured financing, including the use of assessments and Mello-Roos Special Taxes. CDIAC's Mello-Roos Guidelines (1991) suggest that jurisdictions should integrate Mello-Roos financing into the land use regulatory framework. Local governments can create a process for coordinating the use of land secured financing through the provision of this form of integration. The main concern is that in the absence of coordinated planning, property owners/taxpayers could find themselves vulnerable to onerous overlapping property tax burdens imposed by a multitude of local governments that may provide services to the same group of properties. Further, the services funded by these burdens may not reflect property owners' collective priorities for services and infrastructure. This issue is analogous to the current ongoing efforts associated with planning for the future of flood management infrastructure, to the extent that there are a multitude of planning efforts, all developing concurrent funding and financing strategies. These efforts should be coordinated to ensure that there is sufficient funding capacity available from the identified beneficiaries and the funding is dedicated toward the beneficiaries' collective highest priorities.

5. Alternative Analysis Screening Constraints

For the purpose of determining the capacity of the local community to generate funds for O&M and capital improvements, the capacity is assumed to be limited by the assessment rate that would be imposed on residential properties. For this study, the limiting factor is assumed to be a maximum annual assessment acceptable to residential property owners of $200 per single family residence. In addition to constraining the maximum parcel assessment rate, a minimum O&M cost of $16,000 per mile of levee for levees and $1,000 for berms protecting the small community was set by the Colusa Feasibility Study team. This cost was based on the need for the levees to be maintained to meet a minimum 100-year level of protection over time. Using theses limitation, a baseline $100,000 assessment for each alternative is show in **Table 5** (A-F). **Table 6** (A-F) and **Table 7** (A-F) provide an estimated range of the maximum revenue that might be generated for each alternative by scaling the $100,000 assessment, while constraining the maximum assessment for single-family residential. The $100,000 assessment

was used determine the impacts on different land use rates when scaling the capacity up or down. **Table 6** (A-F) constrained the analysis to a $100 annual assessment for single-family residential and **Table 7** (A-F) constrained the analysis based on a $200 annual single-family residential assessment. The results of the assessment evaluation for each alternative are shown in **Table 8** in **Attachment 2 and are summarized in the table below**.

Colusa Small Communities Flood Risk Reduction
Alternatives Cost Summary of Results

Alternative	Total Construction Cost	Assessment Capacity	
		$100 Constraint	$200 Constraint
1	$188,000,000	$405,000	$810,000
2	$214,700,000	$406,000	$812,000
3	$204,100,000	$405,000	$810,000
4	$180,200,000	$406,000	$812,000
5	$206,900,000	$407,000	$813,000
6	$196,300,000	$406,000	$812,000

6. Recommendations for Alternatives Evaluation

Alternatives Analysis Screening Process

The final alternatives were screened and ranked based on an overall analysis of the community's ability to generate local matching funds as a percent of the total project cost. The ability to pay analysis was a three-step screening process. First, a maximum annual land-based assessment was calculated assuming the limitations noted above along with the proportionality requirements of Proposition 218 for the benefited area. Second, each alternative's capacity to raise sufficient annual funding to cover long term O&M costs was determined. Finally, the remaining alternatives were ranked based on their ability to raise local capital to protect Colusa with the remaining assessment capacity after required O&M is funded.

The results of the financial feasibility study are shown in **Tables 4-7** (A-F). Alternatives 1-6 were carried forward into the next stage of the analysis and the remaining capacity was determined for these alternatives. Based on the capacity analysis, LWA recommends that the planning level revenue from the local community be $812,000, see **Table 8.** Based on our experience, a $200 annual single-family residential assessment is a reasonable approximation for an acceptable flood property assessment in the central valley of California.

Figure 1

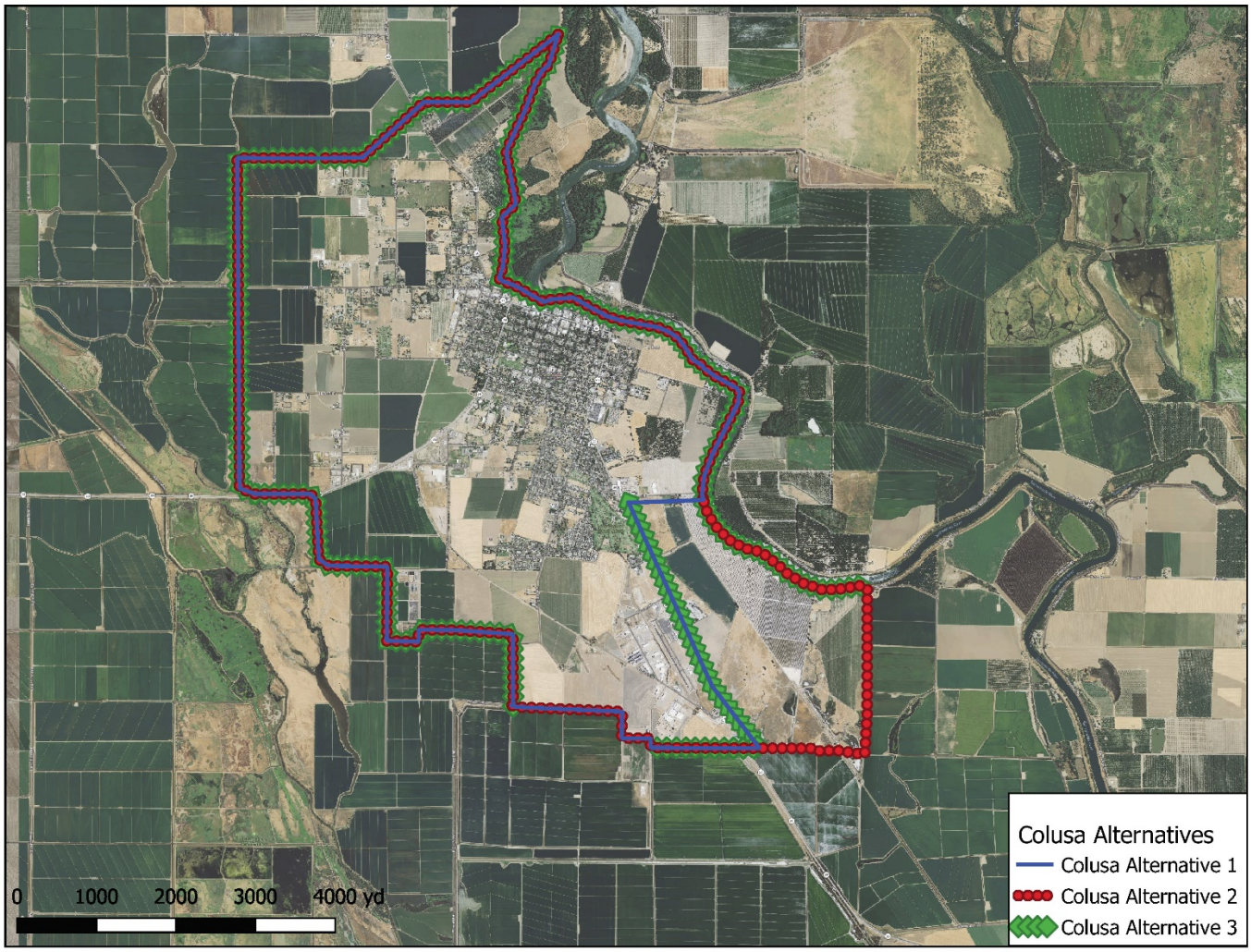

Colusa Alternatives
Colusa Alternative 1
Colusa Alternative 2
Colusa Alternative 3
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1000
2000
3000
4000 yd

Figure 2

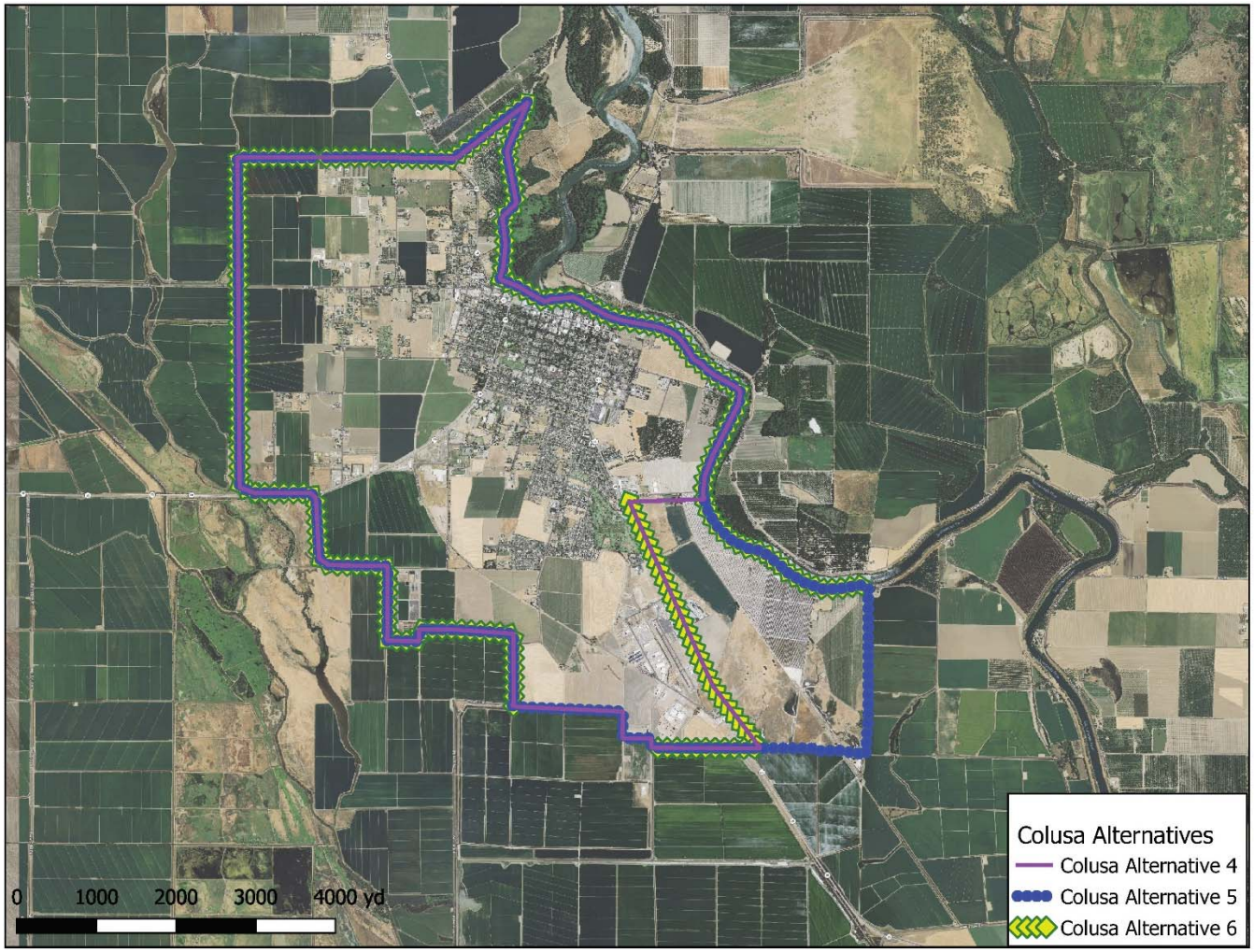

Colusa Alternatives
Colusa Alternative 4
Colusa Alternative 5
Colusa Alternative 6
0
1000
2000
3000
4000 yd

Table 1
Colusa Small Communities Flood Risk Reduction
Zoning and Land use Code

Use Type	Zoning Code	Land Use Type
A	AGRICULTURAL	Agricultural
A9	AGRICULTURAL	Agricultural
AA	AGRICULTURAL	Agricultural
AD	AGRICULTURAL	Agricultural
AK	AGRICULTURAL	Agricultural
AL	AGRICULTURAL	Agricultural
AO	AGRICULTURAL	Agricultural
AR	AGRICULTURAL	Agricultural
AW	AGRICULTURAL	Agricultural
AV	AGRICULTURAL	Vacant
C	COMMERCIAL	Commercial
C9	COMMERCIAL	Commercial
CA	COMMERCIAL	Commercial
CB	BANK	Commercial
CD	COMMERCIAL	Commercial
CE	RETAIL SALES	Commercial
CF	RESTAURANT	Commercial
CG	RECREATIONAL	Commercial
CH	RESID. HOTEL/MOTEL/RESORTS	Commercial
CI	AUTOMOTIVE USES	Commercial
CJ	AUTOMOTIVE USES	Commercial
CM	MEDICAL/DENTAL/LABS	Commercial
CN	COMMERCIAL	Commercial
CP	AUTOMOTIVE USES	Commercial
CU	COMMERCIAL - MOBILE HOME PARK	Commercial
CV	VACANT	Vacant
CW	COMMERCIAL	Commercial
CX	COMMERCIAL	Commercial
CZ	OFFICE	Commercial
EV	VACANT	Vacant
GV	VACANT	Vacant
I9	INDUSTRIAL	Industrial
IA	INDUSTRIAL	Industrial
IT	INDUSTRIAL	Industrial
IV	VACANT	Vacant
IW	INDUSTRIAL	Industrial
R1	RESID. SINGLE FAMILY	Residential Single
R2	RESID. MULTIPLE FAMILY	Residential Multi
R3	RESID. MULTIPLE FAMILY	Residential Multi
R4	RESID. MULTIPLE FAMILY	Residential Multi
R5	RESID. MULTIPLE FAMILY	Residential Multi

Use Type	Zoning Code	Land Use Type
R6	RESID. MOBILE/MANUFACTURED HOMES	Mobile Home
R7	RESIDENTIAL	Residential Multi
R8	RESIDENTIAL	Residential Multi
R9	RESIDENTIAL	Residential Multi
RU	RESID. MOBILE/MANUFACTURED HOME PARK	Mobile Home
RV	VACANT	Vacant
WD	AGRICULTURAL PRESERVE	Agricultural
WL	AGRICULTURAL PRESERVE	Agricultural
WLE	AGRICULTURAL PRESERVE	Agricultural
WW	AGRICULTURAL PRESERVE	Agricultural
YC	CHURCH	Commercial
YS	SCHOOLS	School
YV	VACANT	Vacant
ZR	AGRICULTURAL	Agricultural
	NO VALUE	TBD

Table 2
Colusa Small Communities Flood Risk Reduction
Structure Size by Land Use

Land Use	Acres with Structures [A]	Structure Size (Sq Ft.) [B]	Avg Structure (Sq Ft/Acre) [C = B/A]
Agricultural [1]	0.00	0.00	0.00
Commercial	216.35	1,220,972	5,643.53
Industrial	107.17	414,777	3,870.27
School	7.15	8,161	1,141.40
Residential Multi	73.21	323,097	4,413.29
Mobile Home	8.77	4,046	461.35
Rural Residential	181.87	92,900	510.80
Residential Single	716.33	2,886,864	4,030.08
Vacant [1]	0.00	0.00	0.00
Total	1,310.85	4,950,817	3,776.80

[1] No Structural damage assumed.

Table 3
Colusa Small Communities Flood Risk Reduction
Damage Per Acre Calculations

Land Use	Structure Replacement Value ($/Sq Ft.)	Contents Damage Ratio	Average Depth (Ft.)	Average Damage Value (per Acre or Sq Ft)		Avg Structure (Sq Ft/Acre)	Relative Damage/ Acre	Relative Damage/acre Normalized
	[A] [1,3]	[B] [2,3]	[C][4]	[D][3]		[E] [5]	[F] = [D] * [E]	[G] = [F] / 300
Agricultural	$300.00	100%	4.18	300.00	acre	1	300	1
Commercial	$85.56	51%	2.40	69.82	Building SF	5,644	394,018	1,313
Industrial	$54.51	31%	3.68	34.30	Building SF	3,870	132,740	442
School	$144.46	38%	3.15	100.23	Building SF	1,141	114,406	381
Residential Multi	$84.40	50%	1.91	33.82	Building SF	4,413	149,247	497
Mobile Home	$45.85	50%	1.50	41.36	Building SF	461	19,080	64
Rural Residential	$111.67	50%	2.32	49.46	Building SF	511	25,265	84
Residential Single	$111.67	50%	1.80	43.31	Building SF	4,030	174,538	582
Vacant	$100.00	0%	3.06	100.00	acre	1	100	0.3

[1] See Table 9: Structure Damage Value

[2] See Table 10: Contents Damage Value

[3] See Table 11 Structure, Contents, and Land Damage Value

[4] Average depth damage for each land use

[5] See Table 2: Structure Size by Land Use

Table 4A **Alternative 1**

Colusa Small Communities Flood Risk Reduction

Effective Benefit Unit Summary Table

Land Use	Acres [A]	Parcels [B]	Relative Damage/acre Normalized [C]	Total EBU [D= A*C]	Avg EBU/Parcel [E = D/B]
Agricultural	3,107.20	132	1.00	3,107.20	23.54
Commercial	290.77	246	1,313.39	381,897.21	1,552.43
Industrial	112.67	13	442.47	49,852.86	3,834.84
School	64.49	147	381.35	24,593.48	167.30
Residential Multi	68.78	2	497.49	34,216.67	17,108.33
Mobile Home	3.70	30	63.60	235.39	7.85
Rural Residential	84.07	30	84.22	7,080.29	236.01
Residential Single	462.46	1,415	581.79	269,056.12	190.15
Vacant	580.89	216	0.33	193.63	0.90
Total	**4,775.03**	**2,231**		**770,232.83**	

Notes:

[A] Acres from Calculated per each Alternative

[B] Based on modeling of assessor data in benefit zone. Calculated per each Alternative.

[C] Damage per acre from Table 3

Table 4B **Alternative 2**

Colusa Small Communities Flood Risk Reduction

Effective Benefit Unit Summary Table

Land Use	Acres [A]	Parcels [B]	Relative Damage/acre Normalized [C]	Total EBU [D= A*C]	Avg EBU/Parcel [E = D/B]
Agricultural	4,321.03	154	1.00	4,321.03	28.06
Commercial	291.00	247	1,313.39	382,199.29	1,547.37
Industrial	112.67	13	442.47	49,852.86	3,834.84
School	64.49	147	381.35	24,593.48	167.30
Residential Multi	68.78	2	497.49	34,216.67	17,108.33
Mobile Home	3.70	31	63.60	235.39	7.59
Rural Residential	84.12	31	84.22	7,084.36	228.53
Residential Single	462.46	1,415	581.79	269,056.12	190.15
Vacant	580.89	216	0.33	193.63	0.90
Total	**5,989.14**	**2,256**		**771,752.81**	

Notes:

[A] Acres from Calculated per each Alternative

[B] Based on modeling of assessor data in benefit zone. Calculated per each Alternative.

[C] Damage per acre from Table 3

Table 4C **Alternative 3**

Colusa Small Communities Flood Risk Reduction

Effective Benefit Unit Summary Table

Land Use	Acres [A]	Parcels [B]	Relative Damage/acre Normalized [C]	Total EBU [D= A*C]	Avg EBU/Parcel [E = D/B]
Agricultural	3,107.20	132	1.00	3,107.20	23.54
Commercial	290.77	246	1,313.39	381,897.21	1,552.43
Industrial	112.67	13	442.47	49,852.86	3,834.84
School	64.49	147	381.35	24,593.48	167.30
Residential Multi	68.78	2	497.49	34,216.67	17,108.33
Mobile Home	3.70	30	63.60	235.39	7.85
Rural Residential	84.07	30	84.22	7,080.29	236.01
Residential Single	462.46	1,415	581.79	269,056.12	190.15
Vacant	580.89	216	0.33	193.63	0.90
Total	**4,775.03**	**2,231**		**770,232.83**	

Notes:

[A] Acres from Calculated per each Alternative

[B] Based on modeling of assessor data in benefit zone. Calculated per each Alternative.

[C] Damage per acre from Table 3

Table 4D

Alternative 4

Colusa Small Communities Flood Risk Reduction

Effective Benefit Unit Summary Table

Land Use	Acres [A]	Parcels [B]	Relative Damage/acre Normalized [C]	Total EBU [D= A*C]	Avg EBU/Parcel [E = D/B]
Agricultural	2,939.21	121	1.00	2,939.21	24.29
Commercial	290.77	246	1,313.39	381,897.21	1,552.43
Industrial	112.67	13	442.47	49,852.86	3,834.84
School	64.49	146	381.35	24,593.48	168.45
Residential Multi	67.90	2	497.49	33,780.86	16,890.43
Mobile Home	3.70	30	63.60	235.39	7.85
Rural Residential	84.07	30	84.22	7,080.29	236.01
Residential Single	454.25	1,402	581.79	264,280.74	188.50
Vacant	579.26	215	0.33	193.09	0.90
Total	**4,596.33**	**2,205**		**764,853.12**	

Notes:

[A] Acres from Calculated per each Alternative

[B] Based on modeling of assessor data in benefit zone. Calculated per each Alternative.

[C] Damage per acre from Table 3

Table 4E **Alternative 5**

Colusa Small Communities Flood Risk Reduction

Effective Benefit Unit Summary Table

Land Use	Acres [A]	Parcels [B]	Relative Damage/acre Normalized [C]	Total EBU [D= A*C]	Avg EBU/Parcel [E = D/B]
Agricultural	4,153.04	143	1.00	4,153.04	29.04
Commercial	291.00	247	1,313.39	382,199.29	1,547.37
Industrial	112.67	13	442.47	49,852.86	3,834.84
School	64.49	146	381.35	24,593.48	168.45
Residential Multi	67.90	2	497.49	33,780.86	16,890.43
Mobile Home	3.70	31	63.60	235.39	7.59
Rural Residential	84.12	31	84.22	7,084.36	228.53
Residential Single	454.25	1,402	581.79	264,280.74	188.50
Vacant	579.26	215	0.33	193.09	0.90
Total	**5,810.44**	**2,230**		**766,373.10**	

Notes:

[A] Acres from Calculated per each Alternative

[B] Based on modeling of assessor data in benefit zone. Calculated per each Alternative.

[C] Damage per acre from Table 3

Table 4F **Alternative 6**

Colusa Small Communities Flood Risk Reduction

Effective Benefit Unit Summary Table

Land Use	Acres [A]	Parcels [B]	Relative Damage/acre Normalized [C]	Total EBU [D= A*C]	Avg EBU/Parcel [E = D/B]
Agricultural	2,939.21	121	1.00	2,939.21	24.29
Commercial	290.77	246	1,313.39	381,897.21	1,552.43
Industrial	112.67	13	442.47	49,852.86	3,834.84
School	64.49	146	381.35	24,593.48	168.45
Residential Multi	67.90	2	497.49	33,780.86	16,890.43
Mobile Home	3.70	30	63.60	235.39	7.85
Rural Residential	84.07	30	84.22	7,080.29	236.01
Residential Single	454.25	1,402	581.79	264,280.74	188.50
Vacant	579.26	215	0.33	193.09	0.90
Total	**4,596.33**	**2,205**		**764,853.12**	

Notes:

[A] Acres from Calculated per each Alternative

[B] Based on modeling of assessor data in benefit zone. Calculated per each Alternative.

[C] Damage per acre from Table 3

Table 5A | **Alternative 1**

Colusa Small Communities Flood Risk Reduction

$100,000 Assessment

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$403.41	$3.06	$0.13
Commercial	$49,582.05	$201.55	$170.52
Industrial	$6,472.44	$497.88	$57.45
School	$3,192.99	$21.72	$49.51
Residential Multi	$4,442.38	$2,221.19	$64.59
Mobile Home	$30.56	$1.02	$8.26
Rural Residential	$919.24	$30.64	$10.93
Residential Single	$34,931.79	$24.69	$75.53
Vacant	$25.14	$0.12	$0.04
Total	**$100,000.00**		

Table 5B **Alternative 2**

Colusa Small Communities Flood Risk Reduction

$100,000 Assessment

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$559.90	$3.64	$0.13
Commercial	$49,523.54	$200.50	$170.18
Industrial	$6,459.69	$496.90	$57.33
School	$3,186.70	$21.68	$49.41
Residential Multi	$4,433.63	$2,216.82	$64.46
Mobile Home	$30.50	$0.98	$8.24
Rural Residential	$917.96	$29.61	$10.91
Residential Single	$34,862.99	$24.64	$75.39
Vacant	$25.09	$0.12	$0.04
Total	**$100,000.00**		

Table 5C **Alternative 3**

Colusa Small Communities Flood Risk Reduction

$100,000 Assessment

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$403.41	$3.06	$0.13
Commercial	$49,582.05	$201.55	$170.52
Industrial	$6,472.44	$497.88	$57.45
School	$3,192.99	$21.72	$49.51
Residential Multi	$4,442.38	$2,221.19	$64.59
Mobile Home	$30.56	$1.02	$8.26
Rural Residential	$919.24	$30.64	$10.93
Residential Single	$34,931.79	$24.69	$75.53
Vacant	$25.14	$0.12	$0.04
Total	**$100,000.00**		

Table 5D **Alternative 4**

Colusa Small Communities Flood Risk Reduction

$100,000 Assessment

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$384.28	$3.18	$0.13
Commercial	$49,930.79	$202.97	$171.72
Industrial	$6,517.96	$501.38	$57.85
School	$3,215.45	$22.02	$49.86
Residential Multi	$4,416.65	$2,208.32	$65.04
Mobile Home	$30.78	$1.03	$8.32
Rural Residential	$925.71	$30.86	$11.01
Residential Single	$34,553.14	$24.65	$76.07
Vacant	$25.24	$0.12	$0.04
Total	**$100,000.00**		

Table 5E **Alternative 5**

Colusa Small Communities Flood Risk Reduction

$100,000 Assessment

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$541.91	$3.79	$0.13
Commercial	$49,871.18	$201.91	$171.38
Industrial	$6,505.04	$500.39	$57.74
School	$3,209.07	$21.98	$49.76
Residential Multi	$4,407.89	$2,203.94	$64.92
Mobile Home	$30.71	$0.99	$8.30
Rural Residential	$924.40	$29.82	$10.99
Residential Single	$34,484.61	$24.60	$75.92
Vacant	$25.19	$0.12	$0.04
Total	**$100,000.00**		

Table 5F

Alternative 6

Colusa Small Communities Flood Risk Reduction

$100,000 Assessment

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$384.28	$3.18	$0.13
Commercial	$49,930.79	$202.97	$171.72
Industrial	$6,517.96	$501.38	$57.85
School	$3,215.45	$22.02	$49.86
Residential Multi	$4,416.65	$2,208.32	$65.04
Mobile Home	$30.78	$1.03	$8.32
Rural Residential	$925.71	$30.86	$11.01
Residential Single	$34,553.14	$24.65	$76.07
Vacant	$25.24	$0.12	$0.04
Total	**$100,000.00**		

Table 6A | **Alternative 1**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 1 - $100 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$1,633.81	$12.38	$0.53
Commercial	$200,807.29	$816.29	$690.60
Industrial	$26,213.38	$2,016.41	$232.66
School	$12,931.62	$87.97	$200.52
Residential Multi	$17,991.64	$8,995.82	$261.59
Mobile Home	$123.77	$4.13	$33.44
Rural Residential	$3,722.92	$124.10	$44.28
Residential Single	$141,473.75	$99.98	$305.92
Vacant	$101.81	$0.47	$0.18
	$405,000.00		

Table 6B | **Alternative 2**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 1 - $100 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$2,273.19	$14.76	$0.53
Commercial	$201,065.56	$814.03	$690.94
Industrial	$26,226.35	$2,017.41	$232.77
School	$12,938.02	$88.01	$200.62
Residential Multi	$18,000.54	$9,000.27	$261.72
Mobile Home	$123.83	$3.99	$33.46
Rural Residential	$3,726.90	$120.22	$44.30
Residential Single	$141,543.75	$100.03	$306.07
Vacant	$101.86	$0.47	$0.18
	$406,000.00		

Table 6C | **Alternative 3**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 1 - $100 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$1,633.81	$12.38	$0.53
Commercial	$200,807.29	$816.29	$690.60
Industrial	$26,213.38	$2,016.41	$232.66
School	$12,931.62	$87.97	$200.52
Residential Multi	$17,991.64	$8,995.82	$261.59
Mobile Home	$123.77	$4.13	$33.44
Rural Residential	$3,722.92	$124.10	$44.28
Residential Single	$141,473.75	$99.98	$305.92
Vacant	$101.81	$0.47	$0.18
	$405,000.00		

Table 6D | **Alternative 4**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 1 - $100 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$1,560.19	$12.89	$0.53
Commercial	$202,719.01	$824.06	$697.18
Industrial	$26,462.94	$2,035.61	$234.87
School	$13,054.73	$89.42	$202.43
Residential Multi	$17,931.59	$8,965.79	$264.08
Mobile Home	$124.95	$4.16	$33.76
Rural Residential	$3,758.36	$125.28	$44.70
Residential Single	$140,285.74	$100.06	$308.83
Vacant	$102.49	$0.48	$0.18
	$406,000.00		

Table 6E | **Alternative 5**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 1 - $100 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$2,205.57	$15.42	$0.53
Commercial	$202,975.69	$821.76	$697.51
Industrial	$26,475.50	$2,036.58	$234.98
School	$13,060.93	$89.46	$202.53
Residential Multi	$17,940.10	$8,970.05	$264.20
Mobile Home	$125.01	$4.03	$33.78
Rural Residential	$3,762.31	$121.36	$44.72
Residential Single	$140,352.35	$100.11	$308.97
Vacant	$102.54	$0.48	$0.18
	$407,000.00		

Table 6F | **Alternative 6**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 1 - $100 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$1,560.19	$12.89	$0.53
Commercial	$202,719.01	$824.06	$697.18
Industrial	$26,462.94	$2,035.61	$234.87
School	$13,054.73	$89.42	$202.43
Residential Multi	$17,931.59	$8,965.79	$264.08
Mobile Home	$124.95	$4.16	$33.76
Rural Residential	$3,758.36	$125.28	$44.70
Residential Single	$140,285.74	$100.06	$308.83
Vacant	$102.49	$0.48	$0.18
	$406,000.00		

Table 7A | **Alternative 1**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 2 - $200 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$3,267.62	$24.75	$1.05
Commercial	$401,614.59	$1,632.58	$490.92
Industrial	$52,426.76	$4,032.83	$465.31
School	$25,863.24	$175.94	$401.04
Residential Multi	$35,983.27	$17,991.64	$523.18
Mobile Home	$247.54	$8.25	$66.88
Rural Residential	$7,445.84	$248.19	$88.56
Residential Single	$282,947.51	$199.96	$611.83
Vacant	$203.63	$0.94	$0.35
	$810,000.00		

Table 7B | **Alternative 2**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 2 - $200 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$4,546.37	$29.52	$1.05
Commercial	$402,131.12	$1,628.06	$490.92
Industrial	$52,452.70	$4,034.82	$465.54
School	$25,876.04	$176.03	$401.24
Residential Multi	$36,001.08	$18,000.54	$523.44
Mobile Home	$247.66	$7.99	$66.92
Rural Residential	$7,453.81	$240.45	$88.61
Residential Single	$283,087.49	$200.06	$612.13
Vacant	$203.73	$0.94	$0.35
	$812,000.00		

Table 7C | **Alternative 3**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 2 - $200 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$3,267.62	$24.75	$1.05
Commercial	$401,614.59	$1,632.58	$490.92
Industrial	$52,426.76	$4,032.83	$465.31
School	$25,863.24	$175.94	$401.04
Residential Multi	$35,983.27	$17,991.64	$523.18
Mobile Home	$247.54	$8.25	$66.88
Rural Residential	$7,445.84	$248.19	$88.56
Residential Single	$282,947.51	$199.96	$611.83
Vacant	$203.63	$0.94	$0.35
	$810,000.00		

Table 7D | **Alternative 4**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 2 - $200 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$3,120.38	$25.79	$1.06
Commercial	$405,438.02	$1,648.12	$490.92
Industrial	$52,925.87	$4,071.22	$469.74
School	$26,109.46	$178.83	$404.86
Residential Multi	$35,863.17	$17,931.59	$528.16
Mobile Home	$249.90	$8.33	$67.52
Rural Residential	$7,516.73	$250.56	$89.41
Residential Single	$280,571.47	$200.12	$617.66
Vacant	$204.99	$0.95	$0.35
	$812,000.00		

Table 7E | **Alternative 5**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 2 - $200 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$4,405.71	$30.81	$1.06
Commercial	$405,452.67	$1,641.51	$490.92
Industrial	$52,885.95	$4,068.15	$469.39
School	$26,089.77	$178.70	$404.55
Residential Multi	$35,836.12	$17,918.06	$527.76
Mobile Home	$249.71	$8.06	$67.47
Rural Residential	$7,515.38	$242.43	$89.34
Residential Single	$280,359.85	$199.97	$617.19
Vacant	$204.83	$0.95	$0.35
	$813,000.00		

Table 7F | **Alternative 6**

Colusa Small Communities Flood Risk Reduction

Revenue Estimate 2 - $200 Residential Constraint

Land Use	Total Assessment	Avg Assessment/Parcel	Avg Assessment/Acre
Agricultural	$3,120.38	$25.79	$1.06
Commercial	$405,438.02	$1,648.12	$490.92
Industrial	$52,925.87	$4,071.22	$469.74
School	$26,109.46	$178.83	$404.86
Residential Multi	$35,863.17	$17,931.59	$528.16
Mobile Home	$249.90	$8.33	$67.52
Rural Residential	$7,516.73	$250.56	$89.41
Residential Single	$280,571.47	$200.12	$617.66
Vacant	$204.99	$0.95	$0.35
	$812,000.00		

Table 8
Colusa Small Communities Flood Risk Reduction
Alternatives Cost Summary of Results

Alternative	Total Construction Cost	Assessment Capacity	
		$100 Constraint	$200 Constraint
1	$188,000,000	$405,000	$810,000
2	$214,700,000	$406,000	$812,000
3	$204,100,000	$405,000	$810,000
4	$180,200,000	$406,000	$812,000
5	$206,900,000	$407,000	$813,000
6	$196,300,000	$406,000	$812,000

Table 9
Colusa Small Communities Flood Risk Reduction
Structure Damage Value

Structure Land Use		Replacement Value	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agricultural	**[1]**	300	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Commercial	**[2]**	85.56	7.00%	21.70%	30.20%	31.20%	32.40%	32.40%	39.80%	42.80%	51.70%	53.10%	54.10%	61.80%	64.80%	64.80%	65.50%	86.10%
School	**[3]**	144.46	7.00%	21.70%	30.20%	31.20%	32.40%	32.40%	39.80%	42.80%	51.70%	53.10%	54.10%	61.80%	64.80%	64.80%	65.50%	86.10%
Industrial	**[4]**	54.51	7.00%	21.70%	30.20%	31.20%	32.40%	32.40%	39.80%	42.80%	51.70%	53.10%	54.10%	61.80%	64.80%	64.80%	65.50%	86.10%
Mobile Home	**[5]**	45.85	9.90%	44.70%	45.70%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%
Residential Multi	**[6]**	84.4	13.40%	23.30%	32.10%	40.10%	47.10%	53.20%	58.60%	63.20%	67.20%	70.50%	73.20%	75.40%	77.20%	78.50%	79.50%	80.20%
Rural Residential	**[7]**	111.67	13.40%	23.30%	32.10%	40.10%	47.10%	53.20%	58.60%	63.20%	67.20%	70.50%	73.20%	75.40%	77.20%	78.50%	79.50%	80.20%
Residential Single	**[8]**	111.67	13.40%	23.30%	32.10%	40.10%	47.10%	53.20%	58.60%	63.20%	67.20%	70.50%	73.20%	75.40%	77.20%	78.50%	79.50%	80.20%
Vacant		100	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Reference Table C-1 2012 CVFPP HEC-FDA Structure and Damage Functions - CVFPP Attachment 8F Flood Damage Analysis

[1] Assumed Crop damage per acre

[2] Source: Table B-9 - Good Status for Commercial Retail

[3] Source: Table B-29 Good Status for Public and Private Schools

[4] Source: Table B-21 - Good Status for Industrial Light

[5] Source: Table B-25 - Good Status for Mobile Home

[6] Source: Table B-26 - Good Status Construction Class and Quality for Multi-Family Residential

[7] Source: Table B-33 - Good Status for Single Family Residential

[8] Source: Table B-33 - Good Status for Single Family Residential

Table 10
Colusa Small Communities Flood Risk Reduction
Contents Damage Value

Land Use	Contents Damage Ratio	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agricultural	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Commercial	51%	0.00%	79.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
School	38%	0.00%	87.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Industrial	31%	0.20%	87.60%	96.40%	99.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Mobile Home	50%	0.00%	85.00%	95.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%
Residential Multi	50%	8.10%	13.30%	17.90%	22.00%	25.70%	28.80%	31.50%	33.80%	35.70%	37.20%	38.40%	39.20%	39.70%	40.00%	40.00%	40.00%
Rural Residential	50%	8.10%	13.30%	17.90%	22.00%	25.70%	28.80%	31.50%	33.80%	35.70%	37.20%	38.40%	39.20%	39.70%	40.00%	40.00%	40.00%
Residential Single	50%	8.10%	13.30%	17.90%	22.00%	25.70%	28.80%	31.50%	33.80%	35.70%	37.20%	38.40%	39.20%	39.70%	40.00%	40.00%	40.00%
Vacant	0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Reference Table C-1 2012 CVFPP HEC-FDA Structure and Damage Functions - CVFPP Attachment 8F Flood Damage Analysis

Reference Table 3-10 Contents to Structure Ratio - 2012 CVFPP Attachment 8F Flood Damage Analysis

Table 11
Colusa Small Communities Flood Risk Reduction
Structure and Contents Value

Land Use		Replacement Value	Contents Damage Ratio	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agricultural	**[1]**	300	100%	0.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Commercial	**[2]**	85.56	51%	5.99	53.39	69.47	70.33	71.36	71.36	77.69	80.26	87.87	89.07	89.92	96.51	99.08	99.08	99.68	117.30
School	**[3]**	144.46	38%	10.11	79.55	98.52	99.97	101.70	101.70	112.39	116.72	129.58	131.60	133.05	144.17	148.50	148.50	149.52	179.27
Industrial	**[4]**	54.51	31%	3.85	26.63	32.75	33.74	34.56	34.56	38.59	40.23	45.08	45.84	46.39	50.59	52.22	52.22	52.60	63.83
Mobile Home	**[5]**	45.85	50%	4.54	39.98	42.73	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94
Residential Multi	**[6]**	84.4	50%	14.73	25.28	34.65	43.13	50.60	57.05	62.75	67.60	71.78	75.20	77.99	80.18	81.91	83.13	83.98	84.57
Rural Residential	**[7]**	111.67	50%	19.49	33.45	45.84	57.06	66.95	75.49	83.03	89.45	94.98	99.50	103.18	106.09	108.38	109.99	111.11	111.89
Residential Single	**[8]**	111.67	50%	19.49	33.45	45.84	57.06	66.95	75.49	83.03	89.45	94.98	99.50	103.18	106.09	108.38	109.99	111.11	111.89
Vacant		100	100%	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Reference Table 6 Reclamation District 2140 - Hamilton City Levee O&M Assessment

[1] Assumed Crop damage per acre

[2] Source: Table B-9 - Good Status for Commercial Retail

[3] Source: Table B-29 Good Status for Public and Private Schools

[4] Source: Table B-21 - Good Status for Industrial Light

[5] Source: Table B-25 - Good Status for Mobile Home

[6] Source: Table B-26 - Good Status Construction Class and Quality for Multi-Family Residential

[7] Source: Table B-33 - Good Status for Single Family Residential

[8] Source: Table B-33 - Good Status for Single Family Residential

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Technical Memorandum

Small Community Flood Risk Reduction (SCFRR)

Funding Sources Memorandum *June 7, 2019*

Prepared by: Elisabet Abdissa
Reviewed by: Derek Larsen, P.E.

Purpose

This memorandum has been prepared by Larsen Wurzel & Associates, Inc. (LWA) in support of the Department of Water Resources (DWR) Small Communities Flood Risk Reduction (SCFRR) Program. It is intended that this Memorandum will be used in conjunction with the Financial Feasibility Memo to inform Conceptual Finance Plans in identifying non-local funding sources for preferred structural and non-structural alternatives. The memo provides an extensive list of potential Federal and State funding sources to be considered in flood risk reduction and multi benefit SCFRR projects.

Background

The SCFRR Program was created based on recommendations in the 2012 Central Valley Flood Protection Plan (CVFPP). The intention of this program is to invest in qualifying projects that reduce flood risks for small communities. As specified in the CVFPP, small communities are defined as developed areas with fewer than 10,000 residents, which do not fall in the category of urban. A goal in the 2012 CVFPP was to target a "100-year" level of protection for Small communities. The Federal Emergency Management Agency (FEMA) standard "100-year" level of flood protection is defined as protection from a flood with a 1-in-100 probability of occurrence in any given year for property located within a flood hazard zone.

The SCFRR Program will support the implementation of flood risk mitigation projects for small communities protected by State Plan of Flood Control (SPFC) facilities in the Sacramento-San Joaquin Valley. With assistance from the State, small communities and counties are conducting design, construction, and financial feasibility studies. Projects under the SCFRR Program conduct feasibility studies of structural and/or non-structural alternatives to reduce the risk of flooding for small communities. The structural alternatives are intended to lead to the design of projects that repair, rehabilitate, reconstruct, or replace SPFC facilities to improve flood protection. In the sections to follow, this memorandum will address structural and non-structural alternatives along with possible funding sources to be utilized by Small Communities in implementing flood risk reduction and multi-benefit projects.

Structural & Non-Structural Alternatives

Structural Solutions

Structural solutions are any physical construction implementations intended to avoid or reduce potential impacts of flood hazards. Through the application of engineering techniques or technology, structural solutions are implemented to achieve hazard resistance and resilience in flood structures or systems. Measures including the construction and reconstruction of water courses and water protection facilities such as levees, dikes, dams, floodgates, pumping stations, and other flood protection infrastructure are implemented in areas where flood risk cannot be sufficiently reduced by non-structural methods alone. The State and federal governments offer funding programs to match local funds for structural projects.

This report examines funding for structural solutions that can be implemented to mitigate against flood risk and provide multi-benefit objectives. These alternatives are discussed further in the Structural Solution Summaries section; 1) Levees, 2) Floodwalls, 3) Flood Bypass, 4) Erosion Control, and 5) Dams.

Non-Structural Solutions

According to the United States Army Corp of Engineers (USACE), [1]non-structural solutions are contingent physical or nonphysical measures utilized to mitigate or prevent potential damages from flooding. Implementing such nonstructural flood risk reduction measures is proven to reduce overall flood risk and flood damage. [2]Physical nonstructural measures are applied on a structure by structure basis while nonphysical non-structural measures are floodplain management activities intended to address flood risk through regulation, programs, and best management practices. The State and federal governments offer funding programs to match local funds for non-structural projects.

This report considers funding for non-structural solutions which are discussed further in the Non-Structural Solution Summaries Section; 1) Changes to National Flood Insurance, 2) Levee Relief Cuts, 3) Emergency Flood Fight Plan, 4) Flood Emergency Evacuation Plan, 5) Flood Emergency Warning System, 6) Voluntary Structure Elevation & Floodproofing, and 7) Buyout/Acquisitions.

Multi-Benefit Improvements

The State strongly supports and encourages the planning and implementation of projects that include multi-benefit improvement objectives. Projects can include increasing the flood system resiliency by protecting and restoring crucial ecosystems, and improving water supply, water quality, recreation and public education related to integrated water management. Multi-benefit objectives within and surrounding small communities can be integrated into identified flood improvement alternatives to enhance the function of the region's flood system and management. According to the 2017 CVFPP update, a multi-benefit alternative more efficiently and effectively leverages flood infrastructure to achieve a broader array of public benefits and may potentially

[1] http://www.nwd-mr.usace.army.mil/rcc/MRFTF/docs/USACE-NFPC%20Nonstructural%20Measures%20Definitions.pdf
[2]https://www.floods.org/acefiles/documentlibrary/committees/floodproofing/Nonstructural_Flood_Risk_Management_Pamphlet_v2.pdf

increase access to more funding sources.[3] Available State funding sources for multi-benefit improvement projects are provided in a later section of this memo.

Funding Sources

In general, funding for Flood Risk Management efforts comes from three sources; federal, state and local governments. For the purposes of this of memo, the below sections cover **Federal** and **State** Funding mechanisms, available programs, Requirements, and constraints.

Securing Federal Funding

The process for garnering federal funding for flood risk reduction projects requires that a federal interest in the project be identified. Federal interest has generally been identified and evaluated within feasibility studies prepared by the USACE that evaluate various criteria and generally emphasize the cost in relation to flood damage-reduction benefits associated within a specific project.

Small communities and rural areas generally lack the necessary benefits to justify a significant federal interest, but under programs such as SCFRR, these communities can be served through State lead federal funding solicitations. **Table 1**, **Table 2**, and **Table 3** provide a summary of the Federal programs that are currently and expected to be available to local agencies to assist within funding structural and non-structural projects. Each table is broken apart by specific federal agency. **Table 1** lists available Federal programs currently provided under the Federal Emergency Management Agency (FEMA). **Table 2** lists available Federal funding programs under USACE and **Table 3** lists available United States Department of Agriculture (USDA) Federal programs. The typical cost share percentages for these programs are listed, however, cost sharing percentages can vary widely based upon project specific attributes.

[3] https://cawaterlibrary.net/wp-content/uploads/2017/10/2017CVFPPUpdate-Final-20170828.pdf

Table 1
SCFRR - Funding Sources Memo
FEMA Hazard Mitigation Assistance Grant Programs

Program	Agency/Dept.	Type of Assistance	Purpose	Eligibility	Cost Share	Maximum Project Assistance	Role of Flood In Program	Requirements	Stafford Act Authorization
Flood Mitigation Assistance (FMA)	FEMA	Grant	Mitigate flood-damaged properties in order to reduce or eliminate claims under NFIP	Acquisition, demolition, floodproofing, relocations, elevation, mitigation, flood risk reduction	Only for NFIP insured properties and planning grants - up to 75%/ repetitive loss up to 90%/Severe repetitive loss - 100%	Depends on type of activity funded	Structural and nonstructural projects	All sub applicants for FMA must be participating in the NFIP, and not be withdrawn or suspended, to be eligible to apply for grant funds.	Section 1366 of the National Flood Insurance Act
Repetitive Flood Claims Grant Program (RFCP)	FEMA	Grant	Reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program (NFIP) that have had one or more claim payment(s) for flood damages.	RFC awards will prioritize acquisition projects that create the greatest savings to the NFIF based on a Benefit-Cost Analysis (BCA).	Up to 100%	RFC grants are awarded nationally without reference to State allocations, quotas, or other formula-based allocation(s) of funds. The RFC program is subject to the availability of appropriation funding.	Structural and nonstructural projects	All Applicants and sub applicants must be participating in the National Flood Insurance Program (NFIP), and must not be suspended or withdrawn from the NFIP.	Section 1323 of the National Flood Insurance Act
Pre-disaster Mitigation (PDM)	FEMA	Grant	Assist in Implementation of flood risk mitigation prior to disasters.	Acquisition, demolition, floodproofing, relocations, elevation, mitigation, flood risk reduction	up to 75% & up to 90% if applicant is small, impoverished community	$4 M - Mitigation project/ $400,000 new mitigation plan/ $150,000 local mitigation plan update	Structural and nonstructural projects	HMGP and PDM mitigation project sub applications for projects sited within an SFHA are eligible only if the jurisdiction in which the project is located is participating in the NFIP. There is no NFIP participation requirement for HMGP and PDM project sub applications for projects located outside of the SFHA.	Section 203 of the Stafford Act, 42 U.S.C. §5133.
Hazard Mitigation Grant Program (HMGP)	FEMA	Grant	Flood risk reduction and reduction of reliance on future federal disaster assistance	Acquisition, demolition, floodproofing, relocations, elevation, mitigation, flood risk reduction	Up to 75%	There is no minimum or maximum project/planning grant award amount (within availability of funds)	Structural and nonstructural projects	Available only after a Federally Declared Disaster. HMGP and PDM mitigation project sub applications for projects sited within an SFHA are eligible only if the jurisdiction in which the project is located is participating in the NFIP. There is no NFIP participation requirement for HMGP and PDM project sub applications for projects located outside of the SFHA.	Section 404 of the Stafford Act, 42 U.S.C. §5170c.

Source: Congressional Research Services (2018 Flood Resilience and Risk Reduction: Federal Assistance and Programs)

Table 2
SCFRR - Funding Sources Memo
USACE Grant Programs

Program	Agency/Dept.	Type of Assistance	Purpose	Eligibility	Cost Share	Maximum Project Assistance	Role of Flood In Program	Authorization
Flood Damage Reduction Projects (FDRP)	USACE	Study and construction Grant	Improvements to reduce riverine and coastal storm damages. Pursued as individual projects and not under authorized national program	Flood-damage reduction works, typically engineered works (e.g., levees, engineered dunes and beaches, storm surge gates and dams). Projects generally are required to have national benefits exceeding costs, or address public safety concerns	50% & when P.L 115-123 monies are used and 100% for feasibility study	Depends on project-specific authorization of appropriations	limited to projects that reduce riverine and coastal flood damage; generally do not address drainage or flooding from groundwater	Construction of individual projects is authorized by Congress, typically in a Water Resources Development Act or other omnibus water authorization legislation.
Flood-Related Continuing Authorities Program (FRCA)	USACE	Study and construction Grant	Reduce flood damages via structural and non-structural method (CAPs) section 205.	Flood damage reduction works that have not previously been specifically authorized by Congress and are not part of a larger project.	Study: 50% after initial $0.1 M// Construction: 65%// O&M: 0% (for territories and tribes first $0.455 M of O&M covered)	The maximum federal expenditure per project is $7 million, including feasibility study, design and construction costs.	Limited to projects that reduce flood damages (not including drainage from within community)	Under authorized Continuing Authorities Programs (CAPs) (§205)33 U.S.C. §701s. (§103) 33 U.S.C. §426g. (§14) 33 U.S.C. §701r. (§111) 33 U.S.C. §426i.

Source: Congressional Research Services (2018 Flood Resilience and Risk Reduction: Federal Assistance and Programs)

Table 3
SCFRR - Funding Sources Memo
USDA Grant Programs

Program	Agency/Dept.	Type of Assistance	Purpose	Eligibility	Cost Share	Maximum Project Assistance	Role of Flood In Program	Authorization
Emergency Watershed Protection (EWP) - Floodplain Easements	U.S Department of Agriculture (USDA)	Technical assistance and Grant	floodplain easements are meant to safeguard lives and property from future floods, drought, and the products of erosion through the restoration and preservation of the land's natural values.	Restore and enhance floodplain function and values, includes removing all structures, including buildings, within easement boundaries.	100% of restoration costs and up to 75% of building removal costs.	Landowners receive the smallest of the following values as an easement payment: (1) geographic area rate established by the NRCS; (2) fair market value based on an area-wide market analysis or an appraisal completed according to the Uniform Standards of Professional Appraisal Practices; or (3) the landowner's offer	Land must be within an eligible floodplain	33 U.S.C. §701b-1 and 16 U.S.C. §§2203-2205.
Watershed and Flood Prevention (WFPO)	U.S Department of Agriculture (USDA)	Grant	Planning and installation of watershed projects	Land treatment and structural and non-structural facilities for flood prevention and erosion reduction (structural: dams, levees, canals, and pumping stations)	100% for construction for flood protection up to $25 M before congressional approval is needed / up to 50% of costs for land, easements, and rights-of-way allocated to public fish and wildlife and recreational developments may be paid with program funds. Local sponsors must agree to all O&M	No project may exceed 250,000 acres, and no more than 12,500 acre-feet of floodwater detention capacity or 25,000 acre-feet of total capacity without congressional approval. Congressional approval is also required when a project includes an estimated federal contribution of more than $25 million for construction.	Flood prevention and protection	projects built under two authorities—the Watershed Prevention and Flood Protection Act of 1954 (P.L. 83-566) and the Flood Control Act of 1944 (P.L. 78-534). 33 U.S.C. §701b-1, and 16 U.S.C. §§10011008

Source: Congressional Research Services (2018 Flood Resilience and Risk Reduction: Federal Assistance and Programs)

State Funding

The state of California carries out several programs designed to provide flood management and multi-benefit ecosystem restoration and protection objectives. While some programs are operated directly by the state, others provide grants to local agencies for similar purposes. State flood management and multi-benefit restoration programs have also been funded through general funds. Since 1996, voters have authorized several state general obligation bonds, Including Propositions 1E, 1, 68, and 84. Along with these current general bond provisions, additional programs may potentially become available in the future.

Proposition 1E

The Disaster Preparedness and Flood Prevention Bond Act of 2006 or Proposition 1E authorized funding to repair, rehabilitate, reconstruct, or replace levees, weirs, and bypasses to the SPFC Facilities. The state is Utilizing the remaining Proposition 1E bonds authorized to fund projects consistent with the CVFPP adopted in July 2012. Proposition 1E bond funds used for the SCFRR program has allowed and continues to allow the DWR to fund projects such as, repairing erosion sites and removal of sediment from channels or bypasses, evaluating and repairing levees and any other SPFC facilities, and also in implementing mitigation measures for projects by funding participation in a natural community conservation plan, pursuant of the Fish and Game Code section 2800 et seq., to facilitate eligible projects. **Table 4** presents the total bond allocation and remaining balance of Proposition 1E as of September 2018. Flood management and multi-benefit projects have utilized and continue to utilize grants administered under this proposition. With a total remaining balance of about $34 million of uncommitted funds, SCFRR projects should continue to utilize funding from grant programs that fall under Proposition 1E.

Proposition 1

On November 4, 2014, California voters approved Proposition 1, the Water Quality, supply, and infrastructure improvement Act of 2014. Like Proposition 1E, this state approved general obligation bond has been utilized to fund multi-benefit and flood management projects. $163 Million has been committed and awarded to multiple flood management projects with a remaining balance of $232 Million. **Table 5** presents the total bond allocation and remaining balance of Proposition 1 as of February 2019. Along with flood management committed funds, Proposition 1 authorized $403 million in Integrated Regional Water Management (IRWM) funding. Funds are allocated to 12 hydrologic region-based Funding Areas. The IRWM Grant Program is designed to encourage integrated regional strategies for management of water resources by providing funding for projects and programs that support integrated water management. DWR plans to award grants on a competitive basis in at least two funding rounds. On October 5, 2018 DWR released the 2018 IRWM Implementation Grant Program which is round one of the Proposition. The IRWM Implementation Grant Program provides funding for implementation projects that meet the intent of Proposition 1, Chapter 7. DWR is proposing that approximately $194 million be made available for implementation projects with approximately $18 million designated for projects that provide benefits to disadvantaged communities.

Proposition 68

Proposition 68, the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act is another and more recent general obligation bond passed by voters in June 2018. Multi-benefit ecosystem restoration and recreational projects serve to benefit from this funding source. Listed below in **Table 6** is the total bond allocation and remaining balance of Proposition 68 as of March 2019.

Proposition 84

The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 or Proposition 84 is another general obligation bond that has been utilized to fund flood protection and multi-benefit projects. Listed in **Table 7** Is the total bond allocation and remaining balance to fund future projects as of February 2019.

Table 8 provides a breakdown of current and future state programs available to local agencies to fund structural and non-structural flood management, and multi-benefit objective improvement projects. The typical cost share percentages for these can vary widely based upon project specific attributes. Information specified in the table reflect figures provided by the California Natural Resources agency. Available funding dollar values are as of January 2019.

Table 4
SCFRR - Funding Sources Memo
Proposition 1E Allocation Balance Report (as of September 2018)

Chapter	Original Allocation	Adjusted Allocation[1]	Committed[2]	Balance[3]
Section 5096.821 State plan of flood control	$3,000,000,000	$2,926,650,367	$2,875,371,583	$51,278,784
Section 5096.824 Flood control and flood prevention projects	$500,000,000	$487,775,061	$478,627,900	$9,147,161
Section 5096.825 Flood protection corridors and bypasses	$290,000,000	$282,909,535	$269,397,245	$13,512,291
Section 5096.827 Storm water flood management	$300,000,000	$292,665,037	$289,474,811	$3,190,226
Section 5096.953 et seq. Statewide Bond Cost	$0	$0	$43,150,000	($43,150,000)
Reallocated to Proposition 1	$0	$100,000,000	$100,000,000	$0
Total	**$4,090,000,000**	**$4,090,000,000**	**$4,056,021,539**	**$33,978,462**

Source: State of California Resources

1"Adjusted Allocation" reflects the "Original Allocation" less an adjustment mandated by Prop 1 distributed across all program chapters.

2"Committed" means the amount appropriated, the amount proposed for appropriations, or amount committed in out years.

3"Balance" equals Chapter Balance plus Chapter Set Asides as found on the Summary for Chapters in the Balance Allocations Report under Featured Links.

Table 5
SCFRR - Funding Sources Memo
Proposition 1 Allocation Balance Report (as of February 2019)

Chapter	Original Allocation	Adjusted Allocation[1]	Committed[2]	Balance[3]
Ch. 5 Clean, Safe and Reliable Drinking Water	$520,000,000	$520,000,000	$504,045,698	$15,954,302
Ch. 6 Protecting Rivers, Lakes, Streams, Coastal Waters and Watersheds	$1,495,000,000	$1,495,000,000	$1,251,258,911	$243,741,089
Ch. 7 Regional Water Security, Climate, and Drought Preparedness	$810,000,000	$810,000,000	$786,712,177	$23,287,823
Ch. 8 Statewide Water System Operational Improvement and Drought Preparedness	$2,700,000,000	$2,700,000,000	$2,646,000,000	$54,000,000
Ch. 9 Water Recycling	$725,000,000	$725,000,000	$697,461,270	$27,538,730
Ch. 10 Groundwater Sustainability	$900,000,000	$820,000,000	$788,375,100	$31,624,900
Ch. 11 Flood Management	$395,000,000	$395,000,000	$163,000,000	$232,000,000
Ch. 4/12 Statewide Bond Costs	$0	$0	$149,300,000	($149,300,000)
Reallocated to Proposition 68	$0	$80,000,000	$80,000,000	$0
Total	**$7,545,000,000**	**$7,545,000,000**	**$7,066,153,156**	**$478,846,844**

Source: State of California Resources

1 "Adjusted Allocation" reflects the "Original Allocation" less an adjustment mandated by Prop 68 for WC 79772.

2 "Committed" means any amount appropriated in a current or prior year Budget or proposed for appropriation in a current Proposed Budget.

3 "Balance" equals Chapter Balance plus Chapter Set Asides as found on the Summary for Chapters in the Balance Allocations Report under Featured Links.

Table 6
SCFRR - Funding Sources Memo
Proposition 68 Allocation Balance Report (as of March 2019)

Chapter	Allocation	Committed[1]	Balance[2]
Ch. 2 Investments in Environmental and Social Equity, Enhancing California's Disadvantaged Communities	$706,875,000	$277,379,000	$447,621,000
Ch. 3 Investments in Protecting, Enhancing, and Accessing California's Local and Regional Outdoor Spaces	$277,875,000	$186,012,000	$98,988,000
Ch. 4 Restoring California's Natural, Historic, and Cultural Legacy	$212,550,000	$22,750,000	$195,250,000
Ch. 5 Trails and Greenway Investment	$29,250,000	$117,000	$29,883,000
Ch. 6 Rural Recreation, Tourism, and Economic Enrichment Investment	$24,375,000	$30,000	$24,970,000
Ch. 7 California River Recreation, Creek, and Waterway Improvements Program	$157,950,000	$67,909,000	$94,091,000
Ch. 8 State Conservancy, Wildlife Conservation Board, and Authority Funding	$747,825,000	$132,873,000	$634,127,000
Ch. 9 Ocean, Bay, and Coastal Protection	$170,625,000	$32,652,000	$142,348,000
Ch. 10 Climate Preparedness, Habitat Resiliency, Resource Enhancement, and Innovation	$431,925,000	$182,741,000	$260,259,000
Ch. 11 Clean Drinking Water and Drought Preparedness	$243,750,000	$63,250,000	$186,750,000
Ch. 11.1 Groundwater Sustainability	$78,000,000	$74,000,000	$6,000,000
Ch. 11.5 Flood Protection and Repair	$536,250,000	$98,617,000	$451,383,000
Ch. 11.6 Regional Sustainability for Drought and Groundwater, and Water Recycling	$380,250,000	$120,150,000	$269,850,000
Ch. 13 Statewide bond costs	$102,500,000	$102,500,000	($102,500,000)
Total	**$4,100,000,000**	**$1,360,980,000**	**$2,739,020,000**

Source: State of California Resources
1"Committed" means the amount appropriated, the amount proposed for appropriations, or amount committed in out years.
2"Balance" equals Chapter Balance plus Chapter Set Asides as found on the Summary for Chapters in the Balance Allocations Report under Featured Links.

Table 7
SCFRR - Funding Sources Memo
Proposition 84 Allocation Balance Report (as of February 2019)

Chapter	Original Allocation	Adjusted Allocation[1]	Committed[2]	Balance[3]
Ch. 2 Safe Drinking Water and Water Quality Projects	$1,525,000,000	$1,495,281,200	$1,466,833,000	$28,448,000
Ch. 3 Flood Control	$800,000,000	$784,409,800	$752,247,000	$32,163,000
Ch. 4 Statewide Water Planning and Design	$65,000,000	$63,733,300	$62,299,000	$1,435,000
Ch. 5 Protection of Rivers, Lakes and Streams	$928,000,000	$909,915,400	$847,219,000	$62,696,000
Ch. 6 Forest and Wildlife Conservation	$450,000,000	$441,230,500	$446,667,000	($5,436,000)
Ch. 7 Protection of Beaches, Bays and Coastal Waters	$540,000,000	$529,476,600	$488,841,000	$40,635,000
Ch. 8 Parks and Nature Education Facilities	$500,000,000	$490,256,100	$453,901,000	$36,355,000
Ch. 9 Sustainable Communities and Climate Change Reduction	$580,000,000	$568,697,100	$552,859,000	$15,838,000
Ch. 10/11 Statewide Bond Cost	$0	$0	$83,580,000	($83,580,000)
Reallocated to Proposition 1	$0	$105,000,000	$105,000,000	$0
Total	**$5,388,000,000**	**$5,388,000,000**	**$5,259,446,000**	**$128,554,000**

Source: State of California Resources
1"Adjusted Allocation" reflects the "Original Allocation" less an adjustment mandated by Prop 1 distributed across all program chapters.
2"Committed" means the amount appropriated, the amount proposed for appropriations, or amount committed in out years.
3"Balance" equals Chapter Balance plus Chapter Set Asides as found on the Summary for Chapters in the Balance Allocations Report under Featured Links.

Table 8
SCFRR - Funding Sources Memo
State Flood Management & Multi-benefit Programs

Program	Department	Program Approach	Purpose	Eligible to Apply	State Cost Share	Status	Type of Assistance	Funding Source	Available Funding as of January 2019
Delta Levees Maintenance Subventions	Department of Water Resources (DWR)	Flood Management	Receives funding from Prop 1E, 1 and Proposition 84 for financial assistance to local levee maintaining agencies in the Sacramento - San Joaquin Delta for the maintenance and rehabilitation of nonproject and eligible project levees authorized in the California Water Code § 12980(f)	Local levee maintaining agencies and Reclamation Districts compliant with all requirements in CA Water Code §§ 12980-1299	75%	Ongoing	Grant	Proposition 1E, 1, & 84	$12 million
Delta Levees Special Flood Control Projects	Department of Water Resources (DWR)	Flood Management/ Multi-Benefit	Receives funding from Prop 1E & 84. Provides financial assistance to local levee maintaining agencies for flood control and levee rehabilitation projects in the Delta as authorized in the California Water Code sections 12300-12318	Local levee maintaining agencies and Reclamation Districts compliant with all requirements in CA Water Code §§ 12980-1299	75%	Ongoing	Grant	Proposition 1E & 84	$60 million
Early Implementation Program (EIP) & Urban Flood Risk Reduction (UFRR)	Department of Water Resources (DWR)	Flood Management	The EIP was a State program related to the SPFC and was created to fund high-priority projects to restore or improve flood protection in advance of the 2012 Central Valley Flood Protection Plan (CVFPP). EIP projects existed in both urban and non-urban areas. Since adoption of the CVFPP in 2012, the Urban Flood Risk Reduction (UFRR) Program has extended the work begun under the EIP to support implementation of regional flood-damage-reduction projects for urban areas protected by the SPFC. Section 8.4.4 provides more details on UFRR projects.	Urban areas protected by the SPFC	50% to 90%	Ongoing	Grant	Proposition 1E	$1.2 Billion of Prop 1E
Regional Flood Management Planning (RFMP)	Department of Water Resources (DWR)	Flood Management	Intended to provide meaningful engagement by the Regional Partners in the Central Valley Flood Protection Plan (CVFPP) and maintain working relationships to develop a common understanding of regional flood issues and priorities. formulate and assess flood management solutions and strategies that reflect the vision, feasibility projects, assess the performance of the projects, and develop a plan that reflects the vision of local entities in reducing flood risks in their region.	A California local public agency with responsibility for flood management in the region that is a part of the area protected by the facilities of the SPFC that is willing to participate in, coordinate, and collaborate with other interested parties in the region that are participating in the development of their RFMP.	75%	Ongoing since October 2012	Direct Funding	Proposition 1E	$2.4 million
Small Communities Flood Risk Reduction Program (SCFRRP)	Department of Water Resources (DWR)	Flood Management/ Multi-Benefit	Projects to reduce flood risk in small communities in the Central Valley. Funds for feasibility studies, design, and construction of proactive repairs to flood control facilities of the State Plan of Flood Control (SPFC).	Local Agencies with Land Use Authority (cities/counties), protected by SPFC, and within the Levee Flood Protection one	50% cost share for costs above $500,000.	Ongoing	Grant Funds	Proposition 1E	Phase 2 - Design and Implementation: Approximately $27 million.
Flood System Repair Projects (FSRP)	Department of Water Resources (DWR)	Flood Management/ Multi-Benefit	Evaluate (feasibility), design, and construct repairs of non-urban SPFC Facility (levees, channels, structures, etc.) deficiencies	The FSRP is limited to facilities of the SPFC maintained by LMAs or by DWR, as defined in Public Resources Code § 5096.805(j):	50% to 90%	Ongoing	Grant	Proposition 1E	Up to $150 million Proposition 1E funds
Flood Control Subventions Program (FCSP)	Department of Water Resources (DWR)	Flood Management	Funded by both IE and 84 funded. Implementation of federally-authorized, locally-led, flood control projects (minor or major) and Watershed Protection Flood Prevention Projects.	Local public agencies with federal projects that are not part of the State Plan of Flood Control.	75%	Ongoing	Funds (Claims Reimb.)	Proposition 1E & 84	>170 million
California Streamflow Enhancement Program (CSEP)	Wildlife Conservation Board (WCB)	Multi-Benefit	Providing enhanced stream flow, especially in those streams that support anadromous fish; special status, threatened, endangered or at risk species; or provide resilience to climate change.	Cities, counties, nonprofit organizations, special districts, tribes and state entities	Cost share not required	Ongoing	Grant	Proposition 1	$130 million
Lower American River Conservation Program (LARCP)	Wildlife Conservation Board (WCB)	Multi-Benefit	Work cooperatively with local agencies, particularly the County of Sacramento in its role as the American River Parkway Manager, and nonprofit organizations to restore, enhance, interpret, protect and improve public access to the American River Parkway's natural, recreational, educational and cultural resources.	Local agencies and nonprofit organizations.	Not Specified	Ongoing	Grant	Proposition 1	$10 million
Central Valley Tributaries Program (CVTP)	Department of Water Resources (DWR)	Multi-Benefit	Flood management projects that enhance water quality and ecosystems of rivers and streams tributary to the Sacramento-San Joaquin Delta.	Local Agencies	TBD	Future	Grant	Proposition 1	Up to $36 million. Additional future funding may be available.
Integrated Regional Water Management (IRWM)	Department of Water Resources (DWR)	Multi-Benefit	Development and revisions of IRWM Plans, and implementation of projects in IRWM Plans. Goals of Projects:(a) help water infrastructure systems adapt to climate change, including, but not limited to, sea level rise, (b) provide incentives for water agencies throughout each watershed to collaborate in managing the region's water resources and setting regional priorities for water infrastructure, and (c) improve regional water self-reliance consistent with Section 85021.	Public agencies, non-profit organizations, public utilities, federally recognized Indian tribes, state Indian tribes listed on the Native American Heritage Commission's Tribal Consultation list, and mutual water companies (Water Code Section 97917 (ab)).	Up to 50%	Ongoing	Grant	Proposition 1	$403 million for implementation grants, with not less than $51 million awarded to projects that directly benefit disadvantaged communities.
San Joaquin River Conservancy Proposition 1 Grant Program	San Juaquin River Conservancy	Multi-Benefit	Projects that demonstrate multiple benefits to water quality, water supply, and/or ecosystem and watershed protection and restoration within the Conservancy's jurisdictional planning area (San Joaquin River, Friant Dam to Highway 99). Projects must be consistent with the requirements and purposes of Proposition 1 and the Conservancy's Grant Guidelines	Public agencies, nonprofit 501(c)(3) organizations, public utilities, federally recognized Indian tribes, and mutual water companies	Not Specified	Ongoing	Grant	Proposition 1	$5.9 million
Delta Conservancy Ecosystem Restoration and Water Quality Grant Program	Sacramento-San Joaquin Delta Conservancy	Multi-Benefit	Planning and implementation grants are available for ecosystem protection, restoration and enhancement, water quality, and water-related agricultural sustainability projects	California public agencies, qualifying nonprofit organizations, public utilities, mutual water companies, and eligible tribal organizations	TBD	Future	Grant	Proposition 1	$17.1 million
Specialty Park Program (SPP) Round 3	California State Parks	Multi-Benefit	To Create new parks and new recreation opportunities in underserved communities across California	Cities, Counties, Districts as defined, Joint Powers Authorities, Non Profit Organizations	Cost share not required	Ongoing/ Application Deadline Aug 2019	Grant	Proposition 68	$254,942,000

Program	Department	Program Approach	Purpose	Eligible to Apply	State Cost Share	Status	Type of Assistance	Funding Source	Available Funding as of January 2019
Specialty Park Program (SPP) Future Rounds	California State Parks	Multi-Benefit	To Create new parks and new recreation opportunities in underserved communities across California	Cities, Counties, Districts as defined, Joint Powers Authorities, Non Profit Organizations	Cost share not required	Future	Grant	Proposition 68	$395,333,000
Regional Park Program (RPP)	California State Parks	Multi-Benefit	To Create, expand, or renovate parks and park facilities, including, but not limited to, trails, regional trail networks, regional sports complexes, low-cost accommodations in park facilities, and visitor, outdoor, and interpretive facilities.	Regional park districts, counties, and regional open-space districts, open-space authorities formed pursuant to Division 26 (commencing with Section 35100), joint powers authorities, and eligible nonprofit organizations	TBD	Future	Grant	Proposition 68	$23,125,000
Flood Emergency Response Grants Program: Delta Flood ER Grant	Department of Water Resources (DWR)	Flood Management	Improve local flood emergency response in California and contribute to increased public safety. Examples of eligible projects include: • Preparing or updating the local flood emergency plan • Coordinating flood emergency planning and preparedness, including training and exercises • Developing processes to effectively communicate and coordinate response to flood emergencies • Collecting and exchanging flood information • Purchasing and installing equipment and materials needed for emergency communication and more flood fight, & stockpiling to protect critical infrastructure.	California Public Agencies within the legal delta including primary and secondary zones with primary responsibility for flood emergency response and coordination	TBD	Ongoing	Grant	Proposition 1E	$4.8 million
Urban Stormwater and Waterways Improvement Program	California Natural Resources Agency	Flood Management	Funding for the purposes of multi-benefit projects in urbanized areas to address flooding. Projects shall include but are not limited to stormwater capture and reuse, planning and implementation of low impact development, restoration of urban streams and watersheds, and increasing permeable surfaces to help reduce flooding.	Local agencies, nonprofit organizations, nongovernmental land conservation organizations, federally recognized Native American tribes, or nonfederally recognized California Native American tribes	TBD	Future	Grant	Proposition 68	$92.5 million
Urban Green Infrastructure Program	California Natural Resources Agency	Multi-Benefit	Funding for multi-benefit green infrastructure investments in or benefiting disadvantaged or severely disadvantaged communities.	Local agencies, nonprofit organizations, nongovernmental land conservation organizations, federally recognized Native American tribes, or nonfederally recognized California Native American tribes listed on the California Tribal Consultation List maintained by the Native American Heritage Commission.	TBD	Future	Grant	Proposition 68	$18.5 million
Habitat Enhancement and Restoration Program (HERP)	Department of Water Resources (DWR)	Multi-Benefit	Funded through Props 68 & 84. Consistent with Fish and Game Code section 1301, this program provides assistance for the restoration and enhancement of fish and wildlife resources	Cities, counties, nonprofit organizations, special districts and state entities	Not Specified	Ongoing	Grant	Proposition 68 & 84	$105 million under the Propositions. Under HCF receive approximately $1 million annually for wetland restoration outside the Central Valley until the year 2020.
California Riparian Habitat Conservation Program	Wildlife Conservation Board (WCB)	Multi-Benefit	Supports a coalition of state, federal, local and private organizations whose mission is to develop a coordinated approach to the protection of riparian ecosystems. Grants are awarded for the protection, restoration and enhancement of riparian habitat systems.	Cities, counties, nonprofit organizations, special districts and state entities	Not Specified	Ongoing	Grant	Habitat Conservation Fund	$3 million annually for restoration and acquisitions until the year 2020
Inland Wetlands Conservation Program (IWC)	Wildlife Conservation Board (WCB)	Multi-Benefit	To assist the Central Valley Joint Venture in its mission to protect, restore and enhance wetlands and associated habitats in the Central Valley. The public/private partnership works to increase the populations of wintering and breeding waterfowl, shorebirds, water birds, and riparian songbirds.	Cities, counties, nonprofit organizations, special districts and state entities	Not Specified	Ongoing	Grant	Habitat Conservation Fund, Inland Wetland Conservation Fund	$2 million annually for restoration and acquisitions until the year 2020
Watershed Restoration Grant Program	California Department of Fish and Wildlife	Flood Management/ Multi-Benefit	Program funds water quality, river, and watershed protection and restoration projects of statewide importance outside of the Delta.	Public agencies, Native American tribes, and nonprofit organizations	Not Specified	Ongoing	Grant	Proposition 1	Approximately $122.9 million
Flood Maintenance Assistance Program (FMAP)	Department of Water Resources (DWR)	Flood Management	This program will help ensure that State Plan of Flood Control facilities are properly maintained and have sufficient resources, including funding, to meet applicable federal regulations and Operation and Maintenance (O&M) manual requirements.	Local Maintaining Agencies (LMAs) and Maintenance Areas (MAs) protected by SPFC	75% for the first $10,000 per mile expenditure & 50% for expenditures in excess of $10,000 per mile.	Ongoing/ Application deadline 03/2019	Grant	Budget Act of 2018	All funding will depend on the program demand and fund availability
State Community Developmenmt Block Grant (CDBG)	Housing Urban Development (HUD)	Multi-Benefit	States award grants to smaller units of general local government that develop and preserve decent affordable housing, to provide services to the most vulnerable in our communities, and to create and retain jobs. Annually, each State develops funding priorities and criteria for selecting projects.	Non-entitlement areas, which include those units of general local government which do not receive CDBG funds directly from HUD and have a populations of less than 50,000	Amounts expended on administration in excess of $100,000 must be matched.	Ongoing	Grant	Housing and Community Development Act of 1974, amended 1981	Annually, each State develops funding priorities and criteria for selecting projects.

Source: State of California Resources

Structural Solution Summaries

Structural measures such as the ones listed below, are physical infrastructures that alter characteristics of the flood and reduce the probability of flooding in the location of interest. The section discusses four structural alternatives and potential funding opportunities for communities considering solutions to mitigate against the risk of flooding and meet multi-benefit objectives. **Table 9** provides a matrix of viable funding sources/programs to consider for the implementation of the below structural solutions.

Solution 1: Levees

A levee is an earthen (soil) embankment, designed and constructed to contain, control, or divert the flow of water to provide protection from temporary flooding. A levee is built parallel to a body of water (most often a river) in order to protect lives and properties behind it from some level of flooding. A levee is certified or accredited if a licensed professional engineer or the federal agency responsible for levee design has demonstrated that the structure meets current design, construction, maintenance, and operation standards to provide protection from a flood. For FEMA, certification is for the one percent annual chance flood (100-year) and for Urban areas in California and certification for the State's Urban Level of Protection is 0.5 percent chance flood (200-year). To enhance the multi-benefit possibility of levees, implementation of a setback levee or addition of waterside planting berms can be considered. Creating more room for rivers by moving the levee further away reduces flood risk while also providing additional benefits such as improved fish and wildlife habitat and recreational opportunities. Providing berms along the water side slopes also provides an area for riparian habitat plantings and allows opportunity for natural channel meandering. Small communities implementing levee construction for flood mitigation should also consider a multi-benefit approach, which provides additional funding source eligibility from state programs.

Solution 2: Floodwall

Like Levees, floodwalls are built parallel to a waterway in order to provide protection from flooding. Floodwalls are more likely to be found in urban areas and are made of concrete, steel (or vinyl), or other impermeable and structurally resilient material.

Solution 3: Flood Bypass

A flood bypass is an area along a river or within a floodplain that is intentionally kept undeveloped for the purpose of diverting excess water into the river. This implementation is intended to reduce the risk of flooding in a nearby area, such as a city or business district. If constructed properly, bypasses can also provide valuable wetland and aquatic habitat. This flood control method can be designed and operated without eliminating processes needed to sustain habitats. Unlike levees or floodwalls, bypasses do not block lateral connectivity between the river and its floodplain. Communities in the Central Valley have the most limited access to parks among all California communities and bypass areas can be developed as parks or open spaces when not being used to manage floodwater. Fortunately, this multi-benefit approach, which expand floodways to convey floodwater safely, can improve public safety while also creating riverside parks and trails.

Solution 4: Erosion Control/Repairs
Erosion Control and repair projects are implemented to re-stabilize and protect river and stream banks after a flood event to prevent levee breaches resulting in damages and loss of life. There are different erosion control methods, depending on severity of the erosive forces during the design flood event, including channel bank armoring, bio-engineered vegetation plantings, and hard engineered structures.

Solution 5: Dams
Dams are barriers that impound hydrologic flows and retain floodwaters before they reach areas of risk. In situations of high-precipitation periods, dams hold upstream floodwaters that are gradually released to minimize the likelihood of damage to downstream communities. However, during events of magnitude, the storage capacity of a dam can be exceeded and uncontrolled flood flows are passed downstream. In these circumstances, downstream levees may not be able to contain floodwaters or may be stressed to the point of failure. Unlike a Levee, a dam built for flood protection is usually designed to reduce downstream flow during a flood by containing excess water and releasing it slowly over time. Dams also provide multi-benefit functions such as storing water for irrigation, community water supplies, recreation, and hydroelectric power.

Non-Structural Solution Summaries

In contrast to physical infrastructure, which mitigates flood risk by controlling floodwaters, non-structural approaches adapt to and accommodate the potential of floods occurring. Unlike structural measures, Non-structural methods alter the impact or consequences of flooding and have little to no impact on the characteristics of the flood. In this section, we describe seven major non-structural approaches to consider for implementation. A matrix in **Table 9** outlines viable funding sources/programs corresponding to non-structural and structural solutions.

Solution 1: Changes to National Flood Insurance Programs (NFIP)
The National Flood Insurance Program (NFIP) was established in 1968 by congress to address several policy objectives, including 1) provision of affordable insurance premiums to residents located in flood risk areas, 2) reducing federal disaster assistance costs, 3) pushing efficiency in community-based floodplain management programs, and 4) identifying flood risk regions around the USA. Participating NFIP communities have requirements for mandatory flood insurance for structures with Federally backed loans as well as minimum building standards to reduce damages from a flood. However, these building standards can often result in inequitable costs for low risk agricultural structures and may negatively impact this low risk agricultural use of the floodplain. Revising NFIP standards to allow low risk agricultural development in the floodplain would help preserve equitable use and continue to provide an assessment base for these otherwise un-developable high flood risk areas.

Solution 2: Levee Relief Cuts
Levee relief cuts are flood mitigation techniques where an intentional break is executed in a downstream levee to allow flood water from a breach in an upstream levee to be drained back into an existing river. Levee relief cuts reduce the interior flood elevation by reducing the height of the levee preventing the flood water from

flowing back into the system. If located in the appropriate location so that floodwater can be managed efficiently and safely, this non-structural solution can prove to be viable in reducing flood damage.

Solution 3: Emergency Flood Fight Plan

An Emergency Flood Flight Plan is a written document that establishes how a specific maintaining agency will manage resources and operate during a flood event. To protect life and property, local agencies should utilize available resources to support flood response efforts and seek assistance from State and Federal Agencies when their capabilities are exceeded. According to the 2003 DWR report, "Flood Fighting Methods," The main causes of levee failure during periods of high water are Seepage, erosion, and overtopping. To combat such failures, maintaining agencies need to be equipped with the necessary flood fight stockpiling materials, such as, sandbags, lumber, sacks, and Visquine. In addition, maintainers should be adequately trained in flood fight methods and Standardized Emergency Management System (SEMS).

Solution 4: Flood Emergency Evacuation Plan[4]

Evacuation plans require detailed hydrologic analyses for determining the rate of rise of floodwaters for various rainfall or snowmelt events. In addition to determining the rate and rise of floodwaters, these plans identify total depth of flooding and velocities, which are often the more significant aspect of flooding. Utilizing evacuation plans in conjunction with other flood preparedness plans such as, evacuation warning systems, there is significant potential for the reduction of risk to human life. This solution should only be implemented if there is provision for adequate response and action time available for residents to evacuate. It is critical that rally points and evacuation routes be established and communicated to the public.

Solution 5: Flood Emergency Warning System

A flood emergency warning system is crucial in allowing the public as much time as possible to evacuate or avoid flood areas. Each community's jurisdiction is responsible for notifying residents when conditions of area levees threaten flooding. A well-informed public is likely to respond well in cases of flooding disasters. There are different ways of educating the public, including, a siren system, alert system, emergency calling system, and neighborhood watch and community support programs.

Solution 6: Voluntary Structure Elevation & Floodproofing

a. Elevation

Elevating structures; i.e. buildings, above flood level is a common and effective way of minimizing damage from floodwaters, and a key flood protection provision of the NFIP. The process consists of separating a building from its foundation by lifting the hydraulic jacks and placing it on a new or extended foundation. Elevation can be conducted on existing fills, foundation walls, piers, piles, and posts or columns. The proper elevation technique depends on the overall flood characteristics of the structure; flood depth or velocity.

b. Floodproofing

[4] http://www.nwd-mr.usace.army.mil/rcc/MRFTF/docs/USACE-NFPC%20Nonstructural%20Measures%20Definitions.pdf

Floodproofing is another effective way of minimizing any potential damages caused by floodwaters. This nonstructural solution can be categorized into two techniques; dry floodproofing and wet floodproofing. Dry floodproofing involves methods such as sealing building walls with waterproof compounds (membranes/sealants) for the provision of watertight closures. An important factor to keep in mind with this technique is that walls should be strong enough to withstand the hydrostatic force of the water. Safeguards can also be installed to seal off doors, windows, and any additional openings.

Wet floodproofing is a technique that can reduce the damage to a structure and its contents, while still allowing the structure to flood. With this method, the structure needs to be anchored in order to avoid flotation and include some form of permanent opening that will allow water to flow in and out of the structure without causing any damage to the foundation. [5]The most effective method of protection for equipment and contents is to relocate threatened items out of harm's way. Vulnerable items, such as electrical, mechanical, and utility need be relocated either permanently or temporarily to higher elevations or protected locations. The preferred depth of flood protection is a critical consideration in structure elevation and floodproofing processes. The overall Base Flood Elevation (BFE) will determine the costs associated with executing this nonstructural solution.

Solution 7: Buyout/Acquisition

An acquisition or buyout is a process in which, a local agency or the state decides to acquire and eliminate damageable structures. This would allow inhabitants occupying the residence to relocate away from flood hazards. This nonstructural technique can be executed either by demolishing or auctioning off the structure. New development sites can be established through this proposed solution in order to provide opportunities for displaced people to rebuild homes within other established communities.

Multi-Benefit Funding Summary

Limited funding resources are currently available to support the development of multi-benefit projects as presented in **Table 8**. Multi-benefit projects use time-tested, common sense approaches combined with the latest engineering data to lower flood risk, enhance habitat, increase recreational opportunities, and improve water quality. Setting back levees or adding berms in strategic places and creating designated bypasses are just a few ways of reducing flood risk while at the same time protecting and restoring habitat ecosystems.

Habitat Restoration

State Agencies such as the Wildlife Conservation Board (WCB) have provided funding programs such as the California Riparian Habitat Conservation Program to support organizations whose mission is to develop a coordinated approach to protecting and enhancing riparian ecosystems. Riparian areas are the strips of land adjacent to streams, rivers, and wetlands. While Riparian areas comprise only a very small portion of the land area in the state, they are an extremely important component of healthy watersheds and ecological functions. These areas provide critical habitat for wildlife such as plant species or vegetations. Healthy riparian vegetation

[5] https://www.fema.gov/media-library-data/20130726-1511-20490-8042/tb_7_complete_scan.pdf

helps to reduce erosions and provides shade, which works to lower water temperatures. Lowered water temperatures support higher oxygen levels, which in turn are important in maintaining fisheries.[6]

Recreational Opportunities

The California State Parks department offers two funding programs that promote the creation, expansion, or renovation of parks and park facilities; Regional Park Program (RPP) and Specialty Park Program (SPP). These funding programs promote multi-benefit projects that assist underserved communities across California. Recreational implementations can include, but are not limited to trails, regional trail networks, regional sports complexes, low-cost accommodations in park facilities, and visitor, outdoor, and interpretive facilities.

Water Quality Improvement

The IRWM program promotes multi-benefit projects that improve water quality and water management projects. The program objectives include, providing clean, safe, reliable drinking water, implementing water use efficiency to meet or exceed state and federal requirements, and protect groundwater resources from contamination. Along with IRWM, programs such as the Watershed Restoration Grant Program offered by the California Department of Fish and Wildlife (CDFW) provides funding for projects that increase water quality and watershed protection and restoration.

Conclusion

State and Federal funding is crucial for the viability of many small community flood risk reduction projects in the Central Valley. This Funding Sources memo along with the Financial Feasibility Memo provide a guide in informing small communities to identify non-local funding sources for structural and non-structural implementation strategies. The matrix provided on the next page (**Table 9**) should be used and cross referenced with the tables provided above (**Tables 1 through 8**) that outline the available State and Federal funding programs.

[6] http://deq.wyoming.gov/wqd/non-point-source/resources/why-are-riparian-areas-important/

Table 9
SCFRR - Funding Sources Memo
Funding Sources by Solution Matrix

		Structural				Non-Structural					Study/ Plan/ O&M	
Funding Program	**Agency**	**Levees/ Floodwalls/ Dams/Erosion**	**Bypasses**	**Changes to NFIP**	**Relief Cuts**	**Emergency Flood Fight Plan**	**Flood Emergency Evacuation Plan**	**Flood Emergency Warning System**	**Voluntary Structure Elevation & Floodproofing**	**Buyout / Acquisition**	**Feasibility Study /Flood Management Plan**	**OMRR&R**
Watershed Restoration Grant Program	Ca. DFWS	X	X							X		
Urban Stormwater and Waterways Improvement Program	California Natural Resources Agency	X	X		X							
Urban Green Infrastructure Program	California Natural Resources Agency	X	X		X							
Specialty Park Program (SPP) Round 3	California State Parks	X	X									
Specialty Park Program (SPP) Future Rounds	California State Parks	X	X									
Regional Park Program (RPP)	California State Parks	X	X									
Delta Levees Maintenance Subventions	DWR	X										
Delta Levees Special Flood Control Projects	DWR	X										
Early Implementation Program (EIP) & Urban Flood Risk Reduction (UFRR)	DWR	X	X									
Regional Flood Management Planning (RFMP)	DWR										X	
Small Communities Flood Risk Reduction Program (SCFRRP)	DWR	X	X		X	X	X	X		X	X	
Flood System Repair Projects (FSRP)	DWR	X	X									
Flood Control Subventions Program (FCSP)	DWR	X	X		X					X		
Central Valley Tributaries Program (CVTP)	DWR	X	X		X					X		
Integrated Regional Water Management (IRWM)	DWR	X	X							X		
Flood Maintenance Assistance Program (FMAP)	DWR											X
Flood Emergency Response Grants Program: Delta Flood ER Grant	DWR					X	X	X				
Habitat Enhancement and Restoration Program (HERP)	DWR	X	X		X					X		
Flood Mitigation Assistance (FMA)	FEMA		X		X				X	X		
Pre-disaster Mitigation (PDM)	FEMA	X	X						X	X		
Hazard Mitigation Grant Program (HMGP)	FEMA	X	X						X	X		
Repetitive Flood Claims Grant Program (RFCP)	FEMA									X		
Delta Conservancy Ecosystem Restoration and Water Quality Grant Program	Sacramento-San Joaquin Delta Cons.	X	X							X		
San Joaquin River Conservancy Proposition 1 Grant Program	San Juaquin River Conservancy	X	X							X		
Flood Damage Reduction Projects (FDRP)	USACE	X	X		X	X	X	X		X	X	
Flood-Related Continuing Authorities Program (FRCA)	USACE	X	X		X	X	X	X	X	X	X	
Sacramento River Bank Protection Project (SRBPP)	USACE	X	X		X							
Emergency Watershed Protection (EWP) - Floodplain Easements	USDA									X		
Watershed and Flood Prevention (WFPO)	USDA	X			X							
California Streamflow Enhancement Program (CSEP)	WCB		X									
Lower American River Conservation Program (LARCP)	WCB	X	X							X		
California Riparian Habitat Conservation Program	WCB	X	X							X		
Inland Wetlands Conservation Program (IWC)	WCB	X	X		X							
State Community Developmenmt Block Grant (CDBG)	HUD									X		

LWA
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Final Technical Memorandum

City of Colusa Flood Risk Reduction Feasibility Study
Small Communities Flood Risk Reduction Program

Conceptual Finance Plan *October 2, 2019*

Prepared by: David Lee
Reviewed by: Seth Wurzel, CGFM & Derek Larsen, P.E., CFM

Purpose

This memorandum has been prepared by Larsen Wurzel & Associates, Inc. (LWA) in support of the City of Colusa Flood Risk Reduction Feasibility Study under the Department of Water Resources (DWR) Small Communities Flood Risk Reduction (SCFRR) Program. This memorandum provides a conceptual financial plan and funding strategy for implementation of the preferred alternative.

Approach

The conceptual finance plan applies information from the Financial Feasibility and Funding Sources memos prepared by LWA with funding information provided by the local agencies to identify potential local and non-local matching funds to implement the preferred alternative. Based on cost estimates provided by the Colusa project team, a funding "sources and uses" table was prepared to determine funding capabilities for flood risk reduction features. This memo does not address funding mechanisms for identified multi-benefit projects.

Selected Alternative

The ability to pay analysis was a three-step screening process. First, a maximum annual land-based assessment was calculated using a rate analysis for the benefited area(s). Second, each alternative's capacity to raise sufficient annual funding to cover long term Operations & Maintenance (O&M) costs was determined. Finally, the remaining alternatives were ranked based on their ability to raise local capital with the remaining assessment capacity. Based on the three-step screening process of alternatives, all six alternatives have relatively similar maximum assessment capacities. Each alternative includes a fix-in-place to existing levees, construction of a new ring levee system, Powell Slough repair, and MA12 repair. However, the length of new levee and repair costs vary for each alternative.

Funding Approach

Total Project costs estimates provided by the Colusa Project team and estimated O&M costs are displayed in **Table 1.**

Table 1

Colusa Small Communities Flood Risk Reduction
Alternatives Cost Summary

Alternative	Total Construction Cost [1]	Annual O&M [2]	Maximum Assessment Capacity	Remaining Assessment Capacity
1	$188,000,000	$69,800	$810,000	$740,200
2	$214,700,000	$65,100	$812,000	$746,900
3	$204,100,000	$45,900	$810,000	$764,100
4	$180,200,000	$64,600	$812,000	$747,400
5	$206,900,000	$60,600	$813,000	$752,400
6	$196,300,000	$41,400	$812,000	$770,600

[1] Construction costs and O&M costs are in 2025 dollars.
[2] O&M costs provided by KSN.

The Alternative 1 total construction cost estimate is $188 million, the estimated annual O&M cost is $69,800, and the maximum revenue is $810,000. The estimated remaining annual assessment capacity beyond O&M costs for Alternative 1 is $740,200, which could raise between $10.3 million to $13.2 million based on varying debt financing with interest rates between 3% to 5%.

The Alternative 2 total construction cost estimate is $214.7 million, the estimated annual O&M cost is $65,100, and maximum revenue is $812,000. The estimated remaining annual assessment capacity beyond O&M costs for Alternative 2 is $746,900 which could raise between $10.4 million to $13.3 million.

Alternative 3 was determined to protect the same area as Alternative 1, while reducing the length of new levee required and increasing the length of repaired levee. Alternative 3 has a lower annual O&M cost compared to Alternative 1. The estimated remaining annual assessment capacity beyond O&M costs for Alternative 3 is $764,100 which could raise between $10.7 million to $13.6 million.

Alternatives 4, 5, and 6 are similar to Alternatives 1, 2, and 3, with a reduced length of new levee construction along the northern portion of the city of Colusa. The resulting change would result in a lower O&M cost and additional remaining annual assessment capacity between $10.4 million and $13.7 million.

A detailed breakdown of remaining assessment capacity and potential debt financing for each alternative is displayed in **Table 2**.

Table 2
Colusa Small Communities Flood Risk Reduction
Local Funding Analysis

Alt.	Rem. Assessment Capacity $	Low Int. Rate Millions $ [1,2,4]	High Int. Rate Millions $ [1,3,4]	Project Cost Millions $	Local High %	Local Low %	Non-Local High %	Non-Local Low %	Fund Capacity Ranking
1	$740,200	$13.19	$10.34	$188,000,000	7.02%	5.50%	94.5%	93.0%	2
2	$746,900	$13.31	$10.44	$214,700,000	6.20%	4.86%	95.1%	93.8%	6
3	$764,100	$13.62	$10.68	$204,100,000	6.67%	5.23%	94.8%	93.3%	4
4	$747,400	$13.32	$10.44	$180,200,000	7.39%	5.80%	94.2%	92.6%	1
5	$752,400	$13.41	$10.51	$206,900,000	6.48%	5.08%	94.9%	93.5%	5
6	$770,600	$13.73	$10.77	$196,300,000	6.99%	5.49%	94.5%	93.0%	3

Notes:

[1] Assumes 1.1 Debt Coverage Ratio

[2] Low interest rate for debt issuance assumed to be 3%

[3] High interest rate for debt issuance assumed to be 5%

[4] Term for bond repayment assumed to be 30 years.

Table 3 provides a summary of potential State and federal funding sources that could be sought to complete the proposed improvements.

Table 3
Colusa Small Communities Flood Risk Reduction
Funding Sources by Solution Matrix

		Structural		Study/Plan/OMRR&R	
Funding Program	**Agency**	**Levees/ Floodwalls/ Dams/ Erosion**	**Bypasses**	**Feasibility Study /Flood Management Plan**	**OMRR&R**
Small Communities Flood Risk Reduction (SCFRR) Program	DWR	X	X	X	
Flood System Repair Projects (FSRP)	DWR	X	X		
Flood Maintenance Assistance Program (FMAP)	DWR				X
Flood Mitigation Assistance (FMA)	FEMA		X		
Pre-disaster Mitigation (PDM)	FEMA	X	X		
Hazard Mitigation Grant Program (HMGP)	FEMA	X	X		

Notes:
[1] Potential Funding Programs Identified by LWA from the Funding Sources Memo.

Recommended Next Step

The County should work to determine if advancing a land-based assessment would be a viable approach and should refine assumptions associated with the amount of funding required to complete the proposed improvements. In order to secure local funding, the County will need to prepare a detailed project financing plan and cash flow model to support a land-based assessment. This plan would ultimately become part of a required Engineer's Report. The County could advance design and environmental compliance of the preferred alternative to develop a construction ready project that can better compete for State and federal funding.

The Colusa local funding capacity is sufficient to fund all of the Alternatives' O&M costs. The excess local funding beyond O&M could be utilized to raise up to 7.4% of project costs for Alternative 4 and 7.0% for Alternative 1, through debt financing, towards the local match. In LWA's experience, typical capital improvement projects require at least 10% to 15% local matching funds in order to qualify for State and Federal funding programs.

The County should explore developing a regional assessment district to fund a regional Capital Improvement Program (CIP) that could leverage a larger benefit assessment area to generate local funds to match State and federal funding. Other local maintaining agencies within the area, such as Reclamation District 108 and the Sacramento River West Side Levee District, have identified critical repair areas within the Colusa basin that could be included in a regional CIP. The regional assessment district could initially be utilized to fund SCFRR projects within the County and then other critical projects within the Colusa basin.

As part of developing a larger regional program and CIP, the County would need to determine how to address governance prior to advancing the preferred alternative under this regional approach.

Appendix G
Public and Stakeholder Meeting Sign-In Sheets

For Immediate Release
November 5, 2018

Media Contact: Kim Floyd
(916) 838-2666

Community Asked for Input of Ways to Reduce Flooding in City of Colusa, Grimes & Princeton

Colusa County is conducting Flood Risk Reduction Feasibility Studies for the City of Colusa and the communities of Grimes and Princeton. Ultimately, the studies – which build upon Regional Flood Management Planning efforts – will identify a preferred solution for each community to reduce flood risk and provide opportunities for multi-benefit and habitat enhancement. A series of community meetings will introduce the studies and provide the first opportunity for community input.

Reducing Flood Risk in the City of Colusa
Community Meeting
6 p.m., Tuesday, November 13
City of Colusa Fire Department
750 Market Street, Colusa

Reducing Flood Risk in Grimes
Sac River West Side Levee District Landowner Meeting/Community Meeting
6:30 p.m., Wednesday, November 14
Colusa Industrial Properties
50 Sunrise Boulevard, Colusa

Reducing Flood Risk in Princeton
Community Meeting
6 p.m., Thursday, November 15
Princeton High School Cafeteria
473 State Street, Princeton

Each community's presentation will include an overview of the program along with draft flood risk reduction alternatives for review and input. The programs are fully funded under the CA DWR's Small Community Flood Risk Reduction Program.

For more information, please contact Joe Thomas (KSN, Inc.) at 916-403-5900 or jthomas@ksninc.com.

Meeting Notification on Mid & Upper Sacramento RFMP Website

Meetings & News

UPCOMING MEETINGS

Small Communities Meetings
Reducing Flood Risk in the Town of Grimes

Join us for an introduction to Colusa County's Flood Risk Reduction Feasibility Study for the town of Grimes. The study aims to identify a preferred solution to provide Grimes with a 100-year level of flood protection. Draft alternatives for review and input will be presented. This is a joint meeting with the Sacramento River West Side Levee District.

6:30 p.m, Wednesday, November 14
Colusa Industrial Properties
50 Sunrise Boulevard, Colusa

Reducing Flood Risk for Princeton

The community is encouraged to attend an introduction to the Flood Risk Reduction Feasibility Study for Princeton.

6 p.m., Thursday, November 15
Princeton High School Cafeteria
473 State Street, Princeton

Plan Documents

NOTE: The following link to large files. Please be patient while the files load for viewing.

Mid & Upper Sacramento Regional Flood Management Plan – November 10, 2014

Plan Cover

Table of Contents
Acronyms and Abbreviations
Executive Summary
Chapter 1 – Introduction
Chapter 2 – Regional Setting
Chapter 3 – Assessment of Flood Hazards in the Region
Chapter 4- Operations and Maintenance
Chapter 5 – Emergency Response
Chapter 6 – Land Use and Environmental
Chapter 7 – Rural Areas and Small Communities
Chapter 8 – Urban Areas
Chapter 9 – Levee Maintaining Agency Projects
Chapter 10 – System-Wide Improvements
Chapter 11 – Implementation Strategies
Chapter 12 – Financial Plan
Chapter 13 – References
Appendix A – County Economic Forecasts
Appendix B – Levee Segment

Contact

Kim Floyd
Public Outreach Coordinator
Hotline: 916-838-2666

Submit your comments and questions to Kim@FloydCommunications.com.

Click here to join the project database and begin receiving email updates.

Your help is needed to identify flood risk reduction solutions for the communities of Colusa, Grimes and Princeton.

Colusa County is conducting Flood Risk Reduction Feasibility Studies for Colusa, Grimes and Princeton. Ultimately, the studies – which build upon Regional Flood Management Planning efforts – will identify a preferred solution for each community to reduce flood risk and provide opportunities for multi-benefit and habitat enhancement. Please attend your community's meeting to learn more:

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COLUSA SMALL COMMUNITIES
E-Blast to Mid & Upper Sacramento RFMP Database
November 2018

Your help is needed to identify flood risk reduction solutions for the communities of Colusa, Grimes and Princeton.

Colusa County is conducting Flood Risk Reduction Feasibility Studies for Colusa, Grimes and Princeton. Ultimately, the studies – which build upon Regional Flood Management Planning efforts – will identify a preferred solution for each community to reduce flood risk and provide opportunities for multi-benefit and habitat enhancement. Please attend your community's meeting to learn more:

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Small Communities Flood Risk Reduction Program

City of Colusa

Town of Grimes

Town of Princeton

Project Kickoff Meeting

01:30 PM, November 21st, 2017

Colusa City Hall
425 Webster Street
Colusa, CA 95932

Teleconference Number: (646) 749-3112
Access Code: 517-515-733#

AGENDA

1. Introductions
2. Background
3. Feasibility Study Process
    a. Problem Identification
    b. Alternatives Formulation
    c. Alternatives Evaluation
    d. Preferred Alternative Determination
4. Schedule/Milestones
5. Communications & Coordination Plan
6. Community Specific Discussions
    a. City of Colusa
    b. Town of Grimes
    c. Town of Princeton
7. Questions?
8. Next Meeting

Please contact Joe Thomas at 916-403-5900 or at jthomas@ksninc.com for any additional information or questions.

Date:	**Tuesday, November 21, 2017**
Location:	**Public Works Department, Colusa, CA**
Topic:	**Kick off meeting for Colusa, Grimes, & Princeton SCFRR Feasibility Studies**

KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

	Last Name	First Name	Affiliation Group	E-mail	Phone Number
1	Thomas	Joseph	KSN	jthomas@ksninc.com	916 403-5900
2	Avelar	Elizabeth	KSN	EAvelar@ksninc.com	(916) 403-5900
3	Floyd	Kim	KFC	kim@floydcommunications.com	916 838 2666
4	O'Rega	Barry	KSN	borega@ksninc.com	209 323 9064
5	Fritz	Chris	PBI	cfritz@pbieng.com	916 608-2212
6	Cain	Jesse	City of Colusa	citymanager@cityofcolusa.com	(530) 682-2933
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8					
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	Teleconference Attendees				
13	Pardo	Summer	HDR		
14	Chapman	Tom	HDR		
15	Faghih	Jafar	HDR		
16	Wurzel	Seth	LWA		

Last Name	First Name	Affiliation Group	E-mail	Phone Number
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Small Communities Flood Risk Reduction Program

City of Colusa

Town of Grimes

Town of Princeton

Alternatives Workshop

JOC Annex – South Meeting Room

3464 El Camino Avenue

Suite 210

Sacramento, CA 95821-9000

Agenda

Time	Topic	Facilitator
Study Background		
5 minutes	Introduction	Scott Lanphier
5 minutes	Regional Flood Management Plan Background	Barry O'Regan
5 minutes	Study Goals & Objectives	Joseph Thomas

Town of Grimes

Existing Conditions Technical Discussion		
5 minutes	Geotechnical Initial Findings	Mark Stanley/Kimberly Brown
5 minutes	Hydrology, Hydraulics, & Floodplain Mapping	Chris Fritz
Flood Risk Reduction Strategies		
25 minutes	Alternatives	Joseph Thomas/Elizabeth Avelar
10 minutes	Multibenefits Opportunities	Barry O'Regan
20 minutes	Town of Grimes Questions, Input, & Discussion	Joseph Thomas

Small Communities Flood Risk Reduction Program

City of Colusa

Town of Grimes

Town of Princeton

Town of Princeton

Existing Conditions Technical Discussion		
5 minutes	Geotechnical Initial Findings	Mark Stanley/Kimberly Brown
5 minutes	Hydrology, Hydraulics, & Floodplain Mapping	Chris Fritz
Flood Risk Reduction Strategies		
25 minutes	Alternatives	Joseph Thomas/Elizabeth Avelar
10 minutes	Opportunities for Multiple Benefits	Barry O'Regan
20 minutes	Town of Princeton Questions, Input, & Discussion	Joseph Thomas

City of Colusa

Existing Conditions Technical Discussion		
5 minutes	Geotechnical Initial Findings	Mark Stanley/Kimberly Brown
5 minutes	Hydrology, Hydraulics, & Floodplain Mapping	Chris Fritz
Flood Risk Reduction Strategies		
25 minutes	Alternatives	Joseph Thomas/Elizabeth Avelar
10 minutes	Opportunities for Multiple Benefits	Barry O'Regan
30 minutes	City of Colusa Questions, Input, & Discussion	Joseph Thomas

Next Steps		
5 minutes	Decision Matrix	Joseph Thomas
5 minutes	Path Forward	Joseph Thomas
10 minutes	Open Discussion	Joseph Thomas

Date:	**Wednesday, October 10, 2018**
Location:	**DWR- 210 JOC Annex South Meeting Room**
Topic:	**Alternatives Workshop - Colusa, Grimes, & Princeton**

KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

	Last Name	First Name	Affiliation Group	E-mail	Phone Number
1	Thomas	Joseph	KSN, INC	jthomas@KSNINC.com	916-403-5900
2	Chang	Kristy	KSN, Inc	kchang@ksninc.com	916-403-5900
3	Avelar	Liz	KSN, INC.	eavelar@KSNN.com	
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5	Carpenter	Scott	County of Colusa Co	scarpenter@countyofcolusa.com	530 458 0466
6	Lee	David	LWA	David@Larsenwurzel.com	916-606-1929
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11	Fritz	Chris	PBI	Cfritz@pbiengineering.com	916 608-2212
12	Crane	Robert	DWR	rcrane@water	916 574-0912
13	Ali	Ajala	DWR	Ajala.Ali@water.ca.gov	916-574-1454
14	Yiqun ~~Liang~~ Tsai	Liang	DWR	yliang@water.ca.gov	916-574-1408
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16					

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Date:	**Tuesday, November 13th, 2018**
Location:	**Colusa Fire Department - 750 Market Street, Colusa**
Topic:	**Colusa Small Communities Flood Risk Reduction Public Meeting**

KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

	Last Name	First Name	Affiliation Group	E-mail	Phone Number
1	Thomas	Josem	KSN, INC.	jThomas@KSNINC.com	916-905-5900
2	LAMPHIER	SCOTT	CO DPW	SLAMPHIER@COUNTYOFCOLUSA.ORG	530 458 0466
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5	Marvel	Dick	Colusa Resident	" " "	" " "
6	CARTER	DENISE	COLUSA CO.	d	530.682.9701
7	CARTER	BEN	MUSRFMP	bencarter@sucess.net	530.682.9701
8	MUSTO	CASSANDRA	DEPT WTR RES	cassandra.musto@water.ca.gov	
9					
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Small Communities Flood Risk Reduction Program

City of Colusa

City of Colusa

Southern Levee Alignments Discussion

Agenda

1. Sign-in
2. Review of area to be protected
3. Review of geotechnical issues
4. Review of flood maps
5. Review of other data & maps
6. Review of proposed alignments
7. Conclusion

- ☐ Include ~~S~~ Northern property owners in one meeting (Head count first)
- ☐ Include Southern property owners in one meeting. (HEAD Count)
- ☐ Bring Airport into discussion
- ☐ Add jog to North alignment
- ☐ Repair u/s to 10K & reinforce @ Powell Slough (Alt)
- ☐ "L" levee w/ site specific fix for airport
- ☐ follow up meeting re: financing
- ☐ Meetings in March

Please contact Joe Thomas at 916-403-5900 or at jthomas@ksninc.com for any additional information or questions.

Date: Friday, February 1, 2019

Location: 1550 Harbor Boulevard
Suite 212; West Sacramento, CA 95691

Topic: City of Colusa Southern
Levee Alignments Discussion

	Last Name	First Name	Affiliation Group	E-mail	Phone Number
1	[illegible]	[illegible]	SRWSCD		
2	[illegible]	[illegible]	Co PW		
3	Thomas	Joseph	KSN	jthomas@KSNinc.com	
4	O'Regan	[illegible]	KSN	[illegible]@KSNinc.com	
5					
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City of Colusa Small Communities Flood Risk Reduction Feasibility Study
Community Meeting – May 8, 2019

Name (Please Print)	Email or Mailing Address (Please Print)	Phone Number
Joe Thomas	jthomas@ksnlrc.com	916-403-5900
Benjamin Borrega	borrega@ksnlrc.com	209 323 9864
Scott Landpher	SLANDPHER@COUNTYOFCOLUSA.COM	530 458 0466
Kathy Yerxa	KYERXA@RIVERVISTAFARMS.COM	530-458-2550
John Murphy	FLYJCSHASTA.COM	520 1223
Warren Halsey	P.O. Box 182, Monroe OR 97456	541-847-5733
Nancy Gore	1640 East Clay Colusa	530-458-5338
[illegible]	" " "	" " "
[illegible]	422 Walnut Tree Dr	530-458-8324
[illegible]	3389 Grover Ave Colusa	530-682-9810
Elizabeth & Charles Yerxa	840 Clay St Colusa	530-458-4814; 458-5157 work

City of Colusa Small Communities Flood Risk Reduction Feasibility Study
Community Meeting – May 8, 2019

Name (Please Print)	Email or Mailing Address (Please Print)	Phone Number
Richard Selover	RSELOVER@SELOVERS.COM	530-308-0380
Woody Yserka	PO Box 209 Colusa, CA 95932	530-458-2550
Don Traynham	dtraynham@sunvalleyrice.com	530-682-9889
Ben King	bking@pacgoldag.com	530-723-3119

Date: Thursday, December 12, 2019

Location: Egling Middle School, Colusa, CA

Topic: Small Community Feasibility Study Public Meeting

	Last Name	First Name	Affiliation Group	E-mail	Phone Number
1	O'Rega	Barney	KSN	borega@ksninc.com	2093239864
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4	KING	BEN	SELF	bking@pacgoldag.ca	530 723-3119
5	Lang	Rick + Nita	—		530-713-6941
6	Carter	Denise	Colusa	on file	
7	Pilgrim	Margie & Fred	Colusa	pilgrimfm1976@gmail.com	530-458-5076
8	Bell	Janice	OES/Sheriff	jbell@colusasheriff.com	530-821-9561
9	Stuck	John	Colusa	stuckjohn@yahoo	530-301-1164
10	DaGrossa	Pam	Colusa	pam.dagrossa@gmail	619-0052
11	Poland	Leslie	Colusa		"
12	Deryl Phy		Colusa	DPHY44le@AOL.com	619-0020
13	SuzAnnePhy		Colusa	SPHY120@AOL.com	619 0020
14	SCHEDLER	WALTER	COLUSA	waltschedler@yahoo.com	458 8383
15	MOSS	JERE	COLUSA		458-4276
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18	Moresco	Jeff	Citizen	aggiejeffm@gmail.com	530-624-6820
19	Benitez	Jory	Colusa resident	jorybenitez2@gmail.com	916 3601080
20	Richards	Craig	citizen	jcraigrich@gmail.com	530 383-4544
21	Young	Tim	CITIZEN	howe2180@concast.net	5308440122
22	Yerxa	Alison	"	alisonyerxa@mac.com	213.220.1688
23	Waters	Laurie	"	davelaurie waters@yahoo	530-770-1967
24	YERXA	KATHY	citizen		530-330-0422
25	YERXA	WOODY	citizen	WYERXA@rivervistafarms.com	
26	Rivera	Lorna	Citizen	barnlorn@aol.com	925-784-5619
27	Ortiz	Melissa	citizen	melcortiz@kn.com	530 713 6359
28	STAFFORD	Marlin	Citizen	moosetroopalive.com	530 458-4040
29	Kelley	Tim	"	TheKelleys615@comcast.net	(530) 682-3239
30	SELOVER	RICH	"	RSELOVER@SELOVERS.com	530-308-0380
31	Hiss	Lenore	citizen		530-476-2645
32	Giffin	Jennifer	citizen / Realtor	JGIFFIN@INTEROMOVE.com	530-701-2106
33	Vedo	Scott	citizen / contractor		530-415-1672
34	BRADWELL	MICHAEL	CCSO	MBRADWELL@COLUSASHERIFF.COM	530-682-4319
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Appendix H
Comparison of Alternatives

KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

Stephen K. Sinnock, P.E.
Christopher H. Neudeck, P.E.
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Barry O'Regan, P.E.

2302-0020

TECHNICAL MEMORANDUM

November 11, 2019

Subject: Alternatives Evaluation Methodology

Project: Small Communities Flood Risk Reduction Program Feasibility Study for the City of Colusa

1.0 BACKGROUND AND PURPOSE

The purpose of this memorandum is to document the methodologies used in the evaluation of the alternatives developed in the Small Communities Flood Risk Reduction Program Feasibility Study for the City of Colusa (Feasibility Study).

This memorandum will describe the measurement criteria in which each alternative is evaluated and provide a basis for how the scoring was calculated. Scoring each alternative will facilitate the comparison of the proposed alternatives.

2.0 EVALUATION BASIS

Each alternative was evaluated for its ability to achieve a 100-year level of flood protection for the City of Colusa and their alignment with the State's goals listed in the 2012[1] and 2017 Update CVFPP[2]. More specifically the alternatives were evaluated in their ability to improve flood risk management, promote ecosystem functions and multi-benefit projects, improve institutional and public support, improve Operations and Maintenance (O&M) activities, and the resulting capital and operations and maintenance (O&M) costs. The below sections will further describe the criteria used and how the alternatives were evaluated.

3.0 IMPROVE FLOOD RISK MANAGEMENT

The improvement of flood risk management is the most important criteria for this feasibility study and is the primary goal of the CVFPP. It is anticipated that in the near future, the levees providing the city of Colusa with a 100-year level of flood protection will lose their Federal Emergency Management Agency (FEMA) accreditation, therefore the goal of this Feasibility Study is to select the most feasible alternative to provide the town with at least a 100-year level of flood protection.

The *Improve Flood Risk Management* criteria was subdivided into three sub-categories: People and Properties at Risk, Flood System Flexibility and Resilience, and Floodplain Management. These sub-categories are discussed below.

[1] *2012 Central Valley Flood Protection Plan*, California Department of Water Resources, June 2012
[2] *Central Valley Flood Protection Plan 2017 Update*, California Department of Water Resources, August 2017

3.1. *People and Properties at Risk*

Each alternative was evaluated for its impact on People and Properties at Risk. The way in which each alternative's impact to People and Properties at Risk was quantified was through asking four questions.

1. Is a 100-year level of flood protection achieved through the implementation of the alternative?

2. What fraction of the current population would obtain a 100-year level of flood protection through the implementation of the alternative?

Question 1 is answered with a yes or no answer as to whether 100-year level of flood of flood protection would be attained for the area of protection for Colusa. If the answer is yes, the alternative receives one point; if the answer is no, the alternative receives no point. A 100-year level of flood protection was deemed attained if the area was removed from 100-year floodplain by the alternative.

Question 2 is answered by simply dividing the population being protected to a 100-year level from flooding by the total population within the area of protection for Colusa. As of the 2010 census there were 5,971[3] persons living in the census designated area of Colusa.

3.1.1. *Alternative 1 – Rehabilitation of State Plan of Flood Control Facilities; Complete Ring Levee*

Alternative 1 would provide a 100-year level of flood protection through a combination of rehabilitating existing levees and the construction of new levee sections that will complete a ring around Colusa. The entire area of protection including its inhabitants and commercial assets would be provided a 100-year level of flood protection.

3.1.2. *Alternative 2 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

Alternative 2 would provide a 100-year level of flood protection through a combination of rehabilitating existing levees and the construction of new levee sections along alternative alignments that will complete a ring around Colusa. The entire area of protection including its inhabitants and commercial assets would be provided a 100-year level of flood protection.

3.1.3. *Alternative 3 – Rehabilitation of State Plan of Flood Control Facilities; Construct North and South Levees*

Alternative 3 would provide a 100-year level of flood protection through a combination of rehabilitating existing levees, and the construction of new north and south levees around Colusa. The entire area of protection including its inhabitants and commercial assets would be provided a 100-year level of flood protection.

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[3] American FactFinder, United States Census Bureau, https://factfinder.census.gov/bkmk/cf/1.0/en/place/Colusa city, California/POPULATION/DECENNIAL_CNT

3.1.4. *Alternative 4 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

Alternative 4 would provide a 100-year level of flood protection through a combination of rehabilitating existing levees and the construction of new levee sections along alternative alignments that will complete a ring around Colusa. The entire area of protection including its inhabitants and commercial assets would be provided a 100-year level of flood protection.

3.1.1. *Alternative 5 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

Alternative 5 would provide a 100-year level of flood protection through a combination of rehabilitating existing levees and the construction of new levee sections along alternative alignments that will complete a ring around Colusa. The entire area of protection including its inhabitants and commercial assets would be provided a 100-year level of flood protection.

3.1.1. *Alternative 6 – Rehabilitation of State Plan of Flood Control Facilities; Construct Alternative North and South Levees*

Alternative 6 would provide a 100-year level of flood protection through a combination of rehabilitating existing levees, and the construction of new north and south levees around Colusa. The entire area of protection including its inhabitants and commercial assets would be provided a 100-year level of flood protection.

Table 1 – People & Properties at Risk

Sub-criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Achieves 100-year level of flood protection?	1	1	1	1	1	1
Fraction of Current Population receiving 100-year level of flood protection	1	1	1	1	1	1
Total People and Properties at Risk Score	**2**	**2**	**2**	**2**	**2**	**2**

3.2. *Flood System Flexibility & Resiliency*

Each alternative was evaluated for its flexibility and resiliency in the face of changing hydrologic and hydraulic conditions (e.g. climate change, upstream urbanization, etc.). This Flood System Flexibility & Resiliency was addressed through asking if the alternative was resilient to future climate change.

3.2.1. *Alternative 1 – Rehabilitation of State Plan of Flood Control Facilities; Complete Ring Levee*

The NFIP in general requires a minimum of three feet of freeboard in order for a levee to be accredited as providing flood protection within the NFIP.

Alternative 1's proposed ring levee element is planned to have at minimum four feet of freeboard above the 100-year flood elevations. This additional freeboard above the minimum three required by FEMA is intended to serve serval purposes: it accounts for settlement of the levee and uncertainty in future conditions' flood flows. As this extra freeboard provides additional resiliency and flexibility Alternative 1 was given a point in this subcategory.

3.2.1. *Alternative 2 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

The NFIP in general requires a minimum of three feet of freeboard in order for a levee to be accredited as providing flood protection within the NFIP.

Alternative 2's proposed ring levee element is planned to have at minimum four feet of freeboard above the 100-year flood elevations. This additional freeboard above the minimum three required by FEMA is intended to serve serval purposes: it accounts for settlement of the levee and uncertainty in future conditions' flood flows. As this extra freeboard provides additional resiliency and flexibility Alternative 2 was given a point in this subcategory.

3.2.1. *Alternative 3 – Rehabilitation of State Plan of Flood Control Facilities; Construct North and South Levees*

The NFIP in general requires a minimum of three feet of freeboard in order for a levee to be accredited as providing flood protection within the NFIP.

Alternative 3's proposed levee element is planned to have at minimum four feet of freeboard above the 100-year flood elevations. The shorter south levee segment is enough to protect against the breadth of the 100-year floodplain. This additional freeboard above the minimum three required by FEMA is intended to serve serval purposes: it accounts for settlement of the levee and uncertainty in future conditions' flood flows. As this extra freeboard provides additional resiliency and flexibility Alternative 3 was given a point in this subcategory.

3.2.1. *Alternative 4 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

The NFIP in general requires a minimum of three feet of freeboard in order for a levee to be accredited as providing flood protection within the NFIP.

Alternative 4's proposed ring levee element is planned to have at minimum four feet of freeboard above the 100-year flood elevations. This additional freeboard above the minimum three required by FEMA is intended to serve serval purposes: it accounts for settlement of the levee and uncertainty in future conditions' flood flows. As this extra freeboard provides additional resiliency and flexibility Alternative 4 was given a point in this subcategory.

3.2.1. *Alternative 5 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

The NFIP in general requires a minimum of three feet of freeboard in order for a levee to be accredited as providing flood protection within the NFIP.

Alternative 5's proposed ring levee element is planned to have at minimum four feet of freeboard above the 100-year flood elevations. This additional freeboard above the minimum three required by FEMA is intended to serve serval purposes: it accounts for settlement of the levee and uncertainty in future conditions' flood flows. As this extra freeboard provides additional resiliency and flexibility Alternative 5 was given a point in this subcategory.

3.2.1. *Alternative 6 – Rehabilitation of State Plan of Flood Control Facilities; Construct Alternative North and South Levees*

The NFIP in general requires a minimum of three feet of freeboard in order for a levee to be accredited as providing flood protection within the NFIP.

Alternative 6's proposed levee element is planned to have at minimum four feet of freeboard above the 100-year flood elevations. The shorter south levee segment is enough to protect against the breadth of the 100-year floodplain. This additional freeboard above the minimum three required by FEMA is intended to serve serval purposes: it accounts for settlement of the levee and uncertainty in future conditions' flood flows. As this extra freeboard provides additional resiliency and flexibility Alternative 6 was given a point in this subcategory.

Table 2 – Flood System Flexibility & Resiliency

Sub-criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Is the alternative resilient to changes in future conditions?	1	1	1	1	1	1
Total Flood System Flexibility & Resiliency Score	**1**	**1**	**1**	**1**	**1**	**1**

3.3. *Floodplain Management*

Each alternative was evaluated for their impact on floodplain management. Specifically they were evaluated on the below questions:

1. Will the alternative promote urbanization of rural agricultural areas in deep floodplains?
2. Does the alternative manage and/or address residual risks particularly in areas of deep or rapid flooding?

Question 1 was answered by looking at the area which would be removed from the 100-year floodplain. If there were agricultural areas beyond the developed portions of the area of protection being removed,

this could potentially encourage additional development and subsequently increase the consequences of flooding in Colusa. Increased development within deep floodplains is to be discouraged.

Question 2 was answered by looking at the areas being removed from the floodplains. Specifically are measures planned which would serve to limit residual risk or otherwise manage the increase in residual risk?

3.3.1. *Alternative 1 – Rehabilitation of State Plan of Flood Control Facilities; Complete Ring Levee*

Alternative 1's ring levee creates an area which could potentially be developed into residential or commercial properties behind the ring levee. While the Colusa County General Plan doesn't identify this area as being developed in their 2030 General Plan it is a possibility. For this reason Alternative 1 does not receive a point in the response to the first question. However, the ring levee would allow the of Colusa to be mapped as a Zone X (protected by levee) on the FEMA Flood Insurance Rate Maps (FIRMs) which would provide an affordable, optional flood insurance premium. The area protected by the ring levee would be mapped as a Zone X instead of a Zone D as the ring levee would be hydraulically independent from the non-accredited Sacramento River levees. Hydraulically independent means that the levee does not rely upon other systems or facilities to function in order to maintain its accreditation of providing flood protection in the NFIP. Alternative 1 for this reason receives a point in the second question.

3.3.1. *Alternative 2 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

Alternative 2's ring levee creates an area which could potentially be developed into residential or commercial properties behind the ring levee. While the Colusa County General Plan doesn't identify this area as being developed in their 2030 General Plan it is a possibility. For this reason Alternative 2 does not receive a point in the response to the first question. However, the ring levee would allow the of Colusa to be mapped as a Zone X (protected by levee) on the FEMA Flood Insurance Rate Maps (FIRMs) which would provide an affordable, optional flood insurance premium. The area protected by the ring levee would be mapped as a Zone X instead of a Zone D as the ring levee would be hydraulically independent from the non-accredited Sacramento River levees. Hydraulically independent means that the levee does not rely upon other systems or facilities to function in order to maintain its accreditation of providing flood protection in the NFIP. Alternative 2 for this reason receives a point in the second question.

3.3.1. *Alternative 3 – Rehabilitation of State Plan of Flood Control Facilities; Construct North and South Levees*

Alternative 3's new levees create an area which could potentially be developed into residential or commercial properties behind the ring levee. While the Colusa County General Plan doesn't identify this area as being developed in their 2030 General Plan it is a possibility. For this reason Alternative 3 does not receive a point in the response to the first question. However, the new levees would allow the of Colusa to be mapped as a Zone X (protected by levee) on the FEMA Flood Insurance Rate Maps (FIRMs) which would provide an affordable, optional flood insurance premium. The area protected by the new levees would be mapped as a Zone X instead of a Zone D as the new levees would be hydraulically independent from the non-accredited Sacramento River levees. Hydraulically independent means that the levee does not rely upon other systems or facilities to function in order to maintain its

accreditation of providing flood protection in the NFIP. Alternative 3 for this reason receives a point in the second question.

3.3.1. *Alternative 4 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

Alternative 4's ring levee creates an area which could potentially be developed into residential or commercial properties behind the ring levee. While the Colusa County General Plan doesn't identify this area as being developed in their 2030 General Plan it is a possibility. For this reason Alternative 4 does not receive a point in the response to the first question. However, the ring levee would allow the of Colusa to be mapped as a Zone X (protected by levee) on the FEMA Flood Insurance Rate Maps (FIRMs) which would provide an affordable, optional flood insurance premium. The area protected by the ring levee would be mapped as a Zone X instead of a Zone D as the ring levee would be hydraulically independent from the non-accredited Sacramento River levees. Hydraulically independent means that the levee does not rely upon other systems or facilities to function in order to maintain its accreditation of providing flood protection in the NFIP. Alternative 4 for this reason receives a point in the second question.

3.3.1. *Alternative 5 – Rehabilitation of State Plan of Flood Control Facilities; Complete Alternative Ring Levee*

Alternative 5's ring levee creates an area which could potentially be developed into residential or commercial properties behind the ring levee. While the Colusa County General Plan doesn't identify this area as being developed in their 2030 General Plan it is a possibility. For this reason Alternative 5 does not receive a point in the response to the first question. However, the ring levee would allow the of Colusa to be mapped as a Zone X (protected by levee) on the FEMA Flood Insurance Rate Maps (FIRMs) which would provide an affordable, optional flood insurance premium. The area protected by the ring levee would be mapped as a Zone X instead of a Zone D as the ring levee would be hydraulically independent from the non-accredited Sacramento River levees. Hydraulically independent means that the levee does not rely upon other systems or facilities to function in order to maintain its accreditation of providing flood protection in the NFIP. Alternative 5 for this reason receives a point in the second question.

3.3.1. *Alternative 6 – Rehabilitation of State Plan of Flood Control Facilities; Construct North and South Levees*

Alternative 3's new levees create an area which could potentially be developed into residential or commercial properties behind the ring levee. While the Colusa County General Plan doesn't identify this area as being developed in their 2030 General Plan it is a possibility. For this reason Alternative 3 does not receive a point in the response to the first question. However, the new levees would allow the of Colusa to be mapped as a Zone X (protected by levee) on the FEMA Flood Insurance Rate Maps (FIRMs) which would provide an affordable, optional flood insurance premium. The area protected by the new levees would be mapped as a Zone X instead of a Zone D as the new levees would be hydraulically independent from the non-accredited Sacramento River levees. Hydraulically independent means that the levee does not rely upon other systems or facilities to function in order to maintain its accreditation of providing flood protection in the NFIP. Alternative 3 for this reason receives a point in the second question.

Table 3 – Floodplain Management

Sub-criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Will the alternative increase urbanization of rural agricultural areas in deep floodplains?	0	0	0	0	0	0
Does the alternative manage and/or address residual risks, particularly in areas of deep or rapid flooding?	1	1	1	1	1	1
Total Floodplain Management Score	**1**	**1**	**1**	**1**	**1**	**1**

4.0 PROMOTE MULTI-BENEFIT OPPORTUNITIES

The promotion of ecosystem functions is a supporting goal of the CVFPP. Specifically the CVFPP seeks to "[i]ntegrate the recovery and restoration of key physical processes, self-sustaining ecological functions, native habitats, and species into flood management system improvements."[4]

In order to evaluate each alternative, the goals from the 2016 Conservation Strategies with metrics were utilized. Specifically, these were developed from Table 4-1 of the 2016 Conservation Strategies and presented below in Table 4:

[4] Page 1-4 *Central Valley Flood Protection Plan 2017 Update*, California Department of Water Resources, August 2017.

Table 4 – Promote Ecosystem Functions Metrics

Ecological Goal	*Targeted Ecosystem Process, Habitat, Species, or Stressor*	*Metric*
Ecosystem Processes. Improve dynamic hydrologic and geomorphic processes.	Floodplain inundation	Acres
	Riverine geomorphic processes	Acres
Habitats. Increase and improve quantity, diversity, and connectivity of riverine and floodplain habitats.	Shaded riparian aquatic (SRA) cover	Miles
	Riparian	Acres
	Marshes and other wetlands	Acres
Species. Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.	Targeted species	Acres
Stressors. Reduce stressors related to the development and operation of the SPFC that negatively affect at-risk species.	Revetment removed	Miles
	Levees relocated	Miles
	Fish passage barriers removed	Number
	Invasive plants removed	Acres

Each alternative was evaluated for the metrics identified in Table 4 and found to have identical scoring. An area on the east bank of the Sacramento River across from the city of Colusa was identified in the Central Valley Flood Protection Plan's Conservation Strategy. This area has also been identified as a potential multi-benefit opportunity for all six alternatives. A summary of the scores and how they were derived is further described in the following sections.

4.1. *Ecosystem Processes*

Based upon the work conducted in the Conservation Strategies Floodplain Restoration Opportunities Analysis (FROA), the area near the city of Colusa was identified as a potential site for ecosystem process enhancement. Specifically this area would be lowered to promote more frequent shallow flood inundation.

4.2. *Habitats*

The floodplain lowering offers an opportunity to enhance riparian habitat or perennial wetland that would be reconnected to the Sacramento River floodplain. This would be coupled with SRA cover to provided added benefit to targeted species chinook salmon and steelhead (*Oncorhynchus tshawytscha* and *Oncorhynchus mykiss)*. The total linear length of the SRA would be approximately a 4,700 linear feet. This length was estimated based upon the current shoreline of the floodplain lowering area and will be further refined in a future design phase.

4.3. *Species*

A total of 33 acres would be habitat restored to connectivity with the Sacramento River supporting at-risk species. This area could provide a resting or rearing area for migrating fish (chinook and steelhead salmon) and allow aquatic vegetation and habitat to be established.

4.4. *Stressors*

There is limited opportunity for stressor reduction within the project area. The limited revetments present along the levee near Colusa are needed to prevent additional erosion. The levees protecting Colusa are nestled tightly to the community with no opportunity for setbacks. There are no fish barriers along the Sacramento River near Colusa and no invasive species were identified in the reconnaissance level biological survey. Additional hydraulic analyses are needed to support the potential removal of approximately 250 linear feet of revetment adjacent to the area identified in 4.1.

The summary of the metrics for the multi-benefit area are documented below.

Table 5 – Promote Ecosystem Functions

Ecological Goal	*Targeted Ecosystem Process, Habitat, Species, or Stressor*	*Metric*
Ecosystem Processes. Improve dynamic hydrologic and geomorphic processes.	Floodplain inundation	33 acres
	Riverine geomorphic processes	0 acres
Habitats. Increase and improve quantity, diversity, and connectivity of riverine and floodplain habitats.	Shaded riparian aquatic (SRA) cover	0.9 miles
	Riparian	33 acres
	Marshes and other wetlands	0 acres
Species. Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.	Targeted species	33 acres
Stressors. Reduce stressors related to the development and operation of the SPFC that negatively affect at-risk species.	Revetment removed	0.05 mile (250 feet)
	Levees relocated	0 miles
	Fish passage barriers removed	0 barriers removed
	Invasive plants removed	0 acres located/removed

A supporting goal of the CVFPP is to promote multi-benefit projects to contribute to broader integrated water management objectives. As each alternative incorporates the same multi-benefit area, a 33 acre open space, where ecosystem functions would be promoted, these metrics were not converted to scores as they would be applied to all six alternatives, but all alternatives were given a score of one.

5.0 IMPROVE INSTITUTIONAL SUPPORT

Each alternative was evaluated for institutional support through answering three questions about each alternative. These questions relate gaining the support of local jurisdictions and the public-at-large. These questions are identified below:

1. Is the alternative consistent with local maintaining agency goals and objectives?
2. Is the alternative consistent with community general plan goals and objectives?
3. Is the alternative consistent with community goals and objectives?

4. What is the alternative's relative real estate acquisition?

5. What is the relative increase in new levee miles for the alternative?

All alternatives would impact current operations and maintenance budgets for the local maintaining agency. It would add miles of additional levee to maintain and flood fight. In addition to the real estate acquisition, the new levees as currently conceived would cause parcels to be divided by the levee. Additionally, existing infrastructure such as California Highway 45 and 20 would need to be raised to accommodate minimum sight distances. Due to the increased costs for operations and maintenance, all alternatives were given zero points for the first question.

Table 6 –Improve Institutional Support

Sub-criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Is the alternative consistent with LMA goals & objectives?	0	0	0	0	0	0
Is the alternative consistent with community general plan goals & objectives?	1	1	1	1	1	1
Is the alternative consistent with community goals & objectives?	1	1	1	1	1	1
What is the alternative's relative real estate acquisition?	0	0.2	0.8	0.2	0.4	1
What is the relative increase in new levee miles for the alternative?	0.9	0	0.8	1	0.1	0.9
Total Improve Institutional Support Score	**2.9**	**2.2**	**3.6**	**3.2**	**2.5**	**3.9**

In order to calculate the score for both the real estate and new levee mile scores, the amount of new levees being constructed and the acres of new permanent right of way were normalized for the six alternatives (see equation below). As these two criteria were both deemed to be detractors from an alternative, those with less of an impact were assigned a higher score.

$$Score = 1 - \frac{x - x_{min}}{x_{max} - x_{min}}$$

Where *x* is the variable being normalized (e.g. acres of permanent right-of-way or new levee mi

Except for the necessary real estate acquisition, there will be minimum impacts to the County General Plan and community goals and objectives for all alternatives. Due to this general lack of impact, all alternatives were awarded one point each for question two and three.

6.0 FINANCIAL FEASIBILITY

Each alternative was evaluated for both the financial investments needed to implement the alternative and the increased costs of operating and maintaining these alternatives. The financial investments are both the initial capital costs and long term operations and maintenance costs. These financial investments are typically funded through different funding mechanisms, but for simplicity of analyses the costs were combined to develop a preliminary total project cost.

The primary question evaluated in this category is listed below:

1. What is the preliminary total cost for the alternative?

6.1. *Preliminary Construction Costs*

For all six alternatives, preliminary estimates for construction of the alternative were developed. These costs were estimated using a Preliminary Cost Estimating Tool (PCET) provided by the California Department of Water Resources specifically to assist in the development of these costs. Further discussion regarding the development of these costs can be found in the July 10, 2019 Preliminary Cost Estimate Technical Memorandum prepared by the Project Team.

A summary of these preliminary cost estimates can be found in Table 7.

Table 7 – Estimated Construction Costs

Alternative	Estimated Construction Costs	
Alternative 1	$	188,031,802
Alternative 2	$	214,707,277
Alternative 3	$	204,123,042
Alternative 4	$	180,216,613
Alternative 5	$	206,892,088
Alternative 6	$	196,307,853

6.2. *Incremental Increase to Operations and Maintenance Costs*

All six alternatives were evaluated for estimated incremental increases to operational and maintenance costs for the local maintaining agency. These costs were estimated based upon reported operation & maintenance costs from the local maintaining agency. Further information on the development of these estimated costs can be found in the July 10, 2019 Preliminary Cost Estimate Technical Memorandum.

A summary of these incremental increases in annual costs can be found in Table 8.

In order to combine these annual incremental increases to construction costs, the annual costs were converted to present value. An assumed 3% annual inflation rate was utilized along with an assumed 50 year functional lifespan for the alternative. The present value of the capitalized costs were then advanced to the assumed construction year (2025) which is the same year dollars used in the estimated construction costs. The capitalized present value costs are presented in Table 8 as well.

Table 8 – Estimated O&M Costs

Alternative	Estimated Incremental Increase in Annual O&M Costs	Capitalized Incremental Increase in Annual O&M Costs
Alternative 1	$ 69,751	$ 2,142,936
Alternative 2	$ 65,109	$ 2,000,310
Alternative 3	$ 45,880	$ 1,409,561
Alternative 4	$ 64,633	$ 1,985,690
Alternative 5	$ 60,595	$ 1,861,653
Alternative 6	$ 41,367	$ 1,270,904

To determine the total cost to implement each alternative, the construction costs were added to the capitalized incremental increase in annual O&M costs. A weighted cost factor was then calculated. The weighted cost factor was developed to assign points in a quantitative manner giving higher weight to lower cost options. Unlike the other criteria analyzed in this memorandum, the financial feasibility scores were assigned and determined to the hundredth place to allow for the fine differences in resulting valuations. The weighted cost factor can be calculated by subtracting from one, the alternative's cost divided by the sum of all costs. The total costs and weighted cost factor for each alternative can be found in Table 9.

Table 9 – Total Project Costs & Weighted Cost Factors

Alternative	Total Alternative Cost	Weighted Cost Factor
Alternative 1	$ 190,356,835	0.842
Alternative 2	$ 216,877,577	0.820
Alternative 3	$ 205,652,375	0.829
Alternative 4	$ 182,371,046	0.848
Alternative 5	$ 208,911,921	0.826
Alternative 6	$ 197,686,753	0.836

The weighted cost factor was used for the score of each alternative in the Financial Feasibility Criteria.

7.0 SUMMARY OF FINDINGS

In order to determine the relative merits of each alternative as compared against the other alternatives, the scoring from the above discussed criteria was tabulated and summed into a final score. The structuring of the points system attributed a point for a desired outcome and withheld a point for a negative outcome, thus alternatives with higher total scores have relatively better outcomes than those alternatives with a lower score. This tabulation and summing can be found in Table 10. All alternatives are relatively similar, and it is concluded that cost would be the deciding factor for the alternatives.

Table 10 – Total Score

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Total Improve Flood Risk Management Score	4	4	4	4	4	4
Total Promote Multi-Benefit Opportunities Score	1	1	1	1	1	1
Total Improve Institutional Support Score	2.9	2.2	3.6	3.2	2.5	3.9
Total Construction and O&M Costs Score	0.842	0.820	0.829	0.848	0.826	0.836
Total Score	**8.742**	**8.020**	**9.429**	**9.048**	**8.326**	**9.736**

Through the tabulation process, Alternative 3, Alternative 4, and Alternative 6 were identified as the top three alternatives. When presented to local officials (elected and staff), the general opinion was Alterative 6 would be the recommended alternative as it required less real estate acquisition and created the fewest new levee miles.

Alternative 6 is the most feasible alternative.