Flood Risk Reduction Feasibility Study for:

Delta Legacy Community of Isleton, CA

Funded by California Department of Water Resources Small Communities Flood Risk Reduction Program (SCFRRP)

Submitted to:
City of Isleton

Submitted by:
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NOVEMBER 2022

Visit the Isleton Story Map for more details of the community, its history, and flood risk concerns: Isleton Story Map - City of Isleton Small Communities Flood Risk Reduction Program (http://floodriskreductionisleton.com/)

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Acronyms and Abbreviations

2014 RFMP	Lower Sacramento River/North Delta Regional Flood Management Plan completed in July of 2014
AFOTF	Agricultural Floodplain Ordinance Task Force
APE	area of potential effect
BALMD	Brannan-Andrus Levee Maintenance District
BFE	Base Flood Elevation
BRICK	Federal Emergency Management Agency's Building Resilient Infrastructure and Communities
BWFS	Basin-Wide Feasibility Study
BW-12	Biggert-Waters Flood Insurance Reform Act of 2012
Cal OES	California Governor's Office of Emergency Services
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CFR	California Code of Federal Regulations
cfs	cubic feet per second
Conservancy	Delta Conservancy
CPT	cone penetration test
CRHR	California Register of Historical Resources
CRS	Community Rating System
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CVP	Central Valley Project
CVRMP	Central Valley Riparian Mapping Project
CWC	California Water Code
DAC	disadvantaged communities
DCA	Delta Conveyance Authority
Delta	Sacramento-San Joaquin Delta
DLIS	Delta Levees Investment Strategy
DPC	Delta Protection Commission
DSC	Delta Stewardship Council

DWR	California Department of Water Resources
EAD	Expected Annual Damages
EAP	Emergency Action Plans
EIR	Environmental Impact Report
EOP	Emergency Operations Plan
ESP	Emergency Safety Plan
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FODSS	Flood Operation Decision Support System
fps	feet per second
FSRP	Flood System Repair Project
GAR	Geotechnical Assessment Report
GHAD	Geologic Hazard Abatement District
H&H	hydrologic and hydraulic
HFIAA	Homeowner Flood Insurance Affordability Act
HMP	Hazard Mitigation Plan
HOA	Homeowners Association
Hpm	Holocene peat and muck
H.R.	United States House of Representatives
IWM	Integrated Water Management
Legal Delta	legally defined Sacramento-San Joaquin Delta
LHMP	Local Hazard Mitigation Plan
LM	Levee Mile
LMA	Local Maintaining Agency
LURMP	Land Use and Resource Management Plan
M	million
MA	management action
NAVD 88	North American Vertical Datum 1988
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NRHP	National Register of Historic Places

NULE	Non-Urban Levee Evaluation
OA	Operational Area
OES	Office of Emergency Services
O&M	operations and maintenance
OMRR&R	operation, maintenance, repair, replacement, and rehabilitation
PDM	Pre-Disaster Mitigation
PL	Public Law
RD	Reclamation District
RACER	DWR Remedial Alternatives and Cost Estimates Report
RFMP	Regional Flood Management Plan
RMA	routine maintenance agreement
SB	Senate Bill
SCFRRP	Small Communities Flood Risk Reduction Program
SEMS	Standardized Emergency Management System
SFHA	Special Flood Hazard Area
SOI	sphere of influence
SPA	Special Planning Area
SPFC	State Plan of Flood Control
SRBPP	Sacramento River Bank Protection Project
SRFCP	Sacramento River Flood Control Project
SSJDNHA	Sacramento-San Joaquin Delta National Heritage Area
SWIF	System-wide Improvement Framework
SWP	State Water Project
URS	URS Corporation, An AECOM Company
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WSEL	water surface elevation

Executive Summary

In 2017, the City of Isleton received a grant from the California Department of Water Resources (DWR) Small Communities Flood Risk Reduction Program to complete a feasibility study to reduce flood risk to the Delta Legacy Community of Isleton. The scope of this study includes the following:

- Identifying a potential suite of structural and non-structural flood risk reduction elements
- Developing management actions (MAs) based on the combination of one or more potential flood risk reduction elements
- Developing and preparing implementation costs for each of the MAs
- Identifying a preferred suite of MAs and other non-structural measures based on stakeholder and community input
- Developing an implementation plan which includes an implementation schedule and finance plan

The study considers potential solutions to reduce flood risk while sustaining agriculture and the regional economy, improving riverine habitat viability, addressing regional levee maintenance governance, and improving the resiliency and reliability of conveying fresh water through the Delta with an improved leveed system in the Sacramento River Corridor.

The City of Isleton is located along the left bank of the Sacramento River near the southwest boundary of Sacramento County. Levees which protect the tract of land known as Brannan-Andrus Island where the Delta Legacy Community of Isleton is located are maintained by Brannan-Andrus Levee Maintenance District (BALMD). In total, Brannan-Andrus Island is protected by over 28 miles of levees which provide protection from flows in the Sacramento River to the west, Georgiana Slough and the Mokelumne River to the east, and the San Joaquin River and Sevenmile Slough to the south.

The levees surrounding the community of Isleton were initially constructed between 1860 and 1880 by local interests and were generally built using materials dredged from the adjacent Sacramento River and Georgiana Slough. Over time, various improvements have been made to the levees in the study area located along the left bank of the Sacramento River and they are now considered part of the federally and state authorized Sacramento River Flood Control Project (SRFCP) and are now part of State Plan of Flood Control (SPFC) levees. The levees on the southeast and south sides of BALMD have also been improved over time but are not considered part of the federally and state authorized SRFCP nor a portion of the SPFC levee systems.

The City of Isleton and its consultants developed this feasibility study in coordination with a planning committee comprised of residents living within Isleton, including other landowners and business owners on Brannan-Andrus Island, and representatives from BALMD. Other representative participating stakeholders with interest and knowledge in providing enhanced flood protection for the Delta Legacy Community of Isleton, including residents and landowners within Isleton and agricultural landowners within the larger BALMD basin, were also consulted. Public stakeholder meetings were held to identify existing concerns and solicit feedback on the flood risk reduction efforts for the Delta Legacy Community of Isleton.

Structural-Based Management Actions

A suite of 12 potential structural-based MAs was formulated based on stakeholder input and available geotechnical data, including new geotechnical data collected in late summer of 2020 as part of this feasibility study. These structural-based MAs included repairing known critical and serious sites as previously identified by DWR in their Flood System Repair Project (FSRP); repairing and strengthening-in-place various portions of and/or the entirety of the BALMD perimeter levee system; potentially constructing a cross levee system upstream and downstream of Isleton and also along Highway 12; and securing Federal Emergency Management Agency (FEMA) 100-year accreditation for the community of Isleton.

These 12 structural-based MAs can be paired with a suite of non-structural flood risk reduction measures, including the potential implementation of a community-based private flood insurance program developed specifically for the noted community and/or additional Delta Legacy Communities *via* either a homeowner's association, Sacramento County, or other means such as a Geologic Hazard Abatement District (GHAD). The key non-structural measures preferred by Isleton for consideration are summarized below within this Executive Summary and Section 7.3 of this Feasibility Study Report.

The MAs were evaluated qualitatively against the study's planning objectives of reducing risk to life; reducing risk to property damage; reducing probability of levee failure; reducing high, escalating National Flood Insurance Program (NFIP) flood insurance premiums; improved flood preparedness and response; enhancing resiliency and reliability of through-Delta water conveyance, and identifying multi-objective opportunities. Each of the MAs were also evaluated qualitatively considering agricultural sustainability, local support, and cost.

With this trade-off analysis and a final stakeholder public meeting held by Isleton City Council in June of 2022, a recommended suite of structural-based MAs was further identified as follows:

- **MA 1**: Repair of DWR FSRP Critical and Serious Sites within BALMD

    - 1A: Repair Two DWR FSRP Critical Stability Sites on the Right Banks of the Mokelumne and San Joaquin Rivers
    - 1B: Repair DWR FSRP Serious Erosion Site on the Left Bank of the Sacramento River
    - 1C: Repair Two DWR FSRP Serious Stability Sites on the Right Bank of Georgiana Slough and One Serious Seepage Site on the Right Bank of the Mokelumne River
- **MA 2**: Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Relief Cut along Georgiana Slough
- **MA 3**: All-Weather Flood Fight Access Road for the Community of Isleton
- **MA 4**: Repair and Strengthen-in-Place SPFC Levee along the Left Bank of the Sacramento River (Non-Urban Levee Evaluations [NULE] Segment 378)
    - 4A: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Left Bank of the Sacramento River Immediately Adjacent to Isleton
    - 4B: Repair and Strengthen-in-Place 4.2 Miles of Levee along the Left Bank of the Sacramento River Between the Westerly Boundary of the Community of Isleton and Highway 12
    - 4C: Repair and Strengthen-in-Place 2.4 Miles of Levee along the Left Bank of the Sacramento River Between Highway 12 and West Brannan Island Road
    - 4D: Repair and Strengthen-in-Place 2.0 Miles of Levee along the Left Bank of the Sacramento River Between the Easterly Boundary of the Community of Isleton and the RD 556 Cross Levee
- **MA 5**: Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40)
    - 5A: Repair and Strengthen-in-Place 0.90 mile of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and 450 feet Downstream of the Isleton Wastewater Ponds
    - 5B: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Potential Isleton/Oxbow Marina Cross Levee Alignment
    - 5C: Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Potential Cross Levee Alignment at Jackson Slough Road and Terminous Road *(includes items 5A and 5B above)*

- 5D: Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment at Jackson Slough Road and Terminous Road and the Mokelumne River
- 5E: Repair and Strengthen-in-Place 2.2 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Existing RD 556 Cross Levee

The estimated cost, net reduction in expected annual damages (EAD) to the Isleton study area under existing conditions (without climate change adjustments), and the flood risk reduction payback period in years (excluding interest) associated with select MAs 1, 3, 5, and 6 are summarized below in Table ES-1. The estimated cost for the recommended suite of relatively short-term MAs 1 through 5 is estimated at $163 to $196 million (M) in July 2020 dollars.

From the recommended suite of structural-based management actions, a suite of community preferred structural-based management actions was developed based on stakeholder and public input. The suite of community preferred near-term management actions includes those identified above with the exception of MA 2 (Improving the RD 556 cross levee upstream of Isleton), and MAs 5D and 5E associated with repairing/improving-in-place the right bank levees of Georgian Slough downstream not immediately adjacent to the City and its existing wastewater ponds. However, the City's long-term community preferred management action items include MAs 5D and 5E associated with the multi-objectives of repairing and improving-in-place the entire right bank SPFC levee system of Georgina Slough totaling 6-miles-in-length within the City's study area that closely coincides with the outer boundaries of BALMD. Also included in the City's long-term community preferred structural-based management actions is MA 6C which is a potential cross levee system that closely follows Isleton's proposed Sphere of Influence (SOI). The City's proposed SOI is largely limited to area between the Sacramento River on the west, Georgiana Slough on the east, and as far north and upstream of the Isleton Highway 160 bridge crossing along the Sacramento and River, and as far downstream to the southwest near the City's existing city limit line and along a portion of Jackson Slough Road, Terminous Road, and Oxbow Marina Drive, all located just westerly of Oxbow Marina.

Of the five MAs, MA 1 provides the largest incremental value to the community of Isleton and the larger study area. With the implementation of this MA, the total net reduction in EAD for the Isleton study area is estimated at $18.2M under existing conditions, and as high as $65.2M under future conditions with climate change adjustments. MA 3 also provides significant value to the community of Isleton and the larger study area with an estimated net reduction in EAD of $5.7M under existing conditions, and as much as $27M under future conditions with climate change adjustments. Note that while MAs 4 and 5C as standalone measures would not represent a substantial, incremental reduction in EAD within the study area, they would substantially reduce the potential for life loss associated with a levee breach

along the left bank of the Sacramento River or along the right bank of Georgiana Slough adjacent to the community of Isleton.

Table ES-1. Estimated Costs, Net Reduction in EAD Values, Flood Risk Reduction Payback Periods and Benefit-Cost Ratios for Isleton's Suite of Management Actions Under Existing Conditions.

Management Action (MA)	Estimated Cost[1]	Total Net Reduction in EAD to the Isleton Study Area under Existing Conditions[2]	Flood Risk Reduction Payback Period in Years (excluding interest)[3]	Benefit-Cost Ratio[4]
Repair all 5 remaining DWR FSRP Sites in Isleton Project Area: **(MAs 1A, 1B, & 1C)**	$5,991,000	$18,219,000	0.3 year	82
Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Relief Cut along Georgiana Slough **(MA 2)**	$7,191,000 - $7,660,000	N/A	N/A	N/A
All-Weather Flood Fight Access Road for the City of Isleton **(MA 3)**	$5,898,000	$5,762,000	1.0 year	26.4
Repair and Strengthen-in-Place up to 10.2 Miles of SPFC Levee along the Left Bank of the Sacramento River **(MA 4)**	$68,177,000 - $71,642,000	N/A	N/A	N/A
Repair and Strengthen-in-Place up to 6.0 Miles of SPFC Levee along the Right Bank of Georgiana Slough **(MA 5)**	$76,768,000 - $106,536,000	N/A	N/A	N/A
Cross Levee System **(MA 6C)**	$125,257,000 - $131,938,000	$6,073,000	21.7 years	1.2

Notes:
[1] A range of estimated costs (low-high) are generally provided for each MA concurrent with the costs summarized in Table 6-8
[2] Net Reduction in EAD values are substantially greater under future conditions with climate change adjustments (*see* Table 6-10)
[3] Flood risk reduction payback periods in years are substantially shorter and the benefit-cost ratios are substantially greater under future conditions with climate change adjustments (*see* Table 6-10)
[4] Benefit-Cost Ratio assuming a capital recovery factor of 0.037 (n=50 years, i=2.75%)
N/A: Due to five different SPFC and non-SPFC levee segments within the BALMD study area representing several different levels of flood protection from multiple sources of potential flooding EAD calculations were limited to only a handful of MAs and were not conducted or budgeted for the non-SPFC levee segments. Thus, supporting data for conducting Expected Annual Damages (EAD) assessments and determining Benefit-Cost Ratios was not easily obtainable for the full suite of MAs 1 through MA 12.

A key long-term MA (5) contains state-wide multi-benefits by repairing and strengthening-in-place the Georgiana Slough right bank levee within the bounds of the study area. The

same geotechnical remedial actions would reduce infiltration and inflow to the City's wastewater ponds and improve the resiliency and reliability of the same 6.0-mile length of the freshwater conveyance corridor along Georgiana Slough between its confluence with the Mokelumne River to the south and the boundary between BALMD and Reclamation District (RD) 556 to the north. The current river channel and levee system collectively serve as a critical link of the through-Delta water conveyance system that conveys water *via* the State Water Project (SWP) and the Central Valley Project (CVP) to over 27 million Californians and over 3 million acres of agricultural crops south of the Delta. The noted 6.0-mile stretch of the freshwater conveyance corridor is essential to continued and sustainable freshwater conveyance through the Delta with or without the introduction of a possible dual conveyance facility (tunnels or canal) under consideration by the Delta Conveyance Authority (DCA). The 6.0-mile stretch of SPFC levees along the right bank of Georgiana Slough between the boundary of RD 556 and BALMD and the Mokelumne River represents approximately 24 percent of the non-urban SPFC levees located downstream of the Delta Cross Channel (total of 25 miles) and nearly 10 percent of the total 62 miles of non-urban SPFC levees downstream of Freeport which comprise the freshwater corridor in the North Delta. The multi-benefit of improving both the water conveyance system and the flood control system could gain wide acceptance and cost-sharing opportunities at the regional, state, and federal levels within and south of the Delta. The cost of this multi-benefit element is currently estimated between $77M and $107M within the subject study area of Isleton.

Table 7-3 provides a condensed list of both near-term and long-term community preferred structural-related management actions and their associated costs for implementation. The total cumulative collection of the community preferred structural-related management actions for implementation are estimated to cost between $176M to $208M in 2020 dollars.

Implementation recommendations for implementing the suite of the community preferred actions include the City of Isleton and its neighboring Delta Legacy Communities meeting and working with Regional Flood Management Plan (RFMP) representatives, including Sacramento Area Flood Control Agency, West Sacramento Area Flood Control Agency, the Central Valley Flood Protection Board, and DWR MA 9. There are common interests that suggest implementing levee improvements on a limited number of SPFC levee miles in the North Delta along the Sacramento River in the North Delta will also improve the reliability and resiliency of conveying SWP and CVP water through the entire Delta. The multi-benefit attributes of improving and modernizing the SPFC levee system in tandem with improving conveyance of SWP and CVP water through the Delta should also be presented and shared with the DCA, DWR, the Delta Protection Commission, the Delta Stewardship Council, and the Delta Conservancy.

Non-Structural Flood Risk Reduction Measures

In addition to the key structural-based MAs highlighted above, several non-structural measures were evaluated for their potential to reduce residual flood risk. These non-structural

measures can be implemented independent of, or in combination with, the structural-based improvements. This study recommends the following key non-structural measures for implementation, some of which are already in the early stages of implementation:

- Voluntary structural elevation of residential and commercial structures.
- Wet or dry floodproofing residential, commercial, and agricultural structures.
- Improved emergency response for the City of Isleton study area and adjoining RDs in the Lower-Sacramento - North Delta RFMP region.
- Implementation of a community-based flood-risk insurance program specific to the community of Isleton in lieu of or in tandem with the current FEMA NFIP, which is already in progress. In addition to reducing flood insurance rates the program can also be tailored to buy-down risks by establishing and setting aside local cost-share funds to improve and implement flood risk reduction MAs outlined above and non-structural measures outlined herein.
- Updating the Sacramento County Local Hazard Mitigation Plan and formalizing potential relief cut locations within BALMD
- Continued and improved public education and awareness
- Support continued actions to improve and maintain high NFIP Community Rating System (CRS) score for Sacramento County/Isleton
- Continued state support for refinements and Amendments to the NFIP *via* Agricultural Floodplain Ordinance Task Force and H.R. 3167
- Improved governance between BALMD and other regional RDs in the north Delta, and potentially establishing a Homeowners Association or GHAD for establishing a community-based flood insurance program and reducing flood risks within the community of Isleton.

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1. Introduction

The California Department of Water Resources (DWR) Small Communities Flood Risk Reduction Program (SCFRRP) and the Regional Flood Management Plans (RFMPs) were created following adoption of the 2012 Central Valley Flood Protection Plan (CVFPP) by the Central Valley Flood Protection Board (CVFPB). Both the RFMPs and SCFRRP were created by DWR and are intended to be locally developed flood risk programs authored by regional flood control agencies, Local Maintaining Agencies (LMAs), local Reclamation Districts (RDs), local land-use planning entities such as counties and cities, and the residents of the communities protected by State Plan of Flood Control (SPFC) levees and other facilities. The RFMP program consists of six regional plans within the extent of the CVFPP; three within the Sacramento River Basin; and three within the San Joaquin River Basin. The Lower Sacramento River/North Delta RFMP completed in July of 2014 (herein referred to as the 2014 RFMP) encompasses the greater Sacramento River corridor, the Yolo and Sacramento Bypass systems, and the north Delta Legacy Communities along the Lower Sacramento River system between Sacramento and Rio Vista. Small communities, as defined in the CVFPP, are communities protected by SPFC levees with populations between 200 and 10,000, but exceptions were made to include Delta Legacy communities with populations of less than 200, such as Locke and Ryde.

The SCFRRP is very similar to the DWR 5-year plans developed for and by the levee districts throughout the Delta where the LMAs or RDs are tasked with identifying where their greatest risks are to flooding, and each of the LMAs or RDs prioritize repairs and improvements to their levee systems to minimize flood risks. The key difference between the two programs is the SCFRRP focuses more on the densely populated portions of land tracts protected by SPFC levees; whereas the Delta 5-year plans focus more on the perimeter levee systems protecting the tracts/islands within the Delta independent of whether the levees are SPFC or non-SPFC levee systems.

1.1 Intent of Senate Bill 5 for Small Communities

The Central Valley periodically experiences devastating floods. One of the most recent large events in 1997, as well as increased nationwide awareness of flood risk following Hurricane Katrina in 2005, led to passage of the Central Valley Flood Protection Act of 2008, also known as Senate Bill (SB) 5. SB 5 requires DWR to prepare a strategic systemwide flood protection plan for SPFC[1] facilities in the Sacramento-San Joaquin Valley. The 2012 CVFPP was the first iteration of this plan, and SB 5 mandates that it be updated on 5-year intervals.

[1] In summary, the SPFC includes the state and federal flood control works, lands, programs, plans, conditions, and mode of maintenance and operations of the SRFCP described in Section 8350 of the California Water Code, and of flood control projects in the Sacramento River and San Joaquin River watersheds for which the state (DWR or CVFPB) has provided assurances of nonfederal cooperation to the United States.

Reducing flood risk in currently nonurbanized areas is one objective specified in SB 5. Furthermore, for disadvantaged communities which includes the community of Isleton, SB 5 requires cities, counties, and state and local flood management agencies to collaborate to provide cost-effective strategies for reducing flood risk, and to develop funding mechanisms to finance flood protection responsibilities at the local level. To this end, the 2012 CVFPP included many broad goals for improved flood management for areas protected by SPFC facilities, including small communities and portions of the Sacramento-San Joaquin Valley protected by SPFC levees.

The SCFRRP focuses specifically on reducing flood risks for small communities protected by SPFC facilities, inclusive of areas designated as Delta "Legacy" Communities. Small communities are defined as communities protected by SPFC facilities with a population of less than 10,000 residents. Delta Legacy Communities are a subset of small communities, located within the legally defined (Legal) Delta, which have cultural, historic, and ambiance value that give the Delta a distinctive sense of place (Delta Protection Commission [DPC], 2012) (Figure 1-1).

Under the SCFRRP, the City of Isleton, as the local land-use planning entity, was awarded a DWR grant in 2017 on behalf of Isleton, to prepare a feasibility study to identify and prioritize flood risk reduction MAs. For the purposes of this report, the community of Isleton refers to the densely populated City of Isleton. In addition to Isleton there are seven additional Delta Legacy Communities that received grant funds to prioritize flood risk reduction measures in the Sacramento River corridor of the North Delta. Those Legacy communities include Courtland, Hood, Locke, East Walnut Grove, West Walnut Grove/Ryde, Clarksburg, and Rio Vista.

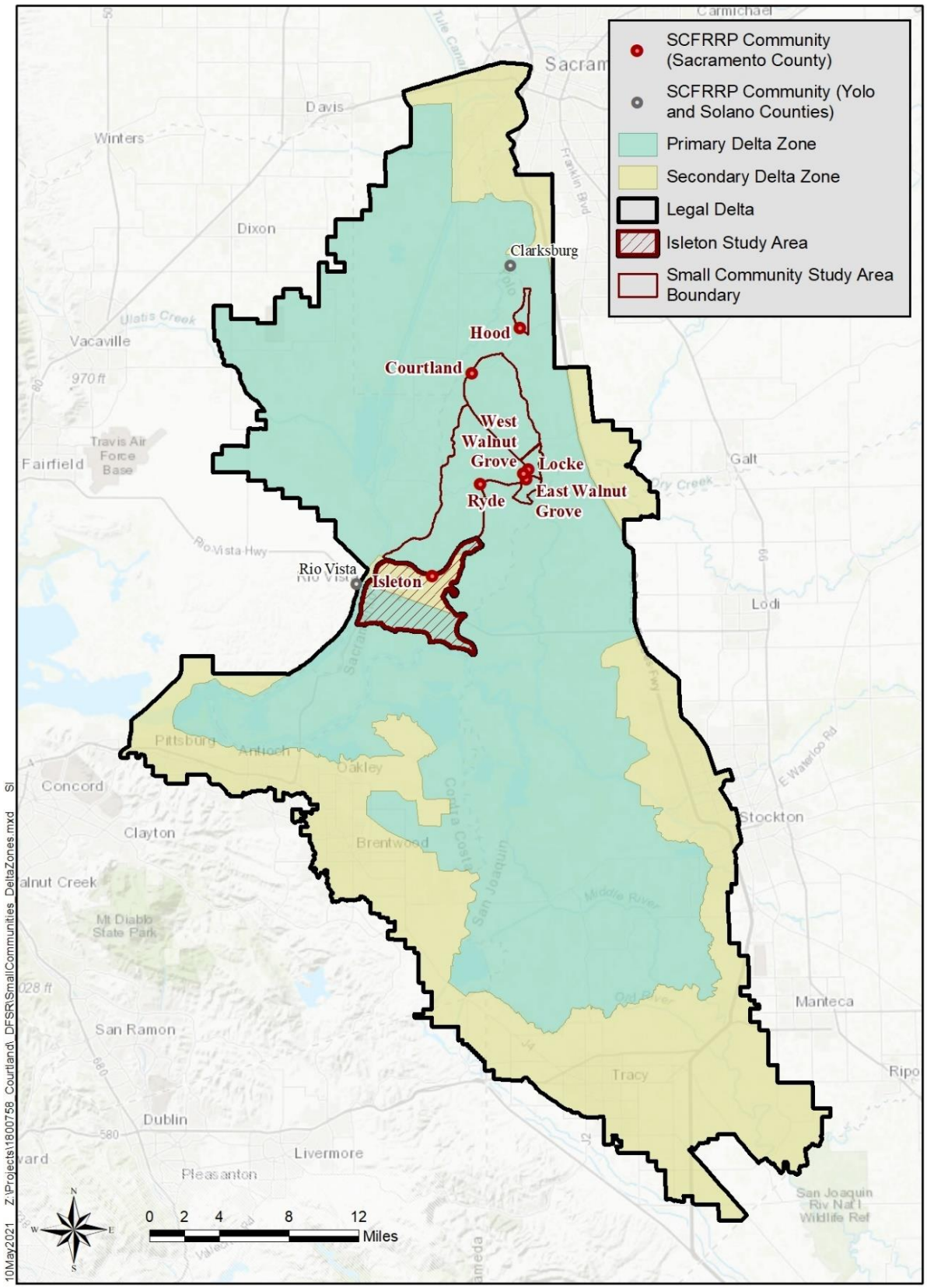

Figure 1-1. Delta Legacy Communities Participating in the DWR Small Communities Flood Risk Reduction Program

1.2 Goals and Scope of the Study

As described in the 2012 and subsequent 2017 CVFPP Update, the goal of the state as well as the Delta Legacy Communities is to improve SPFC levees and applicable adjoining non-SPFC levees protecting small communities to achieve 100-year (1% annual chance) flood protection, as defined by the Federal Emergency Management Agency (FEMA). Consistent with this goal, the goal of this feasibility study is to develop, evaluate, and prioritize structural and non-structural flood risk reduction measures for the Isleton study area, and to ultimately achieve 100-year flood protection and meet FEMA 100-year certification criteria.

Structural Flood Risk Reduction Measures

- Repair/strengthen in-place existing levee system(s)
- Strengthen existing levee(s)/embankments with cut-off walls, seepage berms, stability berms, etc.
- Repair existing erosion sites on levee systems
- Address and correct known encroachments/deficiencies in levee systems that pose threat to levee failure
- New setback levee in place of existing levee system segments

The flood risk reduction measures to be developed include multi-benefit objectives for Isleton and its agricultural, recreation, and socioeconomic attributes, where possible, as well as statewide water conveyance benefits along the Sacramento River and other north Delta freshwater corridors consisting of Georgiana Slough, the Mokelumne River, the San Joaquin River, and Seven Mile Slough. Improvements to the levee systems (SPFC and non-SPFC) protecting the Isleton study area can collectively enhance the resiliency and reliability of through-Delta water conveyance.

Non-Structural Flood Risk Reduction Measures

- New ring levee system(s) and/or new cross levee to isolate smaller areas (communities) from a larger perimeter levee system that may be more susceptible to levee failures
- New all-weather access roads or flood fight berms to address and potentially fend-off rising flood water that may occur in other portions of a large RD compared to a small fractional area (community) protected by a larger perimeter levee system
- Voluntary elevation of structures, ideally for potential flood depths greater than 3-5 feet
- Wet or dry floodproofing of structures, ideally for flood depths less than 5 feet, and some agricultural structures for flood depths greater than 5 feet
- Securing FEMA accreditation by executing a number of combined structural and non-structural measures pursuant to 44 CFR §65.10
- Improved emergency response; local hazard mitigation plans, flood emergency safety plans, and potential relief cuts
- Alternatives to FEMA's national flood insurance program – community- and flood-risk based insurance programs with or without formation of a geologic hazard abatement district
- Public awareness and education of local and regional flood risks
- Improved governance between neighboring LMAs/RDs and communities
- Regional/local flood easements and flood flow/channel conveyance enhancements
- Acquisitions and relocations of structures and residents

1.3 State's Interest in the Delta

The state of California has broad interests in integrated water management within the Delta which must be considered within the context of this feasibility study, including:

- *Water Supply Reliability* – The state supports the availability and conveyance of surface water (when available based on hydrologic conditions), timely delivery, and adequate water quality for urban and

agricultural water users. Water from north of Delta sources is delivered through the Delta by DWR, *via* the State Water Project (SWP), the State Water Contractors, and the U.S. Bureau of Reclamation, *via* the Central Valley Project (CVP).

SWP and CVP supplies conveyed south of Delta serve approximately 3M acres of agricultural lands and a population of 27M.

The entire volume of water conveyed by the SWP and CVP currently passes directly by Isleton *via* the SPFC-leveed channel of Georgiana Slough.

The 6 miles of SPFC levees along the right/west bank of Georgiana Slough protecting the Isleton study area also serve as a vital element of the primary through-Delta water conveyance channel in the North Delta.

Sustainable Delta – the state supports investments that contribute to Delta sustainability and resiliency in the face of sea level rise and climate change, which will likely result in higher and longer duration of flood stages.

- *Delta Ecosystem Protection, Enhancement, and Restoration* – The state supports integrating flood and water management with ecosystem restoration actions that may include, riparian, tidal marsh, freshwater marsh, and floodplain habitats.
- *Preserving the Unique Characteristics of the Delta* – Delta Legacy Communities have a distinct natural, agricultural, and cultural heritage with the state recognizing the importance of preserving and enhancing the unique characteristics of these Delta Legacy communities. Through numerous initiatives, the state has prioritized support for the preservation and revitalization of these communities, as well as the Delta agricultural economy and culture, fishing, boating, waterfowl and upland game bird hunting, wildlife viewing, and recreation. In addition to the state's recognition of significant cultural values, the entire Legal Delta has received the distinction as California's one and only National Heritage Area, designated by Congress in March 2019.
- *Providing Appropriate Levels of Flood Protection* – The state, through DWR, has a long history of cost-sharing with federal and local agencies on projects that provide benefits to the local, state, and national economic interests. Although operations and maintenance (O&M) is coordinated through LMAs in the Delta, for most areas, the state ultimately has O&M responsibility for SPFC facilities, including SPFC channel maintenance and an interest in providing technical and financial assistance for levee maintenance and rehabilitation of non-SPFC facilities within the Delta.

The state's investment in integrated water management must contribute to a sustainable Delta. Therefore, this feasibility study defines which actions could potentially contribute the most to Delta sustainability and how levee investment metrics are defined, tracked, and measured.

1.4 Isleton's Need for Improved Flood Protection

Isleton is one of eight Delta Legacy Communities located along the Lower Sacramento River Corridor in the North Delta participating in the SCFRRP (Figure 1-2). The levees surrounding the community of Isleton were initially constructed between 1860 and 1880 by local interests and were generally built using materials dredged from the adjacent Sacramento River and nearby Georgiana Slough. Various improvements have been made to the SPFC and non-SPFC levees in the study area over the years, including levee reconstruction and construction of setback levees. In 2006, FEMA reached out to Sacramento County and the levee maintenance districts including RDs 317, 407, and 2067 which collectively comprise Brannan-Andrus Levee Maintenance District (BALMD) to learn if adequate documentation supported certification of the levees. In 2012, FEMA updated the flood insurance rate maps (FIRMs) and the entirety of BALMD, inclusive of the City of Isleton, was collectively mapped as a Special Flood Hazard Area (SFHA) Zone AE.

As discussed further in Section 3.1.2, flood insurance is required for buildings with a federally backed mortgage located in a SFHA. To remove the entire study area including the community of Isleton out of SFHA Zone AE, the entire combined perimeter levee system would need to meet current, modern levee design standards to provide a 100-year level of flood protection (pursuant to FEMA accreditation standards in the Code of Federal Regulations, Chapter 1, Subchapter B, Part 65, Section 65.10 [44 CFR §65.10]); however, though the levees protecting the community of Isleton have stood the test of time, they currently fall well short of meeting these levee design standards. The levees also contain critical and serious sites under the DWR Flood System Repair Project (FSRP)[2] that still warrant immediate attention for repair, preferably by 2022-24.

Also, in 2012, the Biggert-Waters Flood Insurance Reform Act (BW-12) and the Homeowner Flood Insurance Affordability Act (HFIAA) were passed putting into motion substantial annual increases to flood insurance costs until premiums are rated based on the elevation certificate (*see* Section 3.1.2 for additional information on HFIAA). The unfortunate oversite in this is that the premiums don't recognize that the homes in Isleton are protected by a levee system. Consequently, whether or not one believes the flood hazard to be of concern, the cost of flood insurance administered by FEMA under the current National Flood Insurance Program (NFIP) has certainly become a large and continuously growing concern.

[2] Flood System Repair Project (FSRP). 2013.

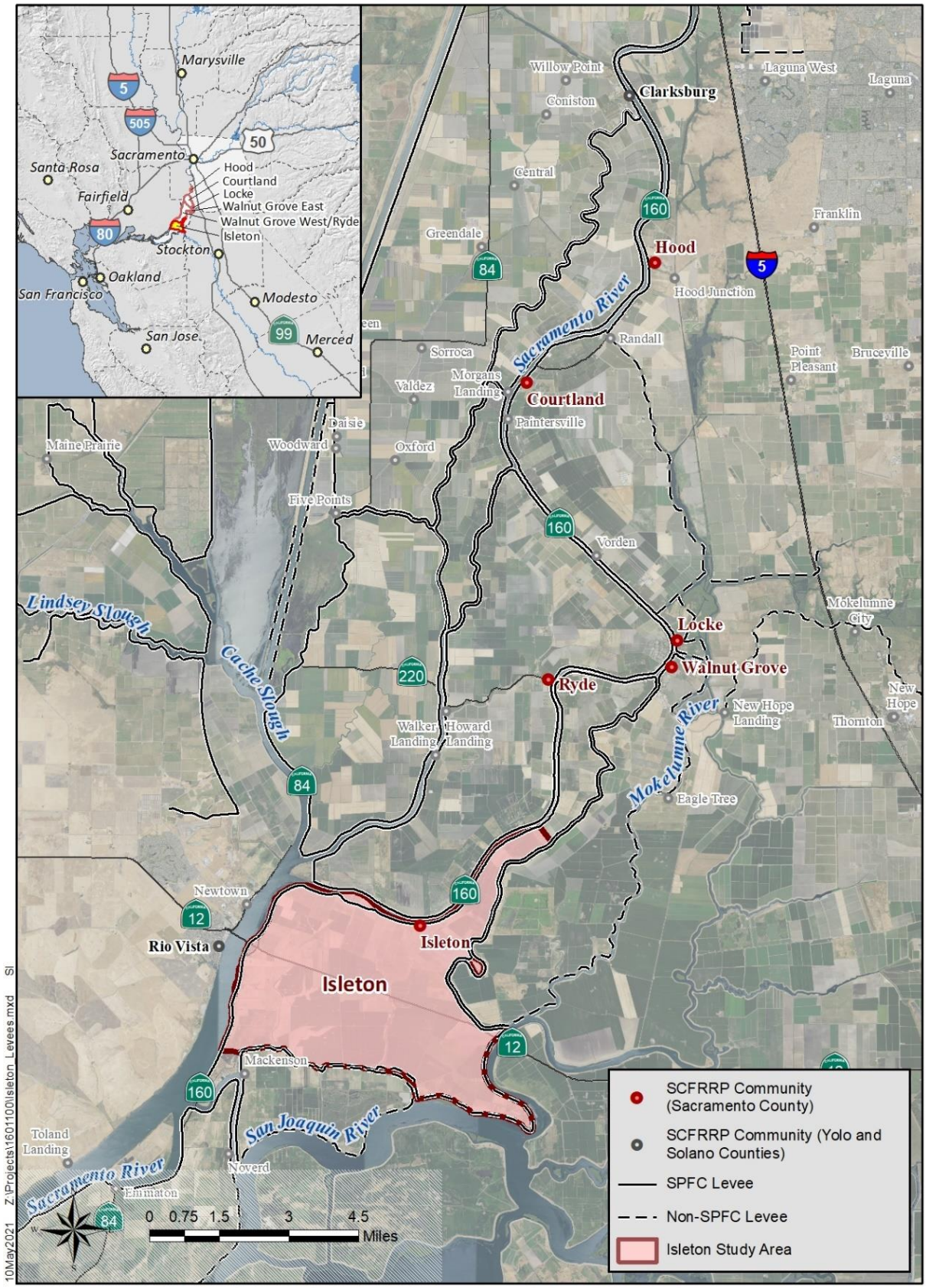

Figure 1-2. Delta Legacy Communities Participating in the SCFRRP

1.5 Study Area and Location

The study area for this SCFRRP effort includes the City of Isleton and the larger 12,800-acre agricultural area shared between BALMD, collectively known as Brannan-Andrus Island. Within the boundary of BALMD, RD 317 encompasses the tract of land known as Lower Andrus Island, RD 407 encompasses the tract of land known as Andrus Island, and RD 2067 includes the tract of land known as Brannan Island (Figure 1-3).

The City of Isleton encompasses approximately 190 acres and sits at an elevation that varies between -6 to +6 feet (North American Vertical Datum 1988 [NAVD 88]) along the east (left) bank of the Sacramento River, northeast of Rio Vista. Elevations and flood depths provided herein are referenced to NAVD 88. BALMD collectively maintains 26.3 miles of levee, excluding a 0.45-mile-long cross levee in RD 407 (RD 556 – Upper Andrus Island cross levee), 16.2 miles of SPFC levees along the collective left or east bank of the Sacramento River and along the right or west bank of Georgiana Slough, and 10.1 miles of non-SPFC levees along the Mokelumne River, the San Joaquin River, and Sevenmile Slough[3]. The RD 407 levee system, which contains roughly 7.5 miles of SPFC levees, protects approximately 1,700 acres, including the City of Isleton, which primarily consists of agricultural lands planted in permanent crops. The City of Isleton sits within the boundaries of RD 407. RD 2067 maintains roughly 8 miles of SPFC levees along the left or east bank of the Sacramento River that protects approximately 7,200 acres of primarily field crops, and RD 317 maintains roughly 2 miles of SPFC levees along the right of west bank of Georgiana Slough that protects approximately 3,900 acres also of primarily field crops. The three RDs which comprise BALMD are hydrologically connected, and a levee breach of the SPFC levees on the left bank of the Sacramento River or on the right bank of Georgiana Slough could very likely result in the inundation of significant portions of BALMD and the City of Isleton.

[3] In addition to other flood management facilities, the SPFC includes "Project levees," which were constructed by USACE as part of Federal-State flood control projects and were turned over to the State for O&M ("assurances"). The State has generally passed on the responsibility for routine maintenance of Project levees to LMAs. The SPFC relies on many other non-SPFC features, such as non-State or federal reservoirs to regulate flows and reduce loading on the system and private levees in the Central Valley or non-project (local) levees in the Delta, for which the State has not provided assurances.

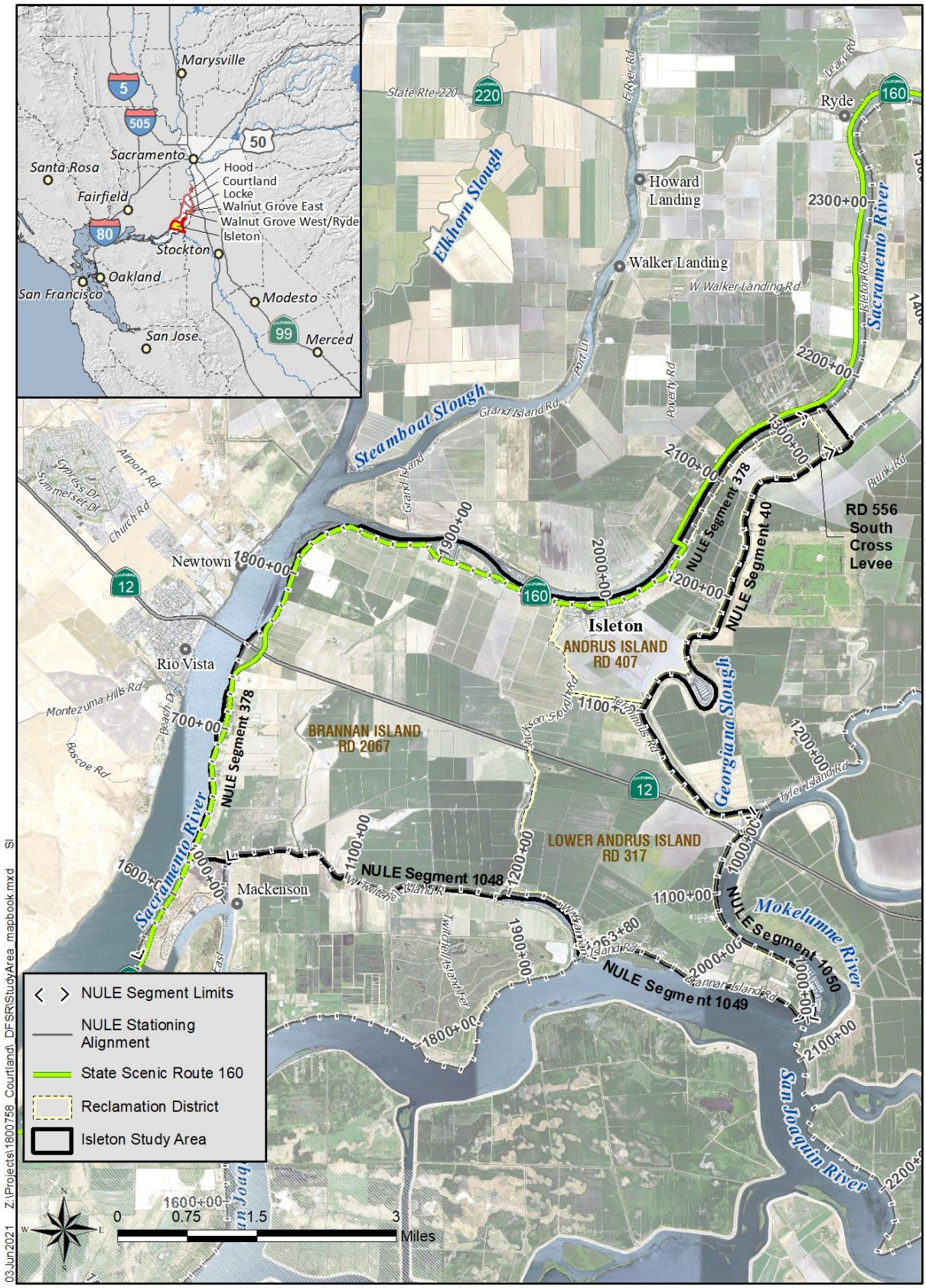

Figure 1-3. Isleton Study Area

1.6 Public Outreach and Engagement

This feasibility study has been prepared in close coordination with the City of Isleton and agencies with a shared interest in a safe, sustainable, and vibrant Delta. Isleton is working with local planning groups to share the story of Isleton, help the public understand flood risks, and share possible flood risk reduction planning documents and solutions for the future.

Visit the Isleton Story Map for more details: Isleton Story Map - City of Isleton Small Communities Flood Risk Reduction Program.

1.6.1 Stakeholder Identification and Outreach

The residents and business owners of Isleton have been invited and encouraged to participate in the planning effort. This feasibility study has been prepared in close coordination with representative participating stakeholders with interest and knowledge in providing enhanced flood protection for the Delta Legacy Community of Isleton. Stakeholders include representatives BALMD (inclusive of RDs 317, 407, and 2067), landowners and NFIP policy holders within BALMD, the City of Isleton, Sacramento County, State, and federal agencies (including FEMA), and non-governmental agencies with interests at the nexus of ecosystem restoration and flood risk solutions within and beyond the Delta. Community residents and landowners within Isleton are encouraged to stay engaged in this process.

1.6.2 Communications and Engagement

The goal of this feasibility study is to have the flood risk reduction solutions developed, promoted, and prioritized by the community of Isleton, inclusive of areas beyond the town of Isleton and within BALMD.

1.6.3 Coordination with Key Agencies within the Delta

This feasibility study has been prepared in close coordination with the Delta stakeholders. They include representatives of LMAs, landowners and FEMA NFIP policy holders within BALMD, the Delta Legacy Communities Task Force, the City of Isleton, Sacramento County, state and federal agencies, and non-governmental agencies with environmental interests that are knowledgeable about the flood risks and potential solutions within the Delta.

Although many agencies are involved in the Delta, three regional agencies are heavily involved in land use policy and sustainability in this region and thus have a special interest in SPFC improvements, as detailed below.

1.6.3.1 Delta Protection Commission

The DPC is focused on conservation of agricultural land and supporting economically sustainable agricultural operations in the Delta. The DPC maintains and implements the Land

Use and Resource Management Plan (LURMP) for the Primary Zone of the Delta. City and County General Plans and future projects that affect land use in the five Delta counties must be consistent with the LURMP and are subject to review by the DPC.

1.6.3.2 Delta Stewardship Council

The Delta Stewardship Council (DSC) was created to achieve the state mandated coequal goals for the Delta. The DSC also drafted, updates, and administers the Delta Plan, a long-term management plan with recommendations to further the coequal goals, in a manner that protects and enhances the unique cultural, recreational, natural resources, and agricultural values of the Delta as an evolving place. All proposed projects within the Delta must be consistent with the Delta Plan, which precludes displacement of agricultural land uses with non-agricultural land uses and subsequent structural solutions, such as improving and modifying the existing levee systems identified in this study for the community of Isleton, which may be subject to a consistency determination by the DSC.

1.6.3.3 Delta Conservancy

The Delta Conservancy (Conservancy) is the primary state agency focused on the implementation of ecosystem restoration in the Delta and supports efforts that advance environmental protection and the economic well-being of Delta residents. The Conservancy collaborates and cooperates with local communities and other parties to preserve, protect, and to restore the natural resources, economy, and agriculture of the Delta and Suisun Marsh. The Conservancy also collaborates on Delta branding and marketing, the Delta Carbon Program, invasive species control, and the California Department of Fish and Wildlife (CDFW) Delta Conservation Framework. The Conservancy's Delta Public Lands Strategy includes integrated conservation for publicly funded lands in the Delta.

DSC Delta Plan Coequal Goals

1) Providing a more reliable water supply for California and
2) Protecting, restoring, and enhancing the Delta ecosystem.

"The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." (CA Water Code §85054)

1.7 Related Plans, Programs and Studies

Many plans influence flood management in the Delta, as summarized below. In particular, this study aggregates and uses evaluations from the CVFPP and DWR's Non-Urban Levee Evaluations (NULE) Program and FSRP to inform the development and prioritization of flood risk reduction measures for the Isleton study area.

1.7.1 Central Valley Flood Protection Plan

The CVFPP, mentioned previously, proposed improvements to SPFC levees, and where applicable, Delta (non-SPFC) levees, ecosystem enhancements, and flood risk reduction

measures for small communities. The CVFPP identifies structural and non-structural options to protect small communities from the 100-year flood and is the basis for selecting flood risk reduction elements and MAs considered in this feasibility study, including (DWR, 2012a):

1. Reconstructing or repairing perimeter levees in-place or making improvements to existing SPFC perimeter levees and non-SPFC levees that could impact and/or enhance the performance of SPFC levees.
2. Protecting small communities "in-place" using ring levees, training levees, or floodwalls when improvements do not exceed a certain predetermined cost threshold.
3. Implementing non-structural improvements, such as developing flood fight berms, raising and elevating structures, floodproofing, willing seller purchases, and/or relocating structures when the in-place improvements described above are not feasible.

1.7.2 Sacramento River Basin-Wide Feasibility Study

The Sacramento River Basin-Wide Feasibility Study (BWFS) was prepared subsequent to the 2012 CVFPP and focused on a multi-benefit approach to expansion of the flood bypasses. Solutions proposed in the BWFS germane to the Isleton study area include addressing system capacity constraints to allow for improved conveyance through widening the Yolo and Sacramento bypasses and Fremont and Sacramento weirs. These expansions and modifications are underway and are expected to provide a reduction in flood stage of 1 to 2 feet along segments of the Sacramento River adjacent to Delta Legacy Communities, as depicted in Figure 1-4. The noted expansions and modifications to the upstream Sacramento and American rivers/bypasses will help neutralize some of the basin-wide impacts of climate change in the Lower Sacramento River as most all excess flows will be diverted into the bypass systems with metered or controlled flows being routed downstream of the American River into the Lower Sacramento River in the North Delta. However, it should be noted that the Sacramento River BWFS did not fully address climate change impacts from the adjoining, largely unregulated basins of Morrison Creek, Snodgrass Slough, the Cosumnes and Mokelumne rivers, and Dry Creek that impact high flow stages in the Mokelumne River abutting the Isleton study area. Climate change could result in higher flood flows and stages within the Morrison Creek, Cosumnes, and Mokelumne river watersheds that can collectively or individually impact downstream flood stages in the Mokelumne River that may increase the risk of flooding to the community of Isleton.

1.7.3 Lower Sacramento River/Delta North Regional Flood Management Plan

The 2014 RFMP was developed by FloodProtect, a regional working group, as the regional follow-on to DWR's 2012 CVFPP. The 2014 RFMP was funded by DWR but drafted by local agencies and identified pre-feasibility level regional flood management solutions (FloodProtect, 2014). The 2014 RFMP also recommended further flood risk reduction feasibility studies for many small communities and Delta Legacy Communities, including Isleton.

1.7.4 Delta Levees Investment Strategy

The Delta Levees Investment Strategy (DLIS) was prepared by the DSC as a follow-up to the Delta Plan to identify funding priorities for state investments in Delta levees. Funding priorities were developed using a risk-based analysis, which quantified risks to people, property and infrastructure, water supply reliability, ecosystems, and the Delta as a place, by developing estimates of flooding probability due to seismic and hydrologic events.

The DSC's goal was to develop a list of very-high priority and high priority islands and tracts by quantifying risks using several metrics, such as expected annual fatalities and expected annual damages (EAD). Seventeen islands were identified as very-high priority and 36 islands and tracts were identified as high priority (DSC, 2017). Brannan-Andrus Island was placed in the "Very High" category, and as such, is currently highly prioritized for state investments under the current DLIS prioritization (Figure 1-5).

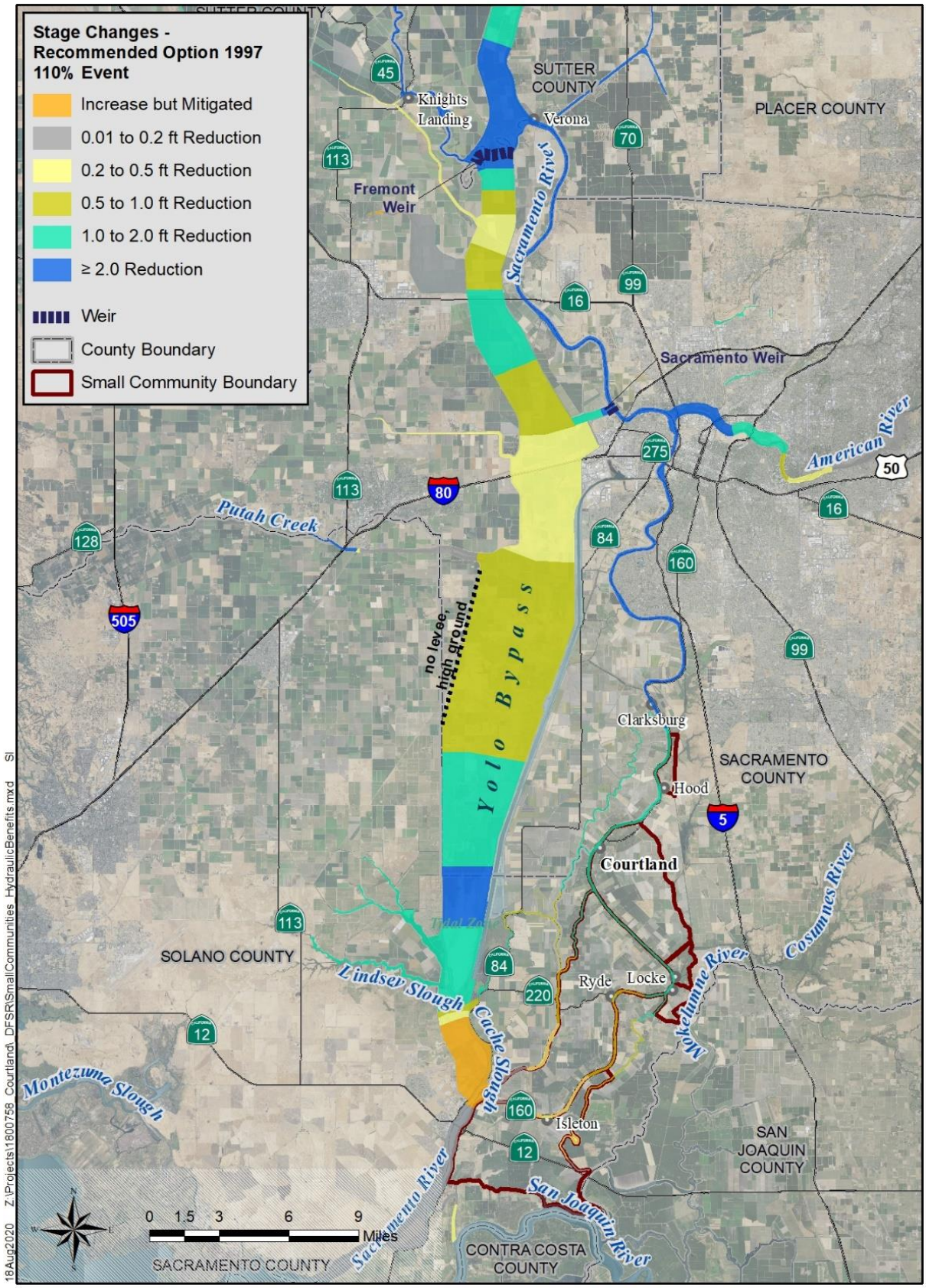

Figure 1-4. Flood Stage Reductions as a Result of the BWFS Expansions and Modifications

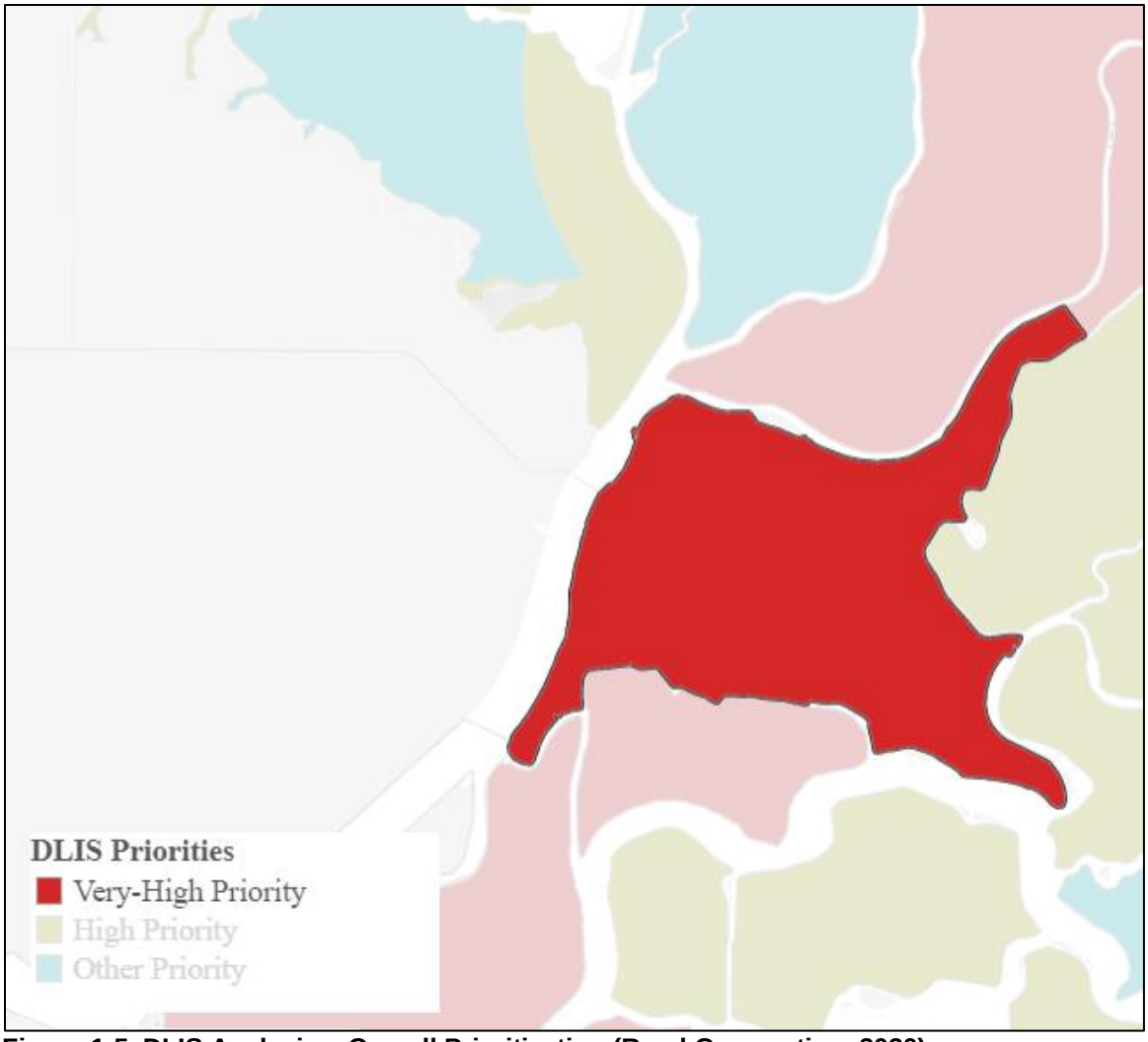

Figure 1-5. DLIS Analysis – Overall Prioritization (Rand Corporation, 2020)

It should be noted that the DSC is in the current process of updating their DLIS, based upon more current data and updated methodologies. A representation of the initial DLIS analysis (annual probability of flooding due to a hydrologic event) is shown in Figure 1-6. The Isleton study area was initially estimated to have an annual probability of 1.9 percent of flooding as a result of a hydrologic event according to DLIS. This annual probability of flooding is largely based upon levee geometry, namely freeboard levels relative to overtopping, combined with information provided in the Delta Risk Management Strategy, and not the current geotechnical characteristics of the BALMD levee system.

The rulemaking process to adopt regulations implementing the DLIS is ongoing. However, the interactive DLIS Decision Support Tool representing the current prioritization and analysis framework is publicly accessible online.[4]

[4] https://www.rand.org/pubs/tools/TL266/tool.html

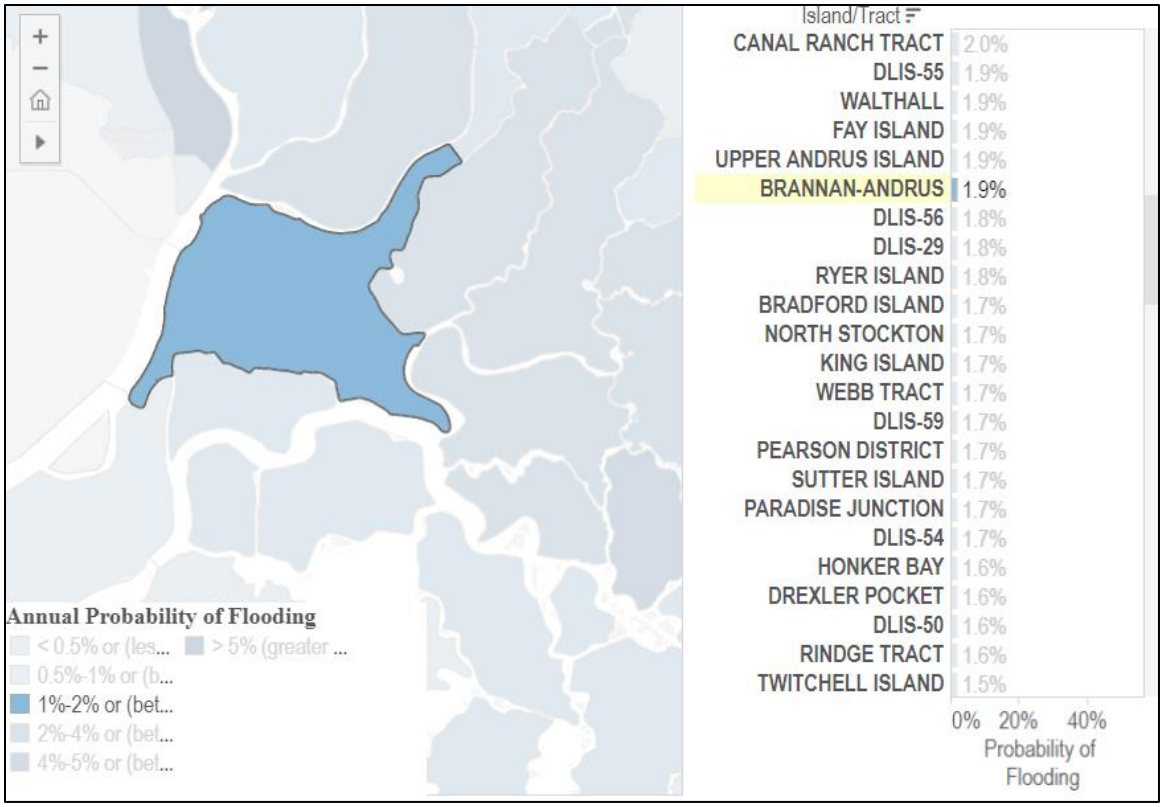

Figure 1-6. DLIS Analysis - Hydrologic Event (Rand Corporation, 2020)

1.7.5 Flood System Repair Project

The FSRP is funded by $150M of Proposition 1E funding and its purpose is to assist LMAs in reducing flood risk on a cost-sharing basis. Through the FSRP, LMAs are provided technical and financial support to repair documented critical or serious problems with flood protection. The master database from the FSRP identifies levees with past performance problems for seepage, slope instability, erosion, and other problems (FloodProtect, 2014). There are four serious sites and one critical site identified by the FSRP along the left bank of the Sacramento River and along the right bank of Georgiana Slough and the Mokelumne River that collectively pose imminent flood threats to the community of Isleton, requiring priority attention. It is hoped that this feasibility study in combination with the DWR FSRP can assist BALMD and the community of Isleton in prioritizing and implementing the remaining repairs of the known and documented FSRP critical and serious sites by 2022 to 2024.

1.7.6 Non-Urban Levee Evaluations

DWR's NULE program evaluated non-urban levees against geotechnical criteria likely to impact levee performance, including stability, through seepage, underseepage, and erosion. In general, the program was administered using a phased approach in communities with less than 10,000 residents and included Phase 1 preliminary geotechnical evaluations using historical data for all NULE levees and Phase 2 geotechnical field investigations to further evaluate those levees

protecting more than 1,000 persons. NULE levee segments were assigned ratings based on potential failure mode and placed in an overall hazard category for which recommendations and cost estimates were prepared. Data from the NULE program are currently used in conjunction with LMA inspection reports and data from the FSRP to characterize SPFC and non-SPFC levees and to inform future state, regional, and local flood planning and financing efforts.

The results of Phase 1 NULE studies for the study area are detailed in Appendix A and in Section 2.1.1, Topography and Levees. However, the Isleton study area did not meet the population threshold for NULE Phase 2 studies, and therefore geotechnical investigations were not conducted as part of that study. Therefore, site-specific geotechnical conditions were warranted, and cone penetration test (CPT) soundings and accompanying soil sample lab tests were conducted as part of this study in 2020 to further inform this feasibility study (*see Appendix A* for additional information).

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2. Existing Conditions

2.1 Existing Conditions

2.1.1 Topography and Levees

Ground elevation for the Isleton study area is highest immediately adjacent to the levees (6-12 feet, NAVD 88 primarily along the left bank of the Sacramento River) and slopes toward the center of BALMD (less than -18 feet, NAVD 88) (Figure 2-1). The community of Isleton generally sits at an elevation of -6 to 6 feet NAVD 88 near the landward base of the adjacent Sacramento River levee in comparison to the larger study area that is 12 feet or greater below sea level (less than 12 feet NAVD 88), near the center of BALMD.

The study area consists of 28.2 miles of levees, including DWR NULE Segments 40, 378, 1048, 1049, and 1050, and a cross levee adjoining BALMD and RD 556 (Figure 2-1). Of these, approximately 17.6 miles are SPFC levees along the Sacramento River (NULE Segment 378, 11.6 miles) and Georgiana Slough (NULE Segment 40, 6.0 miles), and the remaining 10.5 miles are non-SPFC levees located along the Mokelumne River to the east (NULE Segment 1050, 2.9 miles), the San Joaquin River to the south (NULE Segment 1049, 2.6 miles), Sevenmile Slough to the south (NULE Segment 1048, 4.6 miles), and a cross levee adjoining BALMD and RD 556 (0.4 miles) (URS, 2011a).

As part of the 2017 update to the CVFPP, flood risk was assessed by defining impact areas with associated index points within the San Joaquin and Sacramento river basins. Within this context, defined flood risks were quantified at discrete index points with impact area-specific levee performance curves. The levee performance curves were developed to be representative of a levee reach protecting the impact area, typically the worst case. The Isleton study area was aggregated into one impact area (SAC 54 [Andrus Island]) and five index points to represent the hydrologic, hydraulic, and geotechnical conditions for the left bank of the Sacramento River, the right bank of Georgiana Slough, and the Mokelumne and San Joaquin rivers, and the right bank of Sevenmile Slough.

Levee performance curves were collectively updated by DWR and the City of Isleton for each of the project levee segments in the study area during the course of this study as a result of geotechnical explorations performed in 2020. For the purposes of this study, the existing SAC 54 impact area was divided into three new impact areas: SAC 54 - Urban, which is representative of the community of Isleton, SAC 54 - N1, which is representative of RD 556, and SAC 54 - N2, which represents the remainder of BALMD (Figure 2-2). SAC 54 - N1 is outside the bounds of the Isleton study area and is not used within the context of this feasibility study.

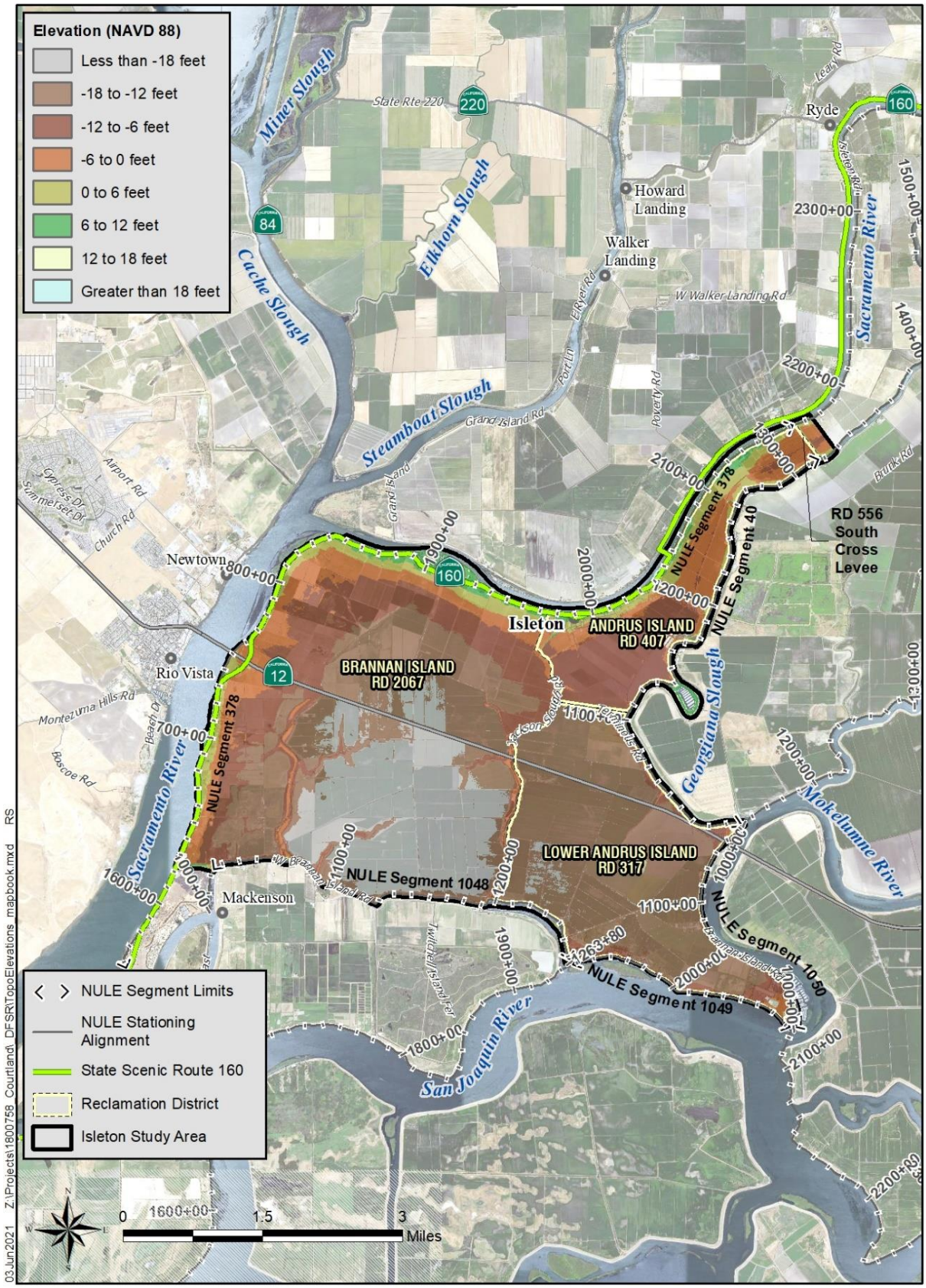

Figure 2-1. Study Area Ground Elevations and Levees

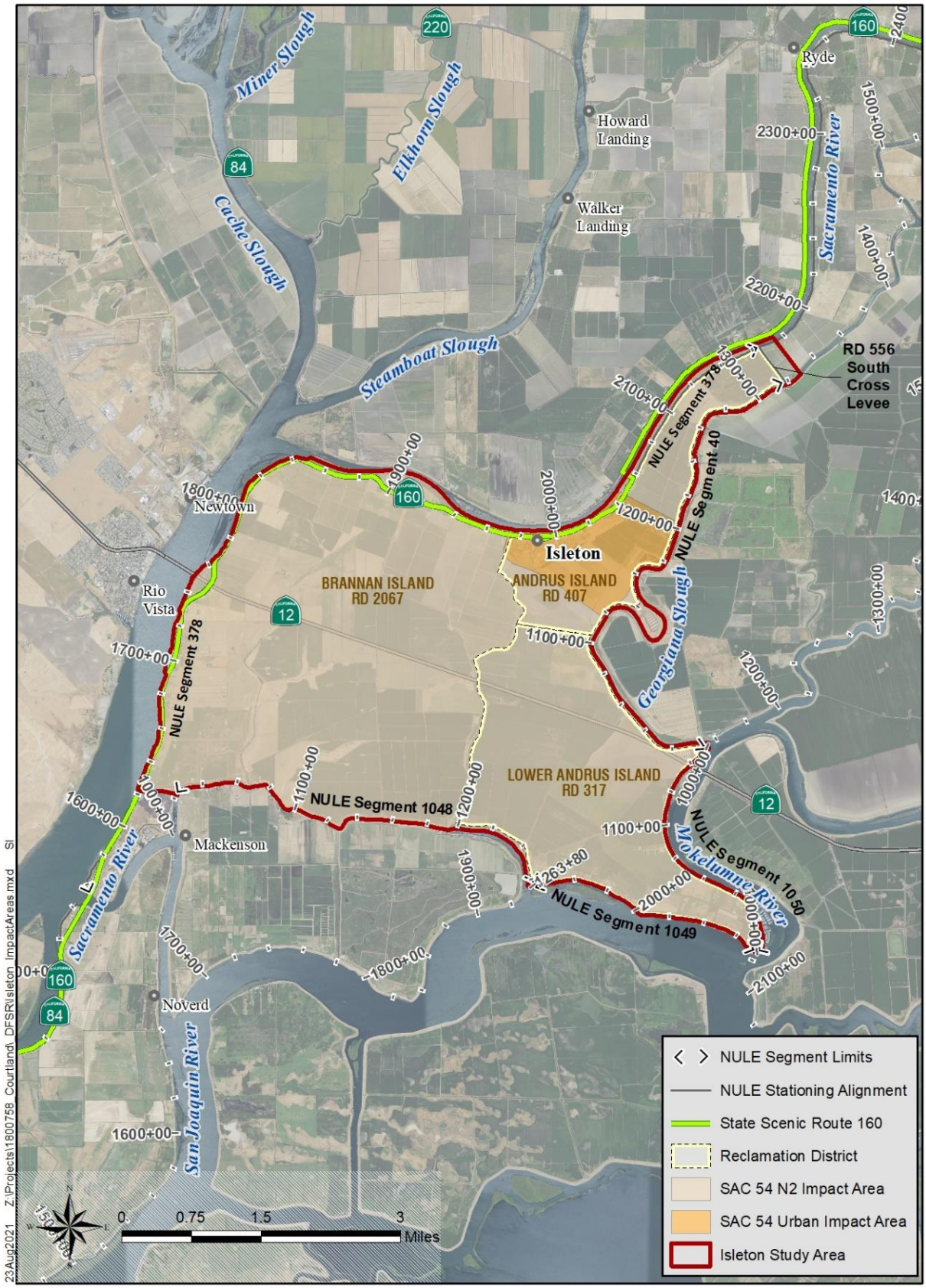

Figure 2-2. Isleton Study Area Impact Areas

The DWR NULE program reviewed and summarized the NULE Segment geometry based on Light Detection and Ranging (commonly known as LiDAR) topography collected for DWR's Central Valley Floodplain Evaluation and Delineation between October 2008 and February 2009. Documented geometry information for the levees in the study area is summarized in Table 2-1.

Table 2-1. Summary of Levee Geometry

NULE Segment	Segment Location	Approximate Levee Height	Approximate Crest Width	Approximate Landside Slopes	Approximate Waterside Slopes
378	Left Bank Sacramento River BALMD (SPFC levee)	Typically, 12 to 15 feet, but range from 8 to 25 feet above the landside toe. High ground on landside for approximately southern 1.3 miles.	25 to 80 feet, except typically 20 to 25 feet from approx. levee mile (LM) 0.1 to LM 2.0 (north of Isleton)	Typically, 2H:1V, but range from 1.5H:1V to 6.6H:1V	Often steeper than 3H:1V, but range from 1.1H:1V to 3.5H:1V
40	Right Bank Georgiana Slough BALMD (SPFC levee)	10 to 20 feet above the landside toe	15 to 40 feet	2H:1V to 4H:1V	2.5H:1V to 1H:1V
1050	Right Bank Mokelumne River BALMD (Non-SPFC levee)	15 to 24 feet above the landside toe for most of segment. 10 to 12 feet above the landside toe for approx. southern 0.5 mile.	15 to 30 feet	4H:1V to 6H:1V Except 2H:1V to 5H:1V for approximately southern 0.5 miles	2H:1V to 3.5H:1V
1049	Right Bank San Joaquin River BALMD (Non-SPFC levee)	17 to 22 feet above the landside toe, except about 12 feet above the landside toe for approximately eastern most 0.4 miles	15 to 25 feet	Typically, 3H:1V, but range from 2H:1V to 4.5H:1V	2H:1V to 3H:1V
1048	Left Bank Seven Mile Slough BALMD (Non-SPFC levee)	20 to 28 feet above the landside toe	15 to 25 feet	Typically, 3H:1V, but range from 2.5H:1V to 5H:1V	1.5H:1V to 3H:1V

Source: URS, 2011a

2.1.2 Geomorphology

Geomorphology (bed and bank erosion and sediment deposition) mapping developed for the DWR NULE project indicates the BALMD levees along the Sacramento River and Georgiana Slough primarily overlie historical overbank deposits (Rob) which is underlain by Holocene

overbank deposits (Hob) (Figure 2-3). Overbank deposits likely consist of interbedded sand, silt, and clay deposited during high-stage flow, overtopping channel banks. Localized areas of historical crevasse splay deposits (Rcs), historical distributary channel deposits (Rdc), and Holocene slough deposits (Hsl) are also present. The crevasse splay deposits are likely to consist of fine to coarse sand with minor lenses of gravel deposited from breaching of natural levees. The distributary channel deposits likely contain sand, silt, and clay from channeled flow conducting sediments to floodplain. The slough deposits are likely to consist of silt, clay, and trace sand, fining upward from low-energy channel deposits. Along the landside of the southern approximately 1.3 miles if the BALMD Sacramento River left bank levee, where high ground is present, dredge spoils are mapped. Interior to the BALMD basin and below Georgiana Slough is mapped as Holocene peat and muck (Hpm), likely composed of interbedded peat and organic-rich silt and clay from former tidal marsh deposits.

The available DWR NULE geomorphology mapping for the BALMD levees along the right bank the North Mokelumne River, the right bank of the San Joaquin River, and the left bank of Seven Mile Slough is less detailed but indicates that these portions of the BALMD levee system overlie Hpm. *See* Appendix A for additional information on existing geotechnical conditions within the study area and the collection and evaluation of 8 recent CPT explorations and subsequent laboratory data that were gathered in 2020 as a component of this feasibility study.

Levees within the study area which are built on sandy soil materials are of particular note since these levees can be particularly impacted by through seepage and underseepage, which can result in levee failure if left unchecked. In these areas where the levees are more susceptible to seepage and underseepage, remediations to address these vulnerabilities are generally more costly, requiring deeper vertical cutoff walls or wider combination seepage/stability berms. Retrofitting these levees, which is required to secure FEMA accreditation, can often cost upwards of $15M per mile. Click here to read FEMA's guidance for levee certification that lists a number of additional criteria that must be met in addition to the underlying seepage problems that are prevalent throughout the North Delta and other leveed areas within the Sacramento and San Joaquin river basins.[5]

[5] https://www.fema.gov/sites/default/files/documents/fema_levee-guidance.pdf

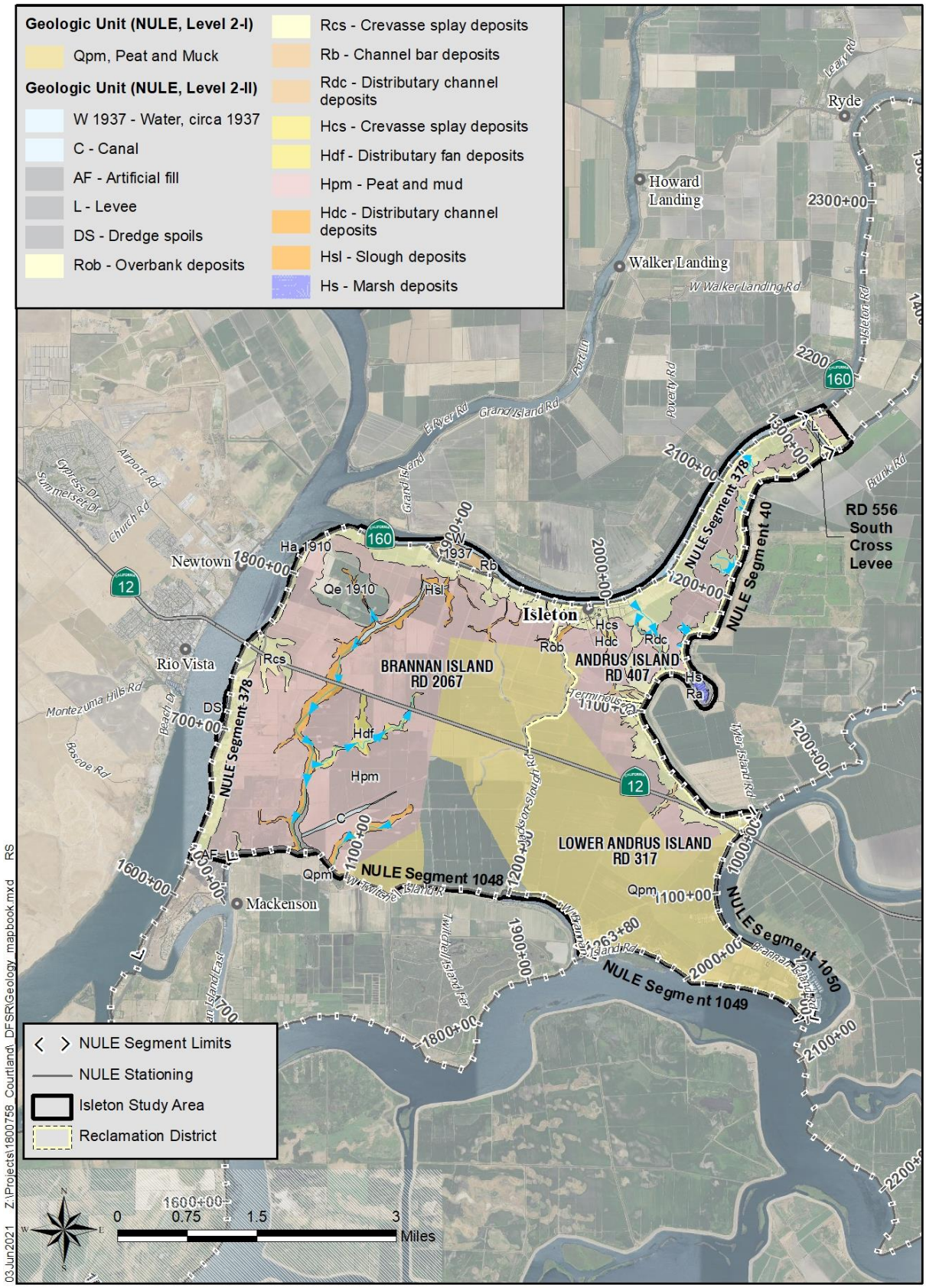

Figure 2-3. Geomorphology within the Study Area

2.1.3 Population, Communities, and Land Use

Isleton's population as reported by Sacramento County in the 2016 Local Hazard Mitigation Plan (LHMP) update is close to 900 residents (Sacramento County, 2016). Between 2018 and 2019 the median household income declined from $47,639 to $46,290 (United States Census Bureau, 2010). As of 2018, Isleton is considered a disadvantaged community by the state of California.

Sacramento County has designated Lower Andrus Island as a Special Planning Area (SPA). The community is subject to the County's SPA ordinance which drives land use planning and development. The limits of the Lower Andrus Island SPA are shown in Figure 2-4.

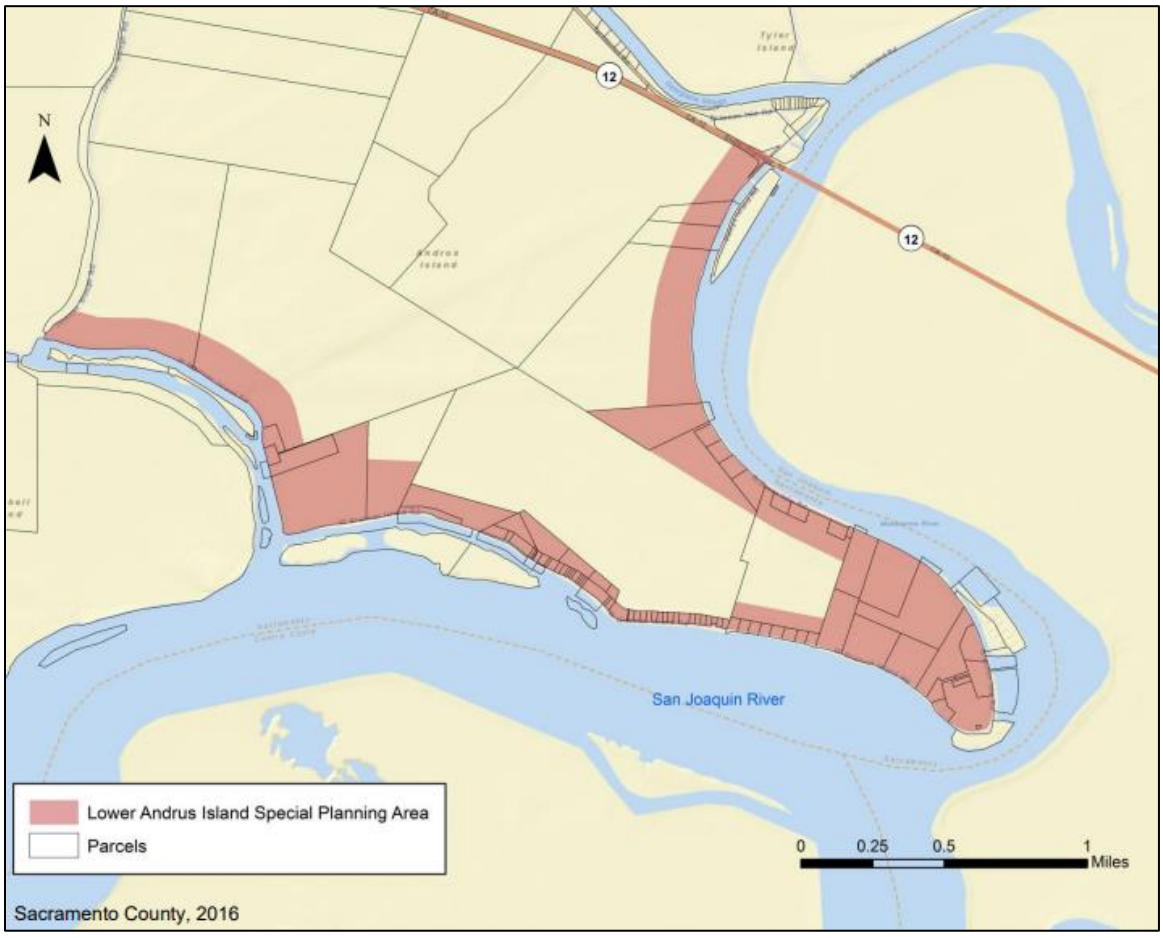

Figure 2-4. Lower Andrus Island Special Planning Area (Sacramento County, 2016)

Unlike many other Delta Legacy Communities, the community of Isleton is not located entirely within the Primary Zone of the Legal Delta. The portion of BALMD south of Highway 12 (portions of Brannan Island and the majority of Lower Andrus Island) is located within the Primary Zone of the Legal Delta, with the remaining portion of BALMD located north of Highway 12, inclusive of the community of Isleton, located within the Primary Zone of the Legal Delta. As a result, local and County general plans and land use decisions within those areas in the Primary Zone of the Legal Delta are the key areas subject to the Delta Plan and reviews by both the DPC and DSC. Permitted land uses under the Delta Plan for the City of Isleton and adjoining areas administered by the Delta Stewardship Council are shown in Figure 2-5.

2.1.4 Hydrology and Hydraulics

The Isleton study area is bounded by the Sacramento River and Georgiana Slough and its tributary waterways. These waterways are influenced by tidal conditions from the San Francisco Bay. The Sacramento River watershed is approximately 27,500 square miles and drains north to south. Flows in the Sacramento River are regulated by four major upstream reservoirs, namely, Shasta, Oroville, New Bullards Bar, and Folsom. The upstream Yolo Bypass and Sacramento Bypass channels are currently designed and operated to divert as much as 75 percent of the total flood flows from the Lower Sacramento River. Systemwide improvements are planned and identified in the 2017 CVFPP Update to enlarge the Sacramento and Yolo Bypass and Weirs upstream of the Delta which will divert or shunt greater amounts of flood flows (greater than 75%) away from the Lower Sacramento River. However, as shown in Figure 1-4, these improvements could result in higher stages in the Sacramento River and Georgiana Slough which abut the Isleton study area.

Estimated existing 100-year flows and future 100-year peak flows adjusted for climate change and sea level rise which account for future systemwide improvements, along with predetermined U.S. Army Corps of Engineers (USACE) 1957 design flow and profile, are summarized in Table 2-2. Additional information on how these peak flows were estimated can be found in Appendix I. The existing 100-year peak flow in the Sacramento River from Georgiana Slough to Cache Slough is approximately 45,200 cubic feet per second (cfs). In Georgiana Slough between the junction with the Sacramento River and the Mokelumne River, 100-year peak flow is estimated at 19,900 cfs. For the Sacramento River, the future 100-year peak flow is approximately 10 percent lower than the existing 100-year peak flow (due to planned upstream Yolo & Sacramento Bypass improvements), with the future 100-year peak flow marginally increased for Georgiana Slough.

Table 2-2. Sacramento River 100-Year Peak Flows and USACE 1957 Design Flows

Reach	Existing 100-Year Peak Flow (cfs)	Future 100-Year Peak Flow (cfs)	USACE 1957 Design Flows
Sacramento River, Georgiana Slough to Cache Slough	45,200	39,070	35,900
Georgiana Slough, Sacramento River to Mokelumne River	19,900	20,050	20,600

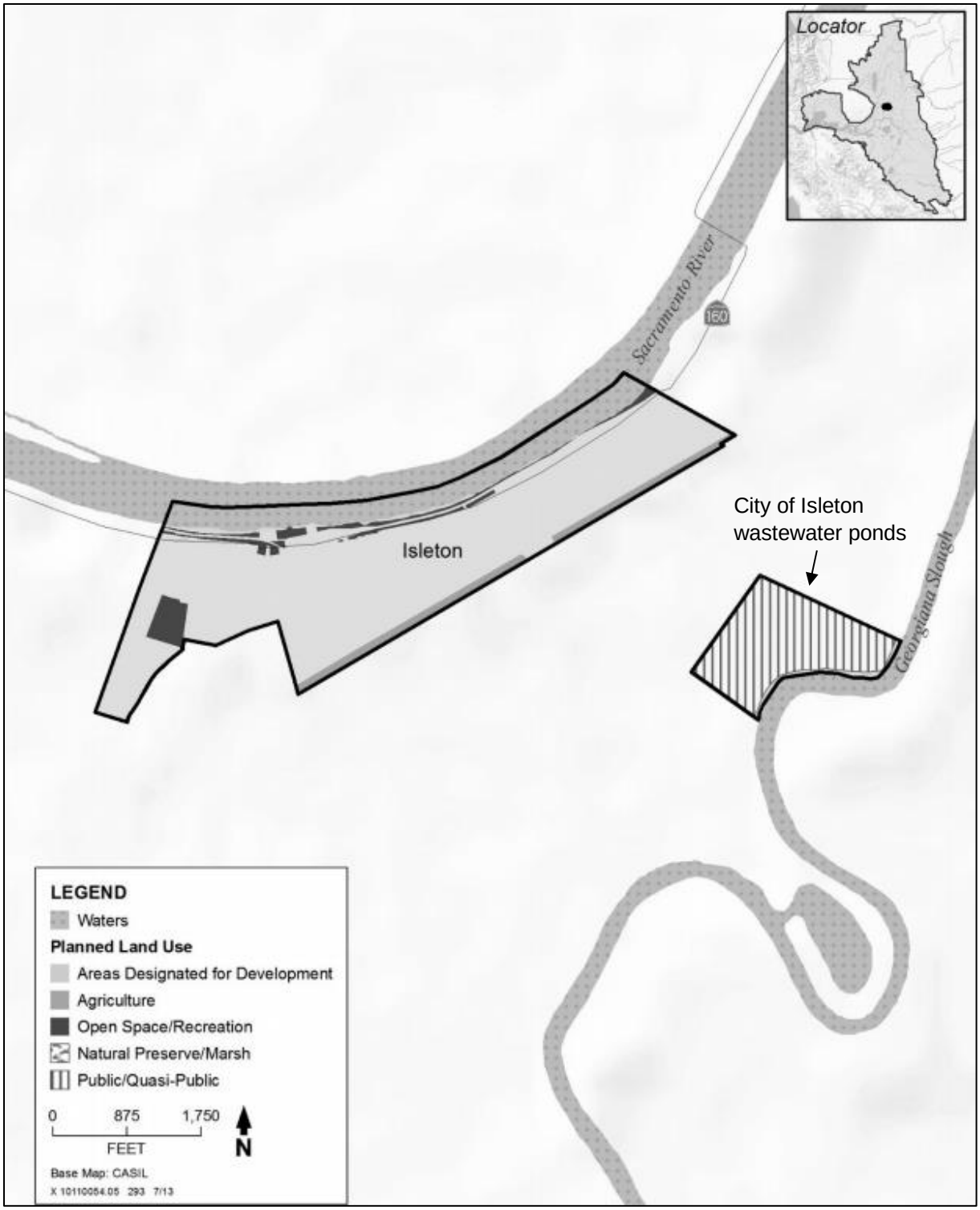

Figure 2-5. City of Isleton Land Use (DSC, 2013)

It should also be noted that, at some locations, the 100-year water surface profile "With Future Conditions" (inclusive of the upstream system-wide bypass/weir improvements, climate change adjustments and downstream sea level rise adjustments) is 1 to 1.5 feet higher than the USACE

1957 profile grade that is used as a guide for the operations and maintenance of the BALMD perimeter levee system (Figure 2-6). *See* Appendix I for further details on the water surface elevations (WSEL), current and future, that are anticipated for the Sacramento River and Georgiana Slough surrounding the Isleton study area.

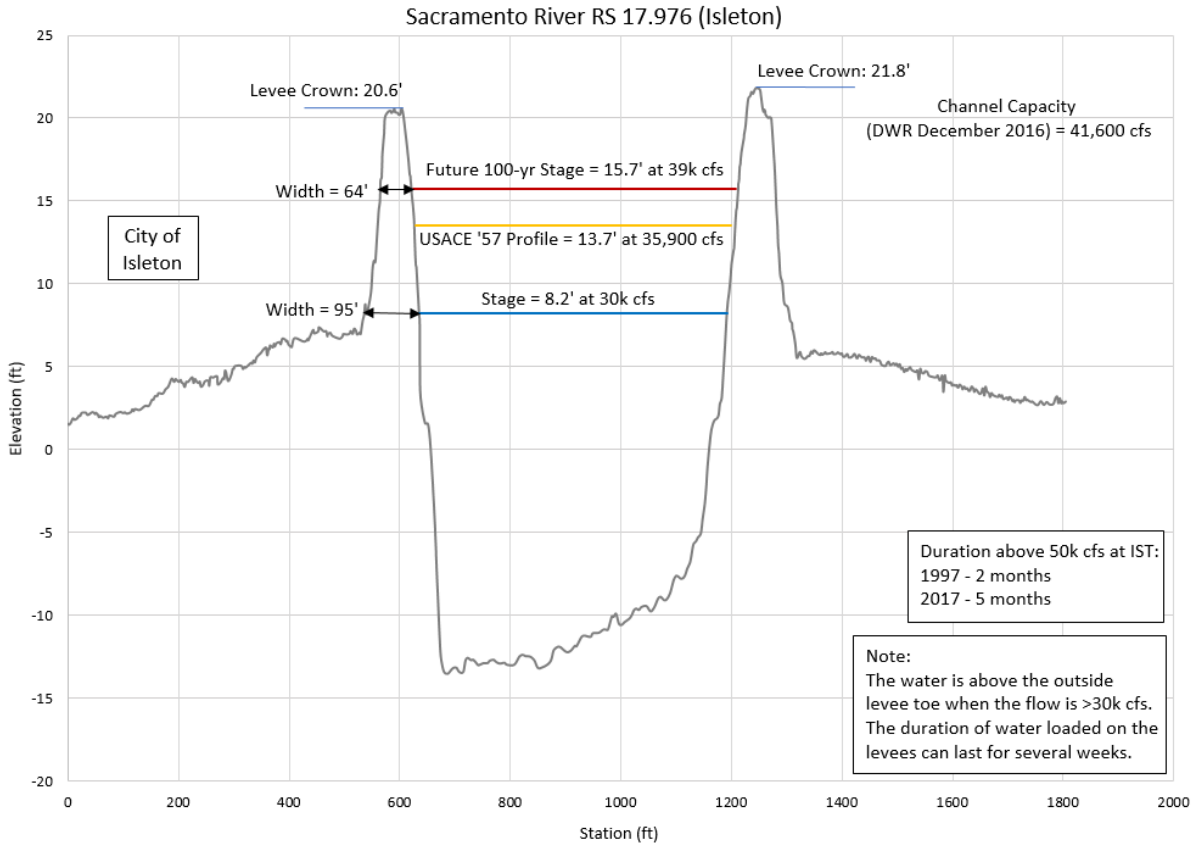

Figure 2-6. Cross Section at Sacramento River Station 17.976 at Isleton Viewing Downstream

Note that the hydrologic and hydraulic (H&H) models and information presented in supporting Appendix I were not deployed in connection with conducting the EAD analyses that were performed by HDR, Inc. (Appendix E, August 2021) in connection with this Feasibility Study. The EAD analyses for the Isleton SCFRRP study efforts were conducted consistent with the same hydrologic and hydraulic models deployed for the most recent CVFPP planning efforts. The EAD evaluations for current hydraulic conditions were performed consistent with the concurrent efforts for the 2022 CVFPP updates; whereas EAD future conditions with adjustments for climate change, inclusive of sea level adjustments, were conducted consistent with the adjustments developed for the previous 2017 CVFPP planning efforts.

2.1.5 Water Resources and Water Conveyance

Delta waterways are important to North Delta communities and the state's water supply system. Isleton lies along the Sacramento River downstream of the Delta Cross Channel. Georgiana Slough, the Mokelumne and San Joaquin rivers, and Sevenmile Slough are also adjacent to

BALMD and the Isleton study area. These waterways provide vital agricultural water supply to local farmers and also convey water to areas throughout the state of California south of the Delta.

2.1.6 Existing Infrastructure

The community of Isleton is served by California American Water, and the City of Isleton owns and operates the wastewater collection, treatment, and disposal system that serves the City. The collection system conveys wastewater from the City of Isleton to two stabilization ponds totaling approximately 7 acres in size, which is ultimately conveyed to evaporation/percolation ponds totaling over 24 acres in size. The City's wastewater collection ponds are subject to flooding from potential levee failures that may occur anywhere within the greater project study area protected by the combination of BALMD SPFC and non-SPFC levees. The same wastewater ponds are also significantly undersized for the seasonal infiltration and inflow that enters the City's wastewater collection system during seasonally high river stages in the Sacramento River and Georgiana Slough. This is due to significant through- and under-seepage that occurs through the two levee systems along the Sacramento River adjoining the City and Georgiana Slough immediately adjacent to the City's wastewater ponds.

Critical infrastructure within the study area is shown in Figure 2-7. Critical infrastructure includes the stabilization and evaporation/percolation wastewater ponds described above located southeast of the community of Isleton, Highways 160 and 12, County maintained paved roads, Tyler Island Road Bridge, and the River Road Bridge, Isleton Elementary School, the Isleton fire station, one gaging station, water wells, oil/gas wells, seven BALMD drainage pumps, and numerous oil/gas production fields and pipelines.

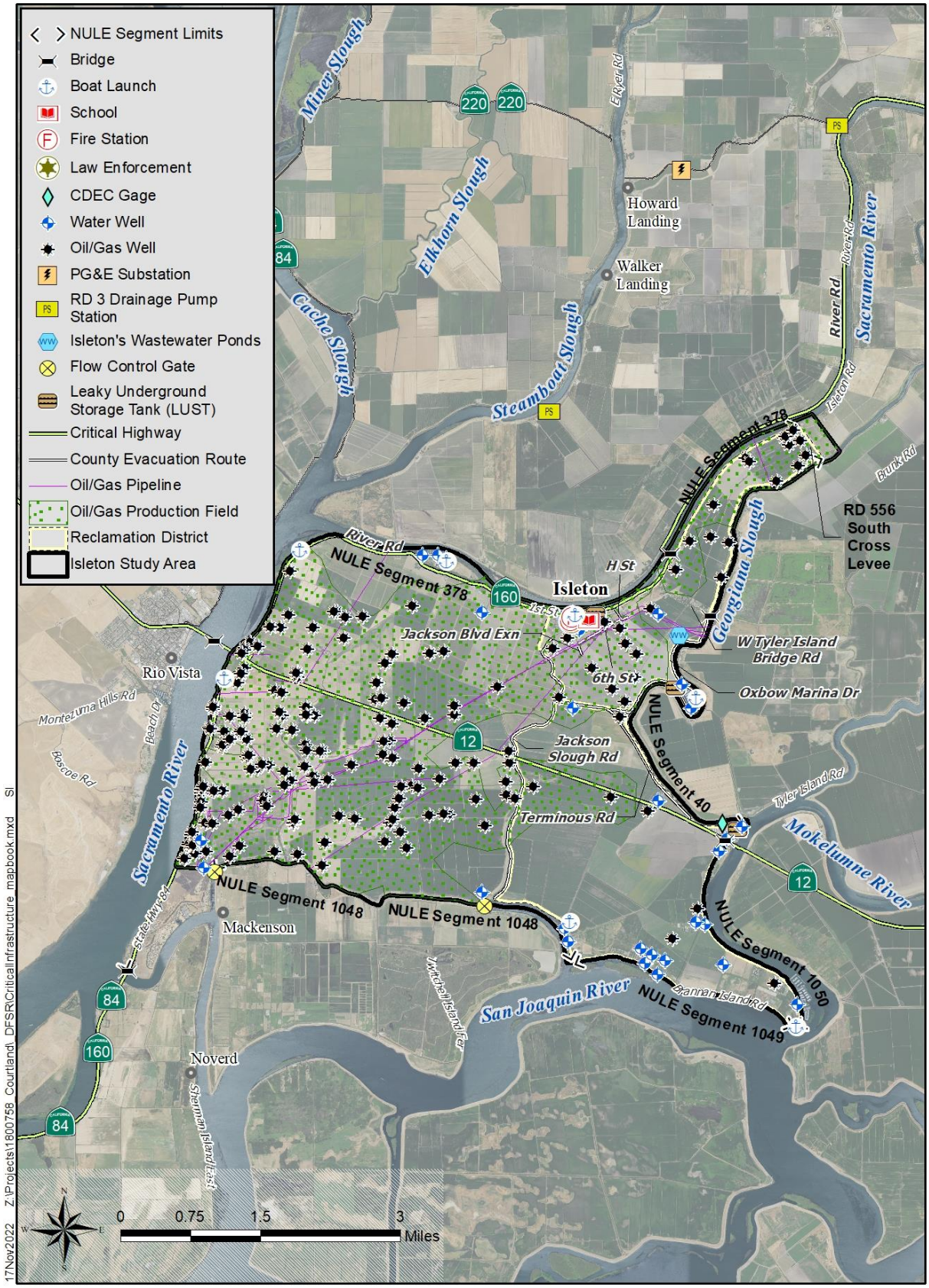

Figure 2-7. Critical Infrastructure within the Study Area

Infrastructure is a critical input in evaluating flood damage, which informs flood risk. The 2017 CVFPP Update inventoried structures, vehicles, highways, and streets within the Isleton study area to evaluate the annualized EAD for the Isleton study area, which were updated during the course of this study as part of the 2022 CVFPP Update. These inventories are largely provided within the discussion of flood risk to the study area in Section 3.1.1.4.

2.1.7 Biological Resources

According to the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory database, database, riverine, freshwater forest/shrub wetland, freshwater pond, and palustrine farmed features are found in the study area. The Sacramento River is the primary aquatic feature and is located adjacent to the northern boundary and western boundary of the study area. Georgiana Slough is adjacent to the eastern boundary of the study area before flowing southward into the Mokelumne River at the southeastern boundary before joining the San Joaquin River at the most southeastern tip of the study area. Sevenmile Slough follows a majority of the southern boundary of the study area immediately west of the San Joaquin River and Mokelumne River confluence. Two smaller aquatic features, Tomato Slough and Jackson Slough, which did not contain water during the time of the 2018 survey, drain the interior of the study area into Sevenmile Slough. Irrigation ditches throughout the interior of the study area, among parcels of agricultural land, provide drainage to the property owners, but the water is removed at a pumping plant before entering waterways.

The majority of the Isleton study area is designated as prime farmland (Figure 2-8). Farmland of local importance is located along the western boundary of the community and along West Brannan Island Road near the confluence of the Mokelumne River and the San Joaquin River as well as near the confluence of the San Joaquin River and Sevenmile Slough.

When conducting work on the waterside slopes, particularly below the ordinary high water lines in any waterways in the North Delta, and particularly within the Lower Sacramento River and adjoining sloughs, work is normally limited to the short construction period of August 1 through October 31 due to the presence of special-status and endangered fish species and supporting habitat.

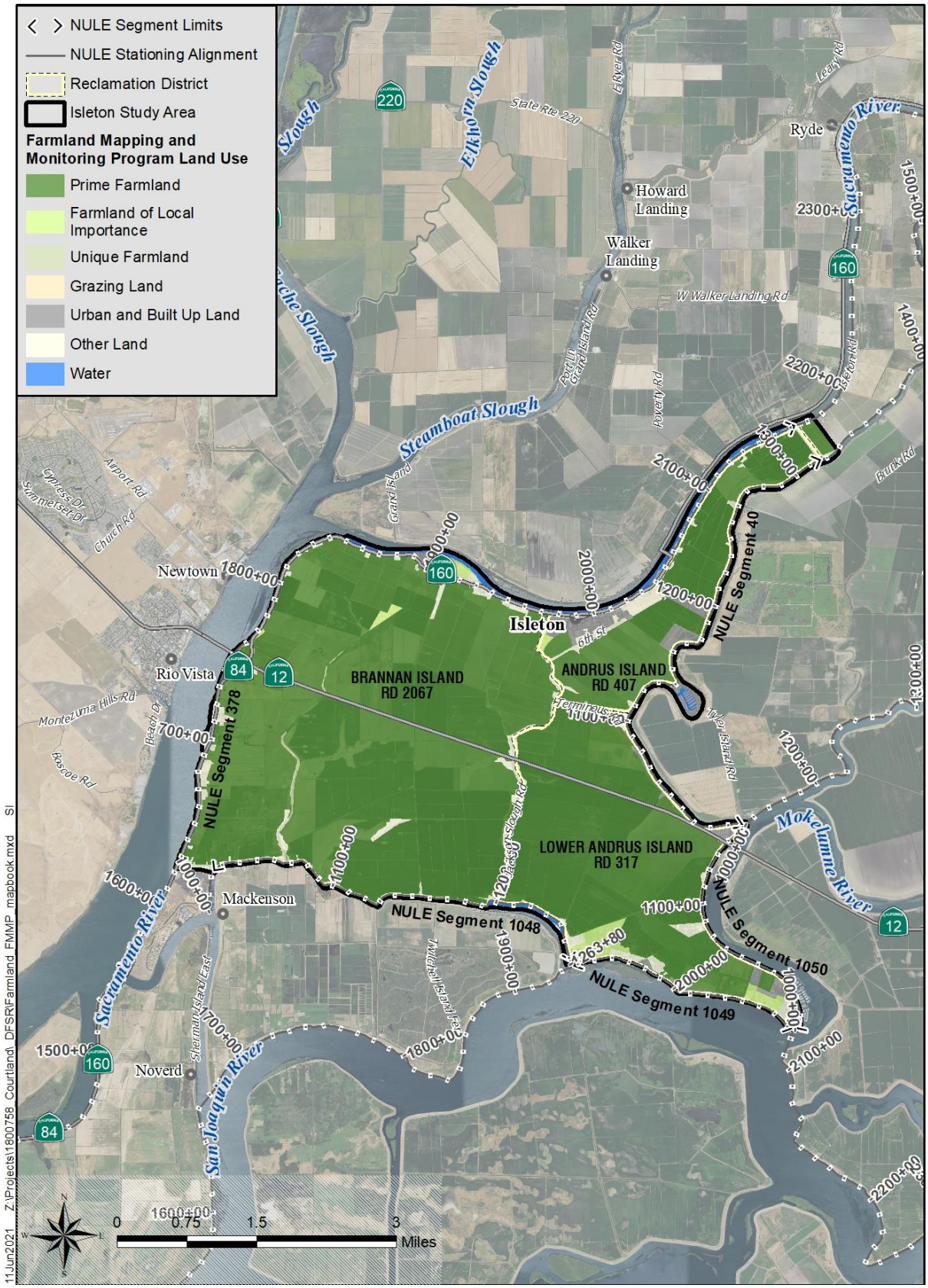

Figure 2-8. Farmland Designations within the Study Area

Vegetation classifications include a crosswalk between Central Valley Riparian Mapping Project (CVRMP) and the United States National Vegetation Classification Standard, whereby habitat is defined by CVRMP. There are nine vegetation communities within the study area (Figure 2-9). The majority of the study area is comprised of cropland, including permanent orchards and vineyards, seasonal corn, alfalfa, and other miscellaneous row crops. Landside vegetation directly adjacent to the levee in the agricultural landscape is typically orchard and vineyard, including pear and grape. Other vegetation types within the study area include riparian forest, riparian scrub, marsh, and seasonal wetland.

Fourteen special-status plant species and 25 special-status wildlife species are documented or have potential to occur in the study area. The study area also supports suitable habitat for five special-status fish species. Designated USFWS and National Marine Fisheries Service critical habitat and Essential Fish Habitat also occur within the Sacramento River, Georgiana Slough, Mokelumne River, and San Joaquin River and border the study area.

See Appendix B for additional information on biological resources within the study area.

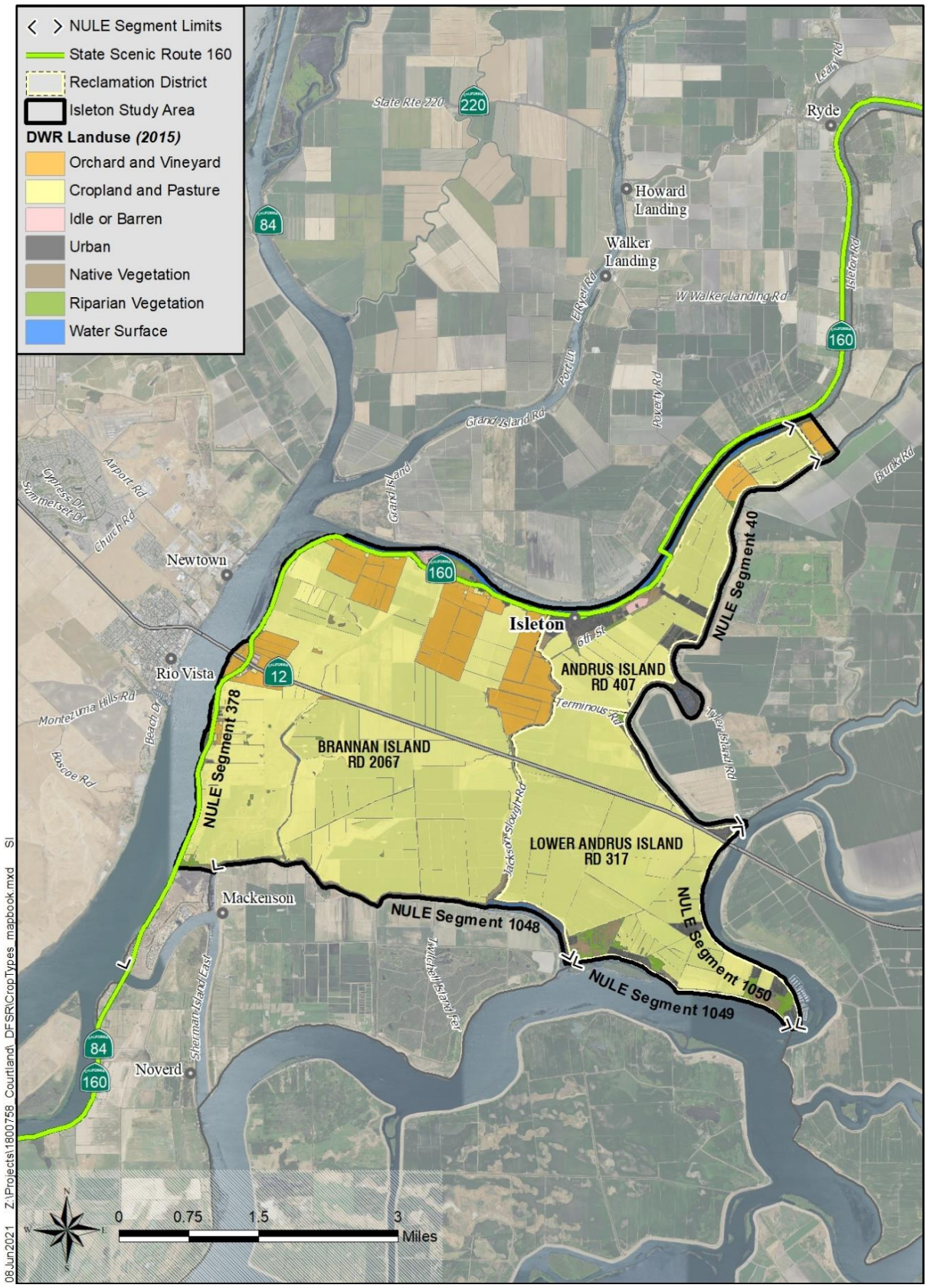

Figure 2-9. Crop Types within the Study Area

2.1.8 Cultural Resources

According to a records search conducted at the North Central Information Center, a total of 13 cultural resources are within the study area (Figure 2-10). Of those, three are historical era archaeological sites, one is a tribal cultural landscape, and the remaining nine are built environment resources dating to the historic era. One of the built environment resources is the Isleton Chinese and Japanese Commercial Districts (P-34-002351), which consists of several contributing and non-contributing elements to the resource's significance. Two other resources, Isleton City Hall (P-34-001541) and Bridge #24-0121/Three Mile Slough (P-34-001291), have been determined eligible for listing in the National Register of Historic Places (NRHP) and the California Register of Historical Resources (CRHR); none of the other identified resources have been evaluated for inclusion in the CRHR, though one, Bridge #24C0042/Georgiana Slough (P-34-004296), is assumed ineligible for listing in the NRHP. One resource, P-34-005225, is described as a Traditional Cultural Landscape that is sacred to several Native American tribes in the area; the NRHP and CRHR status of this resource is unknown.

Information provided by the County of Sacramento indicates an additional three cultural resources within the study area. All of the resources are built environment resources dating to the historic era. All three resources were determined ineligible for listing in the NRHP and CRHR during survey evaluation.

In addition to the above resources located within the Isleton study area, the entire study area is itself a part of the Sacramento-San Joaquin Delta National Heritage Area (SSJDNHA). Established on March 12, 2019, the SSJDNHA, the first National Heritage Area established in California, supports historic preservation, natural resource conservations, recreation, heritage tourism, and educational projects within and beyond the Primary Zone of the Delta, but otherwise has no effect on water rights, property rights, or hunting and fishing rights within the designated area. *See* Appendix C for additional information on cultural resources within the study area.

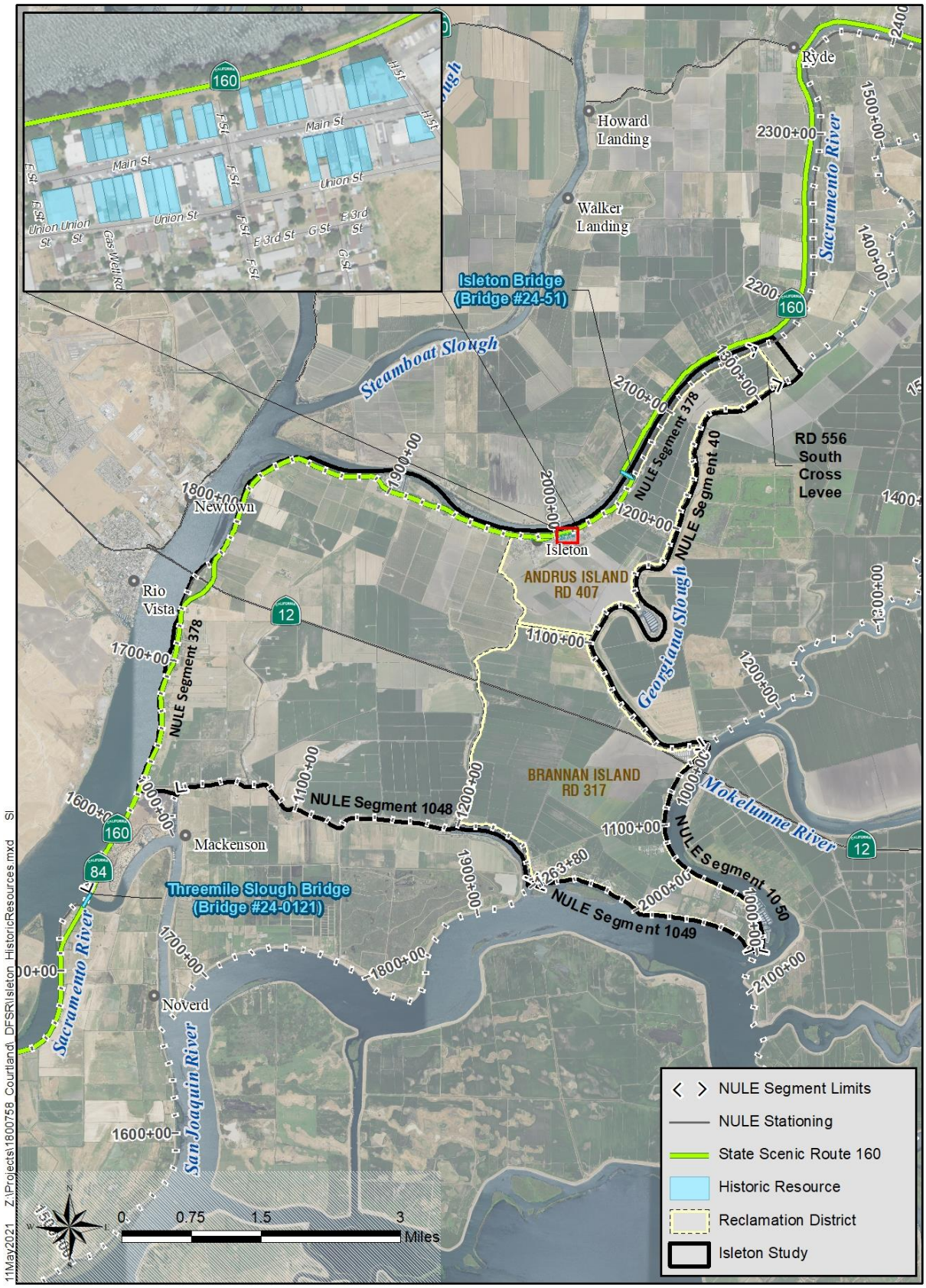

Figure 2-10. Historic Resources within the Study Area

3. Problems, Opportunities and Constraints

3.1 Problems

In order for Isleton to thrive into the future as the wonderful place that it is, the issue of flood risk must be addressed. There are about 28 miles of levees surrounding the Isleton study area and a breach anywhere would cause widespread flooding putting Isleton at risk of significant flood damage, including the potential loss of lives.

Other issues for the study area include escalating NFIP insurance premium rates, vulnerability of levees protecting through-Delta water conveyance, compliance with current FEMA accreditation standards, agricultural sustainability, threatened ecosystems, and threats from climate change and sea level rise.

3.1.1 Flood Risk

In the 2012 CVFPP, flood threats to small communities were characterized using attributes related to flood frequency, potential flood depth, and proximity to the nearest river. These characterizations were then used to prioritize the small communities into four categories (DWR, 2012b):

- **Group A (Flood Threat Level: High Hazard):** Communities subject to high flooding frequency (greater than 1% per year) and also subject to deep flooding conditions (potential flood depths exceeding 3 feet on average).
- **Group B (Flood Threat Level: Moderate to High Hazard):** Communities subject to high flooding frequency (greater than 1% per year), subject to sheet flooding conditions (potential flood depths of less than 3 feet on average), and less than 2 miles from a major flooding source.
- **Group C (Flood Threat Level: Low to Moderate Hazard):** Communities subject to high flooding frequency (greater than 1% per year), subject to sheet flooding conditions (potential flood depths of less than 3 feet on average), and more than 2 miles from a major flooding source.
- **Group D (Flood Threat Level: Low Hazard):** Communities that are not subject to high flooding frequency (less than 1% per year).

Of those small communities protected by SPFC levees, a total of 8 were prioritized as **High Hazard**, including the communities of Isleton, Courtland, Hood, Locke, East Walnut Grove, West Walnut Grove, and Ryde. Consequently, flood risk to these communities, inclusive of the community of Isleton, is the highest relative to flood threats in the larger Central Valley, warranting improved flood protection in these areas.

Within the context of this feasibility study, flood risk is the largest issue facing the Isleton study area. In the event of a levee failure, particularly on the levee immediately fronting and upstream of the community, Isleton and the larger study area could see both life loss and significant property damage.

Flood risk is used as a basis to develop and prioritize flood risk reduction MAs for the purposes of this feasibility study. Flood risk is defined as:

$$\text{Flood Risk} = \text{Probability of a Levee Failure} \ x \ \text{Consequences of a Levee Failure}$$

Probability of levee failure within the Isleton study area has been historically evaluated by the DSC in the DLIS, and by DWR in the FSRP, 2017 CVFPP Update, and through the NULE program. These estimates are provided in Section 3.1.1.2

Within the context of this study, consequences of levee failure are defined in terms of life loss and property damage. Life loss and property damage as a result of flooding within the Isleton study area has historically been evaluated by DWR as part of the 2021 CVFPP and 2017 CVFPP Update and are being re-evaluated as part of the 2022 CVFPP Update. Current life loss estimates for the West Walnut Grove study area are provided in Section 3.1.1.3, and an inventory of property at risk of flooding is provided in Section 3.1.1.4.

The number of lives lost and the extent of property damage as a result of a levee failure also depend on several factors, including depth of flooding, inundation time, and floodwater velocity. Expected flood depths and inundation time within the study area have been estimated as part of the preparation of the Delta Flood Emergency Safety Plan (ESP) for the RDs comprising BALMD and are summarized in Sections 3.1.1.5 and 3.1.1.6.

3.1.1.1 History

Since its founding in 1874, Isleton has been flooded by the Sacramento River at least five times. The most recent flood during the summer of 1972, caused by a failed levee on the south side of BALMD along the right bank levee of the San Joaquin River, left Isleton under as much as 8 feet of water. The flood caused devastating damage to buildings in the downtown and the historic district as well as to residences and agricultural industries throughout Isleton and within BALMD.

3.1.1.2 Probability of Levee Failure

As previously discussed, probability of levee failure within the study area has been historically evaluated by DWR as part of the FSRP, the NULE program, and the 2017 CVFPP Update and by the DSC as part of the DLIS. The collective CVFPP and FSRP analyses aggregated the level of flood protection by impact area. The levels of flood protection offered by the current levee system(s) as detailed in the 2017 CVFPP Update were updated with new geotechnical information during the course of this study. Levee performance curves were collectively updated by DWR and the City of Isleton for each of the project levee segments in the study area and are

provided in Appendix E. With updates to these levee performance curves, the study area as a whole (which includes SAC 54 - Urban and SAC 54 - N2) is conservatively estimated to have only a 6- to 19-year level of flood protection at the USACE 1957 Assessment Water Surface Elevation, largely due to the presence of known FSRP critical and serious sites within BALMD along the SPFC left bank levee of the Sacramento River, the SPFC right bank levee of Georgiana Slough, and along the non-SPFC right bank levees of the Mokelumne and San Joaquin rivers.

The CVFPP and DLIS analyses suggest that the level of flood protection for the SAC 54 impact area ranges from 21 to 26 years. Based upon empirical data and history provided above, the latter estimate of a 21- to 26-year level of flood protection is more applicable, particularly when comparing to the current, modern standard of obtaining a 100-year level of flood protection in accordance with FEMA's accreditation standards, pursuant to 44 CFR §65.10.

DWR's NULE Geotechnical Assessment Report (GAR) qualitatively evaluated probability of failure for the Isleton study area (Table 3-1). These same values are currently being updated by DWR and the City of Isleton during the course of this feasibility study. For each NULE segment, four potential failure mechanisms (underseepage, slope stability, through seepage, and erosion) were evaluated and the segment was categorized based on its overall vulnerability (low, moderate, high) to the various failure mechanisms. Segments were categorized as low, moderate, or high, based on the likelihood of either levee failure or the need to flood fight to prevent levee failure at the USACE 1957 design WSEL. These analyses found NULE Segment 378 levee along the Sacramento River adjacent to Isleton to have a *moderate* likelihood of levee failure at the 1957 design WSEL based on potential vulnerability to slope stability, through seepage, and erosion. The Georgiana Slough levee (NULE Segment 40) was assessed to have a *high* likelihood of levee failure at the 1957 design WSE based on potential vulnerability to underseepage, slope stability, and through seepage. The non-SPFC BALMD levees along the Mokelumne River (NULE Segment 1050), the San Joaquin River (NULE Segment 1049), and Sevenmile Slough (NULE Segment 1048), were identified as having *moderate* to *high* likelihood of levee failure at the assessed WSEL (assigned as 1.5 feet below levee crest) based on potential vulnerability to underseepage, slope stability, and through seepage as well as erosion for NULE Segments 1049 and 1050. These same values are currently being updated by DWR and the City of Isleton during the course of this feasibility study.

Table 3-1. Summary of NULE GAR Assessment Results for the Isleton Study Area

Levee Segment Location	NULE Segment	Overall Segment Characterization	Results by Individual Failure Mechanism			
			Underseepage	Slope Stability	Through Seepage	Erosion
Left Bank Sacramento River BALMD (SPFC levee)	378	Moderate	Low	Lacking Sufficient Data (Low to Moderate)	Lacking Sufficient Data (Low to Moderate)	Moderate
Right Bank Georgiana Slough BALMD (SPFC levee)	40	High	High	Moderate	Moderate	Low
Left Bank Seven Mile Slough BALMD (Non-SPFC levee)	1048	High	High	Moderate	Moderate	Low
Right Bank San Joaquin River BALMD (Non-SPFC levee)	1049	Moderate	Moderate	Moderate	Lacking Sufficient Data (Low to Moderate)	Moderate
Right Bank Mokelumne River BALMD (Non-SPFC levee)	1050	High	High	High	High	Moderate

Source: URS, 2011a

3.1.1.3 Life Loss

The 2017 CVFPP Update estimated potential life loss on an annualized basis for the subject SAC 54 impact area (inclusive of Upper Andrus Island - RD 556, and BALMD). Life loss on an annualized basis was analyzed in the 2017 CVFPP Update for a series of scenarios over a 60-year period of 2007 to 2067. The baseline scenario included an approximation of system performance prior to 2007, before implementation of system improvements in the Sacramento Basin. Four other scenarios were also analyzed which considered, to varying degrees: (1) the impact of implementation of DWR flood control projects, non-structural systemwide actions including enhancement of flood preparedness and warning notifications; (2) larger-scale actions such as widening the Sacramento weir and Yolo Bypass system(s); (3) climate change, sea-level rise; and (4) population and land use changes. The annualized life loss for SAC 54 was estimated

to range from six for the 2007 baseline case down to one for the various 2067 scenarios (DWR, 2017d).

Life loss on an annualized basis was also estimated as part of the DLIS. From this analysis, 0.3 expected annual fatalities were estimated for BALMD (DSC, 2017).

A breach immediately upstream or fronting the community of Isleton could result in floodwater depths in Isleton in excess of 10 feet combined with floodwater velocities in excess of 5 fps. Combined floodwater depths and velocities in this scenario would result in little to no warning time for evacuation, which poses imminent flood threats to the community of Isleton and would very likely result in life loss.

Instantaneous flooding with combined high flood depths and velocities into homes is a messy, dangerous situation likely resulting in loss of lives and costly cleanup expenses.

3.1.1.4 Property Damage

Structure counts, agricultural acreage, vehicle counts, and total miles of highways and streets, along with their associated values, were quantified as part of the 2017 CVFPP Update. These inventories and their associated values were updated as part of the 2022 CVFPP Update efforts during the course of this study. Within the study area, the value of structures, agricultural crops, vehicles, and highways and streets total over $387.4M in 2020 dollars:

- Total estimated depreciated replacement value of the 935 structures in the Isleton study area: $320.0M
- Total estimated value of agricultural crops: $15.1M
- Total estimated vehicle value: $38.1M
- Total estimated value of highways and streets: $14.2M

Structures at risk of flooding are summarized in Table 3-2. The Isleton study area contains approximately 935 structures, with nearly half of these located within the City of Isleton. As part of the 2017 update to the CVFPP, depreciated replacement values for these structures and contents were defined for the SAC 54 impact area, which are being updated as part of the 2022 CVFPP Update. As shown in Source: HDR, 2021

Table 3-3, the total depreciated replacement value for the Isleton study area escalated to 2020 dollars is over $319.9M, with residential and industrial structures, both within and outside the City of Isleton, comprising over 80 percent of this value.

Table 3-2. Structures within the Isleton Study Area (BALMD)

CVFPP Impact Area	Total Structures Count				
	Residential	Commercial	Industrial	Public	Total
SAC 54 – N2 (Isleton study area, less the community of Isleton)	389	2	51	34	476
SAC 54 – Urban (City of Isleton)	350	70	18	21	459
Total Isleton Study Area	739	72	69	55	935

Source: HDR, 2021

Table 3-3. 2022 CVFPP Depreciated Replacement Value for BALMD Impact Area SAC 54

CVFPP Impact Area	Depreciated Replacement Value				
	Residential	Commercial	Industrial	Public	Total
SAC 54 – N2 (Isleton study area, less the community of Isleton)	$87,714,000	$2,721,000	$59,070,000	$5,926,000	$155,431,000
SAC 54 – Urban (City of Isleton)	$97,503,000	$32,303,000	$20,635,000	$14,117,000	$164,557,000
Total Isleton Study Area	$185,217,000	$35,024,000	$79,705	$20,043,000	$319,988,000
Average Depreciated Value of Structures	$251,000	$486,000	$1,155,000	$364,000	$342,000

Notes: Costs are reported in Quarter 1, 2020 dollars; Source: HDR, 2021

Acreage of agricultural crops and their estimated worth, along with the total amount of vehicles and their estimated value, are summarized for BALMD in Table 3-4 and

Table 3-5, below. In summary, crops within the study area are valued at over $15.1M. Vehicles (excluding agricultural equipment) in the study area are valued at over $38M, with the majority of this value located outside the City of Isleton.

Table 3-4. Crop Acreage and Total Value for the Study Area

CVFPP Impact Area (area in acres)	2020 Agricultural Acreage (acres)									Total Value
	Citrus	Deciduous	Field	Grain	Pasture	Rice	Truck	Vineyard	Total	
SAC 54 – N2 (Isleton study area, less the community of Isleton)	0	143	5,295	174	2,856	0	272	941	9,681	$14,871,000
SAC 54 – Urban (City of Isleton)	0	0	441	0	5	0	13	1	460	$267,000
Total Isleton Study Area	0	143	5,736	174	2,861	0	285	942	10,141	$15,138,000

Notes: Costs are reported in Quarter 1, 2020 dollars; Source: HDR, 2021

Table 3-5. Vehicle Count and Value for the Study Area

CVFPP Impact Area (area in acres)	Total Vehicle Count	Total Vehicle Value
SAC 54 – N2 (Isleton study area, less the community of Isleton)	2,983	$26,847,000
SAC 54 – Urban (City of Isleton)	1,251	$11,259,000
Total Isleton Study Area	4,234	$38,106,000

Notes: Costs are reported in Quarter 1, 2020 dollars; Source: HDR, 2021

The total miles of highways and streets are summarized for each impact area and the collective study area in Table 3-6, below. The portions of Highways 12 and 160 which run through the study area are valued at $7.3M. Streets within the greater BALMD basin outside the City of Isleton are valued at $5.4M, and the collective 7.9 miles of streets in Isleton are valued at $1.4M.

Table 3-6. Total Miles of Highways and Streets and Value for the Study Area

CVFPP Impact Area (area in acres)	Highways Miles	Total Highways Value	Streets Miles	Total Streets Value	Total Value of Highways and Streets
SAC 54 – N2 (Isleton study area, less the community of Isleton)	11.6	$6,490,000	30.0	$5,423,000	$11,913,000
SAC 54 – Urban (City of Isleton)	1.5	$811,000	7.9	$1,432,000	$2,243,000
Total Isleton Study Area	13.1	$7,301,000	37.9	$6,855,000	$14,156,000

Notes: Costs are reported in Quarter 1, 2020 dollars; Source: HDR, 2021

Baseline (or without project construction) EAD estimates for the Isleton study area have also been developed as part of the 2022 CVFPP Update efforts (Table 3-7). As previously discussed, EAD is a common metric used to estimate risk within the Delta and other components of the Sacramento River Flood Control Project (SRFCP). EAD is calculated on an annualized basis and represents the annual average expected damages through the consideration of potential flooding conditions. Baseline EAD estimates incorporate updated levee performance curves and are provided for existing conditions and future conditions. Baseline EAD values under existing conditions include the existing conditions of the flood management system(s) in the Central Valley and includes projects that have been authorized and have funding, or that have started construction or implementation under the 2022 CVFPP. Baseline EAD values under future conditions have the same features as the existing conditions, with the addition of the effects of inland climate change projections and sea level rise. As shown below in Table 3-7, the total baseline EAD for the Isleton study area under existing conditions is estimated up to $20.2M in 2020 dollars (acknowledging that the greatest risks to flooding, based upon current geotechnical investigations is from Georgian Slough - SAC 54 and not the Sacramento River - SAC 54a). With the effects of climate change and sea level rise, baseline EAD for the Isleton study area under future conditions is estimated at up to $89.4M in 2020 dollars.

It should be noted that the EAD analyses prepared by HDR, Inc. in 2021 utilized the H&H models developed specifically for the CVFPP 2017 to 2022 updates by DWR's consultant team, and not the H&H models prepared by the GEI Consultant Team in Appendix I.

Table 3-7. 2017-2022 CVFPP EAD Values for Isleton Study Area: SAC 54-N2 and SAC 54-URB

Impact Area	EAD[1], existing conditions	EAD[2], future conditions
SAC 54_N2 (Isleton study area, less the community of Isleton - Georgina Slough)	$13,791,000	$53,783,000
SAC 54_URB (City of Isleton – Georgina Slough)	$6,439,000	$35,572,000
Total Isleton Study Area	$20,230,000	$89,355,000

Notes: [1] EAD as defined by the 2022 Without-Project Scenario from the 2022 CVFPP Update
[2] EAD as defined by the Future Without-Project Scenario from the 2017 CVFPP
Source: HDR, 2021

3.1.1.5 Floodwater Depths and Velocities

Inundation mapping was conducted in May 2017 for BALMD as part of the County's Flood ESPs for the RDs collectively located in the North Delta and in Sacramento County. Hypothetical levee breaches were modeled at three locations: (1) upstream of the community of Isleton (along the left bank of the Sacramento River NULE Segment 378); (2) downstream from the community of Isleton (along the left bank of the Sacramento River NULE Segment 378); and (3) southeast of the community of Isleton (along the right bank of the Mokelumne River NULE Segment 1050).

Based on these analyses, flood depths and corresponding velocities are greatest in the community of Isleton and in the larger BALMD basin when there is a breach along the left bank of the Sacramento River downstream of the community of Isleton along NULE Segment 378. In this scenario, BALMD is predicted to experience flood depths from 10 to 33 feet, and flow velocities in excess of 10 feet per second (fps) at any given breach location. Under this same scenario maximum flood depths in the densely populated community of Isleton are likely to exceed 5 feet, and the maximum velocities could exceed 5 fps (Figure 3-1). As shown in Figure 3-1, denoted by the arrows extending from the hypothetical breach location, these flood depths could also be observed in the event of a levee failure both further upstream or downstream along the left bank of the Sacramento River. Figure 3-1 depicts worse case flood depths that could occur in BALMD with a levee breach along the Sacramento River in the project study area at or downstream of the community of Isleton. Flood depths could actually be reduced by 5 to 6 feet or more as shown in Figure 3-1 down to the Base Flood Elevation (BFE) of 9 feet NAVD 88 indicated if a downstream relief cut could be implemented in the lower reaches of BALMD into the San Joaquin River (*see* Section 5.2.6 – Local Hazard Mitigation Plan and Relief Cuts for more information).

Similar flood depths are expected in the event of a breach along the left bank of the Sacramento River upstream of the community of Isleton, or along the right bank of the Mokelumne River or Georgiana Slough downstream from the community, with flood depths in the community of

Isleton predicted to reach upwards of 5 feet, and flood depths in the larger BALMD basin expected to reach up to 32 feet.

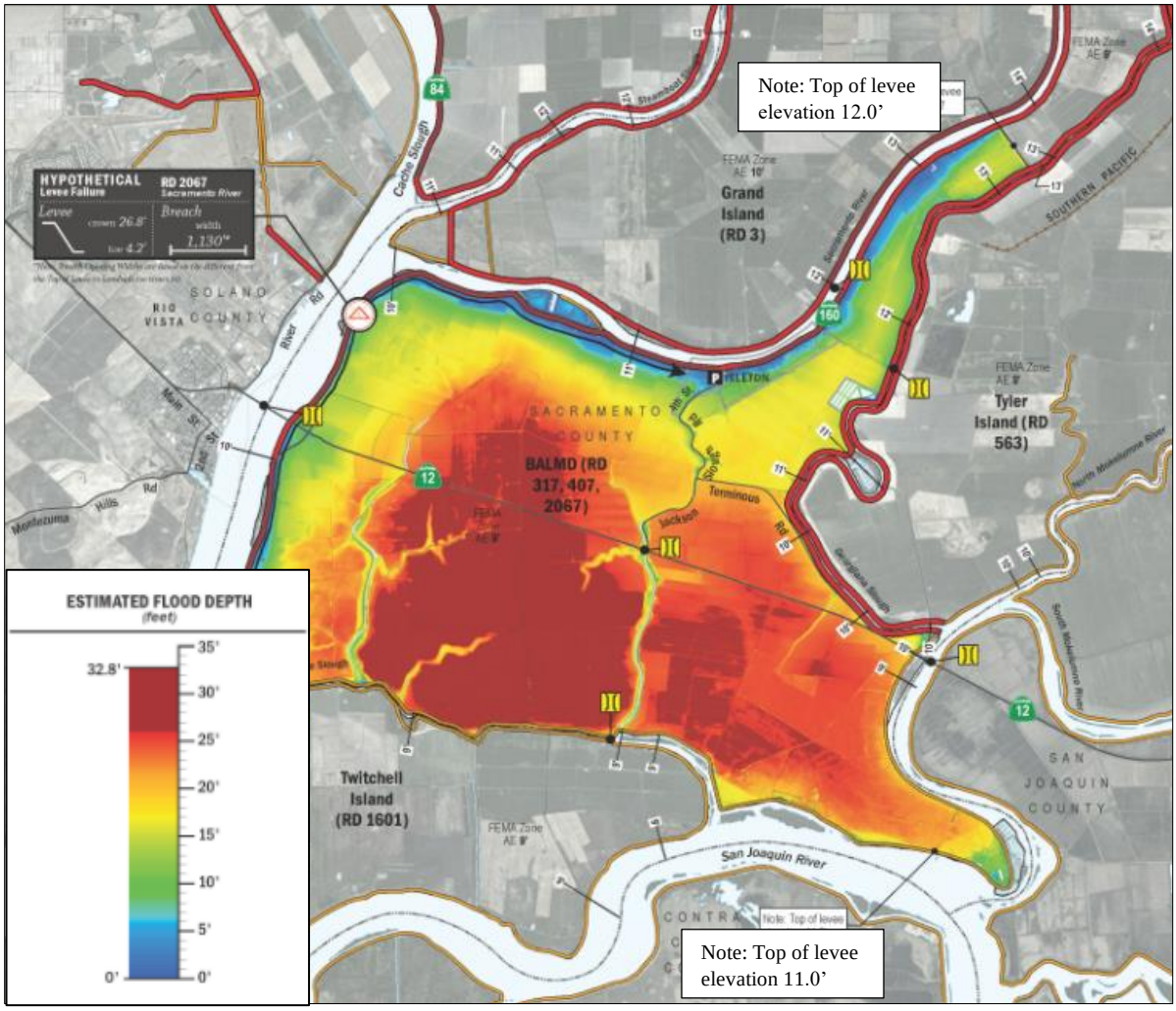

Figure 3-1. Study Area Maximum Flood Depths (Dynamic Planning + Science, 2017 for Sacramento County[6])

3.1.1.6 Inundation Time

Using the same breach locations discussed in the preceding Section 3.1.1.5 the time to 1 foot of inundation for the Isleton study area was estimated as part of the inundation mapping performed for the BALMD Delta Flood ESP. The time to 1 foot of inundation is shortest for the community of Isleton and BALMD assuming a levee breach downstream of the community along the Sacramento River (NULE Segment 378). In this scenario, the majority of Brannan Island

[6] 2017. Local Hazard Mitigation Plan, Annex G Chapter 2 Brannan Andrus Levee Maintenance District; Reclamation Districts 317, 407, 2067. Available at: https://waterresources.saccounty.net/Local%20Hazard%20Mitigation%20Plan%202017/Annex%20G%20Delta%20Chap%202%20Brannan%20Andrus%20Levee%20Maintenance%20Dist%20-%20Reclaim%20Dists%20317,%20407,%202067.pdf

(RD 2067) is inundated to 1 foot in 2 to 8 hours, Lower Andrus Island (RD 317) is inundated to 1 foot in 16 to 32 hours, and Andrus Island (RD 407) is largely inundated to 1 foot in 32 to 40 hours, with the community of Isleton inundated to 1 foot in 56 to 100 hours. The duration of time prior to reaching a 1-foot-depth of flooding within the community of Isleton is longer based on a levee breach along the Mokelumne River (72-150 hours) or upstream of the community along the Sacramento River (greater than 200 hours).

Although the given inundation times for the Sacramento River are representative of a levee breach both upstream and downstream of the hypothetical breach location, it is expected that a breach on the levee immediately fronting the community of Isleton would result in nearly instantaneous inundation within the community with high velocities potentially exceeding 10 fps.

For more information on flood risk and to view a hypothetical flood simulation of the Isleton study area, the Isleton Story Map developed by the City of Isleton located and can be found online.[7]

3.1.2 Escalating NFIP Insurance Premium Rates

Delta legacy communities are subject to deep flooding behind a combination of Federal/State authorized (SPFC) levees and non-SPFC, private levees. However, most all Delta legacy communities have **not** flooded in the last 100 years due to oversized levees with surplus freeboard and low to moderate risk of levee failure.

Flood risk can be determined using information from FEMA's Flood Insurance Study (FIS) in conjunction with FIRMs. FIRMs delineate SFHAs, which are defined as areas that will be inundated by the 100-year flood event. These areas include lands and improvements behind levees that are not fully accredited by FEMA in accordance with 44 CFR §65.10. The current FIS for Sacramento County is dated August 16, 2012 (FEMA, 2012). The community of Isleton, as shown in Figure 3-2, is located within Zone AE, which is defined by FEMA as being "subject to inundation by the 1 percent-annual-chance flood event determined by detailed methods." According to Figure 3-2 excerpted from the FEMA FIRM the Isleton study area is subject to flooding in Zone AE to a BFE of 9.0 feet NAVD 88.

[7] http://floodriskreductionisleton.com

Figure 3-2. Isleton's 100-Year BFE Floodplain Recognized by FEMA (2020)

Flood insurance through the NFIP is mandatory for buildings with a federally backed mortgage located in a SFHA. These premiums have been steadily on the rise since the passage of flood insurance reform laws including BW-12 of 2012 and the HFIAA of 2014. Under HFIAA, policyholders can expect to see gradual increases in annual premiums until they reach a rate that the NFIP deems to be actuarially based. Effective April 1, 2018, NFIP annual premiums increased by 8 percent from $866 per policy to $935 per policy, not including HFIAA surcharges or other fees (FEMA, 2017). In October 2019, FEMA announced that beginning on April 1, 2020, annual renewal premiums would increase by 11.3 percent (FEMA, 2019a). This rate restructuring has been postponed to October 2021 according to FEMA as of November 7, 2019 (FEMA, 2019b).

For those who do not already have a current NFIP policy, they will be rated by FEMA based on the elevation of the living quarters of their structure(s) relative to Isleton's BFE of 9 feet

NAVD 88. Sacramento County currently enjoys up to 40 percent discount on flood insurance costs due to the County's high Community Rating System (CRS) score, which is one of the top 5 CRS scores in the entire nation. Still, the rates are rising rapidly. Many NFIP policies in Isleton are grandfathered in at low rates that increase each year until reaching the rate based on an elevation certificate. *For example: if the floor of a house is 4 feet below the FEMA BFE of 16 feet in Isleton, with a cost of $200,000 per dwelling structure and $40,000 for structure contents, the new (non-grandfathered) NFIP premium would be $6,804 per year plus fees (and this is with the County's favorable 40% discount with its high CRS score).*

Levees protecting the Delta legacy communities fall well short of meeting current seepage and stability criteria pursuant to 44 CFR §65.10

As NFIP flood insurance rates increase the number of insured homes decrease. As a result, the Isleton community is increasingly and significantly under insured. While there are an estimated 935 structures in the Isleton study area valued with an estimated replacement value of $319.9M[8], as of 2019 there were only 339 NFIP policies (valued at $350,000 maximum per policy inclusive of structure contents) providing less than $119M[9] in coverage. This suggests that the City of Isleton is underinsured for flood risks assoicated with a 100-yr event by the amount of approximately $200M.

To remove the entire project study area from the current FEMA BFE of 9 feet NAVD 88, the entire BALMD perimeter levee system would require reparing and strengthening in-place to current engineering standards, consistent with the FEMA 100-year accreditation standards contained in 44 CFR §65.10. To learn more about achieving a 100-year level of flood protection pursuant to the current FEMA accreditation standards *see* link to *2020 Guidance for Flood Risk Analysis and Mapping – Levees,* PDF, in the footnote below.[10]

The current cost estimate of such levee repairs/improvements for strengthening in place to achieve FEMA accreditation for the community of Isleton (with a cross levee system) and the entire study area are provided in Sections 6.1.12 and 6.1.13, respectively.

[8] The FEMA open source data is aggregated by zip code. These estimates represent the summation of SAC 47 and SAC 48 from the draft 2017 CVFPP Update – Technical Analyses Summary Expanded Report, 2017, and have been escalated to July 2020 dollars.
[9] These estimates are sourced from the FEMA Open Source policy database and reported in Appendix J – Community Based Flood Insurance Program White Paper, prepared by Kathleen Schaefer, March 2022.
[10] https://www.fema.gov/sites/default/files/documents/fema_levee-guidance.pdf

3.1.3 Vulnerability of Levees Providing Through-Delta Water Conveyance

There are more than 1,100 combined miles of SPFC and non-SPFC levees in the Delta which convey water to 750,000 acres of farmland within the Delta for irrigation. These levees in concert with the adjoining river channels also convey water toward the Clifton Forebay, which pumps the water south of the Delta to serve approximately 3M acres of agricultural lands and a population of 27M. These same levees serve to protect the community of Isleton, which relies on this critical infrastructure to sustain the local agriculture economy, thus preserving the community's rich agricultural heritage. According to NULE evaluations performed in 2015, over 50 percent of SPFC non-urban levees and 40 percent of non-SPFC non-urban levees do not meet acceptable criteria for underseepage, through seepage, structural stability, and/or erosion (DWR, 2017b).

> *"Maintenance and improvement of the current in-channel river conveyance system for the CVP and SWP water supply system(s) is a vastly better solution than a single-purpose tunnel as presently proposed by the Delta Conveyance Authority"* – Sacramento County Floodplain Administrator

Within the Isleton study area, the majority of the SPFC and non-SPFC levees do not meet acceptable criteria for through seepage, underseepage, slope stability, and erosion. The vulnerability of these levees is further compounded by climate change, which can intensify rain events and heighten flood risk and the risk of a seismic event in the future, which could cause the levees to fail. Additionally, as previously discussed, levees which are vulnerable to through seepage and underseepage can be particularly costly to remediate, making FEMA certification and 100-year flood protection infeasible to attain without significant cost-share from the state or others.

Maintenance and improvement of the current in-channel river conveyance system inclusive of its levee systems for the CVP and SWP water supply system(s) is a more cost-effective solution than all the intakes and tunnel segments as presently proposed by the Delta Conveyance Authority (DCA). Maintenance and improvement of the existing natural river system and its adjoining levee embankments in the North Delta is more cost-effective, its's ecologically friendly, it protects the "Delta as a Place", and it reduces flood risk to the Delta Legacy Towns, inclusive of the community of Isleton, located downstream of the Delta Cross Channel. With or without the DCA as presently proposed, through-Delta conveyance will continue to rely on the freshwater corridor established both upstream and downstream of the Delta Cross Channel. Presently there are 37 miles of non-urban SPFC levees upstream and 25 miles downstream of the Delta Cross Channel in the North Delta that help convey water through the Delta as depicted below in Figure 3-3 for a total of 62 miles of SPFC levees which comprise significant portions of the Delta's freshwater corridor. Improving 6.0 miles of SPFC levees along Georgiana Slough (NULE Segment 40) to current, modern engineering standards consistent with FEMA's 100-year accreditation standards within the Isleton study area would constitute improving 24 percent of the non-urban SPFC levees downstream of the Delta Cross Channel and nearly 10 percent of the total non-urban SPFC levees in the Delta's freshwater conveyance corridor.

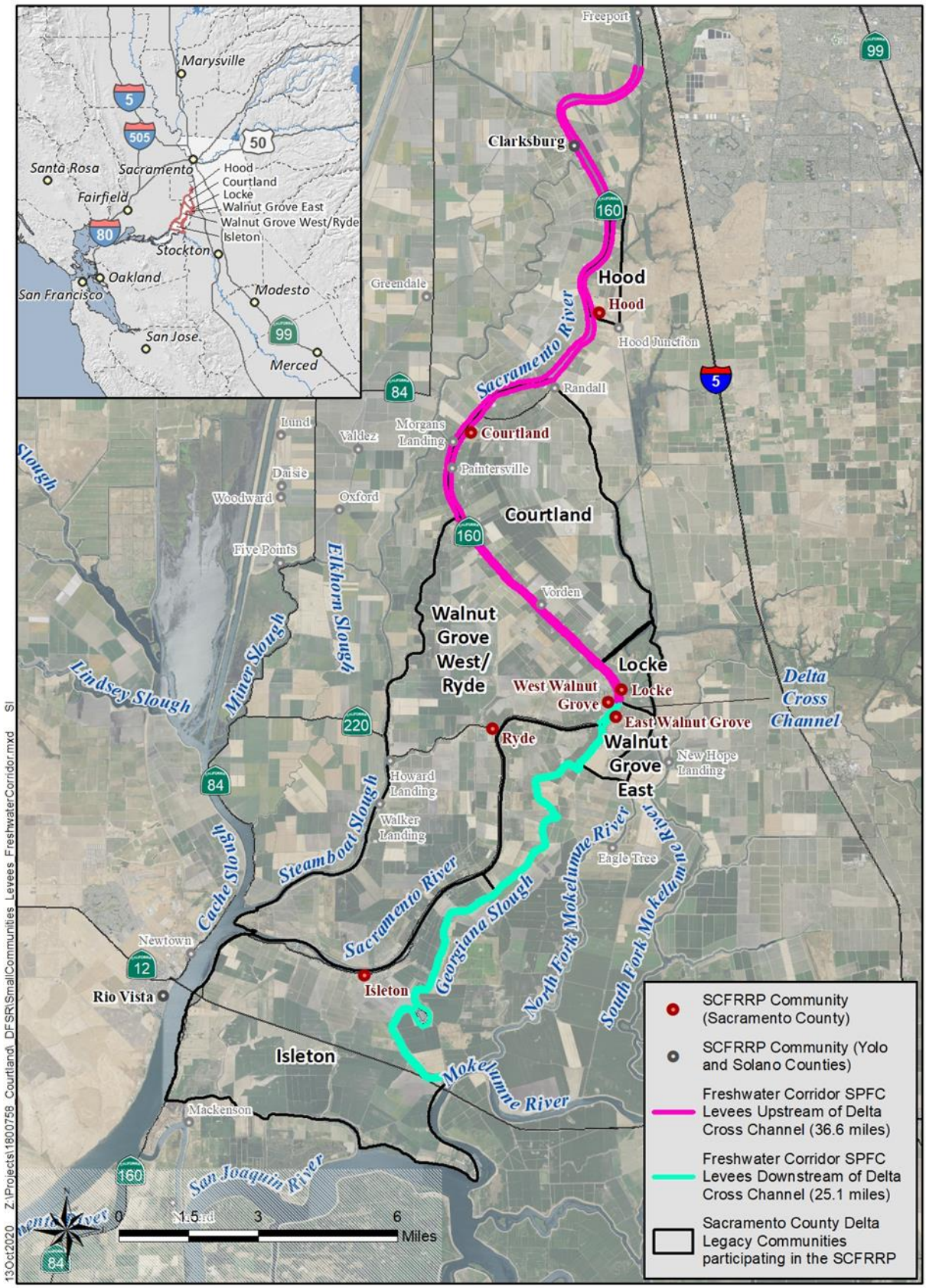

Figure 3-3. SPFC Levees which Comprise the Delta's Freshwater Corridor

3.1.4 Agricultural Sustainability

Agricultural lands within the Delta and in the immediate project study area are a key element of sustaining the economic health for the community of Isleton. In 2001, FEMA began updating FIRMs, and as a result, many small communities, including Isleton in 2012 were subsequently mapped into SFHAs. As a result, these communities are subject to regulations set forth by the NFIP, including land use requirements for elevating or floodproofing new and substantially improved structures and the requirement to purchase a flood insurance policy through the NFIP for each structure with a federally backed mortgage (aka mandatory insurance purchase requirement). These requirements do not provide the flexibility needed to sustain agriculture within the community and can make reinvestments that are needed in support of the agricultural economy infeasible or unattainable.

3.1.5 Threatened Ecosystems

Many of the historic tidal wetland areas of the Delta have been lost to development and placement of levees with a configuration that does not support tidal inundation of areas to sustain viable habitat. Vulnerability to flow and temperature changes associated with Delta water supply conveyance (and naturally occurring drought) and predation of migrating fish species from invasive species is also an issue in certain areas of the Delta.

3.1.6 Threats from Climate Change and Sea Level Rise

Climate change and sea level rise have the potential to increase peak flows and flood stages in the Lower Sacramento River and Mokelumne/Cosumnes River systems. As discussed in Appendix I, peak flows in the Sacramento River could increase by 4 percent for the 100-year flood and 2.3 percent for the 200-year flood as a result of climate change. Additionally, climate change combined with sea level rise is expected to increase the 100-year flood stage in the Sacramento River between Georgiana Slough and Cache Slough at Isleton by nearly 1.6 feet, with the 200-year flood stage along the same extent increased by 1.1 feet Increased flows and flood stages can not only result in more frequent flooding, which can lead to levee failure through greater hydro-dynamic pressures (and potential overtopping) but can also result in greater stresses to the levee system as levees are loaded with water for longer durations of time and *via* other mechanisms resulting from increased flow/flood stages (e.g., erosion).

3.2 Opportunities

Opportunities to address problems within the project study area of Isleton discussed above are summarized below.

3.2.1 Reduce Flood Risks

The levees protecting the Isleton study area do not meet FEMA accreditation and current engineering standards to achieve a 100-year level of flood protection. When a levee is accredited

by FEMA, the levee system is certified to meet current engineering standards contained in 44 CFR §65.10. These standards include criteria for through- and underseepage, freeboard, stability, settlement, encroachments, interior drainage, and other operations and maintenance criteria. These standards and criteria help to reduce the overall probability of levee failure and to ensure that communities and areas located behind the accredited levee(s) are protected during high water events. Since flood risk is partially characterized by the probability of levee failure, improving levees up to FEMA standards can help to reduce flood risk, thereby reducing the potential for life loss and property damage. A discussion surrounding the potential for life loss within the Isleton study area is provided above in Section 3.1.1.3. The potential for property damage within the Isleton study area was evaluated as part of this study using updated inventories of structures, vehicles, agricultural crops, highways, and streets from the forthcoming 2022 CVFPP Update. These inventories were used in a flood damage analysis to quantify EAD for the Isleton study area under existing and future conditions. These updated inventories are provided in Section 3.1.1.4, and results from the flood damage analysis are presented in Section 6.3.1.2 and further detailed in Appendix E.

Securing levee improvements to FEMA accreditation standards can also enhance the resiliency and reliability of the through-Delta water conveyance system and help to ensure that water is conveyed as needed to agricultural farmland within the Delta and through the Delta to the SWP and CVP export pumps in the south Delta. Once a levee is accredited, the designation is shown on FIRM maps and can result in areas being mapped out of SFHAs. This can subsequently result in lower NFIP insurance premium rates. FEMA accreditation could also substantially reduce premiums for a community, flood-risk based insurance program that may be applicable for the community of Isleton and possibly the adjoining larger project area of BALMD and other nearby Delta Legacy Communities.

3.2.2 Agricultural Sustainability

Efforts to improve agricultural sustainability within the Delta, inclusive of the Isleton study area, are outlined in the DPC's LURMP. The LURMP identifies methods for supporting the long-term viability of agriculture within the Delta region while being responsive to enhancing natural habitats and ecosystem restoration efforts by:

- Supporting the continued capability for agricultural operations to diversify and remain flexible to meet changing market demands and crop production technology
- Promoting the ability for agriculture operations to change the crops or commodities produced to whatever is most economically viable at the time
- Supporting the use of new crop production technologies that keep Delta agricultural operations competitive and economically sustainable

The DSC's Delta Plan also identifies policies and recommendations which seek to maintain Delta agriculture as a primary land use, food source, key economic sector, and as a way of life for the community of Isleton and for the Delta as a whole. The purpose of the policies and

recommendations is to address the impacts to local agriculture from changing markets, water conveyance facilities, and changing water quality. A subset of these policies and recommendations include:

- Improving existing levees
- Restricting urban development, while supporting farming and recreation
- Encouraging agritourism in and around legacy communities
- Promoting value-added crop processing

3.2.2.1 Agricultural Floodplain Ordinance Task Force

The Agricultural Floodplain Ordinance Task Force (AFOTF) is comprised of officials from FEMA, DWR, the CVFPB, RDs, levee districts, flood control agencies, counties, engineers, farmers, and non-governmental organizations. After forming in 2015, the AFOTF's goal was to develop administrative options of FEMA's NFIP to address sustainability of modern agriculture in deep floodplains. Administrative options were considered as they could be potentially implemented without changing laws or regulations.

Administrative options to improve agricultural sustainability within the Sacramento Valley were summarized in a technical memorandum prepared in 2016. In total, the memorandum summarized nine recommendations which addressed how rules and practices could be modified to, "(1) reduce or remove elevation and floodproofing requirements for new and substantially improved agricultural structures, and (2) reduce the cost of NFIP insurance premiums for agricultural structures with a federally backed mortgage to a more appropriate portion of the financial risk in the NFIP" (AFOTF, 2016). Further details and recommendations developed by the AFOTF are highlighted as item No. 9 in supporting Appendix H.

3.2.3 Potential Ecosystem Restoration and Recreation Enhancement Opportunities

Eco-restoration enhancement opportunities within the greater Isleton study area of Brannon Andrus Levee Maintenance District (BALMD) potentially include:

1) Enhancing or creating additional Shaded Riverine Aquatic (SRA) habitat along the Sacramento River or Georgiana Slough in connection with addressing erosion concerns and/or replenishing rock slope protection (RSP) at known erosion sites.
2) In connection with developing a flood fight access road there is an opportunity to create as much as two acres of native grassland habitat enhancements along the landward and waterward slopes of said access road/embankment.
3) Similar to the embankments of the flood fight access road, any new cross levee systems with 18 to 20 ft. high embankments containing 3:1 (H:V) side slopes there will be much greater opportunities to create native grassland enhancements. It

estimated that as much as 14.5 acres of native grassland habitat enhancements can take place for every mile of new cross levees that may be constructed.

4) A potential borrow site of the former Walnut Grove - Isleton Branch rail line embankment (approximately 6 acres in size) is identified contiguous to the City limits at the southwesterly extension of 6th Street. This small 6-acre of embankment area could be utilized as a borrow source for either the flood fight access road/berm or any one of the cross levee configurations and could also be modified to create native habitat and create direct connectivity to the existing native woodland habitat that currently exists directly east and south of 6th Street.

5) Opportunities exist to utilize or expand upon the 87-acre combined BALMD borrow and mitigation bank site(s) located in project study area, The noted borrow and mitigation site(s) in the project study area are near the San Joaquin River just east of its confluence with Sevenmile Slough. This same area has been identified as Existing Restoration Project (ER-3) in Appendix D – Ecosystem Multi-benefit Opportunities for the Sacramento County Delta Legacy Small Communities Flood Risk Reduction Feasibility Studies.

6) Formalizing a relief cut at the southern, lower end of Brannan Andrus Island adjoining ER-3 near the confluence of the San Joaquin River and Sevenmile Slough could create an opportunity to create more tidal marsh habitat and greater conectivity between the BALMD mitigation site and the adjoining San Joaquin River.

7) Construction of a potential setback levee or re-channelization of Georgiana Slough immediately northwest of Oxbow Marina could create additional wetland and SRA habitat. However, it may be infeasible to isolate the Oxbow Marina as a separate island, and essentially detaching it from the Brannan Andrus Levee Maintenance District (BALMD).

Recreation enhancement opportunities within the greater Isleton study area of Brannon Andrus Levee Maintenance District (BALMD) potentially include:

1) Local and Regional Multi-Use Trail Opportunities within the City of Isleton Study Area.

   In connection with a flood fight access road and/or berm planned for the City of Isleton along its south and southwesterly borders a muti-use pedestrian/bicyclist trail could be easily integrated with said flood fight access road/berm. This trail could provide for an informative, educational loop trail within and around the historic Asian Communities and structures within the City. The trail system can also offer viewsheds of the nearby agricultural activities along the south and southwest borders of the City without being intrusive to the adjoining agricultural practices of open field crops to the south and adjoining vineyards to the west.

   Similar multi-use trails could also be integrated within cross levee systems east and west of the City limits between the existing SPFC levee systems along the right bank

of Georgiana Slough and the left bank of the Sacramento River. Cross levee trail systems could serve as a great connector loop trail system to and from the communities of Isleton along the Sacramento River and the Oxbow Marina along Georgiana Slough. Similar to a loop trail system described above associated with a flood fight access road, a cross levee loop trail system for Isleton could also serve as a connector trail and/or components of the Great California Delta Trail, as described in more detail below.

2) Great California Delta Trail segments in Central Delta Region including regional connection trails.

On January 20, 2022, the DPC adopted a formal Master Plan for the Great California Delta Trail[11]. The Master Plan calls for further planning of a multi-purpose recreational trail system that could potentially connect a number of the Delta Legacy Communities, including the City of Isleton, utilizing the former Southern Pacific Walnut Grove – Isleton Branch Line that existed from 1906 through 1972. The former rail line that once occupied 6th street within Isleton was abandoned between Isleton and Walnut Grove following the devastating flood that occurred in Isleton in 1972. The cross levee systems or a flood fight access road system described above for the City of Isleton both provide opportunities to develop and/or enhance multi-use recreational use trails within and adjoining the community that can either become a part of the Great California Delta Trail or provide connector trails to the Great Delta Trail.

Ecosystem restoration and recreation enhancement opportunities must be balanced with flood management requirements and in support of continued agricultural land uses in the Delta adjoining the City of Isleton. For additional information on ecosystem restoration and recreation enhancement opportunities within the study area please refer to Section 5.3.2 and Section 5.3.3, respectively, and accompanying Figure 5-19 and Figure 5-21 for opportunities identified in the project study area of BALMD. Appendix D also contains additional information relative to ecosystem restoration opportunities beyond the immediate study area, within the greater northeastern portion of the Delta, and other neighboring Delta Legacy Community SCFRRP study areas in the North/Central Delta.

3.2.4 Enhance Resiliency and Reliability of Through-Delta Conveyance

Levees within the study area are vulnerable to potential subsidence, earthquakes, climate change, and sea level rise, and most levee reaches do not meet current 100-year FEMA accreditation standards. These levees are used to protect both people and property and help convey water used to support the agricultural economy within the community of Isleton and beyond, including south

[11] Delta Protection Commission (DPC). January 20, 2022. Great California Delta Trail Master Plan. Available at: https://delta.ca.gov/recreation-and-tourism/

of Delta interests. SPFC levees in the North Delta are particularly critical since they assist with the conveyance of water to and downstream of the Delta Cross Channel, which augments the flow of the Sacramento River water through the Delta to the collective SWP and CVP export pumps in the south Delta near Tracy. In the event of a levee failure, sea water intrusion from the San Francisco Bay could enter areas that are critical to the distribution of fresh water, threatening water supply.

Over time, through the DWR Delta Levee Subventions and Special Projects local-state cost share programs, the levees have been maintained throughout the Delta, and some have been enlarged or geometrically improved to various Delta standard levels. Although not improving the Delta levees to modern 100-year FEMA accreditation criteria, continuing to maintain and improve levees within the Delta not only enhances flood protection for those people and properties within the study area and the Delta, but enhances the resiliency and reliability of through-Delta water conveyance. To promote this resiliency and reliability, levees both upstream and adjacent to the Delta Cross Channel along the Delta's freshwater corridor should be modernized to at least current 44 CFR §65.10 levee standards but also ultimately to a seismic standard to guard against earthquakes.

3.3 Constraints

3.3.1 Limited Local Funding Sources

LMAs partner with the state through the Delta Levee Subventions program to fund maintenance and repair of their flood control systems. However, the landscape by which levees are maintained by LMAs has drastically changed since levees were first constructed. Today, engineering design standards are more rigorous and environmental regulations are more stringent. In concert with deferred maintenance, these new requirements have increased costs to maintain the levee systems and lack of funding is a common problem facing many LMAs. This is particularly notable in small communities with limited resources and reduced tax base. LMAs derive assessment valuation per acre for each parcel in proportion to benefits derived from reclamation operation. Notably, improvements on parcels including buildings are not included in the assessment calculation per provisions of the California Water Code (CWC). With residential properties often falling below an acre, there is thus a limitation on how much properties within these communities can be assessed (CWC § 50000 et seq.).

3.3.2 Proposition 218 Assessments and Other Funding Issues

Performing levee upgrades or improvements often requires a cost sharing between local and state agencies. State funding for investments in flood management systems has largely been supported by general obligation bonds (DWR, 2017a). Multiple state programs with the purpose of rehabilitating levees within the Delta have been established as a result of these bond funds, including the Delta Subventions Program, and the Delta Levees Special Projects Program.

At the local level, LMAs rely primarily on taxes or special assessments on an acreage basis to make up their share of the funding for flood control projects. In 1996, California voters passed Proposition 218, the so-called "Right to Vote on Taxes Act." Proposition 218 amended the California Constitution by adding procedural and substantive requirements that must be met prior to levying new assessments (California Special Districts Association, 2013). As a result, all new assessments that are used for flood management must be voter approved. This directly impacts a LMA's ability to raise funding for local flood management projects, and with limited local funding, LMAs are limited in their ability to partner in cost-sharing programs through the state.

Direct reclamation district assessments to homeowners are constrained by the CWC, and are approximately $25 per home, annually, in the nearby upstream community of Courtland. This is an order of magnitude lower than average assessments for flood protection in nearby urban areas (for comparison, Sacramento Area Flood Control Agency's assessment for a residential property located behind levees in Sacramento is over $200 annually, excluding costs for applicable flood insurance).

For large repair or improvement projects, like what may be proposed in this feasibility study, LMAs must access a line of credit to implement repairs, but then substantial time may pass before cost-share reimbursements or assessment funds are available for repayment. Thus, large cash reserves are often needed in advance of securing project funds for the state or other entities.

Another difficulty is that LMAs are responsible for mitigation costs associated with repairs and maintenance. These costs increase over time, especially as offsite mitigation opportunities become limited and are a requirement under state cost-share programs.

In addition to assessing properties within the Isleton study area for levee remediation repairs and improvements, the improvements and additional infrastructure may require additional O&M funds, and thus additional Proposition 218 Assessments may be required to address the incremental increases in O&M costs for new infrastructure such as a new cross levee.

3.3.3 Existing Delta Levee Standards

There are three agricultural levee standards that are widely used within the Delta: Hazard Mitigation Plan (HMP), Public Law (PL) 84-99, and the DWR Bulletin 192-82. These standards are summarized below in Figure 3-4. The HMP levee configuration is widely used in the Delta on non-SPFC levees and is regarded as providing the minimal level of flood protection that is required for federal disaster assistance eligibility.

PL 84-99 guidance provides for somewhat better flood protection than the HMP standard, however it does not provide adequate protection from more extreme floods and earthquakes and does not provide a basis for adaption should sea level rise at an enhanced rate. The DWR Bulletin 192-82 standard is similar to the PL 84-99 criteria, except that it is designed relative to a 1- in 300-year flood event (0.33% annual chance of flooding).

The three Delta levee standards mentioned above are focused on protecting agricultural portions of the Delta and fall substantially short of the FEMA accreditation standards for meeting a 100-year level of flood protection pursuant to in 44 CFR §65.10 generally used for urban levees (Appendix D). The economic sustainability of the Delta Legacy Communities cannot be assured when applying the lower agricultural levee standards previously established for the Delta.

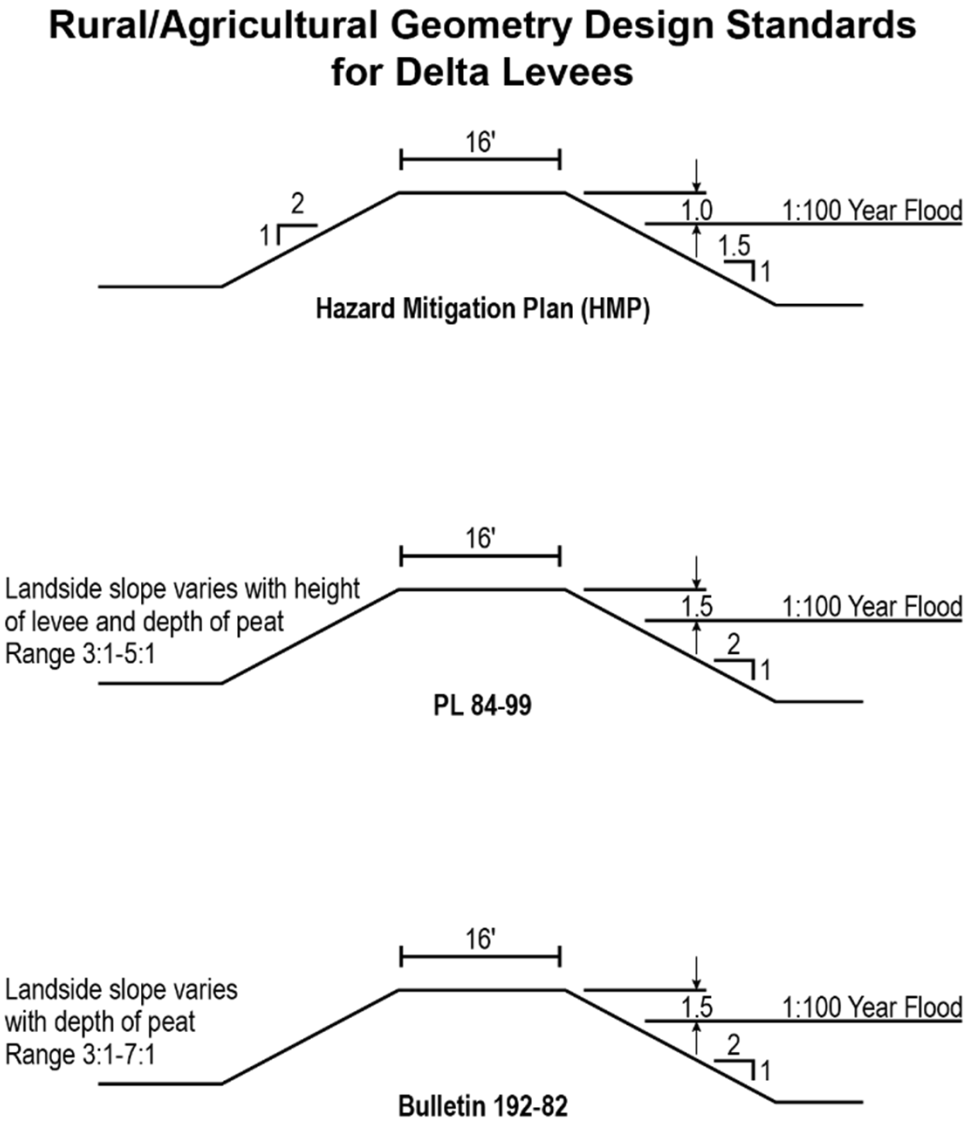

Figure 3-4. Agricultural Levee Geometry Design Standards

Agricultural levees within the Delta and those offering protection to the Isleton study area are largely improved to the PL 84-99 or Bulletin 192-82 geometry standards. However, FEMA accreditation requires levees to also meet USACE criteria contained in 44 CFR §65.10 generally used for urban levees, which goes beyond simple geometry standards. As previously discussed, this includes criteria for through and underseepage, stability, settlement, erosion, and other O&M criteria. Currently, very few Delta levees outside of urban areas meet the USACE criteria required for FEMA accreditation.

If Isleton hopes to be mapped by FEMA as Zone X (as they were before 2012 outside of the floodplain), the entire 28-mile perimeter levee system of the Isleton study area may require certification or smaller segments, such as one fronting the community paired with a cross levee, must be collectively improved to obtain a 100-year level of flood protection pursuant to 44 CFR §65.10.

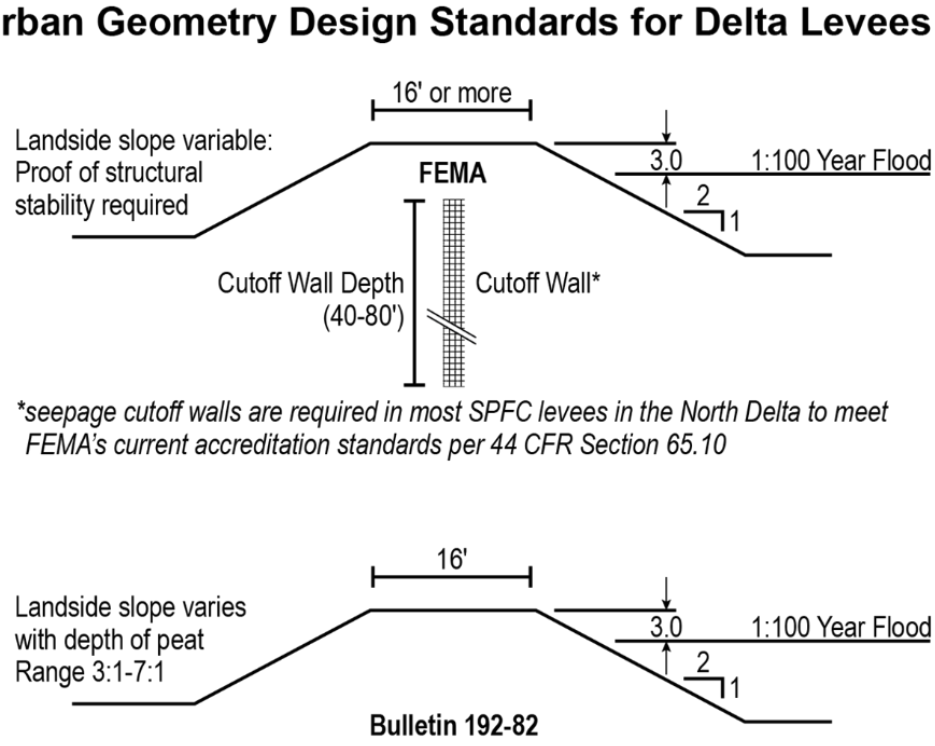

Figure 3-5. Urban Levee Geometry Design Standards

3.3.4 Delta Plan Land Use Constraints

As previously discussed in Section 2.1.3, the Delta Plan prescribes requirements for land use and floodproofing. However, there are a number of other requirements in the Delta Plan aimed at protecting, restoring, and enhancing the Delta which constrain development within the Delta Legacy Communities located in the Primary Zone of the Delta. Levee improvements made within the study area must be consistent with the Delta Plan requirements, in addition to local ordinances or regulations. By prioritizing protection and enhancement of the Delta, the Delta Plan effectively restricts the loss of agricultural lands and/or the displacement of Delta Legacy Communities. This can limit structural levee remediations to more costly alternatives, such as cutoff walls, over less costly alternatives, such as seepage and stability berms, since these berms are constructed on the landside toe of the levee and often require a displacement of agricultural lands or structures with a setback of anywhere from 150 to 350 feet

Additionally, the Delta Reform Act established a certification process for projects within and affecting the Delta. This requires any state or local agency proposing to undertake a "covered action" to submit to the DSC a written certification of consistency with detailed findings as to whether the covered action is consistent with the Delta Plan (CWC, § 85225). The project must not have significant adverse impacts on the achievement of the coequal goals or affect implementation of government-sponsored flood control programs to reduce risks to people and property in the Delta. Development of a consistency determination is usually prepared concurrently and alongside the regulatory documentation for a project, and thus represents a variable cost.

3.3.5 Biological Constraints

As described in Section 2.1.7, the study area contains sensitive vegetation communities and habitat for several special-status species. Project activities that have the potential to affect these sensitive resources will require additional studies and environmental permits prior to project implementation.

Major biological constraints to projects in the study area include very limited work windows in the 3-month period of August 1 to October 31 to perform any in-water work below the ordinary high-water line due to restrictions tied to the presence of several special status and endangered species within the Delta. Repairs of waterside erosion sites have been deferred around Isleton due to the permitting difficulty of completing these projects. There is also significant difficulty in obtaining space for mitigation for any impacts to existing vegetation along the levees. Many past projects in the study area attempted to be "self-mitigating" but this can only occur where the space and opportunity exist on a project site. There are limited (or no) mitigation credits remaining to purchase for SRA impacts in the area.

Any levee improvement project will need to consider biological impacts and resulting mitigation measures. *See* Appendix B for additional information on biological resources within the study area. It is hoped that a programmatic biological mitigation program can be established leading to a practical and effective program to repair and strengthen the levees surrounding the community of Isleton, and possibly other neighboring Delta Legacy Communities as well.

3.3.6 Cultural Resources Constraints

As described in Section 2.1.8, a total of 16 cultural resources were identified during the records search and from information provided by the county of Sacramento, but only five have been formally evaluated for their eligibility for listing in either the NRHP or CRHR. However, before implementation of any project activities, a smaller area of potential effect (APE) would need to be defined and any resources within the APE would be formally evaluated for their cultural or historical significance during the project's California Environmental Quality Act (CEQA)/National Environmental Protection Act (NEPA) permitting process. This evaluation involves consultation with interested Tribes and tribal organizations and consultation under

Section 106 of the Historic Preservation Act (with a concurrence from the State Office of Historic Preservation).

If any significant resources are determined to likely be affected by project construction, then proper treatment of the resource would be determined. Since one form of treatment for cultural resources is avoidance, this could represent a constraint for implementation of a project element. Even if resources are not avoided and the project moves forward for construction, a cost would be incurred during excavation, archiving, or development of interpretive facilities and information, required to mitigate effects to the cultural resource.

See Appendix C for additional information regarding known and potential cultural resources within the project study area of Isleton and how they need to be addressed prior to any ground disturbing activities. Appendix C also further describes the National Heritage Designation Area within the study area and greater Delta.

3.3.7 Additional Regulatory Considerations

A permit under Section 14 of the Rivers and Harbors Appropriation Act of 1899, as amended, and codified in 33 U.S. Code 408 (Section 408 Permission) is required for permanent or temporary alteration or use of facilities that were built as part of a USACE civil works project (the Sacramento-San Joaquin Flood Control Project, along the Sacramento River portion of the study area). A 408 permission is generally needed for any work on SPFC levees and within easements unless the work is classified as maintenance. However, maintenance and repair activities conducted by LMAs on SPFC levees for which they have O&M responsibilities that do not require Section 408 permission may still require coordination or concurrence from the USACE Sacramento District.

Additionally, a permit under Section 10 of the Rivers and Harbors Act of 1899 (applicable to construction of any structure in or over any navigable water of the U.S.) may be needed for work along the Sacramento River, depending on the nature of project implementation. The law applies to any dredging or disposal of dredged materials, excavation, filling, rechannelization, or any other modification of Navigable Waters of the U.S., particularly any navigable waters in the North Delta.

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4. Plan Formulation

The problems and opportunities described above led to the formulation of the study goals (Section 1) and planning objectives, detailed in this Section. These goals and objectives provide solutions for Isleton while capitalizing on opportunities to maximize multi-benefit projects and investment efficiency. Additionally, these goals and objectives, as well as stakeholder input, are utilized to measure how well plan flood risk reduction MAs meet the objectives of this study.

4.1 Planning Objectives

To achieve the study goal of modernizing SPFC levees to meet FEMA 100-year certification criteria, several broad objectives were identified as a framework for developing the preliminary suite of flood risk reduction elements and ultimately the final array of flood risk reduction MAs for Isleton. In prioritized order, these include:

- Reducing risk to life
- Reducing risk to property damage
- Reducing probability of levee failure
- Limitation of high insurance premiums
- Improved flood preparedness and response
- Enhance resiliency and reliability of through-Delta water conveyance
- Foster environmental stewardship

These objectives help to address the problems described in the preceding Section and are aligned with the state's interest as expressed within the framework of the CVFPP, the 2014 RFMP, SCFRRP, and the goals of other Delta agencies, where possible.

4.1.1 Reducing Risk to Life

Reducing risk to life is the first objective used to meet the goal of achieving 100-year flood protection for the Isleton study area. Life loss is the most devastating consequence of flooding. Prior to and since the establishment of the flood management system in the mid-1900s, catastrophic flooding and life loss has been documented in California, particularly in the Central Valley. Deficiencies in the flood control system, fast-moving floodwaters, deep floodplains, and lack of preparedness and emergency response procedures have all contributed to this life loss. Most of these are of similar concern to the Isleton study area.

The risk of life loss is of greatest concern for the Isleton study area within the densely populated community of Isleton. Should a levee breach occur along the Sacramento River immediately

upstream and fronting the community, floodwaters would likely inundate the community at high velocities and depths, leaving little time to respond or evacuate, resulting in substantial life loss.

Reducing risk to life is achieved by reducing flood risk. As described earlier, flood risk within the community and the larger study area is of concern and is based on the probability of flooding and the consequences of levee failure. By implementing flood risk reduction measures which reduce overall flood risk, either by reducing the probability of flooding or reducing the consequences of levee failure, risk of life loss is similarly reduced.

4.1.2 Reducing Risk to Property Damage

Property damage is another significant consequence of flooding. According to USACE, as documented in the 2017 CVFPP Update, flooding in 1986 and 1997 together caused over $1 billion in damage to the areas protected by the SRFCP. Within the Isleton study area, as previously discussed in Section 3, the value of land and structural improvements, agricultural crops, vehicles, and highways and streets are valued at nearly $387.4M. A levee failure could result in substantial property damage in Isleton and the larger study area, particularly in the event of a breach on the levee immediately fronting the community. Additionally, damage to property as a result of flooding could also have a ripple effect within the community, with economic impacts sustained due to damages to businesses, homes, agricultural operations, and disruption to the transportation corridors of Highways 160 and 12. This study prioritizes flood risk reduction MAs which reduce the risk to property damage and to achieve the goal of 100-year flood protection for the City of Isleton and critical infrastructure inclusive of the City's wastewater ponds and wastewater collection system.

4.1.3 Reducing Probability of Levee Failure

Since flood risk is defined as the product of probability of levee failure and the consequences of levee failure, reducing the probability of levee failure is integral to reducing flood risk and thus achieving the goal of 100-year flood protection.

Reducing the probability of levee failure for the Isleton study area can be accomplished by implementing a number of measures:

- Repairing known deficiencies in the levee system, including but not limited to repairing known FSRP critical and serious sites in BALMD
- While repairing known deficiencies also strengthen in-place the existing perimeter levee system(s) to offer improved levels of protection to the community
- Conduct annual inspections of the levee system and correct any known deficiencies inclusive of non-compliant encroachments that may pose a threat to the structural integrity of the levee system
- Enhance existing flood warning, preparedness, flood-fight and response systems and practices as identified in the Flood ESPs developed by Sacramento County

- Secure 100-year FEMA Certification for the community of Isleton and possibly for the entire Isleton project study area pursuant to 44 CFR §65.10

4.1.4 Limitation of High Insurance Premiums

As previously noted in Section 3.1.2, of the estimated 935 structures in the Isleton study area (with an Isleton Zip Code of 95641) valued at an estimated $319.9M, as of 2019 there were only 339 NFIP policies (valued at $350,000 maximum per policy inclusive of structure contents) providing $118.6M in coverage. Rising insurance premiums over the last decade are a contributing factor to this differential and are an increasing problem within the study area. Lowering flood risk, and thus increasing flood protection, is a key action that can be taken to reduce flood insurance costs each year under the existing NFIP or under a new community-based flood insurance program. (For further details see Appendix J – Community-Based Flood InsuranceProgram White Paper, pages 11-14.)

4.1.5 Improved Flood Preparedness and Response

Improved flood preparedness and response is another objective used to complement the goal of 100-year flood protection. Improved preparedness and emergency response can limit the loss of life and property damage as a result of flooding by developing the framework needed to enhance the understanding of local flood risks, foster communication, and to promote public awareness of flood risks, thus reducing flood risk.

4.1.6 Enhancing Resiliency and Reliability of Through-Delta Water Conveyance

As previously noted, the vulnerability of levees protecting through-Delta water conveyance is a problem within the study area. Levees within the study area are vulnerable to through seepage and underseepage, earthquakes, climate change and sea level rise, and in many places do not meet current engineering and FEMA accreditation standards. These levees are used to protect both people and property and support the agricultural economy within the community of Isleton and the adjoining project study area. SPFC levees in the North Delta are particularly critical since they also help convey water to the Delta Cross Channel, which augments the flow of the Sacramento River water through the Delta to the collective SWP and CVP export pumps in the south Delta near Tracy. In the event of a levee failure, sea water intrusion from the San Francisco Bay could enter areas of the freshwater corridor that are critical to the distribution of fresh water, threatening water supply to areas south of the Delta.

Continuing to improve levees within the Delta along the freshwater corridor not only enhances flood protection for those people and properties within the study area and the Delta but enhances the resiliency and reliability of through-Delta water conveyance. The existing through-Delta water conveyance system conveying water to the collective SWP and CVP export pumps in the

south Delta provides water to over 3M acres of agricultural lands and to over 27M Californians south of the Delta.

4.1.7 Environmental Stewardship and Multi-Benefits

In 2010, DWR formally adopted an Environmental Stewardship Policy to advance a department-wide "Total Resource Management" approach to planning and design of projects. By building environmental benefits into projects on a meaningful scale, DWR supports sustainability from an engineering, economic, social, and environmental perspective. The CVFPP includes the supporting goal of integrating recovery and restoration of key physical processes, self-sustaining ecological functions, native habitats, and species into flood management improvements (DWR, 2017c). Additionally, the SCFRRP increases the state cost-share for projects which advance multi-benefit flood protection for small communities (protection of state facilities/highways, contribution to the state's sustainability objectives, water supply, and open space and recreation) (DWR, 2017e).

Waterside levee repairs such as known erosion sites can provide opportunities to introduce more SRA habitat valuable to fisheries and other aquatic species.

4.2 Future Baseline Conditions

The future baseline conditions provide the basis to formulating flood risk reduction MAs and assessing their benefits and impacts. Since impact assessment is the basis for plan evaluation, comparison, and selection, clear definition and full documentation of future baseline conditions are essential (DWR, 2014). These conditions are influenced by climate change, sea level rise, development, and land subsidence and are summarized as the future without project condition. Future baseline conditions in the Lower Sacramento River also consider system-wide benefits that are being implemented upstream in the Sacramento and Yolo Bypass/Weirs that have the added benefit of diverting more flood waters into the bypasses and lowering flood stages in the Lower Sacramento River in the North Delta downstream of Sacramento.

By incorporating EAD assessments for existing baseline conditions (consistent with the values and methodologies utilized by DWR for the 2022 CVFPP update) and comparing them to future baseline conditions (consistent with the adjustments for climate change and sea level rise utilized by DWR for the 2017 CVFPP update) this feasibility study was able to compare net reductions in EAD values for various MAs under existing and future conditions. Appendix E-1 provides more details on the EAD methodologies, net reductions in EAD values for various levels of flood risk reductions measures, and findings based on existing conditions and future conditions that include adjustments for climate change and sea level rise.

4.2.1 Climate Change and Sea Level Rise

Climate change is expected to significantly affect California's water resources in the form of changes to the hydrologic regime, sea level rise, and warmer temperatures. Although sea level

rise is a minor issue in the North Delta, Californians will face a higher flood risk due to more rain and decreasing snowfall. Snow will melt faster and earlier in the season meaning more frequent flooding and less opportunity for natural storage in the mountains and will result in higher flood flows in the Delta. Reservoirs may fill earlier due to changing runoff patterns and operators will need to release water earlier in the season to make space for flood storage.

As previously discussed in Section 3.1.6, climate change and sea level rise have the potential to increase peak flows and flood stages in the Sacramento River, which would have some effects on the Isleton study area. Peak flows in the Sacramento River could increase by 4 percent for the 100-year flood and 2.3 percent for the 200-year flood as a result of climate change, and sea level rise is expected to increase the 100-year flood stage in the Sacramento River between Georgiana Slough and Cache Slough by nearly 1.6 feet on average, with the 200-year flood stage along the same extent increased by 1.1 feet

Climate change and sea level rise also have the potential to impact the estimates of flood damage, or EAD, under future conditions within the Isleton study area. The effects of inland climate change projections and sea level rise were incorporated into the EAD analyses performed as part of this study using a median estimate consistent with the methods and results of the 2017 CVFPP Update. These effects are described in greater detail in Section 6.3.1.2 and a full inventory of potential EAD values for the Isleton study area under future conditions is provided in Appendix E-1.

4.2.2 Development in the Floodplain

Improvement of levees can induce population growth and encourage development within the floodplain. This is true for all areas within the Central Valley, except for those areas within the Primary Zone of the Legal Delta. As noted previously, the portion of BALMD north of Highway 12, inclusive of the community of Isleton, is located within the Secondary Zone of the Legal Delta. Local and County general plans and land use decisions in the Secondary Zone are not necessarily constrained by the Delta Plan which limits new residential, commercial, and industrial development.

4.2.3 Land Subsidence in the Delta

While land subsidence is prevalent throughout most of the Delta due to underlying peat soils and land use practices, the effects are most pronounced within the central Delta and are least pronounced along the perimeter of the Legal Delta. Subsidence within the subject study area has occurred more in the central, agricultural portion, with very little subsidence occurring along the SPFC perimeter levee systems along the Sacramento River and Georgiana Slough.

4.3 Alignment with Goals and Policies of Delta Agencies

Along with meeting the goals, policies, and intended outcomes of the CVFPP, actions required to meet the objectives outlined above also need to be in alignment with the goals and policies of

Delta agencies. Projects and MAs should be qualitatively measured against the requirements of various Delta planning and regulatory agencies. A multitude of broad policies and goals are described in various planning documents drafted by the DPC, DSC, and Conservancy and an exhaustive matrix of potentially relevant Delta goals and policies is included as Appendix G.

4.3.1 Delta Protection Commission

DPC's Economic Sustainability Plan does not include a detailed evaluation of Isleton. However, the report mentions that all Delta levees should be brought to the HMP standard, if not to the more stringent PL 84-99 Standard. Many broad policies generally applicable to the study area are summarized in Appendix G.

4.3.2 Delta Stewardship Council

The Delta Reform Act (CWC §85306) requires that the DSC, in consultation with the CVFPB, recommend Delta Plan priorities for state investments in levee O&M and levee improvements in the Delta, including project levees that are part of the SPFC and non-SPFC levees that are constructed and maintained by LMAs.

The Delta Plan outlines a process to prioritize state O&M investments in Delta levees, O&M, and levee improvements, and sets interim priorities to guide budget and funding for levee improvements, as detailed in Table 4-1. Levee improvements in the Delta should attempt to be responsive to the 3x3 goals established by the DSC in the Delta Plan outlined below in Table 4-1.

Table 4-1. 3x3 Goals of the DSC for State Investment in Delta Integrated Flood Management

Goals	Localized Network	Levee Network	Ecosystem Conservation
1	Protect existing urban and adjacent areas by providing 200-year flood protection.	Protect water quality and water supply conveyance in the Delta, especially levees that protect freshwater aqueducts and the primary channels that carry fresh water through the Delta.	Protect existing and provide for a net increase in channel-margin habitat.
2	Protect small communities and critical infrastructure of statewide importance (located outside of urban areas).	Protect floodwater conveyance in and through the Delta to a level consistent with the State Plan of Flood Control for project levees.	Protect existing and provide for net enhancement of the floodplain habitat.
3	Protect agriculture and local working landscapes.	Protect cultural, historic, aesthetic, and recreational resources (Delta as Place).	Protect existing and provide for net enhancement of wetlands.

As described previously, the DSC also developed an overall DLIS, that: 1) quantifies flood risk, by considering the threats to Delta levees and the assets protected by these levees, and 2)

prioritizes investments for levee repairs, improvements, and rehabilitation as Very High, High, or Other Priority. Generally, the priorities address the relationship between the flood risk of each island or tract and the number of state interests that an island's or a tract's assets encompass (people, property, ecosystem, water supply, and Delta as place). The entirety of the Isleton study area is currently designated as "Very High Priority" under the DLIS prioritization. However, this prioritization is largely based upon levee geometry and availability of freeboard to the noted project area in comparison to other tracts within the Delta. Geotechnical evaluations by DWR under the NULE program and FSRP, including recent explorations conducted in 2020 specifically for this study, collectively confirm there are significant deficiencies, with known seepage concerns that are considered critical and serious. The noted deficiencies warrant immediate attention and repair to reduce the risk of flooding to the Delta Legacy Community of Isleton.

The Delta Plan includes many performance measures focused on reducing flood damages and loss of life, multi-hazard coordination, levee improvements, water supply reliability, sustainability, and recreation and economic opportunities associated with the Delta Legacy Communities. Additional Delta Plan goals generally applicable to the study area are summarized in Appendix G.

4.3.3 Delta Conservancy

The Conservancy's Delta Public Lands Strategy includes integrated conservation for publicly funded lands in the Delta and identifies small areas in and adjacent to the study area for implementation of tidal marsh, dryland habitat, and "urban greening" around Isleton. Additional Conservancy goals generally applicable to the study area are also summarized in Appendix G

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5. Preliminary Suite of Flood Risk Reduction Elements

The following Section details the structural and non-structural preliminary suite of flood risk reduction elements considered as part of this feasibility study. These elements will be used to form MAs which can be implemented by the community of Isleton as funding sources are identified and become available. Potential multi-objective components which could be incorporated as part of the structural elements and non-structural measures are also discussed.

5.1 Structural Elements

Structural elements are those that repair or improve the existing levee/flood control system as it exists today. Structural elements considered in this feasibility study include repair-in-place levee repairs, prioritization of DWR FSRP critical and serious sites, and strengthening the existing levee system to meet the objectives outlined in Section 4.1.

Structural elements discussed in this Section propose various remediations, such as cutoff walls, seepage berms, stability berms, combination seepage and stability berms, and rock slope protection to address levee vulnerabilities within the study area. A brief discussion of these remediations is provided below. The proposed remediations are feasibility level, developed using limited available data, and new, but limited geotechnical data and analyses. Additional geotechnical explorations and analysis are recommended to refine these remediations and to ensure they are designed to FEMA criteria in an effort to secure FEMA accreditation for the community of Isleton and the larger study area in the future.

Cutoff Wall: A cutoff wall is a vertical trench in the levee filled with a slurry material that becomes nearly impermeable. It is used to reduce permeability through and under levee systems that may be susceptible to seepage. Cutoff walls are designed and installed to depths necessary to minimize through seepage and underseepage vulnerabilities. One advantage to this method is that it stabilizes the levee by constructing a barrier at either the levee centerline or near the levee waterside hinge-point and does not require the displacement and reclamation of land on the landside toe, as required by other methods to address seepage as described below. A typical cutoff wall is shown in Figure 5-1.

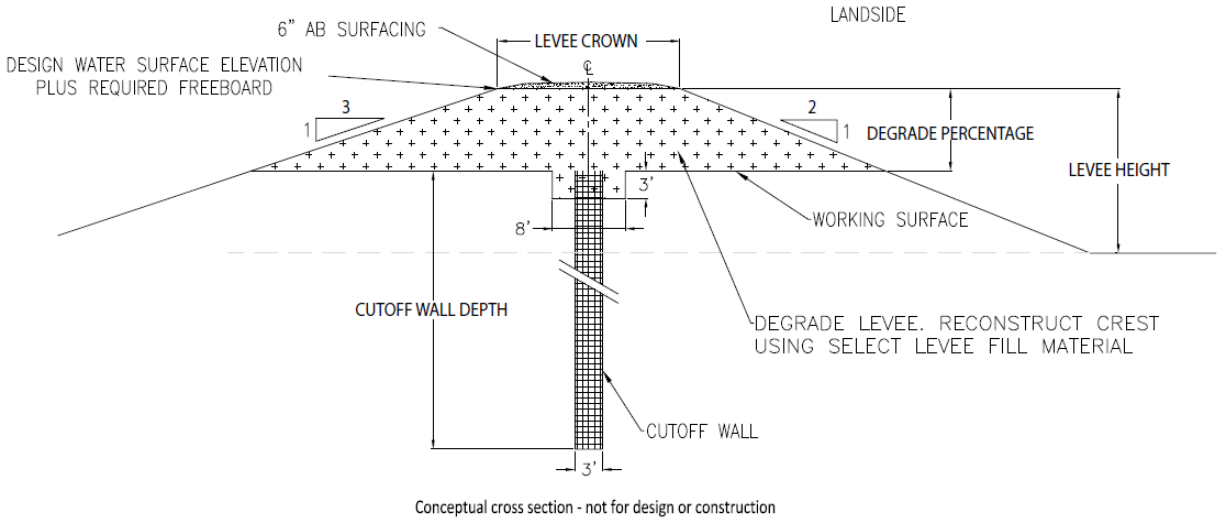

Figure 5-1. Typical Cutoff Wall

Stability Berm: Stability berms are earthen berms constructed on the levee landside slope to address through seepage and stability vulnerabilities. When a levee is only vulnerable to through seepage, a stability berm can be a more cost-effective alternative to a cutoff wall. However, this remediation requires construction on the levee landside and results in a loss of usable land. The overall width and depth of the stability berm depends upon the degree to which the levee is vulnerable to stability. A typical stability berm is shown in Figure 5-2.

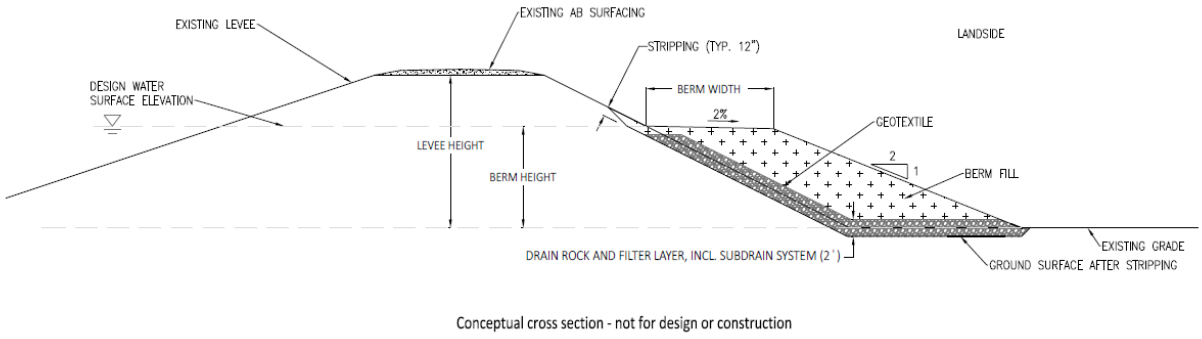

Figure 5-2. Typical Stability Berm

Seepage Berm: Seepage berms are earthen berms constructed on the levee landside to address underseepage. These berms are constructed on the levee landside toe and extend outwards away from the levee anywhere from 150 to 350 feet in width in order to lengthen the seepage path. As a result, construction of seepage berms requires more land than construction of stability berms. A typical seepage berm is provided below in Figure 5-3.

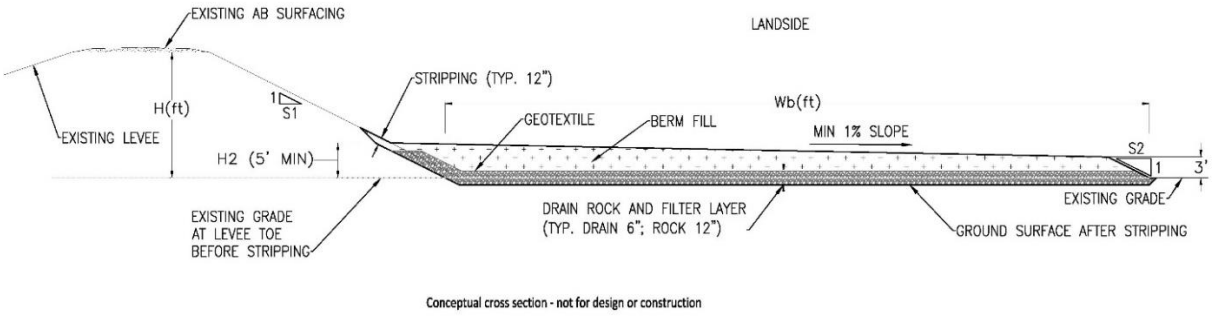

Figure 5-3. Typical Seepage Berm

Combination Seepage and Stability Berm: Combination seepage and stability berms are constructed to address levees which have both underseepage and through seepage vulnerabilities. A typical combination seepage and stability berm is shown in Figure 5-4.

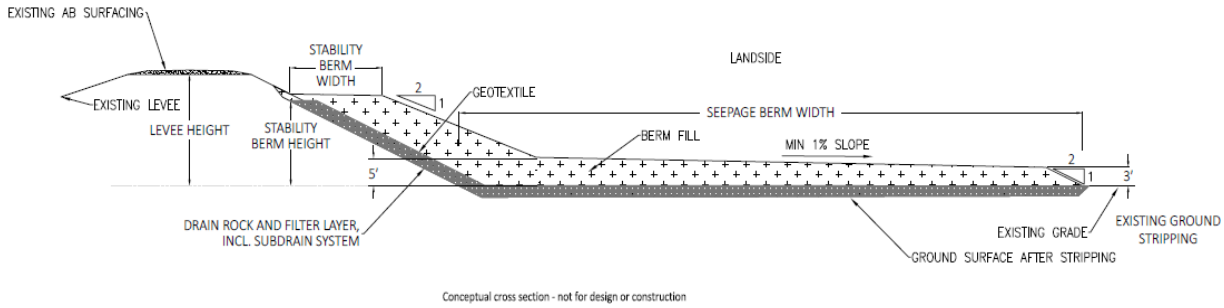

Figure 5-4. Typical Combination Seepage and Stability Berm

5.1.1 Previously Identified Repair Needs

A number of studies and evaluations have identified various issues within the study area associated with through seepage, underseepage, stability, and erosion. The following is a summary of these studies and evaluations.

5.1.1.1 DWR FSRP Critical and Serious Sites

DWR FSRP critical and serious sites are thought to pose the greatest risk to the community of Isleton. This flood risk reduction element repairs these critical and serious sites as documented in the DWR FSRP to current FEMA standards.

Within the context of the FSRP, critical and serious sites are generally defined as follows (URS, 2013a):

Critical Site: If not repaired, the site presents a significant risk of failure or would impede flood control function or flood fight activities during the next high-water event.

Serious Site: If not repaired in a timely manner, the site has the potential to become critical during the next high-water event.

As shown in Figure 5-5, DWR identified a total of 13 critical and serious sites on BALMD (7 serious erosion sites, 2 serious stability sites, 2 serious seepage sites, and 2 critical stability sites). The sites are located throughout the perimeter levee system on the left bank of the Sacramento River, and on the right bank of Georgiana Slough, and the Mokelumne and San Joaquin rivers. These sites are further characterized in Table 5-1 below.

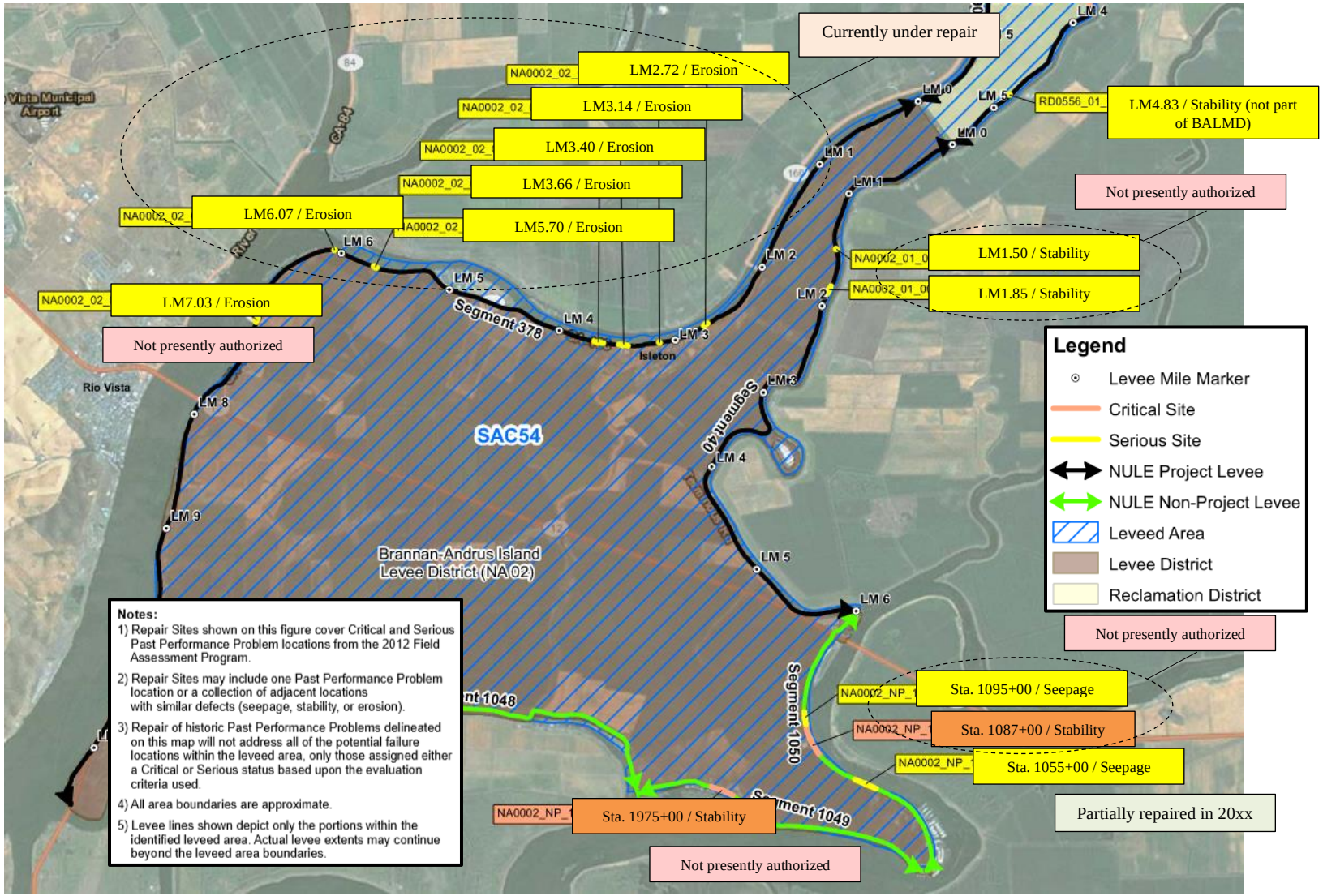

Figure 5-5. FSRP Critical and Serious Seepage Sites within BALMD (URS, 2013b)

Table 5-1. FSRP Critical and Serious Seepage Sites and Proposed Solutions

Segment Location	Failure Mode	Site Status	Approximate Levee Mile Location	Supporting Evidence	Proposed Solution[1]	Repair Length (feet)	Status
Left Bank of the Sacramento River (NULE Segment 378)	Erosion	Serious	2.68 to 2.76	Two erosion sites on the waterside slope and bank about 200 feet apart. Erosion appears to be within the levee prism.	Rock revetment	400	Currently under repair or already repaired
	Erosion	Serious	3.14 to 3.15	Erosion site on waterside slope within levee prism. The erosion is 30 feet long, extends from waterside hinge to the toe of the bank. Appears to be about 6-12 inches deep. Unmitigated progressive erosion likely to extend into levee prism during/following several future high-water events, possibly causing levee failure.		250	
	Erosion	Serious	3.40 to 3.51	Erosion on the waterside bank and slope for roughly 900 feet, likely extending within levee prism. The erosion is worst at the upstream end of the area, with a 10-foot-near-vertical scarp at mid waterside slope. Unmitigated progressive erosion likely to further extend into levee prism during/following several future high-water events, possibly causing levee failure.		550	
	Erosion	Serious	3.60 to 3.72	Erosion and waterside caving site about 500 feet long. There is a steepened slope 0.8:1 to 1:1 at the landside hinge, where the slope appears to have previously failed. This area appears to be progressively failing. The failure area is within 5 feet of the edge of Highway 160. There are erosion pockets every 25-75 feet for the 500-foot stretch. The bank is also near vertical at some places.		700	
	Erosion	Serious	5.66 to 5.84	For about 150-foot-stretch, erosion on the waterside slope from hinge to toe. The erosion has left a steep slope 1:1 to 1.5:1. Crown width is 31 feet. Unmitigated progressive erosion likely to further extend into levee prism during/following several future high-water events		950	
	Erosion	Serious	6.04 to 6.10	Erosion site on the waterside slope and bank, roughly 150 feet long, up to 3 feet deep and extends up to 10 feet into the slope and bank. Erosion is within the levee prism. Unmitigated progressive erosion likely to further extend into levee prism during/following several future high-water events, possibly causing levee failure.		350	
	Erosion	Serious	7.00 to 7.06	Erosion site on the waterside slope and bank. There is a 6- to 10-foot high near vertical scarp on the waterside slope about 4 feet below the crown. Erosion is nearly within projected levee prism. Unmitigated progressive erosion likely to extend into levee prism during/following several future high-water events, possibly causing levee failure.	Rock revetment	350	Not presently authorized

Segment Location	Failure Mode	Site Status	Approximate Levee Mile Location	Supporting Evidence	Proposed Solution[1]	Repair Length (feet)	Status
Right Bank of Georgiana Slough (NULE Segment 40)	Stability	Serious	1.50 to 1.51	Within a seepage area from 1998, there was a toe slip 20 feet long, 1-3 feet high at 1/3 of levee height. Currently, no seepage observed or hydrophytic vegetation. The 1998 slip appears to have been repaired. Unmitigated progressive slope deformation could cause failure during future high-water event.	Drained stability berm	150	Not presently authorized
	Stability	Serious	1.81 to 1.89	Sloughing on landside slope, 400 feet long, 12 inches deep, 12-inch scarp. Not known to be related to previous flooding. 6.5-foot-deep ditch at landside toe contributing to instability. Unmitigated progressive slope deformation could cause failure during future high-water event.	Drained stability berm	500	Not presently authorized
Right Bank of the Mokelumne River (NULE Segment 1050)	Seepage	Serious	Sta. 1095+00 to 1100+00	Recurring seepage/boil area reported by District Engineer for BALMD. The area reportedly has through seepage/small boils year-round at high tides. No reports of underseepage.	Drained stability berm	600	Not presently authorized
	Stability	**Critical**	Sta. 1080+00 to 1095+00	Location of USACE flood fights in 1986 and 1997 due to stability. A small toe berm repair was constructed by USACE in northern part of this area in 1997 to fill in a ditch, but slope is still moving per LMA. At this area, there is slumping at mid slope that has left a 1.5-foot-deep depression/scarp. This depression was wet. The slope regraded after 1987 when a flood fight occurred. Has been sinking since then, according to LMA.	Drained stability berm	1,600	Not presently authorized
	Seepage	Serious	Sta. 1050+00 to 1060+00	Location of recurrent seepage and boils reported by the District Engineer during NULE 2010 interviews. The boils were described as running clear. During the site reconnaissance, wet areas with free water were observed on the landside slope up to 10 feet above the landside toe and at the toe. No wet areas beyond the toe.	Drained stability berm	1,100	Partially repaired prior to 2020
Right Bank of the San Joaquin River (NULE Segment 1049)	Stability	**Critical**	Sta. 1970+00 to 1980+00	Location of breach in 1970s that failed due to stability during construction work during low tide. Currently, there are indications of slope instability including 4-6 inches of vertical offset deformation on the crown 20 feet from the landside hinge, with slope bulging on landside.	Drained stability berm	1,100	Not presently authorized

Notes: [1] As proposed by DWR in the 2013 FSRP Pre-Feasibility Report for Leveed Area SAC 54: Andrus Island
Source: URS, 2013b

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As shown in Table 5-1, six of the seven serious erosion sites on the Sacramento River are currently under repair, with one serious seepage site on the Mokelumne River partially repaired prior to 2020. This element addresses the six remaining critical and serious seepage, stability, and erosion sites identified in Table 5-1 as not presently authorized for repair:

- Two critical stability sites on the right banks of the Mokelumne and San Joaquin rivers (sta. 1087+00 and 1975+00, respectively)
- Two serious stability sites on the right bank of Georgiana Slough (LM1.50 and LM1.85)
- One serious seepage site on the right bank of the Mokelumne River (sta. 1055+00)
- One serious erosion site on the left bank of the Sacramento River (LM7.03)

This element addresses these six critical and serious sites as proposed in the 2013 FSRP Pre-Feasibility Report for Leveed Area SAC54: Andrus Island (2013 FSRP Pre-Feasibility Report) (URS, 2013b). The remediations for the critical and serious seepage and stability sites on Georgiana Slough and the Mokelumne and San Joaquin rivers consist of drained stability berms, and rock revetment is proposed for the serious erosion site along the left bank of the Sacramento River as detailed in Table 5-1 above.

5.1.1.2 Repair and Strengthen-in-Place Sacramento River Left (east) Bank SPFC Levees (NULE Segment 378)

Levees along the left bank of the Sacramento River are documented by DWR to have a moderate risk of levee failure or the need to flood fight based on vulnerabilities to through seepage, slope stability, and erosion. As previously discussed, a breach on the left bank of the Sacramento River within BALMD could result in flood depths of up to 5 feet in the community of Isleton, with flood depths reaching up to 32 feet in the larger BALMD basin. To reduce the risk of life loss and property damage within the community of Isleton and the larger BALMD basin, this element repairs and strengthens the entirety of NULE Segment 378 located along the left bank of the Sacramento River (10.2 to 11.6 miles). Improvement of this portion of levee was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2014 RFMP. Remediations for this element were developed by DWR based on the assessment performed as documented in the NULE GAR and as provided in the 2011 Remedial Alternatives and Cost Estimates Report (RACER) for the North NULE study area. To develop these remediations, the levee was assessed for four potential failure modes (through seepage, underseepage, slope stability, and erosion) and for freeboard and geometry. For each hazard, the levee segment was categorized based on its overall vulnerability to the various failure mechanisms (low, moderate, high) and the likelihood of levee failure. The hazard extent, or the percentage of levee that was deemed vulnerable to each hazard, was also identified. With this assessment, a suite of remedial alternatives was identified primarily to address through seepage, slope stability, and erosion. A preferred alternative was selected to address each hazard or group of hazards through a least cost approach. The preferred alternatives as identified by DWR to address vulnerabilities on the 10.2 miles of levee located along the left bank of the Sacramento River (NULE Segment 378)

between the RD 556 Cross levee (at LM 0.0) and West Brannan Island Road (at LM 10.2) are provided in Table 5-2. Additional geotechnical explorations and analysis are highly recommended by BALMD and the City of Isleton to refine these remediations.

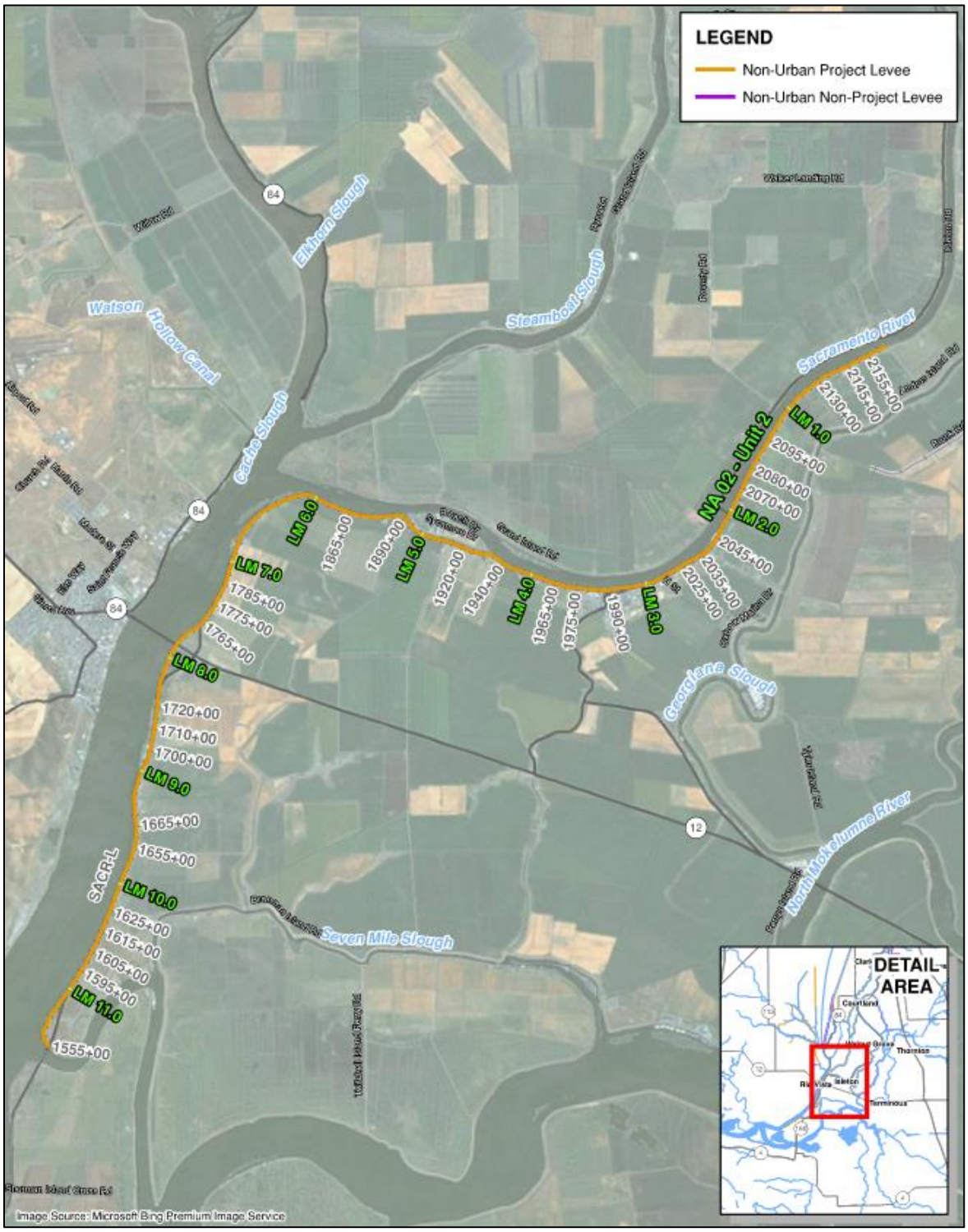

Figure 5-6. SPFC Levee Segment along the Left Bank of the Sacramento River (10.2 Mile Portion of NULE Segment 378, north of West Brannan Island Road - LM 0.0 to 10.2) (URS, 2011a)

Table 5-2. Summary of Remedial Alternatives to Address Levee Vulnerabilities along the Left Bank of the Sacramento River in BALMD between RD 556 Cross Levee and Threemile Slough

Levee Segment Location	NULE Segment (61,200 feet Length)	Hazard Remediated	Percent of 11.6[1]-mile Total Levee Segment	Remedial Alternatives
Left Bank Sacramento River	378 (SPFC Levee Segment)	T	10% @ 1.2 miles	14-foot-High Levee 4-foot-High Drained Stability Berm, or 20' Deep Slurry Wall
		S	30% @ 3.5 miles	14-foot-High Levee 4-foot-High Drained Stability Berm
		T	20% @ 2.3 miles	14-foot-High Levee 4-foot-High Drained Stability Berm
		E	20% @ 2.3 miles	14-foot-High Levee

Notes: T = Through Seepage, S = Slope Stability, E = Erosion; Source: URS, 2011b

[1] NULE Segment 378 is 11.6 miles in length but the furthest downstream 1.4-mile segment, between West Brannan Island Road and Threemile Slough is considered high ground and is not likely subject to failure

5.1.1.3 Repair and Strengthen-in-Place Georgiana Slough Right (west) Bank SPFC Levees (NULE Segment 40)

As described above, levees along the right bank of Georgiana Slough are documented by DWR to have a high risk of levee failure or the need to flood fight based on vulnerabilities to underseepage, through seepage, and slope stability. A breach on the right bank of Georgiana Slough within BALMD could result in flood depths of up to 5 feet in the community of Isleton, with flood depths reaching up to 32 feet in the larger BALMD basin. To reduce the risk of life loss and property damage within the community of Isleton and the larger BALMD basin, this element repairs and strengthens the entirety of NULE Segment 40 located along the right bank of Georgiana Slough (total of 6.0 miles) (Figure 5-7).

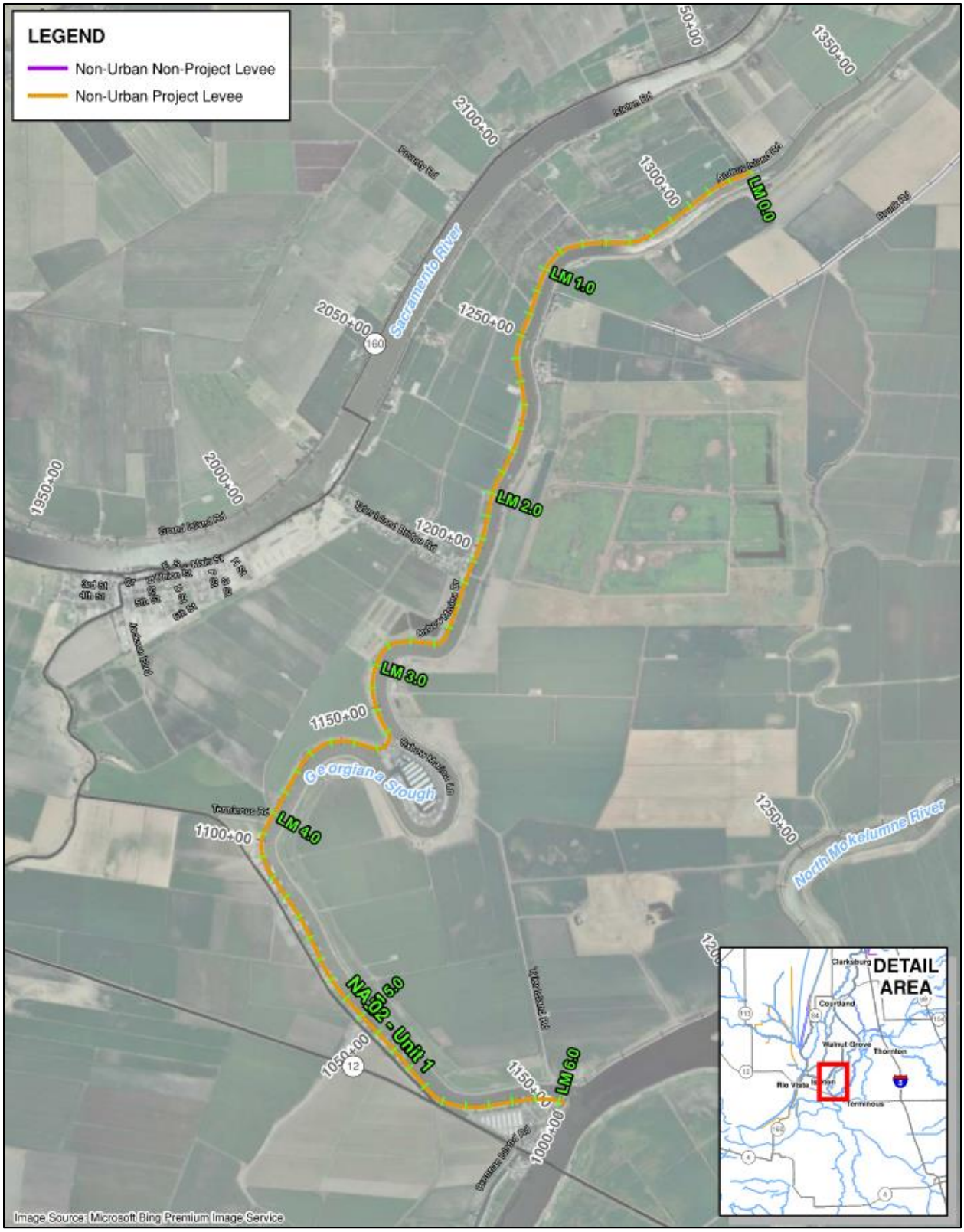

Figure 5-7. 6.0 miles of SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) (URS, 2011a)

Improvement of this portion of levee was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2014 RFMP. Remediations for this element were developed by DWR based on the assessment performed as documented in the NULE GAR and as provided in the 2011 RACER for the North NULE study area. To develop these remediations, the levee was assessed for four potential failure modes (through seepage, underseepage, slope stability, and erosion) and for freeboard and geometry. For each hazard, the levee segment was categorized based on its overall vulnerability to the various failure mechanisms (low, moderate, high) and the likelihood of levee failure. The hazard extent, or the percentage of levee that was deemed vulnerable to each hazard, was also identified. With this assessment, a suite of remedial alternatives was identified primarily to address through seepage, underseepage, slope stability, and geometry deficiencies. A preferred alternative was selected to address each hazard or group of hazards through a least coast approach. The preferred alternatives as identified by DWR to address vulnerabilities on the 4.3 miles of levee located along the right bank of Georgiana Slough (NULE Segment 40) are provided in Table 5-3. Additional geotechnical explorations and analysis are thus highly recommended by BALMD and the City of Isleton consultant team to refine these remediations.

Table 5-3. Summary of Remedial Alternatives to Address Levee Vulnerabilities along the Right Bank of Georgiana Slough in BALMD

Levee Segment Location	NULE Segment (31,700 feet Length)	Hazard Remediated	Percent of 6.0-mile Total Levee Segment	Remedial Alternatives
Right Bank Georgiana Slough	40 (SPFC Levee Segment)	T + U	10% @ 0.6 miles	13-foot-High Levee 65-foot-Wide Combination Berm, or 55' Deep Slurry Wall
		U	5% @ 0.3 miles	13-foot- High Levee 70-foot-Wide Seepage Berm, or 55' Deep Slurry Wall
		T + U	15% @ 0.9 miles	13-foot-High Levee 75-foot-Wide Combination Berm, or 55' Deep Slurry Wall
		T + U + S	30% @ 1.9 miles	13-foot-High Levee 11-foot-High Stability Berm, or 55-foot-Deep Slurry Wall
		T + U + S	30% @ 1.9 miles	13-foot-High Levee 70-foot-Wide Combination Berm, or 55-foot-Deep Slurry Wall
		FG	90% @ 5.6 miles	13-foot-High Levee

Notes: T = Through Seepage, U = Underseepage, S = Slope Stability, FG = Freeboard and/or Geometry
Source: URS, 2011b

5.1.1.4 Repair and Strengthen-in-Place Mokelumne River Right (west) Bank Non-SPFC Levees (NULE Segment 1050)

Levees along the right bank of the Mokelumne River are documented by DWR to have a high risk of levee failure or the need to flood fight based on vulnerabilities to underseepage, through seepage, slope stability, and erosion. To reduce the risk of life loss and property damage within BALMD, inclusive of the community of Isleton, this element repairs and strengthens the entirety of the 2.9 miles of non-SPFC levee located along the right bank of the Mokelumne River in BALMD (NULE Segment 1050) (Figure 5-8).

Improvement of this portion of levee was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2014 RFMP. Remediations for this element were developed by DWR based on the assessment performed as documented in the NULE GAR and as provided in the 2011 RACER for the North NULE study area. To develop these remediations, the levee was assessed for four potential failure modes (through seepage, underseepage, slope stability, and erosion) and for freeboard and geometry. For each hazard, the levee segment was categorized based on its overall vulnerability to the various failure mechanisms (low, moderate, high) and the likelihood of levee failure. The hazard extent, or the percentage of levee that was deemed vulnerable to each hazard, was also identified. With this assessment, a suite of remedial alternatives was identified to address underseepage, through seepage, slope stability, erosion, and geometry deficiencies. A preferred alternative was selected to address each hazard or group of hazards through a least coast approach. The preferred alternatives as identified by DWR to address vulnerabilities on the 2.9 miles of levee located along the right bank of the Mokelumne River (NULE Segment 1050) are provided in Table 5-4. Additional geotechnical explorations and analysis are thus highly recommended by RD 554 and the City of Isleton consultant team to refine these remediations.

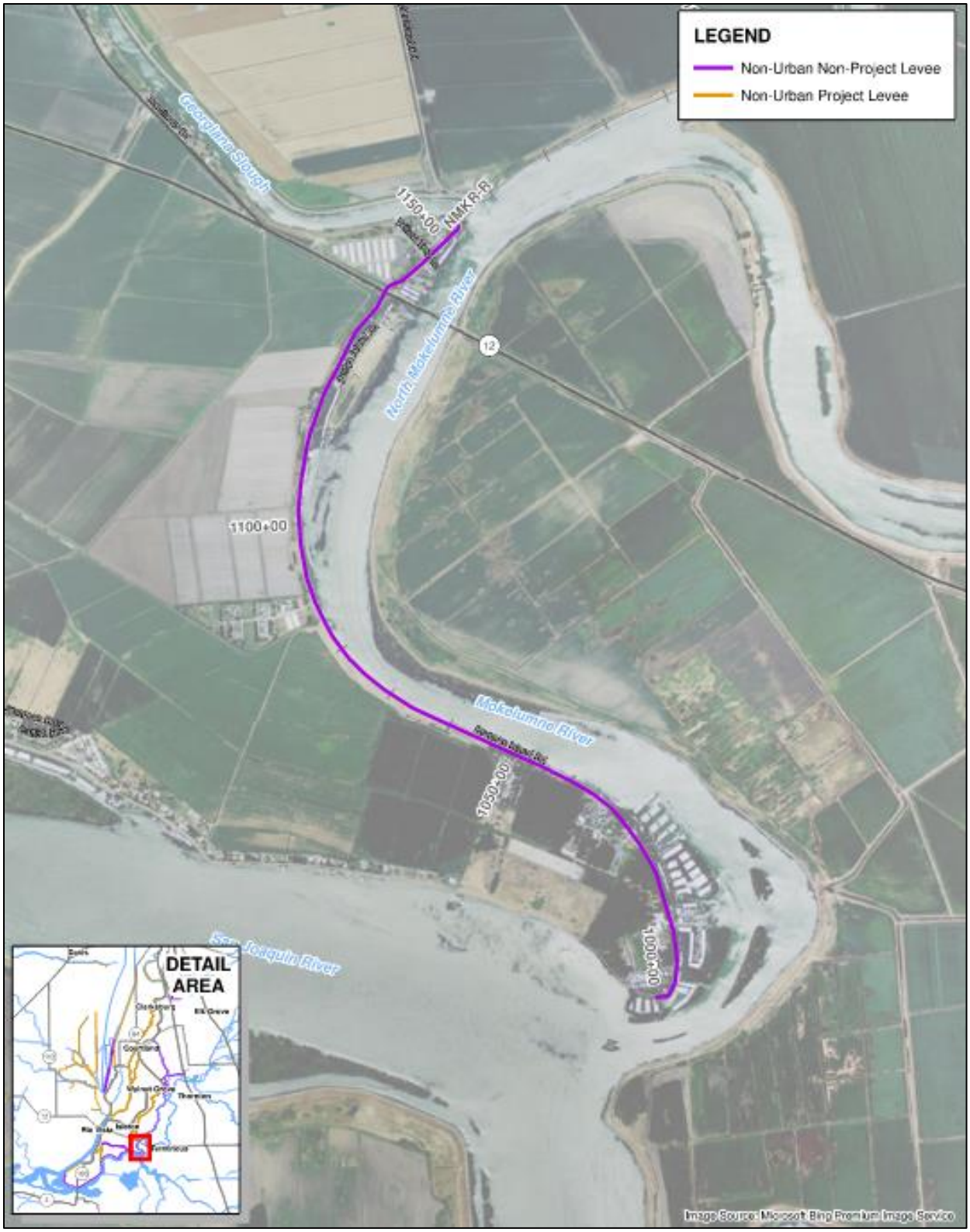

Figure 5-8. Right Bank Mokelumne River Non-SPFC Levee in BALMD (NULE Segment 1050) (URS, 2011a)

Table 5-4. Summary of Remedial Alternatives to Address Levee Vulnerabilities along the Right Bank of the Mokelumne River in BALMD

Levee Segment Location	NULE Segment (15,300 feet Length)	Hazard Remediated	Percent of 2.9-mile Total Levee Segment	Remedial Alternatives
Right Bank Mokelumne River	1050 (Non-SPFC Levee Segment)	T + U + S	60% @ 1.7 miles	20-foot-High Levee 100-foot-Wide Combination Berm 19-foot-High Drained Stability Berm, or 45-foot-Deep Slurry Wall
		E	10% @ 0.3 miles	20-foot-High Levee
		FG	10% @ 0.3 miles	20-foot-High Levee Geometry Deficiency Only

Notes: T = Through Seepage, U = Underseepage, S = Slope Stability, E = Erosion, FG = Freeboard and/or Geometry
Source: URS, 2011b

5.1.1.5 Repair and Strengthen-in-Place San Joaquin River Right (west) Bank Non-SPFC Levees (NULE Segment 1049)

Levees along the right bank of the San Joaquin River are documented by DWR to have a moderate risk of levee failure or the need to flood fight primarily based on vulnerabilities to underseepage, slope stability, and erosion. To reduce the risk of life loss and property damage within BALMD, inclusive of the community of Isleton, this element repairs and strengthens the entirety of the 2.6 miles of non-SPFC levee located along the right bank of the San Joaquin River in BALMD (NULE Segment 1049) (Figure 5-9).

Improvement of this portion of levee was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2014 RFMP. Remediations for this element were developed by DWR based on the assessment performed as documented in the NULE GAR and as provided in the 2011 RACER for the North NULE study area. To develop these remediations, the levee was assessed for four potential failure modes (through seepage, underseepage, slope stability, and erosion) and for freeboard and geometry. For each hazard, the levee segment was categorized based on its overall vulnerability to the various failure mechanisms (low, moderate, high) and the likelihood of levee failure. The hazard extent, or the percentage of levee that was deemed vulnerable to each hazard, was also identified. With this assessment, a suite of remedial alternatives was identified to address underseepage, through seepage, slope stability, erosion, and geometry deficiencies. A preferred alternative was selected to address each hazard or group of hazards through a least coast approach. The preferred alternatives as identified by DWR to address vulnerabilities on the 2.6 miles of levee located along the right bank of the San Joaquin River (NULE Segment 1049) are provided in Table 5-5. Additional geotechnical explorations and analysis are thus highly recommended by RD 554 and the City of Isleton consultant team to refine these remediations.

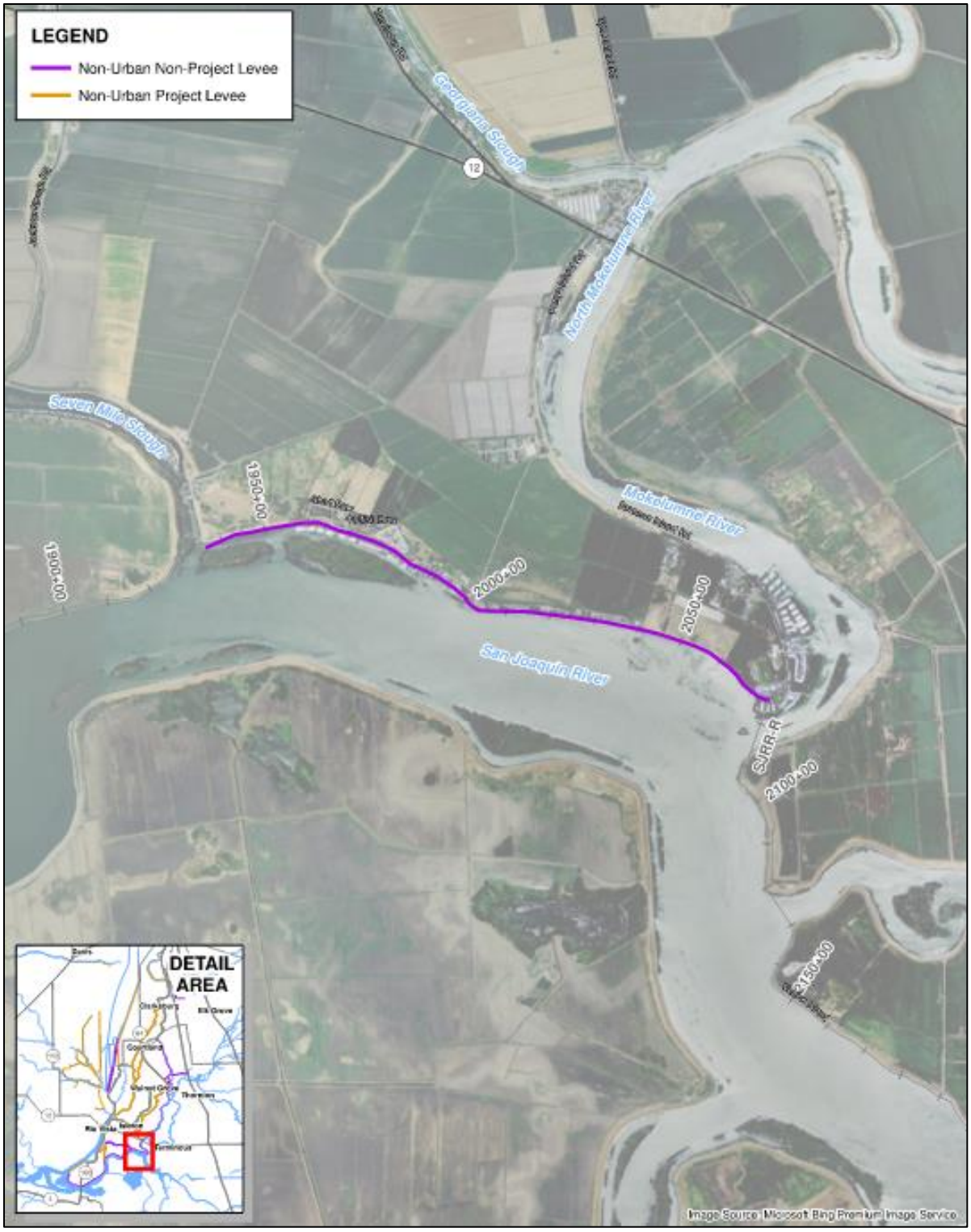

Figure 5-9. Right Bank San Joaquin River Non-SPFC Levee in BALMD (NULE Segment 1049) (URS, 2011a)

Table 5-5. Summary of Remedial Alternatives to Address Levee Vulnerabilities along the Right Bank of the San Joaquin River in BALMD

Levee Segment Location	NULE Segment (13,700 feet Length)	Hazard Remediated	Percent of 2.6-mile Total Levee Segment	Remedial Alternatives
Right Bank San Joaquin River	1049 (Non-SPFC Levee Segment)	U + S	30% @ 0.8 miles	20-foot-High Levee 19-foot-High Drained Stability Berm, or 70-foot-Deep Slurry Wall
		T + U + S	30% @ 0.8 miles	20-foot-High Levee 19-foot-High Drained Stability Berm, or 70-foot-Deep Slurry Wall
		U + S	30% @ 0.8 miles	20-foot-High Levee 100-foot-Wide Combination Berm 19-foot-High Drained Stability Berm, or 70-foot-Deep Slurry Wall
		U + S	10% @ 0.3 miles	14-foot-High Levee 13-foot-High Drained Stability Berm, or 70-foot-Deep Slurry Wall
		E	10% @ 0.3 miles	20-foot-High Levee
		FG	15% @ 0.4 miles	20-foot-High Levee Geometry Deficiency Only

Notes: T = Through Seepage, U = Underseepage, S = Slope Stability, E = Erosion, FG = Freeboard and/or Geometry
Source: URS, 2011b

5.1.1.6 Repair and Strengthen-in-Place Sevenmile Slough Left (east) Bank Non-SPFC Levees (NULE Segment 1048)

Levees along the left bank of Sevenmile Slough are documented by DWR to have a high risk of levee failure or the need to flood fight primarily based on vulnerabilities to underseepage, through seepage, and slope stability. To reduce the risk of life loss and property damage within BALMD, inclusive of the community of Isleton, this element repairs and strengthens the most easterly 1.35 miles of non-SPFC levee located along the left bank of Sevenmile Slough in BALMD (NULE Segment 1048) (Figure 5-10). Water along this easterly portion of the slough is controlled by a gated dam with two 48-inch diameter pipes with gate valves, located on West Brannan Island Road just beyond the south end of Jackson Slough and Jackson Slough Road. Certifying this closure structure, along with the other structure located at West Brannan Island Road at Twitchell Island Road near Brannan Island State Recreation Area (BISRA), would negate the need to repair and improve the westerly 3.25 miles of non-SPFC levee segment along the left bank of Sevenmile Slough. As a result, this element pairs the repairs and improvements along the 1.35 miles of non-SPFC levee along the left bank of Sevenmile Slough with certification of said closure structures.

Improvement of this portion of levee was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2014 RFMP. Remediations for this element were developed by DWR based on the assessment performed as documented in the NULE GAR and as provided in the 2011 RACER for the North NULE study area. To develop these remediations, the levee was assessed for four potential failure modes (through seepage, underseepage, slope stability, and erosion) and for freeboard and geometry. For each hazard, the levee segment was categorized based on its overall vulnerability to the various failure mechanisms (low, moderate, high) and the likelihood of levee failure. The hazard extent, or the percentage of levee that was deemed vulnerable to each hazard, was also identified. With this assessment, a suite of remedial alternatives was identified to primarily address underseepage, through seepage, slope stability, and geometry deficiencies. A preferred alternative was selected to address each hazard or group of hazards through a least coast approach. The preferred alternatives as identified by DWR to address vulnerabilities on the 4.6 miles of levee located along the left bank of Sevenmile Slough (NULE Segment 1048) are provided in Table 5-6. Additional geotechnical explorations and analysis are thus highly recommended by BALMD and the City of Isleton consultant team to refine these remediations.

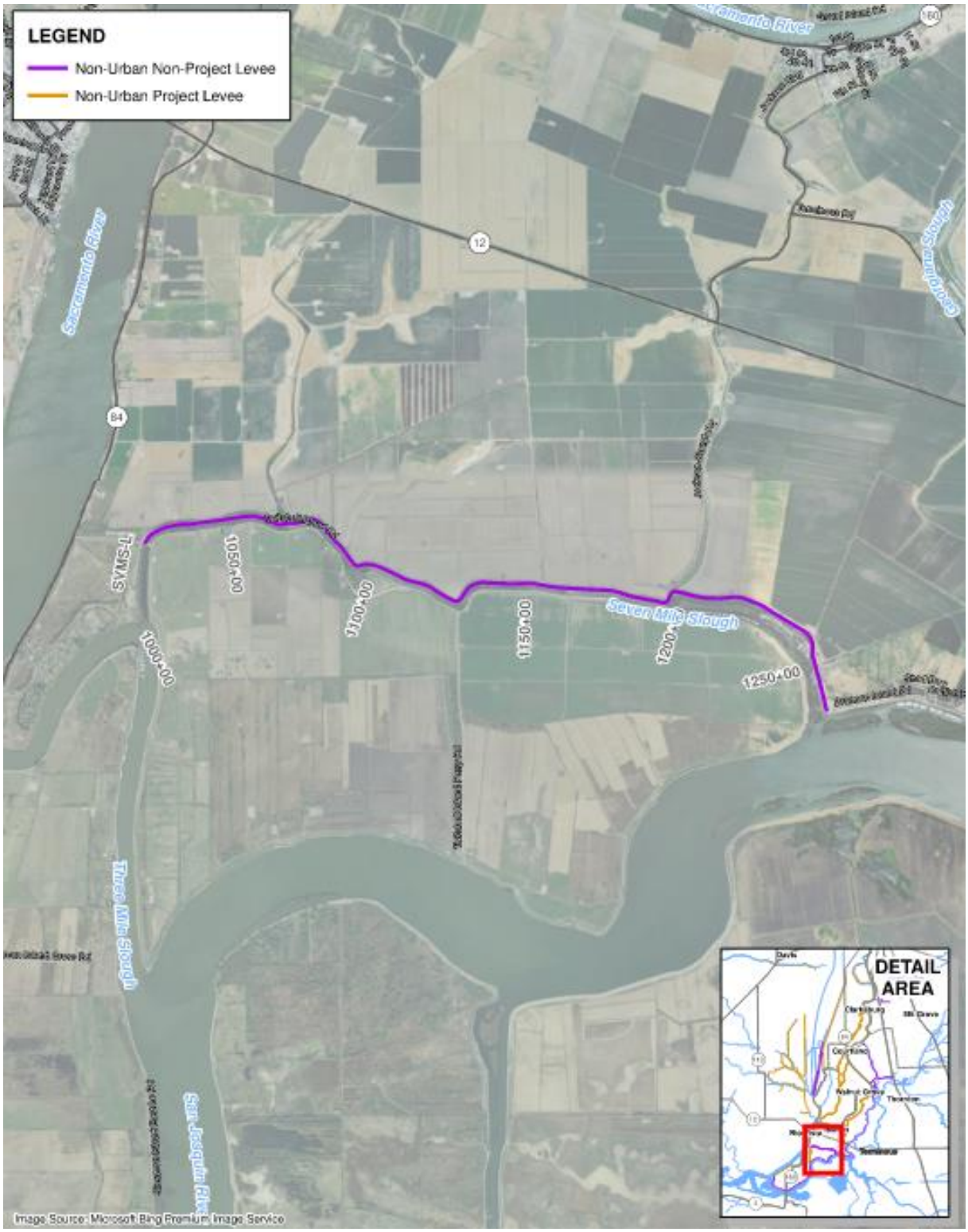

Figure 5-10. Left Bank Sevenmile Slough Non-SPFC Levee in BALMD and Closure Structures (URS, 2011a)

Table 5-6. Summary of Remedial Alternatives to Address Levee Vulnerabilities along the Left Bank of Sevenmile Slough in BALMD

Levee Segment Location	NULE Segment (24,300 feet Length)	Hazard Remediated	Percent of 4.6-mile Total Levee Segment	Remedial Alternatives
Left Bank Sevenmile Slough	1048 (Non-SPFC Levee Segment)	T + U + S	40% @ 1.8 miles	27-foot-High Levee 26-foot-High Drained Stability Berm 162-foot-Wide Combination Berm, or 70-foot-Deep Slurry Wall
		U + S	30% @ 1.4 miles	27-foot-High Levee 26-foot-High Drained Stability Berm 162-foot-Wide Combination Berm, or 70-foot-Deep Slurry Wall
		T	30% @ 1.4 miles	27-foot-High Levee 26-foot-High Drained Stability Berm, or 20-foot-Deep Slurry Wall
		FG	55% @ 2.5 miles	27-foot-High Levee Geometry Deficiency Only

Notes: T = Through Seepage, U = Underseepage, S = Slope Stability, FG = Freeboard and/or Geometry
Source: URS, 2011b

5.1.2 Additional Remediations and Improvements

Additional remediations to improve flood protection for the community of Isleton and the larger study area were investigated as part of this feasibility study and are provided below.

5.1.2.1 Repair and Strengthen-in-Place Sacramento River Left (east) Bank SPFC Levee Adjacent to Isleton (Portion of NULE Segment 378)

As previously discussed, a breach on the Sacramento River levee immediately fronting the community poses great risk to Isleton and the larger study area since a failure would likely result in significant property damage and life loss as a result of high floodwater depths and velocities and little time to evacuate. This flood risk reduction element repairs and strengthens the 1.6-mile-long portion of levee immediately adjacent to and upstream of the community of Isleton along the left bank of the Sacramento River, primarily downstream of the Isleton State Route 160 bridge crossing.

Improvement of this portion of levee was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2014 RFMP. This feasibility study leverages data from the NULE Phase 1 study along with additional data from CPTs collected in 2020 to develop two remedial alternatives for this segment of levee.

Remediations for this element, and those discussed in Section 5.1.2.2, were developed considering through seepage, underseepage, slope stability, and freeboard. Erosion was not

included in this analysis as BALMD is currently repairing the erosion sites identified by the FSRP. Additional information regarding the data used to develop these remediations and how levee vulnerabilities were identified can be found in Appendix A. Based on the available data, remediations were developed to primarily address vulnerabilities for through seepage and underseepage, as well as geometry deficiencies. As depicted in Figure 5-11, this element includes two remedial alternatives to primarily address these vulnerabilities: a 30-foot-deep cutoff wall (Remediation Alternative 1) or a 9-foot tall, 65-foot-wide combination seepage and stability berm (Remediation Alternative 2). To address freeboard deficiencies, the levee would be raised by 0.5 foot over distance of 500 ft. from station 1987+50 to 1992+50. These remediations are summarized below in Table 5-7. Further geotechnical investigations in connection with obtaining FEMA accreditation may be needed to confirm the levee fronting the community is not vulnerable to slope stability.

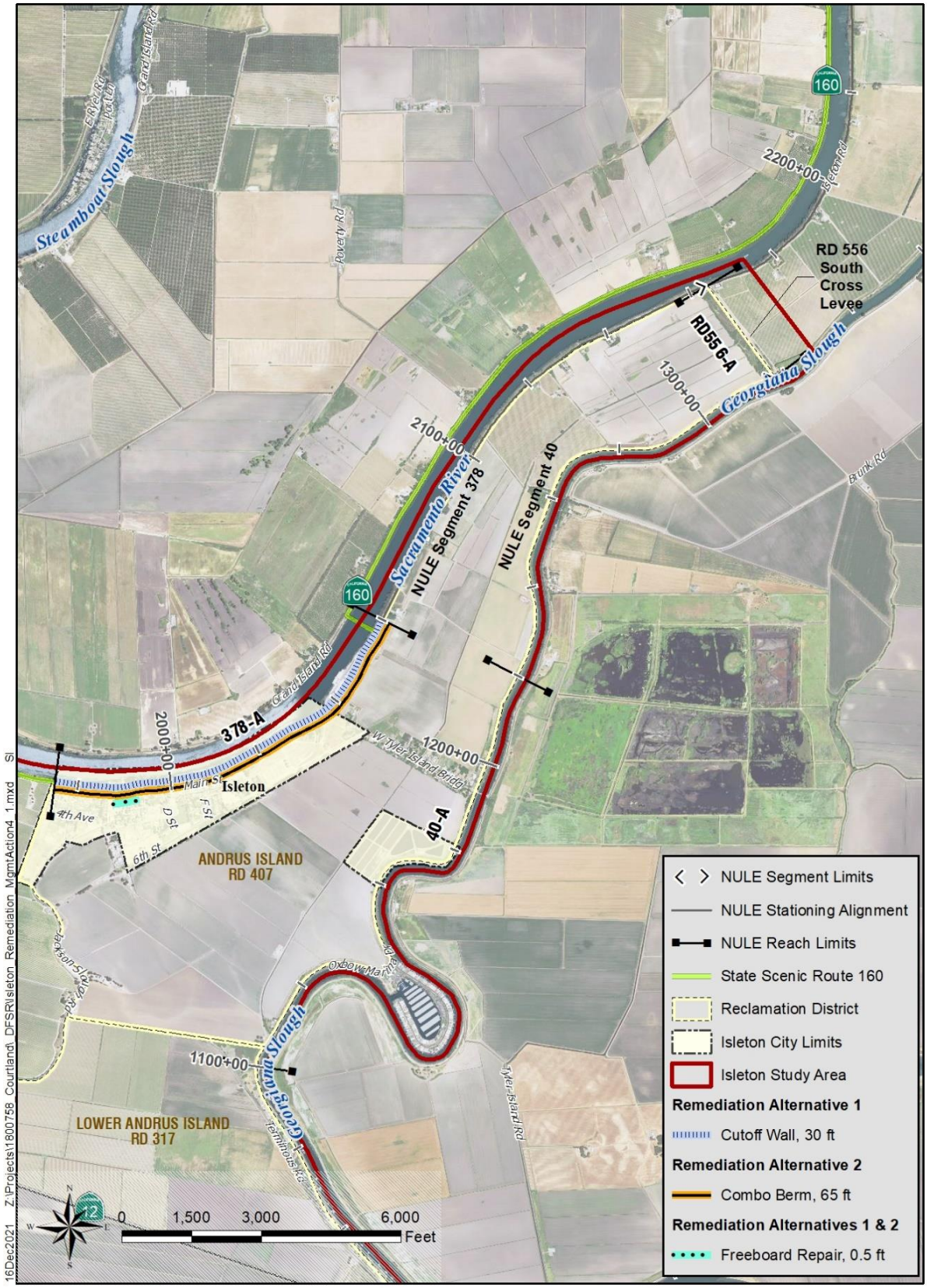

Figure 5-11. Remedial Alternatives to Repair and Strengthen the Left Bank of the Sacramento River Adjacent to the Community of Isleton (378-A Portion of NULE Segment 378)

Table 5-7. Summary of Remedial Alternatives to Repair and Strengthen the Left Bank of the Sacramento River Adjacent to the Community of Isleton (378-A Portion of NULE Segment 378)

Levee Segment Location	Reach	Start Station	End Station	Reach Length (feet)[1]	Remediation Alternative 1	Remediation Alternative 2	Vulnerability			Freeboard (% Deficient)
							Under-Seepage	Through-Seepage	Slope Stability	
Left Bank Sacramento River	378-A	1975+00	1987+50	1,250	30-foot-deep cutoff wall	9-foot-tall, 65-foot-wide combination seepage and stability berm (combo berm)	X	X	-	5%
		1987+50	1992+50	500	30-foot-deep cutoff wall 0.5-foot-levee raise	9-foot-tall, 65-foot-wide combo berm 0.5-foot levee raise				
		1992+50	2060+.00	6,750	30-foot-deep cutoff wall	9-foot-tall, 65-foot-wide combo berm				

Notes:[1] Reach length rounded to the nearest 50 feet

5.1.2.2 Repair and Strengthen-in-Place Georgiana Slough Right (west) Bank SPFC Levee Opposite the Community of Isleton (Portion of NULE Segment 40)

Levees along the right bank of Georgiana Slough are documented by DWR to have a high risk of levee failure or the need to flood fight based on vulnerabilities to underseepage, through seepage, and slope stability. A breach on the Georgiana Slough levee adjacent to the community poses great risk to Isleton and the larger study area since a failure would likely result in significant property damage and could result in life loss as a result of high floodwater depths and velocities. This flood risk reduction element repairs and strengthens the 2.25-mile-long portion of levee opposite the community of Isleton along the right bank of Georgiana Slough.

Improvement of this portion of levee was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2014 RFMP. This feasibility study leverages data from the NULE Phase 1 study along with additional data from CPTs collected in 2020 to develop two remedial alternatives for this segment of levee.

Remediations for this element were developed considering through seepage, underseepage, slope stability, and freeboard. As noted above, erosion was not included in this analysis as BALMD is currently repairing the erosion sites identified by the FSRP. Additional information regarding the data used to develop these remediations and how levee vulnerabilities were identified can be found in Appendix A. Based on the available data, remediations were developed to primarily address vulnerabilities for through seepage and underseepage, as well as geometry deficiencies. As depicted in Figure 5-12, this element includes two remedial alternatives to primarily address these vulnerabilities: a 75-foot-deep cutoff wall (Remediation Alternative 1) or a 13-foot-tall, 70-foot-wide combination seepage and stability berm (Remediation Alternative 2). To address freeboard deficiencies, the levee would be raised by 1.5 feet over the entirety of the levee reach.

Further geotechnical investigations in connection with obtaining FEMA accreditation may be needed to confirm the levee fronting the community is not vulnerable to slope stability.

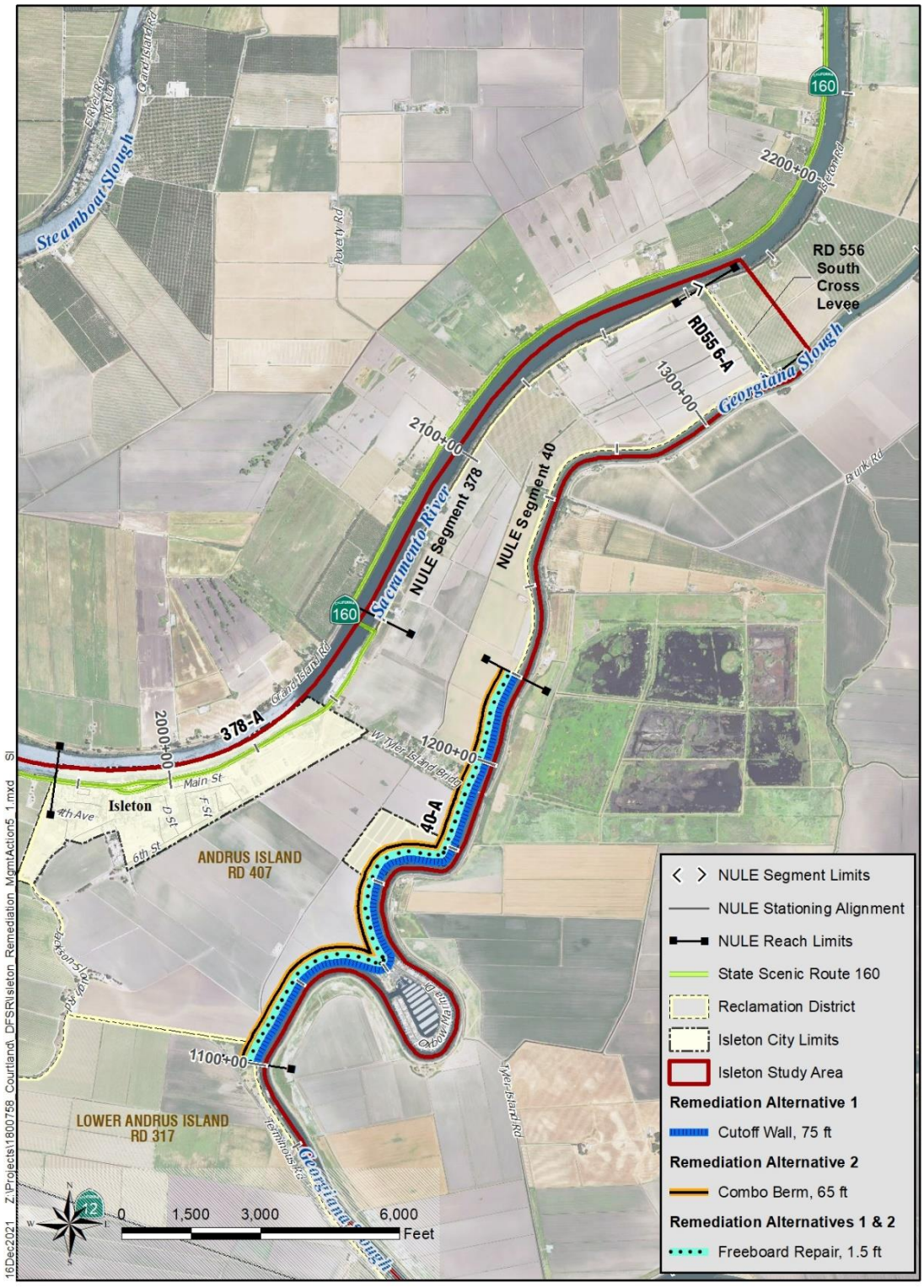

Figure 5-12. Remedial Alternatives to Repair and Strengthen the Right Bank of Georgiana Slough Opposite the Community of Isleton (40-A Portion of NULE Segment 40)

Table 5-8. Summary of Remedial Alternatives to Repair and Strengthen the Right Bank of Georgiana Slough Opposite the Community of Isleton (40-A Portion of NULE Segment 40)

Levee Segment Location	Reach	Start Station	End Station	Reach Length (feet)	Remediation Alternative 1	Remediation Alternative 2	Vulnerability			Freeboard (% Deficient)
							Under-Seepage	Through-Seepage	Slope Stability	
Right Bank Georgiana Slough	40-A	1105 +00	1224 +00	11,900	75-foot-deep cutoff wall 1.5-foot-levee raise	13-foot-tall, 70-foot-wide combo berm 1.5-foot levee raise	X	X	-	100%

5.1.2.3 Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Relief Cut along Georgiana Slough

This element raises, repairs and strengthens-in-place the entirety of the 0.45-mile-long cross levee maintained by RD 556 which extends from the RD 556/BALMD left bank Sacramento River levee southeast to the right bank of Georgiana Slough. Additional information regarding the data used to develop these remediations and how levee vulnerabilities were identified can be found in Appendix A. Based on the available data, remediations were developed to address vulnerabilities primarily for through seepage, as well as geometry deficiencies. As depicted in Figure 5-13, this element includes two remedial alternatives to address these vulnerabilities: a 20-foot-deep cutoff wall (Remediation Alternative 1) or a 15-foot-wide, 23-foot-tall stability berm (Remediation Alternative 2). To address freeboard deficiencies, the levee would be raised by 8 feet from station 2+50 to 24+47. These remediations are summarized below in Table 5-9. Further geotechnical investigations in connection with obtaining FEMA accreditation are warranted to confirm the RD 556 cross levee does not have underseepage or slope stability deficiencies.

Raising and repairing/strengthening-in-place the RD 556 cross levee would also be coupled with a potential relief cut upstream of the RD 556 cross levee to mitigate flood depths in Upper Andrus Island. A carefully planned relief cut excavated into the levee at the lower downstream end of RD 556 along the right bank of Georgiana Slough would allow the water to escape or drain out of Upper Andrus Island before filling up the entire basin (Figure 5-13). Though RD 556 personnel would determine if a relief cut would be necessary should flooding occur, a potential relief cut along the right bank of Georgiana Slough upstream of the RD 556 cross levee could be implemented in tandem with raising and repairing the RD 556 cross levee. Potential relief cut locations should be identified and further evaluated while updating the LHMP which addresses RD 556 and BALMD.

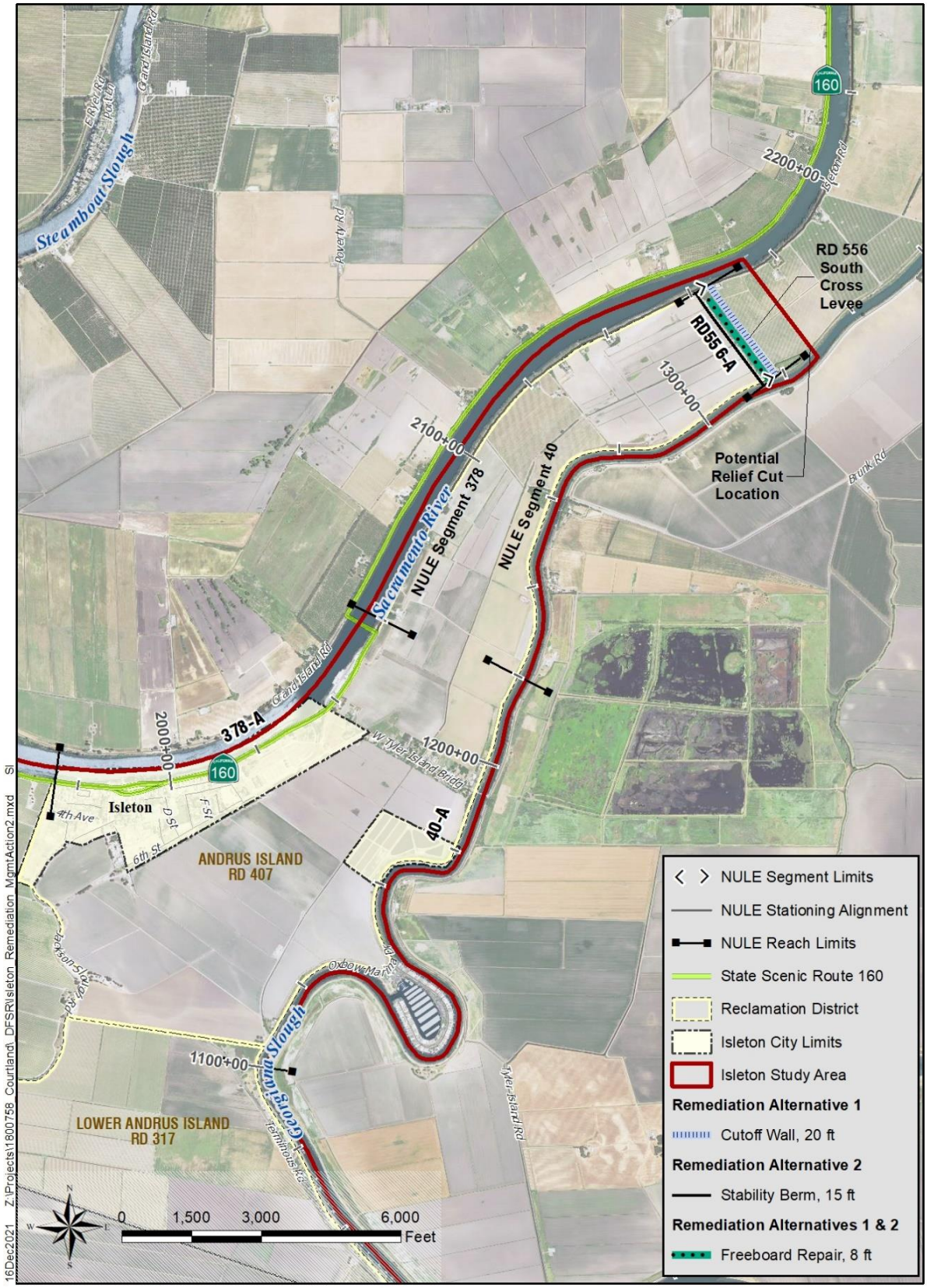

Figure 5-13. Remedial Alternatives to Raise and Repair/Strengthen the RD 556 Cross Levee along with a Potential Relief Cut Location along the Right Bank of Georgiana Slough

Table 5-9. Summary of Remedial Alternatives to Address Levee Vulnerabilities on the RD 556 Cross Levee

Levee Segment Location	Reach	Start Station	End Station	Reach Length (feet)[1]	Remediation Alternative 1	Remediation Alternative 2	Vulnerability			Freeboard (% Deficient)
							Under-Seepage	Through-Seepage	Slope Stability	
RD 556 Cross Levee	RD556-A	0+00	2+50	300	20-foot-deep cutoff wall	15-foot-wide, 23-foot-tall stability berm	-	X	-	90%
RD 556 Cross Levee	RD556-A	2+50	24+47	2,200	20-foot-deep cutoff wall 8.0-foot- levee raise	15-foot-wide, 23-foot-tall stability berm 8.0-foot levee raise				

Note: [1] Reach length rounded to the nearest 100 feet

5.1.2.4 Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP

As previously discussed, a breach on the levee immediately fronting the community poses great risk to Isleton and the larger study area since a failure would likely result in significant property damage and life loss as a result of high floodwater depths and velocities and little time to evacuate. The community of Isleton and the larger study area are also at risk of flooding from the south should a levee breach occur anywhere in the southern portion of BALMD and from the north should a levee breach occur in the most northerly portion of BALMD or in RD 556. In these scenarios, BALMD could experience flood depths up to 33 feet, with maximum flood depths in the densely populated community of Isleton reaching up to and beyond 5 feet

This flood risk reduction element repairs and strengthens the portion of SPFC levee immediately adjacent to the community of Isleton along the left bank of the Sacramento River (total of 1.4 miles) and along the right bank of Georgiana Slough (total of 1.9 miles) in conjunction with two new cross levees northeast and southwest of Isleton to fend off floodwaters from the north and south and further reduce flood risk to the community of Isleton. As shown in Figure 5-14, the most northeasterly of the two potential cross levee alignments (or the "Cross Levee North of Fertile Acres") would extend approximately 0.65 miles from River Road northeast of the community of Isleton through BALMD to the levee along the right bank of Georgiana Slough. The most southwesterly of the two potential cross levee alignments (or Cross Levee at Jackson Slough Road and Terminous Road) also shown in Figure 5-14 would extend approximately 1.8 miles across BALMD, beginning at Highway 160 near the western boundary of the City of Isleton and terminating at Oxbow Marina Drive. This potential cross levee system including the adjoining levee system improvements would be collectively improved to allow for FEMA accreditation pursuant to the engineering standards contained in 44 CFR §65.10. The cross levee would most likely be maintained by BALMD but funded by the community, DWR and possibly others. Liability for the cross levee could be held by BALMD, DWR, and/or by the community, to be determined depending upon funding sources.

Improvement of the SPFC levees along the Sacramento River in BALMD was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2012 CVFPP and 2014 RFMP. This feasibility study leverages data from the NULE Phase 1 study along with additional data from CPTs collected in 2020 to develop two remedial alternatives for the levees located along the left bank of the Sacramento River and the right bank of Georgiana Slough between the bounds of the two potential cross levees. The new cross levee alignments are similar to those previously developed by DWR for the 2012 CVFPP; however, the potential Cross Levee North of Fertile Acres would be located approximately 625 feet further northeast as preferred by local interests and landowners, and the potential Cross Levee at Jackson Slough Road and Terminous Road would have a straighter alignment (than shown in the 2012 CVFPP and 2014 RFMP) and extend southwest just beyond Jackson Slough Road and be located closer and parallel to Terminous Road. Both potential cross levees would be constructed with a 20-foot-minimum crown width and 3H:1V landside and waterside slopes. The levee crest elevation for the potential Cross Levee North of Fertile Acres would be 19 feet, assuming a design WSEL of 16 feet NAVD 88 and 3 feet of freeboard, while the levee crest elevation for the potential Cross Levee at Jackson Slough Road and Terminous Road would be 13 feet, assuming a design WSEL of 10 feet NAVD 88 and 3 feet of freeboard (Table 5-10). The potential cross levees could also be constructed with a minimum crown width between 38 to 42 feet and contain the multi-benefit of accommodating a new elevated city or county road to improve local traffic circulation between the Sacramento River and Georgiana Slough to and from Oxbow Marina and adjoining areas.

As previously discussed, remediations for this element for the existing levee system(s) between the two potential cross levees were developed considering through seepage, underseepage, slope stability, and freeboard. Additional information regarding the data used to develop these remediations and how levee vulnerabilities were identified can be found in Appendix A. As depicted in Figure 5-14 and summarized in

Table 5-11, this element primarily addresses through seepage, underseepage, and geometry deficiencies by reach using available data. Two remedial alternatives are provided to address the vulnerabilities associated with each reach of the existing levee systems. Further geotechnical investigations in connection with obtaining FEMA accreditation are warranted to confirm these existing levee segments do not have slope stability deficiencies.

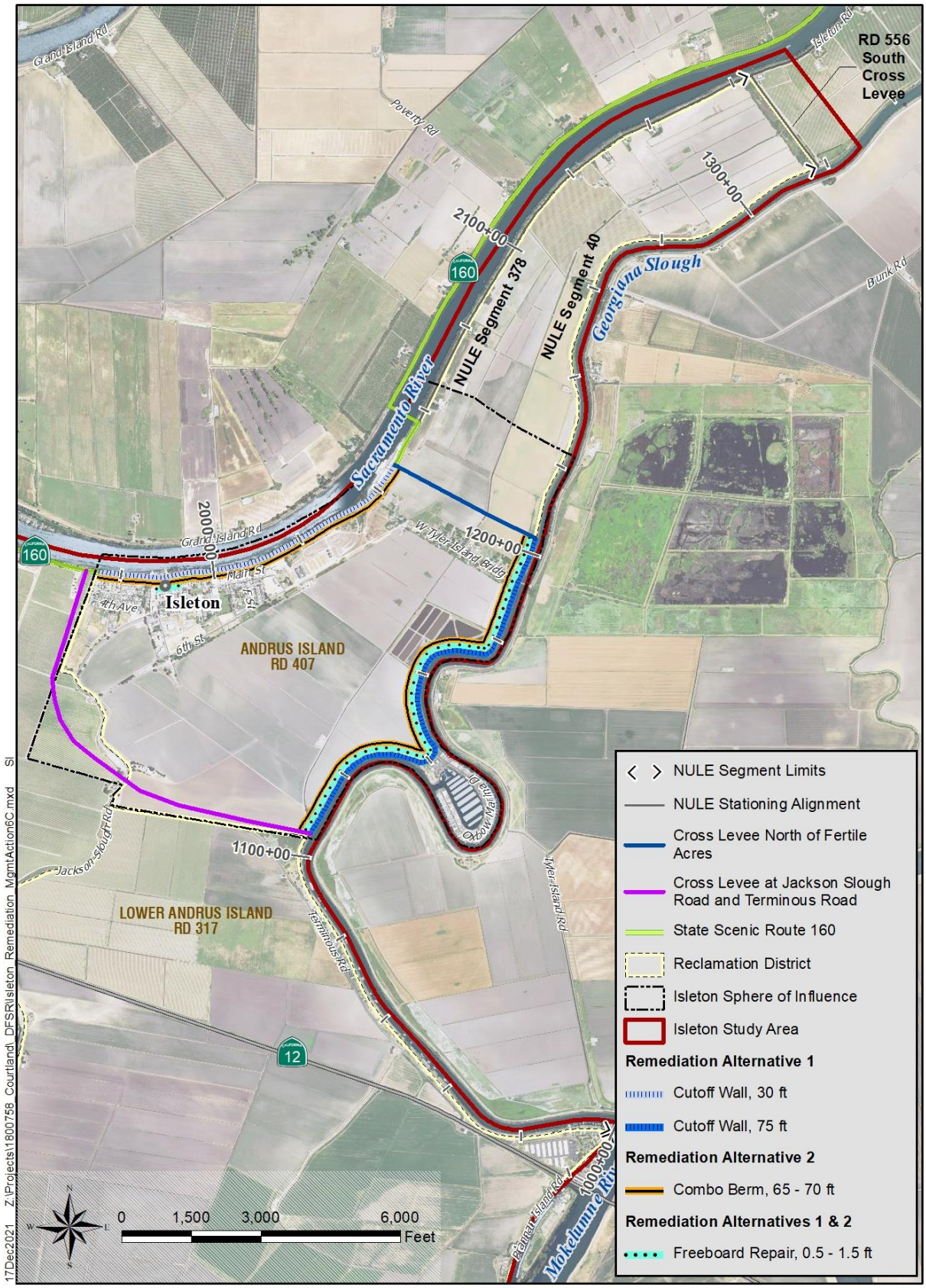

Figure 5-14. Potential Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP

Table 5-10. Proposed Dimensions of Potential Cross Levees, North of Fertile Acres and South of Isleton at Jackson Slough Rd and Terminous Rd

Cross Levees Adapted from 2012 CVFPP and 2014 RFMP	Crown Width	Landside Slope (H:V)	Waterside Slope (H:V)	Crest Elevation	Average Cross Levee Height
Cross Levee North of Fertile Acres	20 feet minimum to 42 feet with City/County Road	3:1	3:1	19 feet NAVD 88	20.0 feet
Cross Levee at Jackson Slough Road and Terminous Road	20 feet minimum to 42 feet with City/County Road	3:1	3:1	13 feet NAVD 88	19.6 feet

Table 5-11. Summary of Remedial Alternatives to Improve the SPFC Sacramento River Levee Immediately Fronting Isleton and to Improve the SPFC Georgiana Slough Levee Southeast of Isleton as part of Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP

Levee Segment Location	Reach	Start Station	End Station	Reach Length (feet)[1]	Remediation Alternative 1	Remediation Alternative 2	Vulnerability			Freeboard (% Deficient)
							Under-Seepage	Through-Seepage	Slope Stability	
Left Bank Sacramento River	378-A	1975+00	1987+50	1,300	30-foot-deep cutoff wall	9-foot-tall, 65-foot-wide combination seepage and stability berm (combo berm)	X	X	-	5%
		1987+50	1992+50	500	30-foot-deep cutoff wall 0.5-foot-levee raise	9-foot-tall, 65-foot-wide combo berm 0.5-foot-levee raise				
		1992+50	2048+50	5,600	30-foot-deep cutoff wall	9-foot-tall, 65-foot-wide combo berm				
Right Bank Georgiana Slough	40-A	1105+00	1205+00	10,000	75-foot-deep cutoff wall 1.5-foot- levee raise	13-foot-tall, 70-foot-wide combo berm 1.5-foot levee raise	X	X	-	100%

Note: [1] Reach length rounded to the nearest 100 feet

5.1.2.5 Isleton - Oxbow Marina Cross Levee System

This element is similar to the potential cross levee system described in Section 5.1.2.4; however, the southeasterly 1.8-mile-long cross levee as adapted from the 2012 CVFPP would be replaced with a 2.0-mile-long cross levee (Isleton/Oxbow Marina Cross Levee) as shown in Figure 5-15. The Isleton/Oxbow Marina Cross Levee alignment would start at Highway 160 similar to the Cross Levee at Jackson Slough Road and Terminous Road but would diverge approximately 0.20 mile south of Highway 160, extending southeast towards Oxbow Marina Drive approximately 0.50 mile further north than the Cross Levee at Jackson Slough Road and Terminous Road. At Oxbow Marina Drive, the proposed Isleton/Oxbow Marina Cross Levee would continue approximately 0.50-mile northeast until terminating at the Isleton Wastewater Ponds. This cross levee configuration would also be constructed along with the Cross Levee North of Fertile Acres alignment as described in Section 5.1.2.4 (Table 5-12). Additionally, this element could also possibly include a potential setback levee at Oxbow Marina at a later date.

With this configuration, a total of 1.4 miles of levee along the left bank of the Sacramento River and 1.6 miles of levee along the right bank of Georgiana Slough would be repaired and improved-in-place. As discussed in Section 5.1.2.4, data from the DWR NULE Phase 1 study and additional CPTs collected in 2020 were used to develop potential remediations for this element. As shown in Figure 5-15 and Table 5-13 this element primarily addresses through seepage, underseepage, and geometry deficiencies by reach using the best available existing data. Two remedial alternatives are provided to address the vulnerabilities associated with each existing levee reach. Further geotechnical investigations in connection with obtaining FEMA accreditation are warranted to confirm these existing levee segments do not have slope stability deficiencies. Additional information regarding the data that was used to develop these remediations of the existing levee segments and how levee vulnerabilities were identified can be found in Appendix A.

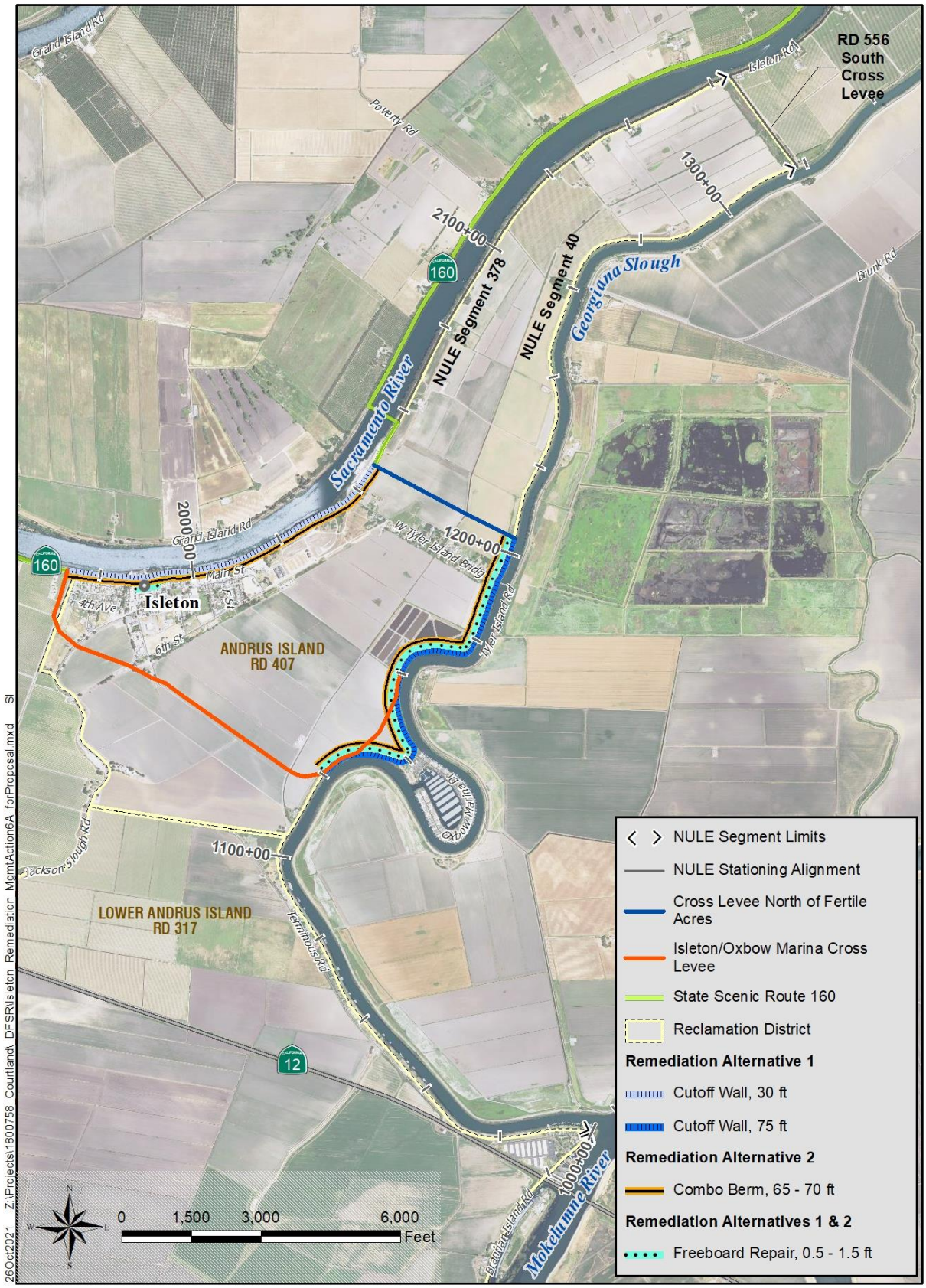

Figure 5-15. Potential Isleton/Oxbow Marina Cross Levee System

Table 5-12. Proposed Dimensions of the Cross Levee North of Fertile Acres and the Isleton/Oxbow Marina Cross Levee

Cross Levee Segments for Isleton /Oxbow Marina	Crown Width	Landside Slope (H:V)	Waterside Slope (H:V)	Crest Elevation	Average Cross Levee Height
Cross Levee North of Fertile Acres	20 feet minimum to 42 feet with City/County Road	3:1	3:1	19 feet NAVD 88	20.0 feet
Isleton/Oxbow Marina Cross Levee	20 feet minimum to 42 feet with City/County Road	3:1	3:1	13 feet NAVD 88	18.0 feet

Table 5-13. Summary of Remedial Alternatives to Improve the SPFC Levee Immediately Fronting Isleton and to Improve the SPFC Levee Southeast of Isleton along the Right Bank of Georgiana Slough as part of a Smaller Cross Levee System

Levee Segment Location	Reach	Start Station	End Station	Reach Length (feet)[1]	Remediation Alternative 1	Remediation Alternative 2	Vulnerability			Freeboard (% Deficient)
							Under-Seepage	Through-Seepage	Slope Stability	
Left Bank Sacramento River	378-A	1975+00	1987+50	1,300	30-foot-deep cutoff wall	9-foot-tall, 65-foot-wide combination seepage and stability berm (combo berm)	X	X	-	5%
		1987+50	1992+50	500	30-foot-deep cutoff wall 0.5-foot levee raise	9-foot-tall, 65-foot-wide combo berm 0.5-foot levee raise				
		1992+50	2048+50	5,600	30-foot-deep cutoff wall	9-foot-tall, 65-foot-wide combo berm				
Right Bank Georgiana Slough	40-A	1120+50	1205+00	8,500	75-foot-deep cutoff wall 1.5-foot levee raise	13-foot-tall, 70-foot-wide combo berm 1.5-foot levee raise	X	X	-	100%

Note: [1] Reach length rounded to the nearest 100 feet

5.1.2.6 Isleton Sphere of Influence Cross Levee System

This flood risk reduction element includes a cross levee system which closely coincides with the City of Isleton's Sphere of Influence (SOI) boundary (Figure 5-15). The most northeasterly alignment of the two cross levees (Cross Levee North of Isleton Bridge) would total 0.60 miles in length and would extend from Isleton Road approximately 0.20 miles north of the Isleton Bridge through BALMD to the levee along the right bank of Georgiana Slough. The most southwesterly alignment of the two cross levees (the Cross Levee at Jackson Slough Road and Terminous Road) would extend approximately 1.8 miles across BALMD, beginning at Highway 160 near the western boundary of the City of Isleton and terminating at Oxbow Marina Drive as described in Section 5.1.2.4. The potential cross levees would be constructed with a 20-foot minimum crown width (or up to 42-feet in width to accommodate a city or county roadway) and 3H:1V landside and waterside slopes. The levee crest elevation for the Cross Levee North of

Isleton Bridge would be 19 feet, assuming a design WSEL of 16 feet NAVD 88 and 3 feet of freeboard. The levee crest elevation for the Cross Levee at Jackson Slough Road and Terminous Road would be 13 feet, assuming a design WSEL of 10 feet NAVD 88 and 3 feet of freeboard (Table 5-14).

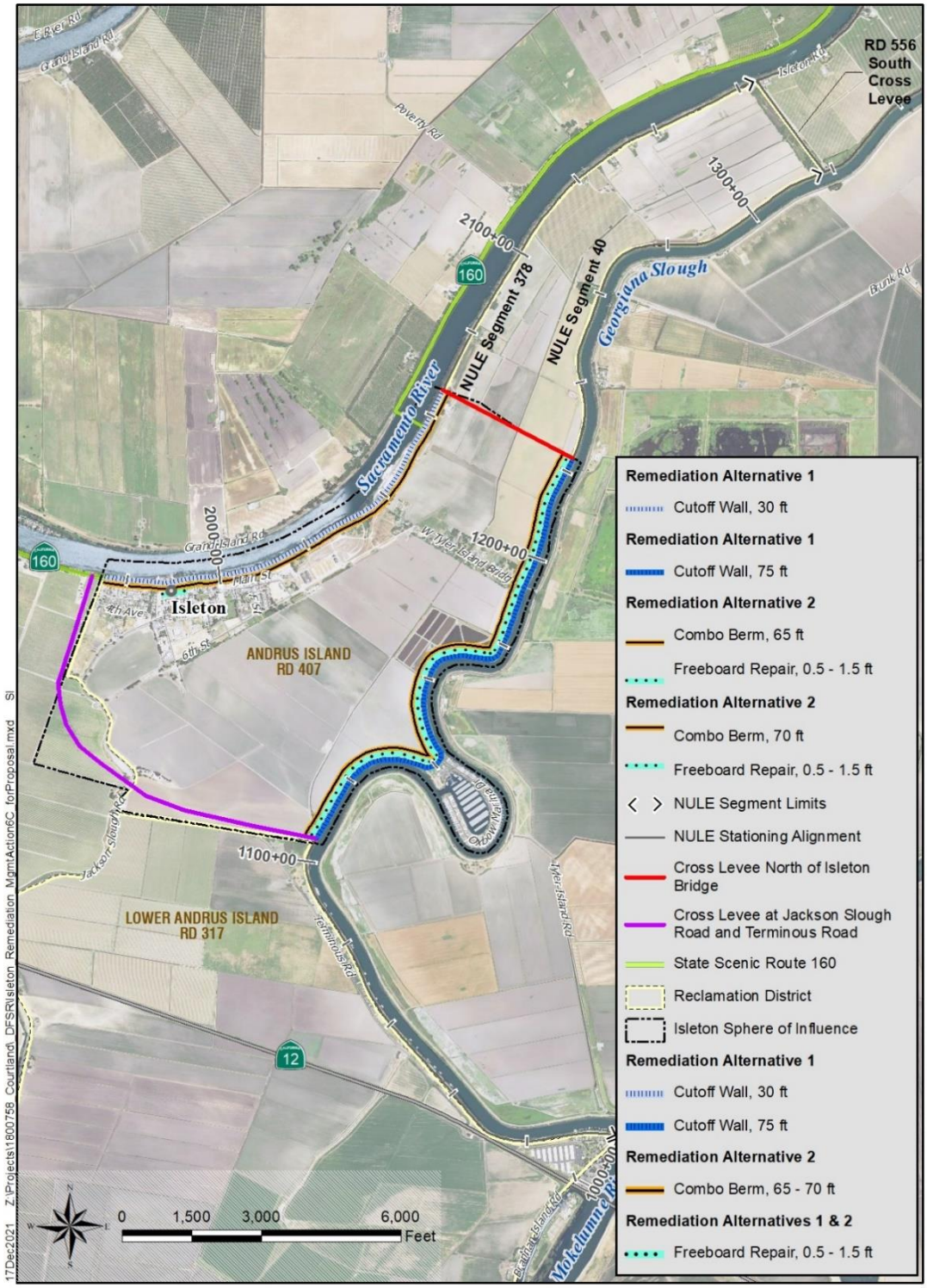

Figure 5-16. Potential Sphere of Influence Cross Levee System

Table 5-14. Proposed Dimensions of the Isleton Sphere of Influence Cross Levees

Cross Levee Segments for Sphere of Influence Cross Levee System	Crown Width	Landside Slope (H:V)	Waterside Slope (H:V)	Crest Elevation	Average Cross Levee Height
Cross Levee North of Isleton Bridge	20 feet minimum to 42 feet with City/County Road	3:1	3:1	19 feet NAVD 88	20.0 feet
Cross Levee at Jackson Slough Road and Terminous Road near South SOI line	20 feet minimum to 42 feet with City/County Road	3:1	3:1	13 feet NAVD 88	19.6 feet

Along with the two cross levees, this flood risk reduction element repairs and strengthens the portion of SPFC levee immediately adjacent to the community of Isleton along the left bank of the Sacramento River (total of 1.75 miles) and along the right bank of Georgiana Slough (total of 2.3 miles) to fend off floodwaters from the north and south and further reduce flood risk to the community of Isleton using the proposed remediations detailed in the previous two sections and detailed below in Table 5-15. This cross levee system including the adjoining levee system improvements would be collectively improved to allow for FEMA accreditation pursuant to the standards contained in 44 CFR §65.10.

Table 5-15. Summary of Remedial Alternatives to Improve the SPFC Levee Immediately Fronting Isleton and to Improve the SPFC Levee Southeast of Isleton along the Right Bank of Georgiana Slough as part of the SOI Cross Levee System

Levee Segment Location	Reach	Start Station	End Station	Reach Length (feet)[1]	Remediation Alternative 1	Remediation Alternative 2	Vulnerability			Freeboard (% Deficient)
							Under-Seepage	Through-Seepage	Slope Stability	
Left Bank Sacramento River	378-A	1975+00	1987+50	1,300	30-foot-deep cutoff wall	9-foot-tall, 65-foot-wide combination seepage and stability berm (combo berm)	X	X	-	5%
		1987+50	1992+50	500	30-foot-deep cutoff wall 0.5-foot levee raise	9-foot-tall, 65-foot-wide combo berm 0.5-foot levee raise				
		1992+50	2067+00	7,450	30-foot-deep cutoff wall	9-foot-tall, 65-foot-wide combo berm				
Right Bank Georgiana Slough	40-A	1120+50	1242+00	12,150	75-foot-deep cutoff wall 1.5-foot levee raise	13-foot-tall, 70-foot-wide combo berm 1.5-foot levee raise	X	X	-	100 %

5.1.2.7 Highway 12 Cross Levee

This flood risk reduction element constructs a new 5.7-mile-long cross levee along the portion of Highway 12 which bisects BALMD. This cross levee could be constructed and joined with levee repairs and improvements along the left bank of the Sacramento River, the right bank of Georgiana Slough and the Mokelumne River, and to the RD 556 cross levee to form a complete levee system which could be certified by FEMA to secure 100-year flood protection for the community of Isleton and the northern portion of the study area north of State Highway 12. The new cross levee would be a multi-benefit project that would include raising and widening Highway 12 and the combined road levee embankment section would be constructed with a minimum 38-foot-crown-width, 3H:1V landside and waterside slopes, and levee crest elevation of 13 feet, assuming a downstream design WSEL of 10 feet NAVD 88 and 3 feet of freeboard.

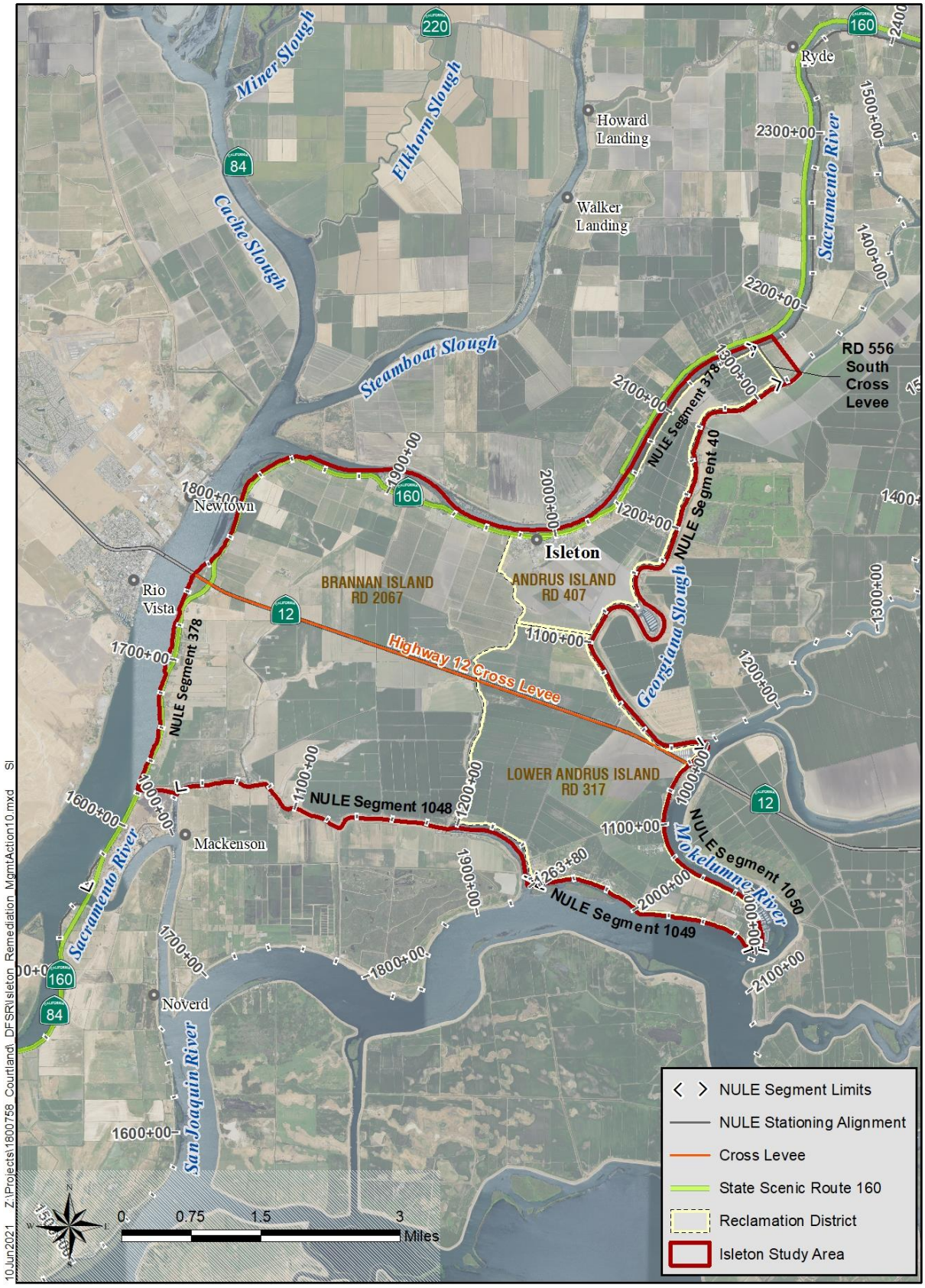

Figure 5-17. Highway 12 Cross Levee

5.1.2.8 Secure 100-Year FEMA Certification for the Community of Isleton with Highway 12 Cross Levee

This element builds on the previous collection of elements by improving the SPFC perimeter levee segments north of Highway 12 in accordance with FEMA standards for freeboard, seepage, erosion, and stability and settlement concerns pursuant to 44 CFR §65.10 in concert with a cross levee along Highway 12. In addition to the proposed structural remediations for the perimeter levee system north of Highway 12 described in Sections 5.1.1.1 through 5.1.1.4 and Sections 5.1.2.1 through 5.1.2.3, O&M requirements, and documentation requirements specified in 44 CFR §65.10 are also addressed. These FEMA accreditation requirements are discussed briefly below.

Freeboard: Riverine levees must provide a minimum freeboard of 3 feet above the 100-year water-surface level, preferably that addresses both climate change and sea level rise. An additional 1 foot above the minimum is required within 100 feet on either side of structures (such as bridges) riverward of the levee or wherever the flow is constricted.

Embankment Protection: Engineering analyses must be submitted that demonstrate no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability. The factors to be addressed in such analyses include but are not limited to: Expected flow velocities (especially in constricted areas); expected wind and wave action; ice loading; impact of debris; slope protection techniques; duration of flooding at various stages and velocities; embankment and foundation materials; levee alignment, bends, and transitions; and levee side slopes.

Embankment and Foundation Stability (Including Through Seepage and Underseepage): Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined in the USACE manual, "Design and Construction of Levees" (EM 1110-2-1913, Chapter 6, Section II), may be used. The factors that shall be addressed in the analyses include, Depth of flooding, duration of flooding, embankment geometry and length of seepage path at critical locations, embankment and foundation materials, embankment compaction, penetrations, other design factors affecting seepage (such as drainage layers), and other design factors affecting embankment and foundation stability (such as berms).

Settlement: Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained within the minimum standards set forth in paragraph (b)(1) of this section. This

analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in the USACE manual, "Soil Mechanics Design - Settlement Analysis" (EM 1100-2-1904) must be submitted.

Design Criteria

Closures/Encroachments: All openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice.
Interior Drainage: An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than 1 foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters.
Other Design Criteria: In unique situations, such as those where the levee system has relatively high vulnerability, FEMA may require that other design criteria and analyses be submitted to show that the levees provide adequate protection. In such situations, sound engineering practice will be the standard on which FEMA will base its determinations. FEMA will also provide the rationale for requiring this additional information.

Operations Plans and Criteria

Closures: Operation plans for closures must include the following: • Documentation of the flood warning system, under the jurisdiction of federal, state, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure. • A formal plan of operation including specific actions and assignments of responsibility by individual name or title. • Provisions for periodic operation, at not less than 1-year intervals of the closure structure for testing and training purposes.
Interior Drainage Systems: Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood protection purposes only if the following minimum criteria are included in the operation plan: • Documentation of the flood warning system, under the jurisdiction of federal, state, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system. • A formal plan of operation including specific actions and assignments of responsibility by individual name or title. • Provision for manual backup for the activation of automatic systems. • Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than 1-year shall elapse between either the inspections or the operations.
Other Operations Plans and Criteria: Other operating plans and criteria may be required by FEMA to ensure that adequate protection is provided in specific situations. In such cases, sound emergency management practice will be the standard upon which FEMA determinations will be based.

Maintenance Plans and Criteria

Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner. All maintenance activities must be under the jurisdiction of a federal or state agency, an agency created by federal or state law, or an agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance. This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, maintenance plans shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

5.2 Non-Structural Measures

Non-structural measures improve flood system performance and reduce exposure, vulnerability, and consequences of flooding. The suite of non-structural measures can be implemented in most cases with or without modifying the existing levee and flood control system. The full suite of non-structural measures considered in this feasibility study for the community of Isleton and the adjoining North Delta Legacy Communities within Sacramento County are described in detail in Appendix H and summarized below:

1. Flood Fight Access Road or a Ring Levee/Cross Levee System
2. Voluntary Elevation of Structures
3. Wet or Dry Floodproofing
4. Acquisition and Relocation
5. Flood Emergency Safety Plans
6. Sacramento County Office of Emergency Services (OES) Decision Support Tool
7. Local Hazard Mitigation Plan and Relief Cuts
8. Alternatives to FEMA's NFIP – Private, Community-Based Flood Insurance
9. NFIP Flood Insurance Enhancements *via* AFOTF
10. Mokelumne River Conveyance Improvements & Staten Island Overflow Area
11. Improve FEMA's CRS Score for Sacramento County/Isleton
12. Land Use Regulations and Limitations
13. Improved Governance Between Neighboring LMAs/RDs
14. System-wide Improvement Frameworks (SWIFs) & Periodic Inspections with USACE
15. Public Education/Public Awareness

The key non-structural measures identified above and within Appendix H that are community-specific to the Isleton study area and warrant further discussions and descriptions are described in more detail below. All of the above non-structural measures identified above were presented

to the Isleton study area planning committee with most measures deemed acceptable, as summarized in Section 7.3. Appendix H also provides a description of why some measures may be more applicable to neighboring Delta Legacy Communities or why they may not be applicable to each specific Delta Legacy Community.

5.2.1 All-Weather Flood Fight Access Road for the Community of Isleton

This element includes construction of an all-weather access road to reduce flood risk within the community of Isleton (Figure 5-18). Similar to a ring levee, an access road would encircle the vast majority of Isleton and isolate the community from potential flood waters that could occur due to levee breaches occurring anywhere outside of the immediate community but within the larger agricultural BALMD basin. An all-weather access road is essentially a slightly elevated all-weather roadway, ideally paved and routed mostly along existing city streets to accommodate the temporary placement of interlocking Muscle Wall during flood fight conditions in BALMD. The noted access road would accommodate the temporary flood fight installation of a 4- to 8-foot-high Muscle Wall. The access road/flood fight berm would total approximately 1.5 to 1.70 miles in length west of Willoughby Road, with a 20-foot-wide road width, 3H:1V landside and waterside slopes, and the road crown elevation would vary between a minimum elevation of 2.0 ft and a maximum elevation of 10.0 ft. (NAVD 88), assuming a downstream design WSEL of 9 ft. NAVD 88 and 1 ft. of freeboard. The design WSEL of 9 ft. matches the existing FEMA BFE of 9.0 ft. (NAVD 88), and it also assumes a relief cut would be executed within the lower downstream end of the BALMD basin. The elevation of the flood fight access road would need to be 4 to 5 feet higher if a relief cut were not executed in the downstream portion of the basin. The flood fight Muscle Wall (similar to a plastic Jersey barrier containing a 4-8 ft. minimum wide base) would be stored nearby within the Delta by either the community, the local RD, the County, and/or by DWR and could be transported, handled, and assembled expeditiously to fend off rising flood waters that may occur in the larger agricultural BALMD basin. The flood fight access road would likely be maintained by the City, and funding for the installation improvements, and maintenance of the flood fight access road would likely be the sole responsibility of the community/landowners protected by said access road system, including but not limited to the Geological Hazard Abatement District (GHAD) that was most recently established on March 29, 2022.

Figure 5-18 below notes the anticipated height of Muscle Wall needed along the alignment of the flood fight access road, along with the estimated total length of 4-, 6-, and 8-foot-high Muscle Wall needed. The Muscle Wall heights depicted in Figure 5-18 are preliminary in nature and are subject to change particularly west of 6th street, along the smaller streets adjoining nearby residential structures. It may be advisable to secure greater quantities of 8 foot-high Muscle Wall (as much as 7,000 ft. vs. 4,100 ft. indicated in Figure 5-18) and deploy closer to only 1,000 feet of the shorter 4-foot-high Muscle where streets do not currently exist near the tie-in locations closest to the existing Sacramento River levee system nearest Georgiana Drive on the west side of town and George Apple Drive on the east side of town (between Joseph Place and Willoughby Road).

In general, the height of the access road/flood fight berm is highest along 6th street between Jackson Boulevard and D Street, with an average height of 5.1 feet. This segment of the flood fight access road would coincide with 6th street, where the existing ground is lowest, and it would require 3,000 to 4,000 feet of 8-foot-high Muscle Wall. The flood fight road improvements at this lowest portion of the City would essentially require a total reconstruction of 6th street in its entirety between Jackson Boulevard and Joseph Place (or Willoughby Road) by raising it by approximately 5 feet, or by constructing an adjoining all-weather service road directly south of 6th street that would be 5 feet higher than 6th street.

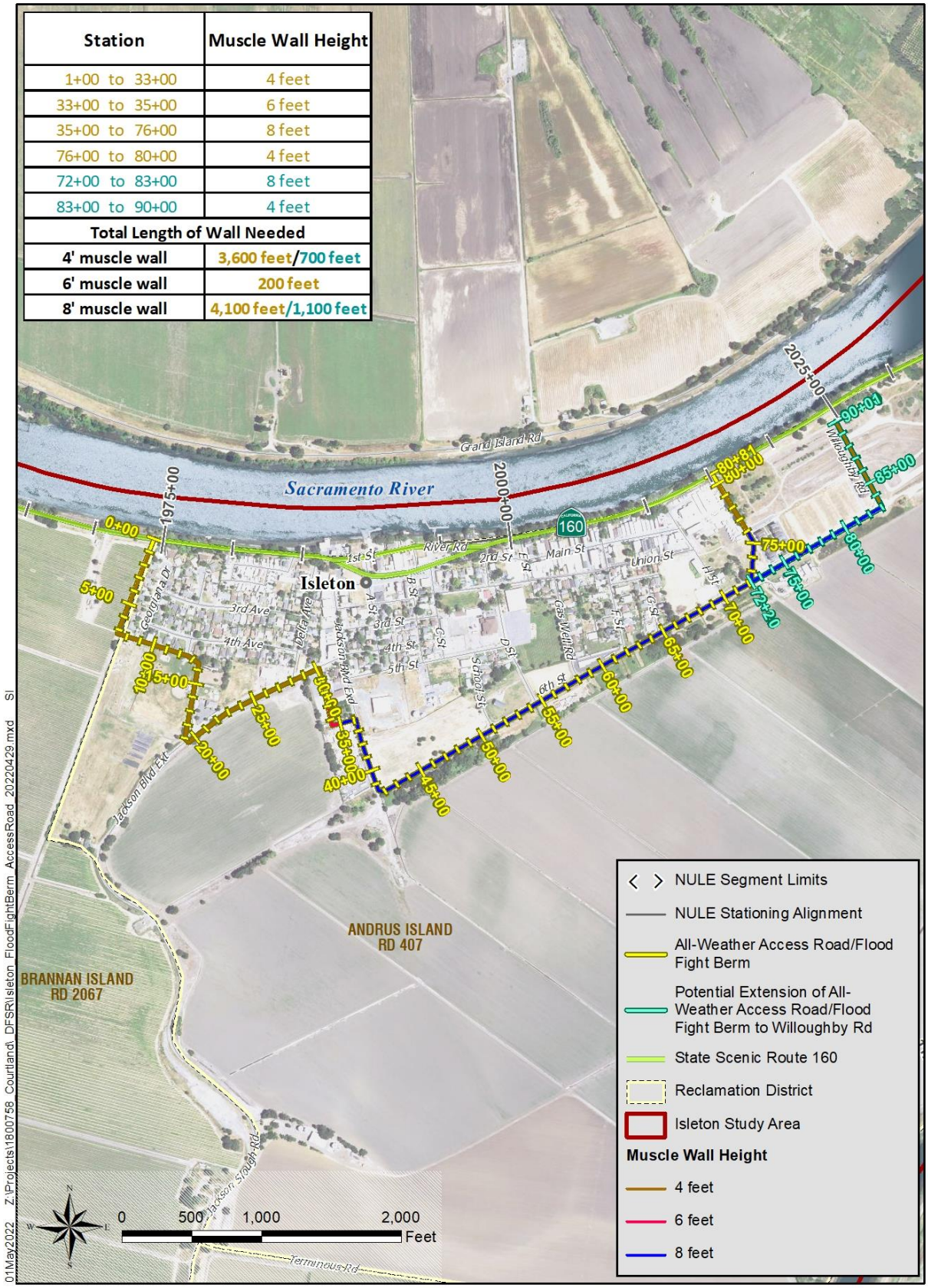

Figure 5-18. All-Weather Flood Fight Access Road for the Community of Isleton

5.2.2 Voluntary Structural Elevation

The voluntary structural elevation program collectively administered by FEMA and Sacramento County (and possibly others) is a flood risk reduction element that involves physically raising existing structures to an elevation 1.5 feet or greater above the FEMA BFE resulting from natural overland flows and/or a levee breach. For the Isleton study area, the current BFE is currently set at 9 feet NAVD 88 that assumes a relief cut could be deployed in the lower, downstream portion of BALMD. This is a common and effective way to minimize damage from flooding and is a key flood protection provision of the NFIP.

Hydraulics and hydrologic modeling of the Lower Sacramento River system indicates that the structures in the study area would require raising between 5 and 10 feet to be elevated to or above the maximum floodplain. Elevations of this height may require additional seismic (and other practical) considerations to ensure stability and continued utility of the structures in question.

Below is a summary table (excerpted from Appendix H) that indicates the number and types of structures located within the community of Isleton (SAC 54-Urban), and within the greater Isleton study area (SAC 54-N2). The table also indicates the likely minimum cost of raising each of the noted structures, acknowledging that commercial and industrial structures will undoubtedly be more than the current estimate of $170,000/ea. to raise residential structures.

Table 5-16. Total Count and Cost to Elevate Structures in the Isleton Study Area

Community and Study Area	CVFPP Impact Area	Total Structure Count and Cost to Elevate @ $170,000/Structure				
		Residential	Commercial	Industrial	Public	Total
City of Isleton	SAC 54-Urban	350	70	18	21	459
		$59,500,000	$11,900,000	$3,060,000	$3,570,000	$78,030,000
Isleton Study Area	SAC 54 - Urban and SAC 54-N2	739	72	69	55	935
		$125,630,000	$12,240,000	$11,730,000	$9,350,000	$158,950,000

5.2.3 Wet or Dry Floodproofing

Damages to structures behind levees can be greatly reduced through effective floodproofing. Floodproofing can be cost effective for most structures where maximum depths of potential flooding are not expected to exceed 5 feet. However, agricultural-related structures have been known to be flood-proofed for flood depths far exceeding 5 feet. If the flood depth at a site is above the practical height limits of available floodproofing barriers, an alternate mitigation method, such as raising of structures should be considered.

Though the base flood depth in the Isleton study area is 9 feet NAVD 88, wet or dry floodproofing could be implemented for select structures in the study area where maximum potential flood depths are not expected to exceed 5 feet.

5.2.4 Acquisitions or Relocations

This flood risk reduction element involves acquiring land or relocating dwelling units, businesses, or agricultural structures to reduce flood risk. This element is included for comparison purposes, but it is not a preferred action for the subject Delta Legacy Community of Isleton due to relocations of homes and businesses being disruptive to residents and the overall community. DWR and others have suggested select communities subject to either deep or repetitive flooding should consider relocation to higher ground that is not subject to flooding. Relocating entire communities within the Delta, particularly Delta Legacy Communities, is inconsistent with the goals and objectives of both the Delta Plan and the SSJDNHA designation.

5.2.5 Improved Emergency Response – Flood Emergency Safety Plans and County OES Decision Support Tool

Flood ESPs are one tool aimed at improving emergency response within Sacramento County. Public information, posted at the County's webpage, includes the following for individual RD ESPs: a Delta Area Flood Map, flood depth maps, how long it will take to flood the individual RDs, evacuation routes, and timetables indicating the duration of time in hours, days, weeks, or months to pump-out and entirely drain the individual RDs, depending upon the rate of pumping capacity.

The Flood Operation Decision Support System (FODSS) tool is another effort aimed at improving emergency response within Sacramento County. Funded by DWR and sponsored by the county of Sacramento, Governor's OES, the FODSS tool aims to improve emergency response, emergency management and coordination during high water and flood emergencies within the county.

5.2.6 Local Hazard Mitigation Plan and Relief Cuts

The Sacramento County LHMP is a multi-jurisdictional plan that geographically covers the entire area within Sacramento County's jurisdictional boundaries (planning area), including BALMD. The LHMP identifies hazards within Sacramento County, including those from floods and levee failure, assesses the vulnerability of the planning area to these hazards, and identifies mitigations to reduce or eliminate long-term risk to life loss and property damage from these hazards. The county of Sacramento developed the initial LHMP in 2005 and was last updated in 2016. The Sacramento County LHMP is updated every 5 years and is currently scheduled for a new update in 2021/2022 that will likely include a greater discussion regarding potential relief cuts in BALMD. A relief cut at the lower end of the BALMD along the San Joaquin River near

its confluence with Sevenmile Slough could potentially lower flood depths in the City of Isleton by a few feet, and should be evaluated in closer detail while updating the subject LHMP.

As a mitigation measure which can be used to reduce risk to life loss and property damage as a result of flooding or levee failure, potential locations of relief cuts should be formalized within the LHMP. The levee system protecting the Isleton study area acts somewhat as a bowl with the water filling up to the top of the lowest downstream levee, typically at the lowest elevations within BALMD. However, a carefully planned relief cut excavated into the levee at the lower downstream end of BALMD during or immediately following a breach event in the northerly portion of the basin would allow the water to escape or drain out of the RD before filling up the entire basin. For example, if there is 5 feet of freeboard at the lower downstream end of BALMD, the relief cut could potentially reduce flood depths by as much as 5 feet over the entirety of BALMD, while waiting for the lower, downstream levee reach to overtop. The BALMD personnel will determine if a relief cut will be necessary should flooding occur; however, in most cases there is no written description nor agreement for a planned relief cut. Potential relief cut locations should be identified and further evaluated while updating the LHMP which addresses BALMD.

5.2.7 Alternatives to NFIP – Community- and Flood-Risk Based Insurance Programs

The NFIP is managed by FEMA through its subcomponent, known as the Federal Insurance and Mitigation Administration. It is currently the only federally backed flood insurance program, so the introduction of alternative flood insuring options for homeowners (such as private community-based flood insurance) carries the advantage of offering potentially more favorable terms to residents within any of the noted Delta Legacy Communities of Sacramento County, including the City of Isleton.

A review of FEMA's current and planned mapping procedures, insurance, requirements, insurance rates, and policies indicates that agricultural facilities in leveed areas of the Sacramento Valley, including Isleton, have been bearing a disproportionately large share of the financial burden of the NFIP. Private sector involvement in the flood insurance industry could protect this area's flood insurance premiums by matching rates to risk through an emerging market for private community-based flood insurance policies. As NFIP premiums continue to increase for residents in Isleton, private insurers are entering the market. They are taking advantage of better flood mapping, modeling, the accessibility of increasingly high-resolution national data sets, innovations in statistical analysis, and sophisticated global financial markets to fill the affordability gap. In 2019, over 10,000 private insurance policies were written in California (Wholesale & Specialty Insurance Association, 2019).

Private insurers use their own models to establish the price of a policy. These models, the number of which is increasing, vary in their complexity and detail. For example, the nonprofit

First Street Foundation[12] recently released a nationwide flood model accessible from any mobile device similar to many used by private insurers. It is an easily understood, easily accessible nationwide tool for presenting flood risk information. By visiting FloodFactor.com a resident in Isleton can easily get a general picture of their flood risk. Flood risk is specified by assigning a risk score from 1 to 10. The score is based on cumulative likelihood of flooding at different flood depths based on riverine analyses which indicate flood depths can exceed 10 feet in certain North Delta Communities.

Potential Benefits of a Community-Based Flood Insurance Program

- Potential source for project finance to reduce risk to community and assets
- Improved understanding of underlying risks and resilience opportunities
- Communities could renegotiate contracts every 5 to 7years and decide how much risk to retain and how much to transfer
- Project financing would not be accounted for as debt on the community's balance sheet, providing added flexibility to the community
- Insurance could cover additional items such as funding for continuity of services, community equipment, and other items that are currently self-insured
- *See* Appendix K for further details for a community-based flood insurance program for Courtland

Flood risk information obtained from sites like FloodFactor.com will be different than flood information produced by DWR or FEMA because the methods to assess risk are different.

An alternative to individual NFIP homeowner policies is a community-based flood insurance program. A community-based flood insurance program would have the opportunity to lower flood insurance costs by working with an insurer to provide better risk information and by actively implementing agreed upon mitigation measures. A community might choose to: (1) sell their risk to an insurer; (2) finance the risk through a capital markets; or (3) by actively managing the flood risk, the community flood risk program would provide the opportunity to both reduce flood insurance premiums and finance levee improvements and/or implement non-structural measures identified herein Section 5.2, and in Section 7.3.

One way that a community might choose to implement a community-based flood insurance program is through the establishment of a Homeowners Association (HOA) or a Geologic Hazard Abatement District (GHAD). A GHAD is a state-level public agency for the purpose of providing prevention, rapid response, and funding to address hazardous geologic conditions. They were established in 1979 by the Beverly Act to allow local residents to develop self-funding mechanisms that address the long-term abatement and maintenance of structures that protect real property from geologic hazards.

The City of Isleton has already taken the initial steps in July of 2021 by formalizing the Delta Region Geologic Hazard Abatement District (GHAD) to formalize a path for property owners within the Isleton City limits to aggregate their resources and establish a community-based flood

[12] First Street Foundation. 2020. Flood Factor Matrix. Available at: https://floodfactor.com/methodology

insurance program that can be used to augment and/or replace the current set of NFIP policies held within the City of Isleton. The Delta Region GHAD developed specifically for the City of Isleton, that can be potentially expanded to include other nearby regional Delta Legacy Communities, held its inaugural meeting on Tuesday March 29, 2022. *See* Appendix J - Community Based Flood Insurance Program White Paper, prepared in March of 2022, by Kathleen Schaefer, P.E., CFM, former FEMA regional administrator of NFIP.

5.2.8 NFIP Flood Insurance Enhancements, Risk-Based Insurance Program, and Potential Enhancements via AFOTF

The AFOTF *via* its Technical Memorandum of December 28, 2016, has recommended as many as seven administrative refinements of the NFIP to sustain agriculture as a wise use of the floodplain in leveed SFHAs. The NFIP administrative refinements (and amendments proposed by H.R. 830) are focused on improving agricultural sustainability while collectively reducing flood risks. The recommendations address how rules and practices could be modified to: (1) reduce or remove elevation and floodproofing requirements for new and substantially improved agricultural structures, and (2) reduce the cost of flood insurance for agricultural structures with a federally backed mortgage to a more appropriate risk-based portion of the financial risk in the NFIP. The key elements include the following, of which most are applicable to the Courtland study area:

a) Levee relief cuts with emergency operation plans and floodplain management ordinance

b) Zone X for certified levee reaches: The partial accreditation of a basin or levee reach could potentially lead to lower NFIP insurance rates as portions of levee systems are approved.

c) Wet floodproofing rules for agricultural structures

d) Insurance rates for nonaccredited levees: The AFOTF recommends that FEMA use sound actuarial science to amend its insurance rates to reflect flood protection provided by a non-accredited levee as documented by a civil engineer.

e) Insurance rates for agricultural structures

f) Insurance rates for wet floodproofed structures

g) Add levee risk management activities to FEMA CRS

5.2.9 Mokelumne River Conveyance Improvements/Flood Easements

In October 2010, a Final Environmental Impact Report (EIR) was published by DWR for the North Delta Flood Control and Ecosystem Restoration Project. The purpose of this project was to implement flood control improvements in a manner that benefits aquatic and terrestrial habitats, species, and ecological processes. Specifically, improvements were sought which were expected to reduce damage to land uses, infrastructure, and the Bay-Delta ecosystem resulting from overflows caused by insufficient channel capacities and catastrophic levee failures in the North

Delta study area. One option analyzed and presented in this EIR included dredging components of the channel along the North and South Forks of the Mokelumne River. Dredging is expected to directly reduce flood stages in the Mokelumne River and Snodgrass Slough providing a flood risk reduction benefit to the adjoining nearby communities. Another option specific to this area which could reduce flood risks to the study area involves allowing flood stages along the North and South Forks of the Mokelumne River to overtop into Staten Island, or portions thereof, and serve as a flood relief overflow area.

This option's feasibility stems largely from the fact that this area is sparsely populated, and its use for a flood easement would allow for significant lowering of water stages in the North Delta Region adjoining and upstream of the North and South Forks of the Mokelumne River.

This element is included for comparison purposes, but it is not expected to result in flood risk reduction benefits for the Delta Legacy communities of West Walnut Grove and Ryde and Isleton. Isleton and West walnut Grove/Ryde along the Sacramento River are somewhat isolated from the high-water conditions within the unregulated watersheds associated with the Cosumnes River, Dry Creek and Snodgrass Slough that drain into the capacity-constrained Mokelumne River system adjoining and upstream of Staten Island.

5.2.10 Improve FEMA Community Rating System

Sacramento County, *via* its floodplain administrator program, is a very active participant of the NFIP, and through its County-wide Flood Protection Ordinance the County strives to reduce flood risks throughout the unincorporated areas of Sacramento County while also attempting to reduce NFIP premium policy rates. Through different flood mitigation activities outlined within the NFIP, Sacramento County has been able to reduce flood insurance through the FEMA CRS. Since 1992, Sacramento County has steadily improved its CRS score and as of May 2017, Sacramento County has maintained a Class 2 designation, which has yielded a 40 percent reduction of NFIP insurance premiums for SFHAs (an average reduction of $547 in annual NFIP premiums), within Sacramento County, inclusive of the Isleton study area.

Unfortunately the City of Isleton, being an incorporated City within Sacramento County and with FEMA's introduction of Risk 2.0, may no longer benefit from the County's high community rating systems. Thus, the City of Isleton, in addition to forming its own Geological Hazard Abatement District (GHAD), may need to improve its CRS to help keep NFIP flood insurance premiums and any community-based flood insurance rates at a lower more attractive rates to ensure the community if fully covered for potential flood damages.

5.2.11 Improved Governance between Neighboring LMAs and RDs and Community

The RDs in the North Delta are protected by a system of leveed channels, multipurpose reservoirs, and other structures that now comprise the SRFCP. The goal of the SRFCP is to

reduce the chance of flooding to communities and agricultural lands in the Sacramento Valley and the Delta, including the Delta Legacy communities in Sacramento County. Under the Standardized Emergency Management System (SEMS), Sacramento County establishes an Operational Area (OA). Traditionally, LMAs have not been included in planning or exercises. LMAs have relied mainly on DWR as their primary flood fight trainer, resources provider, and the next link in the SEMS chain of command rather than the local OA management structure. The Sacramento County Delta Flood ESP, written in June 2017, is an effort to improve communication between Sacramento County and the Delta LMAs by providing a better understanding of the river system, providing rescue and evacuation mapping, laying out the flood emergency response process, formulating detailed hazard information for LMAs, and providing flood response trainings.

Due to assessment limitations imposed by the California Water Commission, BALMD and other similar RDs are limited to assessing properties within their District(s) by acreage and not by property improvements. Thus, it may be advantageous for BALMD to work closer together with the City in potentially developing an improved assessment or a GHAD for implementing flood risk reduction measures specific beyond the immediate community of Isleton. Framework exists for community-specific assessments similar to the County assessments that are in place for regional sanitation services, water supply and storm drainage services that are provided by the County and/or others beyond those provided by BALMD.

5.2.12 Public Education and Awareness

There are currently three programs within the Delta that provide public education, awareness, and notifications about flood risk. One is the Delta Flood Preparedness Week hosted annually by the DPC. As part of this effort the DPC provides calendars that consolidate important flood-related information specific to the Delta including emergency phone numbers and websites with flood education as well as safety information.

A second is the Sacramento County Program for Public Information that aims to increase awareness through informational materials (such as the Storm Ready Booklets) and multiple levels of outreach, ranging from radio spots to specific stakeholder engagement. This program can act as a conduit of flood risk information and coordination directly with the community members of Courtland.

The third program is the DWR Flood Risk Notification Program that includes sending annual notices in advance of the flood season to every property owner who is located behind a SPFC levee within the Delta. The individual notices include the property owner's address and informs the owners their property may be exposed to potential flood risk from the failure of the levee system. The notice also suggests each property owner visit DWR's Flood Risk Notification site[13] and enter their address to get the most information on state-federal levees in their area.

[13] http://water.ca.gov/myfloodrisk

5.3 Multi-Objective Components

There are several opportunities for including multi-objective components during construction of structural elements and implementation of select non-structural measures. Multi-objective options could offer benefits outside of the Isleton Legacy Community boundary and benefit the broader community within and beyond the larger study area.

5.3.1 Water Quality and Water Supply, including Through-Delta Conveyance Reliability and Operational Flexibility

With or without the DCA intakes and associated tunnel improvements as proposed by the DCA in 2020, through-Delta conveyance will continue to rely on the freshwater corridor established both upstream and downstream of the Delta Cross Channel. Presently there are 37 miles of non-urban SPFC levees upstream and 25 miles downstream of the Delta Cross Channel in the North Delta that help convey water through the Delta for a total of 62 miles of SPFC levees. These levees constitute significant portions of the Delta's freshwater corridor as previously indicated in Figure 5-19 - SPFC Levees which Comprise the Delta's Freshwater Corridor. Improving up to 6.0 miles of SPFC levees along the right bank of Georgianna Slough (NULE Segment 40) to current, modern levee engineering standards consistent with FEMA's 100-year accreditation standards within the BALMD project boundary would constitute improving 24 percent of the non-urban SPFC levees downstream of the Delta Cross Channel and nearly 10 percent of the total non- urban SPFC levees in the Delta's freshwater conveyance corridor.

5.3.2 Ecosystem Restoration Enhancements

Eco-restoration enhancement opportunities within the greater Isleton study area of the Brannon Andrus Levee Maintenance District (BALMD) potentially include:

1) Enhancing or creating additional Shaded Riverine Aquatic (SRA) habitat along the Sacramento River or Georgiana Slough in connection with addressing erosion concerns and/or replenishing rock slope protection (RSP) at known erosion sites. There is one known DWR Flood System Repair (FSR) serious site in the project area along the Sacramento River left bank levee (NULE Segment 378, near LM 7.0) just north of State Route of 12, approximately 350 ft. in length. This site has the potential to incorporate SRA enhancements and it is further identified in Table 5-1 and as Management Action 1B within Section 6.1.2. This SRA enhancement along the left bank of the Sacramento River could offer greater connectivity to the SRA opportunities previously outlined further upstream along the Sacramento River in the 2014 RFMP.
2) In connection with developing a flood fight access road identified above in Section 5.2.1 along the 6th Street southerly boundary line of the city limits (coinciding with approximately 0.60 miles of the former West Walnut Grove – Isleton Branch Line Rail alignment) there is an opportunity to create native grassland habitat

enhancements along the landward and waterward slopes of said access road/embankment. It is estimated that as much as two acres of native grassland enhancements, adjoining existing upland woodland habitat to the south of 6th Street, could be created along the 6th Street portion of the flood fight access road.

3) Similar to the embankments of the flood fight access road, any new cross levee systems with 18 to 20 feet high embankments containing 3:1 (H:V) side slopes there will be greater opportunities to create native grassland enhancements. It is estimated that as much as 14.5 acres of native grassland habitat enhancements can take place for every mile of new cross levees that may be constructed as described above in Sections 5.1.2.4 through 5.1.2.6 and as depicted in Figures 5-14 through 5-16. In reviewing the collection of the three cross levees alignments between Georgiana Slough and the Sacramento River, as described in Sections 5.1.2.4 through 5.1.2.6, the total length of new cross levee segments (excluding improvements to the existing SPFC levee segments) is relatively consistent among all the three configurations at approximately 2.60 miles. At 14.5 acres per mile this equates to an opportunity of creating approximately 37.8 acres of native grassland habitat enhancements for any one of the three cross levee configurations.

4) A potential borrow site of the former Walnut Grove - Isleton Branch rail line embankment (approximately 6 acres in size) is identified in Figure 5-19 that is just beyond, but contiguous to the city limits at the southwesterly extension of 6th Street. This small 6-acre of embankment area could be utilized as a borrow source for either the flood fight access road/berm or any one of the cross levee configurations and could also be modified to create native habitat and create direct connectivity to the existing native woodland habitat that currently exists directly east and south of 6th Street.

5) Opportunities exist to utilize or expand upon the 87-acre combined BALMD borrow and mitigation bank site(s) located in project study area, The noted borrow and mitigation site(s) in the project study area are near the San Joaquin River just east of its confluence with Sevenmile Slough, as depicted in Figure 5-21 below. This same area has been identified as Existing Restoration Project (ER-3) in Appendix D – Ecosystem Multi-benefit Opportunities for the Sacramento County Delta Legacy Small Communities Flood Risk Reduction Feasibility Studies.

6) Formalizing a relief cut at the southern, lower end of Brannan Andrus Island adjoining the 87-acre site (shown in Figure 5-21) near the confluence of the San Joaquin River and Sevenmile Slough could create an opportunity to create more tidal marsh habitat and greater conectivity between the BALMD mitigation site (ER-3) and the adjoing the San Joaquin River. Restoration of this area would be consistent with local Delta stakeholder requests to conduct restoration activities first on public managed lands.

7) Construction of a potential setback levee or re-channelization of Georgiana Slough immediately northwest of Oxbow Marina could create additional wetland and SRA habitat. However, it would require the construction of a new bridge to retain access into Oxbow Marina and it would essentially disconnect Oxbow Marina onto a separate isolated marina island, separate from BALMD. There are also underground utilities that would require relocating and routing underneath the potential rerouting of Georgiana Slough at this noted location. Rerouting Georgiana Slough to the northwest of Oxbow Marina could also impact the navigability of vessels in and around Oxbow Marina, suggesting the rechanneling of Georgiana Slough at Oxbow Marina is beyond the scope of this feasibility study.

Figure 5-19 below indicates the location of some of ecosystem restoration opportunities described above in the Isleton study area that is contained within the bounds of the BALMD. Ecosystem restoration opportunities must be balanced with flood management requirements and in support of continued agricultural land uses in the Delta adjoining the City of Isleton. Appendix D also contains additional information relative to ecosystem restoration opportunities beyond the immediate study area, within the greater northeastern portion of the Delta.

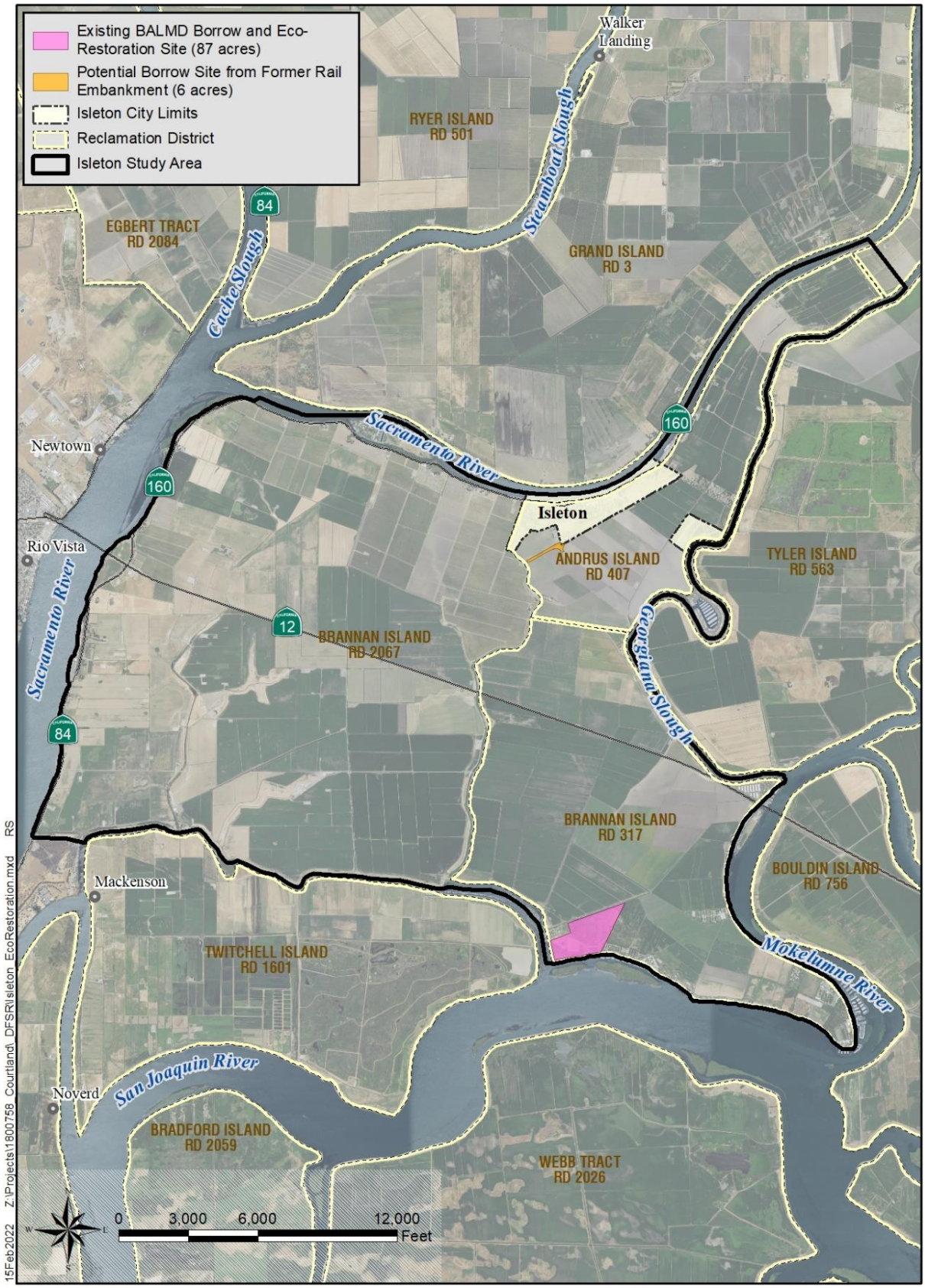

Figure 5-19. Ecosystem Restoration Opportunities for the Community of Isleton Study Area

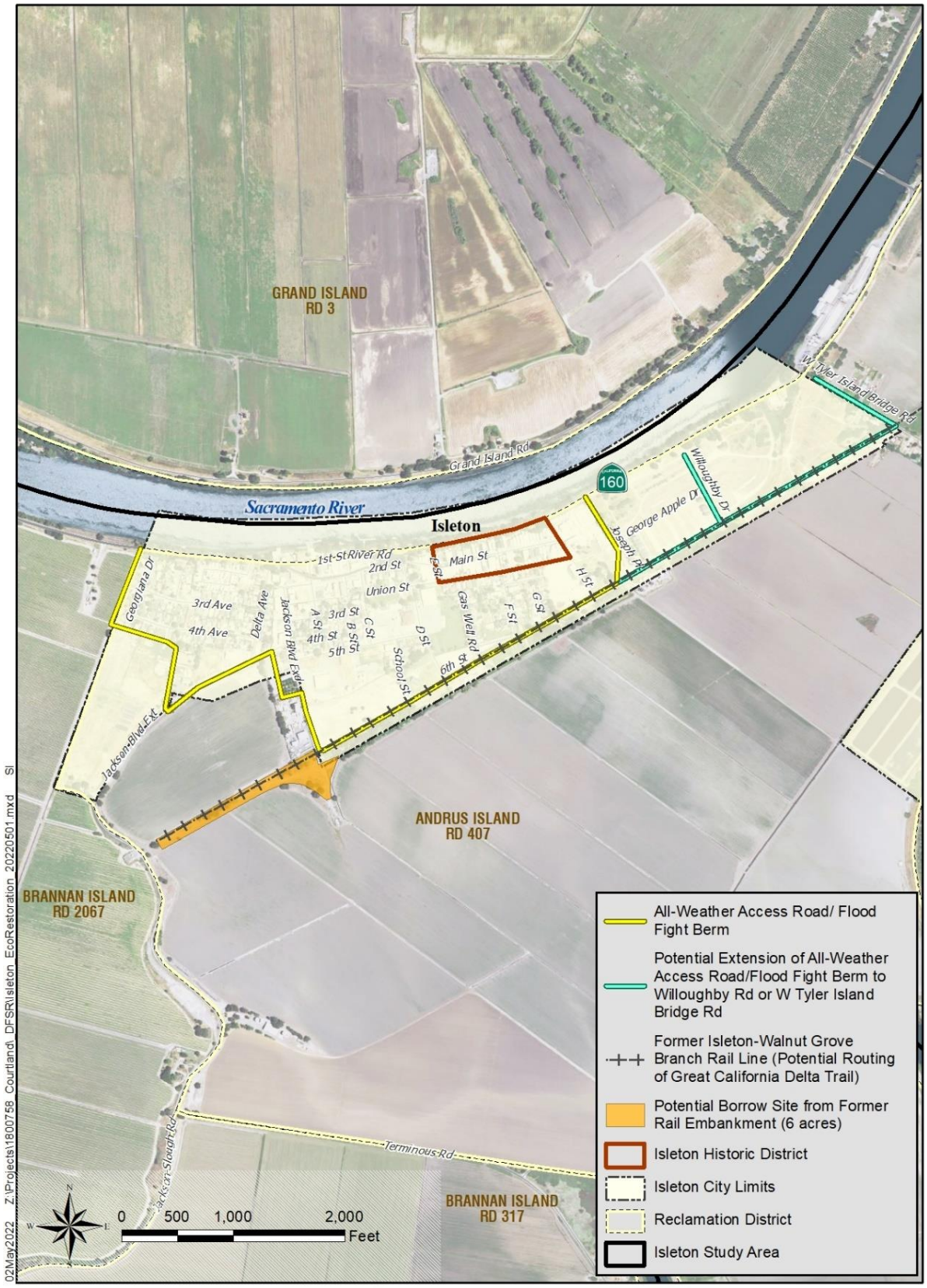

Figure 5-20. Potential Ecosystem Restoration and Recreational/Educational Enhancement Opportunities with Flood Risk Reduction Efforts Within the City of Isleton

5.3.3 Public Recreation and Education Enhancement Opportunities

The Delta Legacy Communities and encompassing study areas provide a unique mix of modern working agricultural lands, wildlife habitat and viewing opportunities, pastoral landscapes, and a glimpse into history. Also, Isleton's Asian American District is the only Asian community that was constructed in the Delta during the 1920s, and the architectural style of the buildings, particularly the use of pressed tin siding, is unique to Delta Asian communities and to the town of Isleton[14]. The uniqueness of Isleton, its history, and surrounding areas provide an opportunity to encourage public education and recreation opportunities for community residents and visitors from outside the Delta and to provide economic stimulus from Delta-centric tourism.

Local and Regional Multi-Use Trail Opportunities for City of Isleton Study Area

In connection with a flood fight access road and/or berm planned for the City of Isleton along its south and southwesterly borders a muti-use pedestrian/bicyclist trail could be easily integrated with said flood fight access road/berm as described above in Section 5.2.1 and as depicted in supporting Figure 5-18 above and Figure 5-18 below. This trail could provide for an informative, educational loop trail within and around the historic Asian Communities and structures within the City (Figure 5-18). The trail system can also offer viewsheds of the nearby agricultural activities along the south and southwest borders of the City without being intrusive to the adjoining agricultural practices of open field crops to the south and adjoining vineyards to the west. A 1.5 to 1.7-mile-long trail segment could be developed along the alignment of flood fight access road with another 0.85-mile-long trail segment developed along existing streets, particularly along Main Street or Union Street west of H Street to the most westerly street in Isleton, namely Georgiana Drive. This would result in an informative, local multi-use loop trail approximately 2.35 to 2.55 miles in length that could be enjoyed by local residents as well as out of town visitors. This same loop trail could also serve as a connector trail and/or components of a local trail system that could also serve as components of the Great California Delta Trail, as described in more detail below.

Similar multi-use trails could also be integrated within the cross levee systems east and west of the city limits between the existing SPFC levee systems along the right bank of Georgiana Slough and the left bank of the Sacramento River described above in Sections 5.1.2.4 through 5.1.2.6 and as depicted in Figure 5-15 and Figure 5-16. Cross levee trail systems, (with or without incorporating new or paved public access roads along the crown of any new cross levees), could serve as a great connector loop trail system to and from the communities of Isleton and the Oxbow Marina. The smallest cross levee configuration depicted in Figure 5-15 could result in a cross levee loop trail system totaling approximately 4.9 miles; and the largest cross levee system closely following the City's proposed 2020 Sphere of Influence (SOI) line depicted

[14] Delta Protection Commission (DPC). January 20, 2022. Great California Delta Trail Master Plan. Available at: https://delta.ca.gov/recreation-and-tourism/

in Figure 5-16 could total approximately 6.6 miles in length. The said loop system would likely require enlarged levee crowns along the right bank of Georgiana Slough and along portions of the left bank of the Sacramento River wherever a parallel trail/road system doesn't exist along or near State Scenic Route 160. The subject cross levees containing multi-use trails would greatly enhance the connectivity of the two neighboring communities of Isleton and Oxbow Marina, and the noted public trails could also serve as a destination link for visitors visiting the Delta. Similar to a loop trail system described above associated with a flood fight access road, any of the cross levee loop trail systems for Isleton could also serve as a connector trail and/or components of the Great California Delta Trail, as described in more detail below.

These multi-use trail plans must be balanced with maintaining the quality of life for residents and agricultural practices of the greater Isleton community and require further refinement and discussion with landowners, stakeholders, and Sacramento County. Isleton has much to share with visitors, as detailed on the Story Map for the community, accessible online.[15]

Great California Delta Trail in Central Delta Region Including Regional Connection Trails

On January 20, 2022, the DPC adopted a formal Master Plan for the Great California Delta Trail[16]. The Master Plan calls for further planning of a multi-purpose recreational trail system that could potentially connect a number of the Delta Legacy Communities, including the City of Isleton, utilizing the former Southern Pacific Walnut Grove - Isleton Branch Line that existed from 1906 through 1972. The former rail line that once occupied 6th street within Isleton was abandoned between Isleton and Walnut Grove following the devastating flood that occurred in Isleton in 1972. The former rail line formally abandoned operations further north between Walnut Grove and Sacramento in 1978. Management actions including cross levee systems or a flood fight access road system described above for the City of Isleton provide the opportunity to develop and/or enhance multi-use recreational use trails within and adjoining the community that can either become a part of the Great California Delta Trail or provide connector trails to the Great Delta Trail.

With the flood fight access road coinciding with 6th street the opportunity exists to provide recreational and educational opportunities within the community as well as potentially reconnecting the former Walnut Grove - Isleton Branch Line in Isleton as a multi-use trail to other communities in the North Delta via the former right-of-way that still exists today in large segments within BALMD to the southeast towards the Mokelumne River and to the north on Tyler Island towards Walnut Grove and Locke.

Figure 5-21 on the following page, excerpted as Figure 3-6 from the DPC Great California Delta Trail Master Plan of January 2022, depicts the possible routing of existing regional trail systems

[15] http://floodriskreductionisleton.com/

[16] Delta Protection Commission (DPC). January 20, 2022. Great California Delta Trail Master Plan. Available at: https://delta.ca.gov/recreation-and-tourism/

and potential routings for the Great California Delta Trail including the identification of Isleton potentially serving as a "Potential Adventure Hub" in the Central Delta Region.

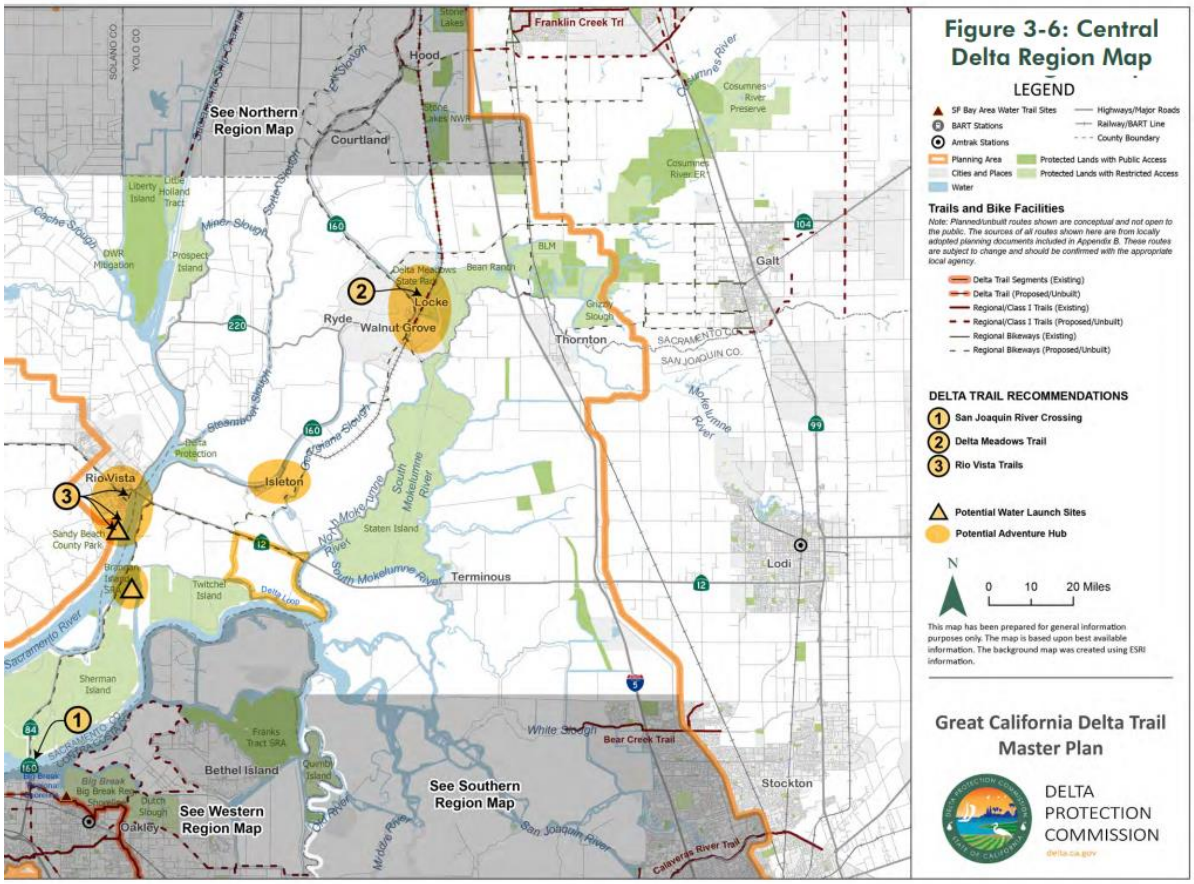

Figure 5-21. Excerpt of DPC's Great California Delta Trail Master Plan Identifying Isleton as "Potential Adventure Hub" and Existing/Proposed Trails/Bikeways in Central Delta Region

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6. Identification and Trade-Off Analysis of Flood Risk Reduction Management Actions

This Section uses the structural elements and non-structural measures previously described in Section 5 to develop and prioritize MAs based on risk reduction and responsiveness to planning objectives, as well as constraints regarding funding, implementation, and capital costs. These MAs are recommended to be implemented in a successive fashion as funding is collectively identified and secured. This Section also provides the capital costs associated with each MA, as well as a trade-off analysis using the planning objectives identified above in Section 4.1.

The structural elements and non-structural measures identified in Section 5were prioritized into 12 MAs based on the most efficient approaches to reducing risk and achieving the previously identified objectives of:

- Reducing risk to life
- Reducing risk to property damage
- Reducing probability of levee failure
- Limitation of high insurance premiums
- Improved preparedness and response
- Enhancing resiliency and reliability of through-Delta water conveyance
- Prioritizing environmental stewardship and multi-benefit projects

As previously discussed, risk reduction is defined as the product of the probability of levee failure and the consequences of failure. The consequences of levee failure are defined in this study in terms of life loss and property damage. Of the 12 MAs, those which resulted in the greatest risk reduction by reducing the probability of levee failure of the weakest levee segments and reducing the consequences of levee failure through reduced life loss and property damage were given priority. However, funding, implementation, and capital cost are also considered during the prioritization process.

6.1 Identification of Structural-Related Flood Risk Reduction Management Actions

The 12 MAs are summarized below. These MAs are compared against the no action, future without project condition to quantify and qualify how well each MA addresses the objectives of this study using the planning objectives identified above in Section 4.1.

6.1.1 No Action, Future Without Project

Future without project conditions represent the current level of flood protection within the study area, does not incorporate any structural or non-structural flood risk reduction elements, and incorporates expected changes to the study area from climate change, sea level rise, and future land uses.

Without any changes to the flood management system or implementation of non-structural measures:

- The study area remains at a high risk of flooding. As previously discussed, according to previous studies conducted by DWR and the DSC DLIS, it is estimated that the study area could have a level of flood protection of less than 40 years.
- There is a high risk of life loss for the densely populated community of Isleton. Currently, the levee fronting the community of Isleton, as documented by DWR in the NULE GAR, is estimated to have a moderate risk of levee failure or the need to flood fight based on the potential vulnerability to slope stability, through seepage, and erosion. In the event of a levee failure at this location, significant life loss is likely as a result of high floodwater stages and velocities which would leave little time to evacuate.
- There is also a high risk of property damage for the community of Isleton and the larger study area. As documented by DWR in the NULE GAR, the SPFC levees in the study area are estimated to have a moderate to high risk of levee failure or the need to flood fight, primarily based on the potential vulnerability to through- and underseepage. A levee breach in BALMD could result in significant property damage to the community. The total value of structures and their contents, highways and streets, agricultural crops, and vehicles (excluding agricultural equipment) within BALMD totals over $387M. With the current level of flood protection noted above, this equates to an EAD for the Isleton study area of up to $22M under existing conditions and up to $94M under future conditions with the effects of climate change and sea level rise.
- The community remains susceptible to high NFIP annual premium increases, which could result in a net reduction of insured homes, further increasing flood risk.
- Levees within the Delta remain at risk of failure, which could significantly impact the agricultural economy within and adjacent to the community of Isleton and the conveyance of water to SWP and CVP water contractors south of the Delta.

6.1.2 Management Action 1: Repair of Remaining DWR FSRP Critical and Serious Sites within BALMD

The two critical and four serious sites within the Isleton study area that are not presently authorized for repair pose imminent flood threats to the community of Isleton and the larger study area. These six sites were identified under the DWR FSRP in 2013 and remain unrepaired. One of the critical stability sites and the serious seepage site are located on the right bank of the

Mokelumne River, and both serious stability sites are located on the right bank of Georgiana Slough. As previously discussed, these levees are identified by DWR as having a high likelihood of levee failure. The remaining two sites are located on the left bank of the Sacramento River (serious erosion site) and the right bank of the San Joaquin River (critical stability site), which are both identified by DWR as having a moderate likelihood of levee failure. A levee failure at any of these locations could result in life loss in the Isleton study area via high floodwater depths and velocities. Property damage is also of concern in the Isleton study area in the event of a levee failure at any of the six FSRP sites as a result of deep flooding. Repairing these previously identified FSRP sites would not only reduce the probability of levee failure, but also reduce the risk of life loss and property damage, resulting in a net reduction in flood risk.

Considering capital cost, implementation, and funding, the repair of the six DWR FSRP critical and serious sites located within the Isleton study area was selected as the most efficient, no regrets means for reducing flood risks to the community of Isleton and the larger study area and was thus prioritized as MA 1. Proposed remediations for the six FSRP critical and serious sites in the Isleton study area are described in Section 5.1.1.1, Table 5-1 and consist of drained stability berms for the critical and serious stability and seepage sites, along with rock revetment for the serious erosion site. MA 1 is comprised of the following prioritized flood risk reduction elements, with 1A presenting the greatest risks to the community of Courtland (Figure 6-1):

- 1A: Repair Two DWR FSRP Critical Stability Sites on the Right Banks of the Mokelumne and San Joaquin Rivers
- 1B: Repair DWR FSRP Serious Erosion Site on the Left Bank of the Sacramento River
- 1C: Repair Two DWR FSRP Serious Stability Sites on the Right Bank of Georgiana Slough and One Serious Seepage Site on the Right Bank of the Mokelumne River

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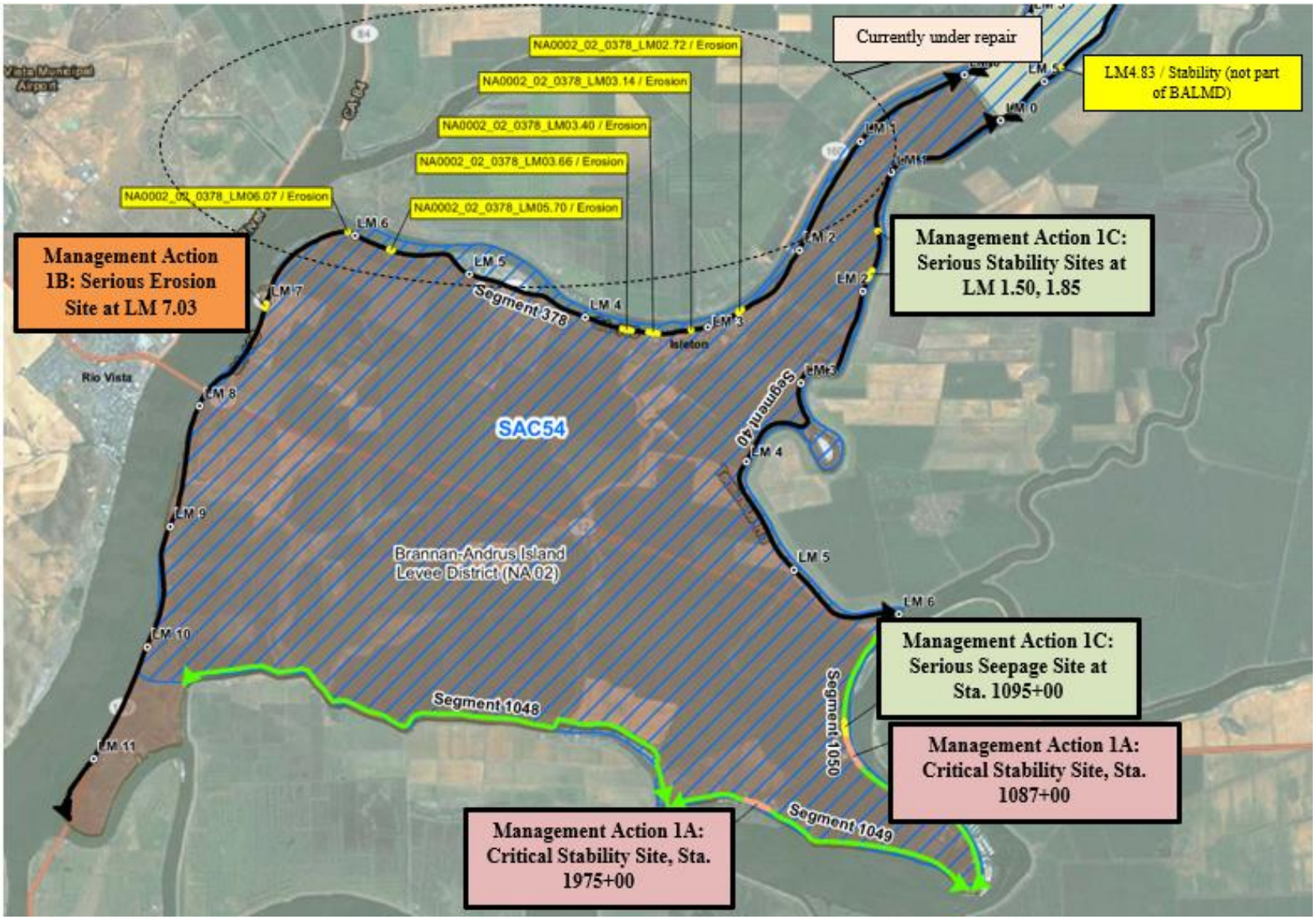

Figure 6-1. DWR FSRP Critical and Serious Sites Repaired under Management Actions 1A, 1B, 1C (URS, 2013b)

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6.1.3 Management Action 2: Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Relief Cut along Georgiana Slough

A levee breach on the left bank of the Sacramento River or along the right bank of Georgiana Slough upstream of the Isleton study area in RD 556 – Upper Andrus Island could result in deep flooding in the community of Isleton and the larger BALMD basin. Repairing, strengthening, and raising the 0.45-mile RD 556 cross levee at the northern boundary of the study area would prevent floodwaters originating from a levee breach along the left bank of the Sacramento River or along the right bank of Georgiana Slough upstream in RD 556 from entering the community of Isleton and the larger study area, reducing the overall risk to life loss and property damage, and resulting in a net reduction in flood risk. Repairing, raising and strengthening-in-place the RD 556 cross levee along the northern boundary of the Isleton study area was selected as the next most efficient means to reducing flood risk to the community of Isleton and the Isleton study area, considering capital cost, implementation, and funding constraints. Proposed remediations for MA 2 are shown in Section 5.1.2.1, Figure 5-13.

Raising and repairing/strengthening-in-place the RD 556 cross levee as part of MA 2 would also be coupled with a potential relief cut upstream of the RD 556 cross levee along the right bank of Georgiana Slough to mitigate flood depths in Upper Andrus Island as previously shown in Figure 5-13. Potential relief cut locations should be identified and further evaluated while updating the LHMP which addresses RD 556 and BALMD.

6.1.4 Management Action 3: All-Weather Flood Fight Access Road for the Community of Isleton

Construction of an all-weather flood fight access road would not result in reduced probability of levee failure, or reduced risk to the larger Isleton study area; however, constructing an all-weather flood fight access road would prevent floodwaters originating upstream or downstream within the BALMD basin from entering the community. In addition to preventing floodwaters from entering the community, the flood fight access road could allow additional time for evacuation, thus further reducing life loss and property damage, and ultimately reducing flood risk for the community. An all-weather flood fight access road could also lend multi-benefit opportunities for public recreation and education along the perimeter limits of the community and potentially beyond the community if linked or further connected to other Delta Legacy Communities with the Great California Delta Trail as contemplated in the DPC Great Delta Trail Master Plan of January 20, 2022[17]. While this flood risk reduction element would likely result in a greater reduction in life loss than raising and repairing the RD 556 cross levee, the all-weather access road/flood fight berm will not reduce risk to the larger BALMD basin. As a result, the flood fight access road was prioritized as MA 3.

[17] Delta Protection Commission (DPC). January 20, 2022. Great California Delta Trail Master Plan. Available at: https://delta.ca.gov/recreation-and-tourism/

6.1.5 Management Action 4: Repair and Strengthen-in-Place SPFC Levee along the Left Bank of the Sacramento River (NULE Segment 378)

As previously discussed, the risk of life loss is of greatest concern within the densely populated community of Isleton since a levee breach along the left bank of the Sacramento River directly adjacent to the community could likely result in high floodwater velocities, leaving little time to evacuate. Additionally, as previously discussed, flood depths in the community and in the larger BALMD basin are expected to be the greatest in the event of a levee failure on the left bank of the Sacramento River along or downstream of the community of Isleton. In this scenario, maximum flood depths in the community of Isleton are likely to exceed 5 feet, with flood depths in the greater BALMD basin ranging between 10 and 33 feet, which could result in significant property damage within and outside of the community of Isleton.

Since flood risk is defined in terms of probability of levee failure and risk of life loss and property damage, and the left bank of the Sacramento River is identified by DWR as having a moderate likelihood of levee failure. Repairing and strengthening the left bank of the Sacramento River along or downstream of the community would result in: (1) a great reduction in flood risk for both the densely populated community of Isleton and the larger study area; and (2) significant reductions of inflow and infiltration to the City's wastewater collection with the installation of levee seepage cutoff walls.

Repairing and strengthening the left bank of the Sacramento River upstream or downstream of the community of Isleton would also reduce flood risk for the community and the larger study area, but to a lesser degree since a levee breach along this segment of levee is expected to result in lesser flood depths within the community and the BALMD basin. MA 4 is thus comprised of the following prioritized flood risk reduction elements along the 10.2-mile-long section of the Sacramento River left bank SPFC levee, with MA 4A adjacent to the community presenting the greatest risks to the community of Isleton with NULE Segment 378 (Figure 6-2):

- 4A: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Left Bank of the Sacramento River Adjacent to Isleton (between the Isleton bridge and the southwest boundary of the City limits)
- 4B: Repair and Strengthen-in-Place 4.2 Miles of Levee along the Left Bank of the Sacramento River Between the Westerly Boundary of the Community of Isleton and Highway 12
- 4C: Repair and Strengthen-in-Place 2.4 Miles of Levee along the Left Bank of the Sacramento River Between Highway 12 and West Brannan Island Road
- 4D: Repair and Strengthen-in-Place 2.0 Miles of Levee along the Left Bank of the Sacramento River upstream of Isleton between the Isleton bridge and the RD 556 Cross Levee.

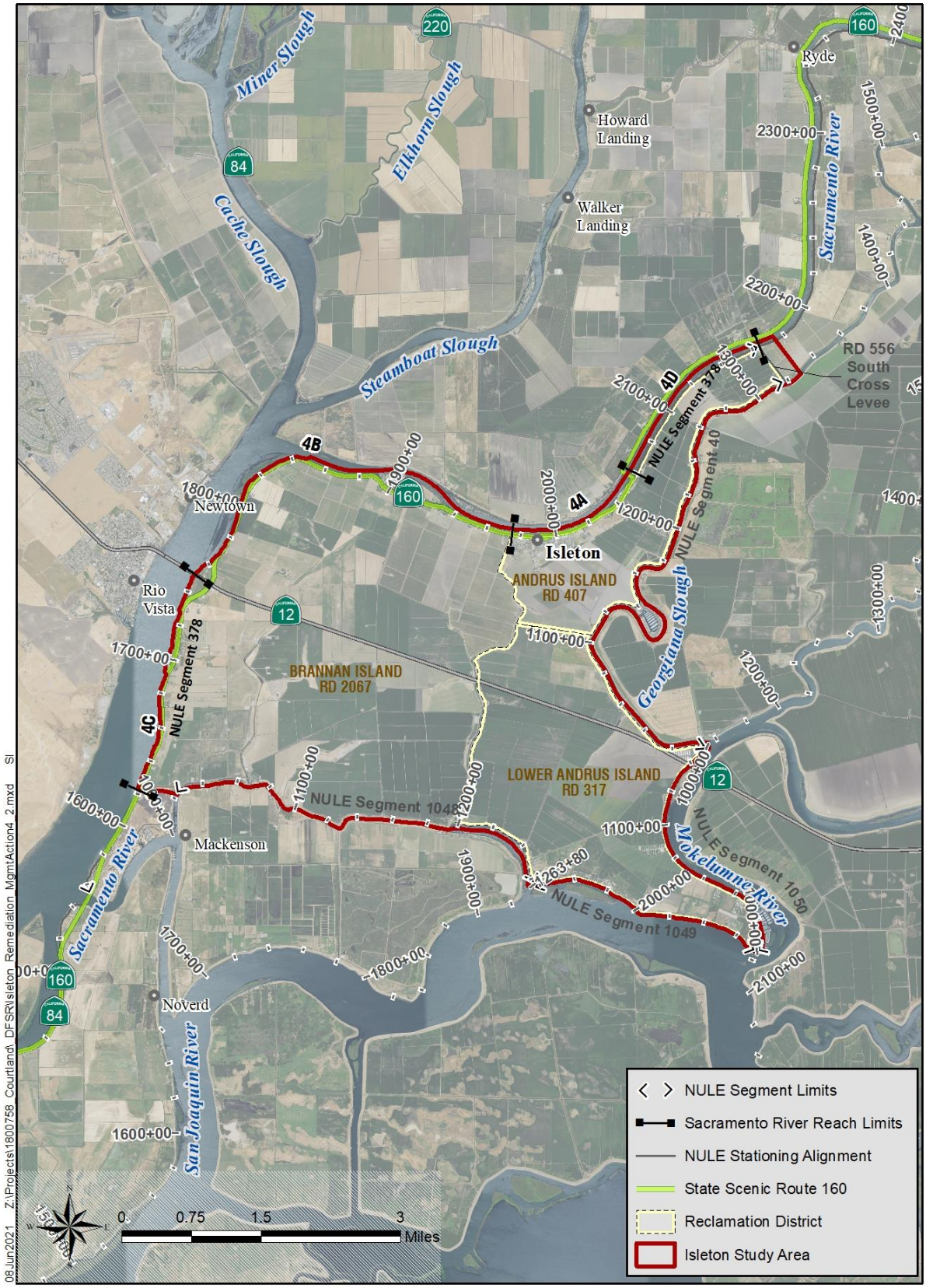

Figure 6-2. Management Action 4 - Repair and Strengthen-in-Place Various Portions of the 10.2-Mile SPFC Levee (NULE Segment 378) along the Left Bank of the Sacramento River

As previously noted, additional data from CPTs collected in September of 2020 informed the remedial alternatives developed for the 1.6-mile-long segment of levee downstream of the Isleton bridge and adjacent to the community of Isleton. These remediations are proposed for MA 4A and are described in Section 5.1.2.1. Remediations for the remaining 8.2 miles of SPFC levee along the left bank of the Sacramento River upstream of West Brannan Island Road (at LM 10.2) are adapted from DWR's 2011 RACER. These remediations are proposed for MAs 4B, 4C, and 4D and are described in Section 5.1.1.2.

6.1.6 Management Action 5: Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40)

A breach along the right bank of Georgiana Slough could result in significant property damage within the community of Isleton and the larger study area as a result of flood depths ranging from 5 feet within the community of Isleton, up to 32 feet in the larger BALMD basin. Currently, the right bank of Georgiana Slough (approximately 6 miles in length within the project study area) is identified by DWR as having a high likelihood of levee failure as a result of vulnerabilities to underseepage, through seepage, and slope stability. Repairing and strengthening the right bank of Georgiana Slough would result in a great reduction in flood risk for both the densely populated community of Isleton and the larger study area by reducing the risk of property damage and the probability of levee failure. When considering capital cost, implementation, and funding, repairing, and strengthening the levee along the right bank of Georgiana Slough was selected as the next most efficient means of reducing flood risk to the community of Isleton. MA 5 is comprised of the following prioritized flood risk reduction elements, with 5A through 5C presenting the greatest risks to the community of Isleton within NULE Segment 40 (Figure 6-3):

- 5A: Repair and Strengthen-in-Place 0.90 miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee North of Fertile Acres and 450 Feet Downstream of the Isleton Sewer Ponds. The installation of a seepage cutoff wall in Reach 5A would also eliminate excessive through and under-seepage that interferes with the operation of the City's existing wastewater ponds directly adjacent to the existing right bank SPFC levee of Georgia Slough.
- 5B: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee North of Fertile Acres and the Isleton/Oxbow Marina Cross Levee (includes 5A)
- 5C: Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee North of Fertile Acres and the Cross Levee at Jackson Slough Road and Terminous Road (includes 5A and 5B)
- 5D: Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential southwesterly Cross Levee at Jackson Slough/ Terminous Roads and the Mokelumne River

- 5E: Repair and Strengthen-in-Place 2.2 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee North of Fertile Acres and the RD 556 Cross Levee

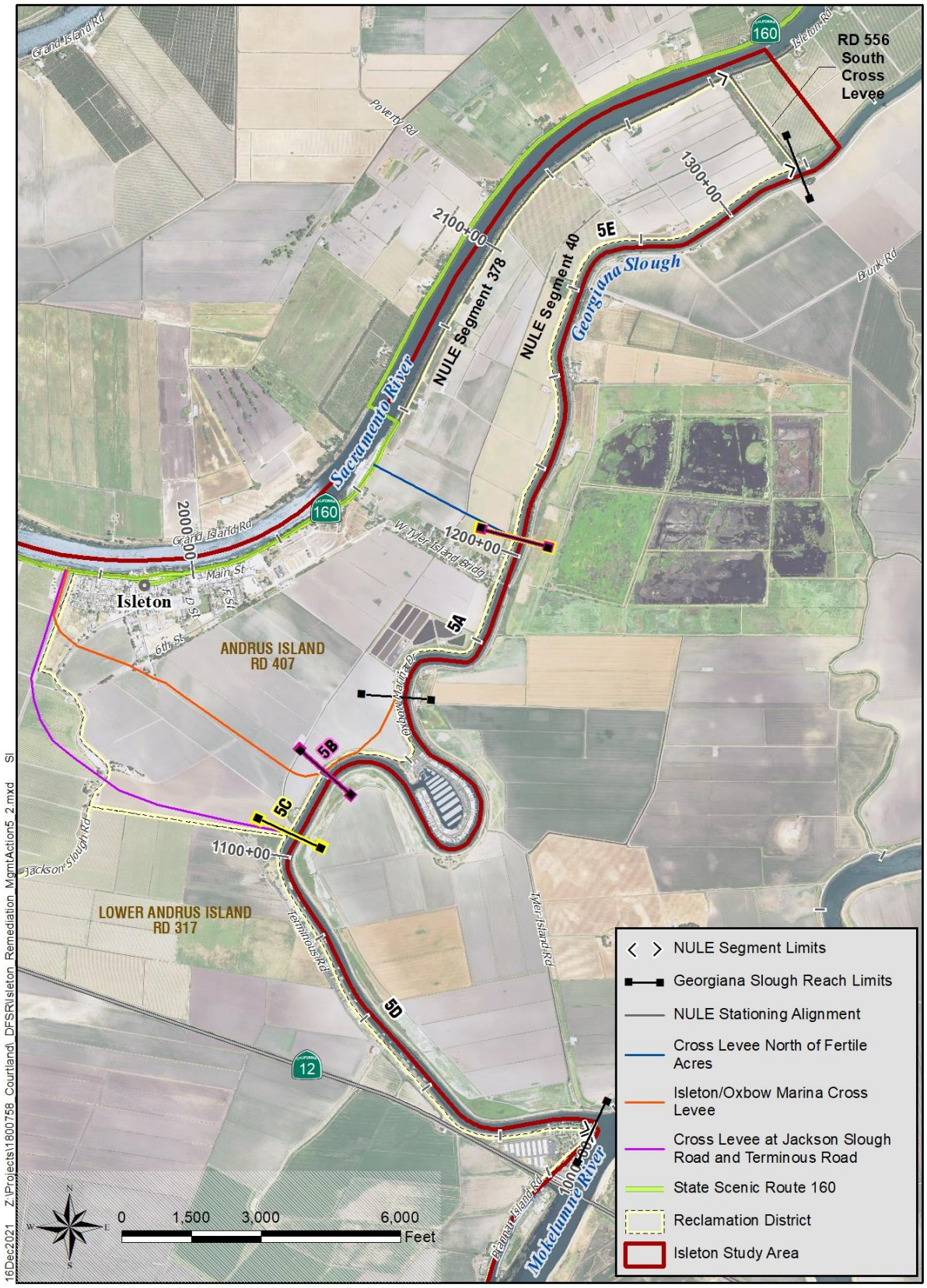

Figure 6-3. Management Action 5 - Repair and Strengthen-in-Place Various Portions of the SPFC Levee (NULE Segment 40) along the Right Bank of Georgiana Slough

As previously noted, additional data from CPTs collected in September of 2020 informed the remedial alternatives developed for 12,000 ft. (or 2.25 miles) of levee along the right bank of Georgiana Slough, inclusive of 10,000 ft. (or 1.9 miles) between the potential Cross Levee North of Fertile Acres and the potential Cross Levee at Jackson Slough Road and Terminous Road proposed as part of this feasibility study. These remediations are described in Section 5.1.2.2, shown if Figure 5-12, and correspond to MAs 5A, 5B, and 5C in their entirety, and small portions of MAs 5D and 5E. Remediations for the remaining 4.1 miles of SPFC levee along the right bank of Georgiana Slough are largely adapted from DWR's 2011 RACER. These remediations are proposed for MAs 5D and 5E and are described in Section 5.1.1.3.

When collectively implemented, Management Action 5 associated with improving 6.0 miles of SPFC levee NULE Segment 40 in its entirety also provides the multi-benefit of improving the resiliency and reliability of through-Delta water conveyance. Management Action 5 improves up to 24 percent of the non-urban SPFC levees located downstream of the Delta Cross Channel (total of 25 miles) and nearly 10 percent of the total non-urban SPFC levees downstream of Freeport (total of 62 miles) which comprise the freshwater corridor in the North Delta. *See* Appendix K for further details in support of the multi-benefit opportunities identified by the Sacramento County Delta Legacy Communities associated with reducing flood risks combined with improving SWP water conveyance through the Delta.

6.1.7 Management Action 6: Cross Levee System(s) with FEMA Certification for the City of Isleton

Constructing the levee systems described in Sections 5.1.2.4 through 5.1.2.6, which consists of strengthen-in-place improvements and repairs to the levees along the left bank of the Sacramento River and the right bank of Georgiana Slough, as well as potential new cross levees northeast and southwest of Isleton, would effectively eliminate the probability of levee failure along the remediated levees, and prevent floodwaters from inundating the community from the northeast or south to southwest. Furthermore, FEMA certification of the cross levee system(s) would ensure a minimum of a 100-year-level of flood protection for the community of Isleton, which would greatly reduce flood risks and would help to limit high insurance premiums within the community. However, FEMA certification of the cross levee system(s) may be cost-prohibitive without support from others, including but not limited to through- and south-of-Delta water conveyance interests associated with the CVP and SWP. The potential cross levee systems for the City of Isleton have been prioritized as MA 6. FEMA accreditation could be attained once the perimeter levee system between the bounds of the new cross levees is remediated and improved to FEMA criteria for erosion, through seepage, underseepage, slope stability, and freeboard, consistent with the latest engineering standards that would also be applied to the new cross levees. All design criteria, O&M requirements, and documentation requirements included in 44 CFR §65.10 would also need to be addressed to secure 100-year FEMA certification. MA 6 is comprised of the following flood risk reduction elements:

- 6A: Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP, including:

    - Repairing and Strengthening-in-Place 1.4 Miles of Levee along the Left Bank of the Sacramento River
    - Repairing and Strengthening-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough
    - Two New Cross Levees as shown in Section 5.1.2.4, Figure 5-14 ("Cross Levee North of Fertile Acres" and "Cross Levee at Jackson Slough Road and Terminous Road")
- 6B: Isleton - Oxbow Marina Cross Levee System:
    - Repairing and Strengthening-in-Place 1.4 Miles of Levee along the Left Bank of the Sacramento River
    - Repairing and Strengthening-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough
    - Two New Cross Levees as shown in Section 5.1.2.5, Figure 5-15 ("Cross Levee North of Fertile Acres" and "Isleton/Oxbow Marina Cross Levee")
    - Potential Setback Levee at Oxbow Marina at a later date
- 6C: Isleton Sphere of Influence Cross Levee System, including:
    - Repairing and Strengthening-in-Place 1.75 Miles of Levee along the Left Bank of the Sacramento River
    - Repairing and Strengthening-in-Place 2.3 Miles of Levee along the Right Bank of Georgiana Slough
    - Two New Cross Levees as shown in Section 5.1.2.6, Figure 5-16 ("Cross Levee North of Isleton Bridge" and "Cross Levee at Jackson Slough Road and Terminous Road")

Proposed remediations and improvements for MAs 6A and 6B are described in Sections 5.1.2.4 and 5.1.2.5, respectively. The proposed remediations and improvements for MA 6C are described in Section 5.1.2.6.

6.1.8 Management Action 7: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the Mokelumne River (NULE Segment 1050)

A breach along the right bank of the Mokelumne River could result in significant property damage within the community of Isleton and the larger study area as a result of flood depths ranging from 5 feet within the community of Isleton, and up to 32 feet in the larger BALMD basin. Currently, the right bank of the Mokelumne River is identified in the DWR NULE investigations as having a high likelihood of levee failure as a result of vulnerabilities to underseepage, through seepage, and slope stability. Repairing and strengthening the right bank of

the Mokelumne River would result in a great reduction in flood risk for both the densely populated community of Isleton and the larger study area by reducing the probability of levee failure and reducing potential risk of property damage. When considering capital cost, implementation, funding, repairing, and strengthening the levees along the right bank of the Mokelumne River the subject MA was selected as the next most efficient means of reducing flood risk to the community of Isleton. The proposed remediations for MA 7 are described in Section 5.1.1.4.

6.1.9 Management Action 8: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the San Joaquin River (NULE Segment 1049)

The right bank of the San Joaquin River is currently identified by DWR as having a moderate likelihood of failure as a result of vulnerabilities to underseepage, slope stability, and erosion. A levee breach along the right bank of the San Joaquin River could result in significant property damage as a result of flood depths ranging from 5 feet in the community of Isleton and up to 32 feet in the larger study area. Repairing and strengthening the right bank of the San Joaquin River would result in a reduction in flood risk for the community of Isleton and the larger study area; however, due to the levee's current moderate hazard rating, this reduction in flood risk is likely to be lower than the reduction in flood risk associated with repairing and strengthening the levees along the right bank of the Mokelumne River, which are estimated by DWR to have a high likelihood of failure. As a result, and when considering capital cost, implementation, funding, repairing, and strengthening the levees along the right bank of the Mokelumne River was selected as the next most efficient means of reducing flood risk to the community of Isleton. The proposed remediations for MA 8 are described in Section 5.1.1.5.

6.1.10 Management Action 9: Repair and Strengthen-in-Place 1.35 Miles of Non-SPFC Levee along the Left Bank of Sevenmile Slough (NULE Segment 1048) East of Jackson Slough and Certify Sevenmile Slough Closure Structures

Although the left (north) bank of Sevenmile Slough is currently identified by DWR as having a high likelihood of failure, water into the westerly 3.25 miles of Sevenmile Slough (west of Jackson Slough Road and station 1200+00 of NULE Segment 1048) is regulated by two control structures, leaving a total of only 1.35 miles of levee along the left bank of Sevenmile Slough at risk of flooding Isleton and the larger study area. As a result, and when considering capital cost, implementation, funding, repairing, and strengthening the levees along the left (north) bank of Sevenmile Slough and certifying the two closure structures west of Jackson Slough Road was selected as the next most efficient means of reducing flood risk to the community of Isleton. The proposed remediations for MA 9 are described in Section 5.1.1.6.

6.1.11 Management Action 10: Highway 12 Cross Levee

Constructing a new 5.7-mile-long cross levee by raising and improving Highway 12 would effectively prohibit floodwaters originating downstream or southerly from entering the portion of the study area north of Highway 12, inclusive of the community of Isleton. This multi-purpose project of keeping Highway 12 dry during a downstream flooding event would not protect the portion of the study area north of Highway 12, inclusive of the community of Isleton, from floodwaters originating upstream in RD 556 without accompanying perimeter levee improvements along the Sacramento River, Georgiana Slough, the Mokelumne River, and the RD 556 cross levee. Constructing a new cross levee along Highway 12 was prioritized as MA 10. The proposed cross levee is described in Section 5.1.2.6.

6.1.12 Management Action 11: Secure 100-Year FEMA Certification for the Community of Isleton with a Highway 12 Cross Levee Paired with Perimeter Levee Improvements within BALMD North of Highway 12

MA 11 consists of several flood risk reduction elements which when combined form a complete, certifiable levee system for the City of Isleton and all areas north of Highway 12 within the boundaries of BALMD. These flood risk reduction elements include a new 5.7-mile-long cross levee along the portion of Highway 12 which bisects BALMD in concert with repairing and strengthening approximately 7.8 miles of levee along the left bank of the Sacramento River, 6.0 miles of levee along the right bank of Georgiana Slough, 0.30 mile of levee along the right bank of the Mokelumne River, and the 0.45 mile of cross levee adjoining RD 556 and BALMD. FEMA certification of the RD 556 cross levee and the combined 13.8 miles of SPFC levees located along the left bank of the Sacramento River and the right banks of Georgiana Slough and the Mokelumne River north of Highway 12 along with the 5.7-mile connecting cross levee along Highway 12 would ensure 100-year flood protection for the community of Isleton. This would greatly reduce flood risks and would help to limit high insurance premiums within the community and the multi-benefit of enhancing the resiliency and the reliability of through-Delta water conveyance by improving six miles (nearly 10 percent) of the total SPFC levees downstream of Freeport (62 miles) which comprise the freshwater corridor in the North Delta. However, FEMA certification of this cross levee system may be cost-prohibitive without support from others including through- and south-of-Delta water conveyance interests associated with the CVP and SWP. As a result, securing 100-year FEMA certification for this levee system was prioritized as MA 11. FEMA accreditation could be attained once the perimeter levee system inclusive and north of Highway 12 is remediated and improved to FEMA criteria for erosion, through seepage, underseepage, slope stability, and freeboard. All design criteria, O&M requirements, and documentation requirements included in 44 CFR §65.10 would also need to be addressed to secure 100-year FEMA certification.

6.1.13 Management Action 12: Secure 100-Year FEMA Certification for the Entire Study Area inclusive of the Community of Isleton

FEMA certification of the study area perimeter levee system ensures 100-year flood protection for the community of Isleton and the larger BALMD basin. FEMA certification helps to limit high insurance premiums and enhances the resiliency and the reliability of through-Delta water conveyance by improving six miles (nearly 10 percent) of the total non-urban SPFC levees downstream of Freeport (62 miles) which comprise the freshwater corridor in the Delta. However, FEMA certification of the entire perimeter levee system may be cost-prohibitive without support from others including through- and south-of-Delta water conveyance interests associated with the CVP and SWP. As a result, securing 100-year FEMA certification for the entire perimeter levee system was prioritized as MA 12. FEMA certification would be performed once the perimeter levee system is remediated and improved to FEMA criteria for erosion, through seepage, underseepage, slope stability, and freeboard. All design criteria, O&M requirements, and documentation requirements included in 44 CFR §65.10 would also need to be addressed to secure 100-year FEMA certification for the entire study area within BALMD.

6.2 Capital Costs

Cost estimates were developed and/or updated for each of the structural elements identified in Section 5.1 and for the construction of an all-weather access road/flood fight berm as well as potential cross levee systems for the community of Isleton.

Using data from the NULE GAR and DWR's FSRP, along with additional data from CPTs collected in September of 2020, an assessment was performed for select levee reaches nearby and adjoining the City of Isleton to identify potential vulnerabilities. These levee reaches include a 1.6-mile-long stretch of levee along the left bank of the Sacramento River directly adjacent to Isleton, up to a 2.25-mile-long stretch of levee along the right bank of Georgiana Slough closest to Isleton, and the entirety of the short 0.45-mile-long RD 556 cross levee upstream of Isleton. The assessment analyzed each reach for vulnerabilities to underseepage, through seepage, slope instability, and freeboard, which informed the development of conceptual levee remediations as previously described in Section 5.1.2. Capital cost estimates were developed using these conceptual levee remediations which are summarized in Table 6-1 below by levee reach. Erosion was not included in this analysis as costs for erosion repairs were previously identified and estimated by DWR's FSRP. However, the erosion repair cost previously identified through DWR's FSRP, was updated to July 2020 dollars (Section 6.2.1 and Table 6-2) for the single outstanding serious erosion site along the Sacramento River left bank levee near LM 7.03, located approximately one mile upstream of State Highway 12.

For the remaining larger balance of the BALMD levee reaches within the Isleton study area not mentioned above in the preceding paragraph and included below within in Table 6-1, the project study team study relied heavily upon the previous cost estimates developed in the DWR NULE program. The previous costs developed in 2012-2013 by the DWR NULE program were simply

updated to July 2020 dollars by the project study team for the various repair/strengthen-in-place remediation measures for the collection of SPFC and non-SPFC perimeter levee segments within the project study that closely coincide with the BALMD boundaries.

Costs presented in this Section are intended to be Class 4 (Feasibility Level) estimates as defined by the Association for Advancement of Cost Engineering International, and additional geotechnical explorations and analysis are recommended to further refine these cost estimates. Costs for all approaches are escalated to a cost basis of July 2020 using the 20 cities average from the Engineering News-Record Construction Cost Index. Further description of the development of the capital costs can be found in Appendix F.

Table 6-1. Repair and Strengthen-in-Place Cost Estimates for Select Levee Reaches in Isleton Study Area Evaluated by Project Study Team

Levee Segment Location	NULE Segment/ Reach	Start Station	End Station	Length (feet)[1]	Remediation Alternative 1, Vertical Cutoff Walls	Remediation Alternative 1 Cost Estimate	Remediation Alternative 2, Horizontal Levee Berms	Remediation Alternative 2 Cost Estimate
Sacramento River Left Bank SPFC Levee (SACR-L)	378-A	1975+00	1987+50	1,250	30-foot-deep cutoff wall	$3,131,000	65-foot-wide 9-foot-tall combo berm	$3,270,000
	378-A	1987+50	1992+50	500	30-foot-deep cutoff wall 0.5-foot-levee raise	$1,303,000	65-foot-wide 9-foot-tall combo berm 0.5-foot levee raise	$1,677,000
	378-A	1992+50	2060+00	6,750	30-foot-deep cutoff wall	$17,733,000	65-foot-wide 9-foot-tall combo berm	$18,105,000
Total for Sacramento River				**8,500 feet (1.61 Mi.)**		**$22,167,000 ($13.8M/mile)**		**$23,052,000 ($14.3M/mile)**
Georgina Slough Right Bank SPFC Levee (GGASR-R)	40-A	1100+00	1220+00	12,000	75-foot-deep cutoff wall 1.5-foot-levee raise	$40,172,000	70-foot-wide 13-foot-tall combo berm 1.5-foot-levee raise	$33,808,000
Total for Georgiana Slough				**12,000 feet (2.27 Mi.)**		**$40,172,000 ($17.7M/mile)**		**$33,808,000 ($14.9M/mile)**
Reclamation District RD 556 South Cross Levee (ILNCL)	RD556-A	0+00	2+50	250	20-foot-deep cutoff wall	$527,000	15-foot-wide 23-foot-tall stability berm	$828,000
	RD556-A	2+50	24+47	2,200	20-foot-deep cutoff wall 8.0-foot-levee raise	$6,664,000	15-foot-wide 23-foot-tall stability berm 8.0-foot-levee raise	$6,832,000
Total for RD 556 Cross Levee				**2,450 feet (0.46 Mi.)**		**$7,191,000 ($15.6M/mile)**		**$7,660,000 ($16.7M/mile)**
Total for 1.60 miles of levee along the Sacramento River, 2.25 miles of levee along Georgiana Slough, and the 0.45 mile of RD 556 cross levee				**22,950 feet (4.35 Mi.)**		**$69,530,000 ($16M/mile)**		**$64,520,000 ($14.8M/mile)**

Note: [1] Reach lengths rounded to the nearest 100 feet
Mi. = mile / miles

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6.2.1 Repair Remaining DWR FSRP Critical and Serious Sites (Management Action 1)

The estimated cost to repair the six remaining FSRP critical and serious sites not presently authorized for repair as documented in the 2013 FSRP Pre-Feasibility Report, escalated to July 2020 dollars, is $5,991,000. The estimated costs associated with each of the components of MA 1 are summarized in Table 6-2 below (URS, 2013b).

Table 6-2. Estimated Costs Associated with Management Actions 1A-1C – DWR FSRP Sites

Management Action	Estimated Cost
MA 1A: Repair Two DWR FSRP Critical Stability Sites on the Right Banks of the Mokelumne and San Joaquin Rivers	$3,655,000
MA 1B: Repair DWR FSRP Serious Erosion Site on the Left Bank of the Sacramento River	$1,258,000
MA 1C: Repair Two DWR FSRP Serious Stability Sites on the Right Bank of Georgiana Slough and One Serious Seepage Site on the Right Bank of the Mokelumne River	$1,078,000
Total	$5,991,000

6.2.2 Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Relief Cut along Georgiana Slough (MA 2)

Cost estimates to raise, repair, and strengthen the RD 556 cross levee were developed for both the cutoff wall and berm alternatives previously provided in Section 5.1.2.3. The estimated cost to repair this cross levee ranges from $7,191,000 (20-foot-deep cutoff wall) to $7,660,000 (15-foot-wide, 23-foot-tall stability berm) (or $15.6M to $16.7M per mile). Both remedial alternatives include an 8-foot levee raise for 2,200 feet to address geometry deficiencies and would be coupled with a potential relief cut upstream of the RD 556 cross levee along the right bank of Georgiana Slough to mitigate flood depths in Upper Andrus Island.

6.2.3 All-Weather Flood Fight Access Road for the Community of Isleton (MA 3)

The estimated cost to construct the all-weather flood fight access road described in Section 5.2.1 is $5.9M and is further detailed in Appendix F. This cost estimates assumes that 6th street needs to be raised by as much as 5 feet or an adjoining berm must be developed immediately adjacent to 6th street for a distance of approximately 3,000 feet between Jackson Boulevard to the west and Joseph Place to the east. This cost estimate also doesn't include the cost of procuring the Muscle Wall which could vary between $3.2M and $4.4M depending upon the final lengths of the higher 8-foot-high Muscle Wall that is better suited for the City's needs than the shorter 4-foot-high Muscle Wall. Greater utilization of 8-foot-high Muscle Wall versus the shorter 4-foot-high Muscle Wall will greatly reduce the cost of having to raise or modify the City's existing paved streets and associated drainage along the flood fight access road alignment. The

incremental costs of procuring the different heights and lengths of Muscle are summarized below:

Range of Procurement Costs for Muscle Wall							
Muscle Wall Heights, Lengths and Associated Costs per Figure 5-18					Muscle Wall Heights, Lengths and Associated Costs to Minimize City Street and Drainage Modifications		
Height (ft.)	Length (ft.)	$/ft.	Total Costs		Height (ft.)	Length (ft.)	$/ft.	Total Costs
4	3,600	$175	$630,000		4	1,000	$175	$175,000
6	200	$390.50	$78,100		-	-	-	-
8	4,100	$606	$2,484,610		8	7,000	$606	$4,242,000
Totals	7,900		$3,192,700		Totals	8,000		$4,417,000

6.2.4 Repair and Strengthen-in-Place SPFC Levee along the Left Bank of the Sacramento River (NULE Segment 378) (MA 4)

Cost estimates to repair and strengthen the levee immediately fronting the community of Isleton (MA 4A) were developed for both the cutoff wall and berm alternatives previously provided in Section 5.1.2.1. Assuming that the levee adjacent to the community (between the Isleton Bridge and the westerly downstream end of the city limits) totals 1.6 miles in length, the cost to repair this segment of levee ranges from $22,167,000 (30-foot-deep cutoff wall) to $23,052,000 (65-foot-wide, 9-foot-tall combination berm) (or $13.8 to $14.3M per mile). Both remedial alternatives include a 0.5-foot levee raise for 500 feet to address geometry deficiencies. However, it is expected that a cutoff wall would be implemented along this segment of levee to reduce physical impacts associated with a stability berm that would displace structures within the community located on and/or directly adjacent to the landward toe of the existing levee system.

In comparison, as detailed in the 2011 RACER for the North NULE study area, DWR estimated a low total cost of only $49,096,000 to $51,896,000 to remediate the entirety of NULE Segment 378 (extending a total 11.6 miles, between RD 556 and Threemile Slough, including an additional 1.4 miles south of the study area, south of West Brannan Island Road). The noted NULE RACER estimate of 2011, when escalated to July 2020 dollars equates to $61,921,000 to $65,453,000, or $5.35M to $5.65M per mile. When applying the DWR NULE Segment 378 costs developed by DWR in 2011 and escalated to July 2020 dollars, the 1.6 miles of levee remediation adjacent to the community would only range between $8,560,000 to $9,040,000. This latter estimate is less than 40 percent of the current estimate developed by the project study team that incorporates updated geotechnical data. Further description of the development of these sets of cost estimates can be found in Appendix F.

The range of cost estimates for MAs 4B, 4C, and 4D are adapted from the 2011 RACER. As described above, remediation of the levee along the left bank of the Sacramento River NULE Segment 368 within the Isleton study area (excluding the 1.6-mile-long sub-reach of 4A) is

estimated to cost $5.35M to $5.65M per mile based on the remediations proposed in the RACER and escalated to July 2020 dollars. As such, the range of costs for MAs 4B, 4C, and 4D (for 8.6 miles of levees) range between $46,010,000 and $48,590,000. These costs, along with the estimated range of costs for MA 4A, are provided in Table 6-3 below. Further description of the development of cost estimates for MA 4 are further described in Appendix F.

Note that the assessment performed for the 1.6-mile-long stretch of levee along the Sacramento River adjacent to the community of Isleton (MA 4A), which incorporated new data collected from the CPTs collected in September of 2020, indicates that there may be potential vulnerabilities to underseepage and through seepage along the entirety of the reach. In contrast, DWR's evaluation of the entirety of NULE Segment 378 along the left bank of the Sacramento River as documented in the RACER did not indicate any vulnerabilities to underseepage, and only 30 percent of the reach was estimated to be vulnerable to through seepage. Since DWR's proposed remediations based on this evaluation were used to develop cost estimates for MAs 4B-4D, the costs per mile for these MAs are consequently lower than the cost per mile for MA 4A. If levee mitigation needs for this study area progress to subsequent study or design, additional subsurface exploration and analysis will be necessary to refine the understanding of the levee and foundation conditions and repair requirements.

Table 6-3. Estimated Range of Costs for Management Action 4 - Repair and Strengthen-in-Place 10.2 Miles of Sacramento River Left Bank SPFC Levee Segments

Management Action (MA)	Estimated Cost
MA 4A: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Left Bank of the Sacramento River Adjacent to Isleton *(See Table 6-1 for NULE Segment 378-A levee station 1975+00 thru 2060+00)*	$22,167,000–$23,052,000 ($13.8M–$14.3M per mile)
MA 4B: Repair and Strengthen-in-Place 4.2 Miles of Levee along the Left Bank of the Sacramento River Between the Westerly Boundary of the Community of Isleton and Highway 12	$22,470,000–$23,730,000 ($5.35M–$5.65M per mile)
MA 4C: Repair and Strengthen-in-Place 2.4 Miles of Levee along the Left Bank of the Sacramento River Between Highway 12 and West Brannan Island Road	$12,840,000–$13,560,000 ($5.35M–$5.65M per mile)
MA 4D: Repair and Strengthen-in-Place 2.0 Miles of Levee along the Left Bank of the Sacramento River Between the Easterly Boundary of the Community of Isleton and the RD 556 Cross Levee	$10,700,000–$11,300,000 ($5.35M–$5.65M per mile)
Total	**$68,177,000 – $71,642,000**

Source for MAs 4B through 4D`: URS, 2011b

6.2.5 Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) (MA 5)

Cost estimates to repair and strengthen the Georgiana Slough levee opposite the community of Isleton were developed for both the cutoff wall and berm alternatives previously provided in Section 5.1.2.2. The total cost to remediate the entire 1.9 miles of levee between the potential cross levee alignment north of Fertile Acres and the potential cross levee alignment at Jackson

Slough Road and Terminous Road (MA 5C) ranges from $28,310,000 (70-foot-wide, 13-foot-tall combination berm) to $33,630,000 (75-foot-deep cutoff wall) (or $14.9M to $17.7M per mile). Both remedial alternatives include a 1.5-foot levee raise to address geometry deficiencies. However, it is expected that a cutoff wall would be implemented along this segment of levee to reduce physical impacts associated with a stability berm that would displace structures and the City's wastewater ponds that are located directly adjacent to the landward toe of the existing levee system.

In comparison, as detailed in the 2011 RACER for the North NULE study area, DWR estimated a total cost of $56,434,000 to $84,910,000 to remediate the entirety of NULE Segment 40 (6.0 miles) in the Isleton study area, which equates to $71,176,000 to $107,091,000 when escalated to July 2020 dollars (or $11.8M to $17.8M per mile). With an estimated length of 1.9 miles, DWR's estimated cost for MA 5C equates to $22,456,000 to $33,786,000. Further description of the development of this cost estimate can be found in Appendix F.

Using the per mile cost of $14.9M to $17.7M per mile, the estimated cost to remediate the 1.6 miles of levee between the potential cross levee alignment north of Fertile Acres and the potential Isleton/Oxbow Marina cross levee alignment (MA 5B) ranges from $23,840,000 (70-foot-wide, 13-foot-tall combination berm) to $28,320,000 (75-foot-deep cutoff wall). Similarly, the estimated cost to remediate the 0.9 mile of levee between the potential cross levee alignment north of Fertile Acres and 450 feet downstream of the Isleton sewer ponds (MA 5A) ranges from $13,410,000 (70-foot-wide, 13-foot-tall combination berm) to $15,930,000 (75-foot-deep cutoff wall).

The range of cost estimates for MAs 5D and 5E are adapted from the 2011 RACER. As described above, remediation of the entire 6.0 miles of levee along the right bank of Georgiana Slough within the Isleton study area (NULE Segment 40) is estimated to cost $11.8M to $17.8M per mile based on the remediations proposed in the RACER and escalated to July 2020 dollars. As such, MA 5D at 1.9 miles is estimated at $33,786,000 and MA 5E at 2.2 miles is estimated at $39,120,000. These costs, along with the estimated range of costs for MA 5A-5C, are provided in Table 6-4 below. Further description of the development of cost estimates for MA 5 are further described in Appendix F.

Table 6-4. Estimated Range of Costs for Management Action 5 - Repair and Strengthen-in-Place Georgina Slough Right Bank SPFC Levee

Management Action (MA)	Estimated Cost
MA 5A: 5A: Repair and Strengthen-in-Place 0.90 mile of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and 450 feet Downstream of the Isleton Sewer Ponds *(See Table 6-1 NULE Segment 40A levee stations 1100+00 thru 1220+00)*	$13,410,000 - $15,930,000 ($14.9M to $17.7M per mile)
MA 5B: Repair and Strengthen-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Potential Isleton - Oxbow Marina Cross Levee Alignment *(See Table 6-1 NULE Segment 40A levee stations 1100+00 thru 1220+00)*	$23,840,000 - $28,320,000 ($14.9M to $17.7M per mile)

Management Action (MA)	Estimated Cost
MA 5C: Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Potential Cross Levee Alignment at Jackson Slough and Terminous Road *(Inclusive of 5A and 5B above, and see Table 6-1 NULE Segment 40A levee stations 1100+00 thru 1220+00)*	$28,310,000 - $33,630,000 ($14.9M to $17.7M per mile)
MA 5D: Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment at Jackson Slough and Terminous Road and the Mokelumne River	$22,456,000 - $33,786,000 ($11.8M - $17.8M per mile)
MA 5E: Repair and Strengthen-in-Place 2.2 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the RD 556 Cross Levee	$26,002,000 - $39,120,000 ($11.8M - $17.8M per mile)
Total	**$76,721,000 - $106,490,000**

6.2.6 Cross Levee System(s) for the City of Isleton (MA 6)

The estimated costs of the cross levee systems described in Sections **5.1.2.4** through **5.1.2.6** is the summation of all the costs associated with: (1) repairing and strengthening the 1.4 miles of levee along the left bank of the Sacramento River; (2) repairing and strengthening the various segments of levee along the right bank of Georgiana Slough associated with each of the cross levee systems; and (3) constructing the potential cross levees northeast and southwest of the community of Isleton. These cost components and the associated costs of MAs 6A through 6C are summarized in

Table 6-5 below.

Table 6-5. Estimated Range of Costs for Management Actions 6A-6C – Potential Cross Levee Systems for Isleton

Cost Component	Estimated Cost
MA 6A: Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP	
1. Repair and Strengthen-in-Place 1.4 Miles of Levee along the Left Bank of the Sacramento River (MA 4A) *from Tables 6-1 and 6-3*	$19,320,000 (cutoff wall) - $20,020,000 (berm)
2. Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough (MA 5C) *from Tables 6-1 and 6-4*	$28,310,000 (berm) - $33,630,000 (cutoff wall)
3. Cross Levee North of Fertile Acres *(see Appendix F)*	$15,950,000
4. Cross Levee at Jackson Slough Road and Terminous Road *(see Appendix F)*	$43,660,000
5. FEMA Certification (5% of items 1-4 above)	$5,362,000 (berm) - $5,663,000 (cutoff wall)

Cost Component	Estimated Cost
Total	$112,602,000 (berm) - $118,923,000 (cutoff wall)
MA 6B: Cross Levee System with Isleton - Oxbow Marina Cross Levee with Potential Future Multi-Objective Setback Levee at Oxbow Marina (excludes cost of potential setback levee of rerouting mainstem of Georgiana Slough northwest of Oxbow Marina)	
1. Repair and Strengthen-in-Place 1.4 Miles of Levee along the Left Bank of the Sacramento River (MA 4A) *from Tables 6-1 and 6-3*	$19,320,000 (cutoff wall) - $20,020,000 (berm)
2. Repair and Strengthen-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough (MA 5B) *from Tables 6-1 and 6-4*	$23,801,000 (berm) - $28,320,000 (cutoff wall)
3. Cross Levee North of Fertile Acres *(see Appendix F)*	$15,950,000
4. Isleton/Oxbow Marina Cross Levee *(see Appendix F)*	$39,460,000
5. FEMA Certification (5% of items 1-5 above)	$4,928,000 (berm) - $5,188,000 (cutoff Wall)
Total	$103,498,000 (berm) - $108,938,000 (cutoff wall)
MA 6C: Isleton Sphere of Influence Cross Levee System	
1. Repair and Strengthen-in-Place 1.75 Miles of Levee along the Left Bank of the Sacramento River *from Tables 6-1 and 6-3*	$24,150,000 (cutoff wall) - $25,025,000 (berm)
2. Repair and Strengthen-in-Place 2.3 Miles of Levee along the Right Bank of Georgiana Slough *from Tables 6-1 and 6-4*	$34,270,000 (berm) - $40,710,000 (cutoff wall)
3. Cross Levee North of Isleton Bridge *(see Appendix F)*	$16,260,000
4. Cross Levee at Jackson Slough Road and Terminous Road *(see Appendix F)*	$43,660,000
5. FEMA Certification (5% of items 1-4 above)	$5,917,000 (berm) - $6,283,000 (cutoff wall)
Total	$124,257,000 (berm) - $131,938,000 (cutoff wall)

6.2.7 Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the Mokelumne River (NULE Segment 1050) (MA 7)

As detailed in the 2011 RACER for the North NULE study area, DWR estimated a total cost of $28,051,000 to $40,341,000 to remediate the entirety of NULE Segment 1050 (2.9 miles), which equates to $35,379,000 to $50,879,000 (or $12.2M to $17.5M per mile) when escalated to July 2020 dollars. Further description of the development of this cost estimate can be found in Appendix F.

6.2.8 Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the San Joaquin River (NULE Segment 1049) (MA 8)

As detailed in the 2011 RACER for the North NULE study area, DWR estimated a total cost of $29,751,000 to $58,228,000 to remediate the entirety of NULE Segment 1049 (2.6 miles), which equates to $37,523,000 to $73,439,000 (or $14.4M to $28.2M per mile) when escalated to July 2020 dollars. Further description of the development of this cost estimate can be found in Appendix F.

6.2.9 Repair and Strengthen-in-Place 1.35 Miles of Non-SPFC Levee along the Left Bank of Sevenmile Slough (NULE Segment 1048) East of Jackson Slough and Certify Sevenmile Slough Closure Structures (MA 9)

As detailed in the 2011 RACER for the North NULE study area, DWR estimated a total cost of $75,585,000 to $115,147,000 to remediate the entirety of NULE Segment 1048 (4.6 miles), which equates to $95,330,000 to $145,226,000 when escalated to July 2020 dollars (or $20.9 to $31.8M per mile). With a length of 1.35 miles, MA 9 is estimated to range in cost from $28,166,000 to $42,908,000. The two closure structures west of Jackson Slough are estimated at $5M each for an additional $10M.

6.2.10 Highway 12 Cross Levee (MA 10)

The estimated cost to raise and improve Highway 12 as a cross levee is $192,970,000. Further description of the development of this cost estimate can be found in Appendix F.

6.2.11 Secure 100-Year FEMA Certification for the Community of Isleton with a Highway 12 Cross Levee Paired with Perimeter Levee Improvements North of Highway 12 (MA 11)

The cost of securing 100-year FEMA certification for the portion of BALMD north of Highway 12 inclusive of the community of Isleton is the summation of all the costs associated with:

(1) Repairing and strengthening the 7.9 miles of levee along the left bank of the Sacramento River between Highway 12 and the RD 556 cross levee to current FEMA engineering certification standards outlined above in Section 5.1.2.8

(2) Repairing and strengthening the 6.0 miles of levee along the right bank of the Georgiana Slough between Highway 12 and the RD 556 cross levee to current FEMA engineering certification standards outlined above in Section 5.1.2.8

(3) Repairing and strengthening the 0.3 miles of levee along the right bank of the Mokelumne River between the confluence with Georgiana Slough and Highway 12 to current FEMA engineering certification standards outlined above in Section 5.1.2.8

(4) Raising and repairing/strengthening the 0.45-mile-long RD 556 cross levee to current FEMA engineering certification standards outlined above in Section 5.1.2.8

(5) Repairing DWR FSRP serious stability (2 in total) and erosion (1 in total) sites

(6) Constructing a new cross levee by raising and improving Highway 12

(7) Addressing any reaches that contain an immediate freeboard issue (currently none) or potential long-term settlement issues (none presently identified), as outlined above in Section 5.1.2.8, consistent with FEMA design criteria specified in 44 CFR §65.10

(8) Correcting all encroachments (closures, pipelines, and structures) within and/or adjacent to the entirety of the perimeter levee system that pose a threat to the structural and/or operational integrity of the levee system, as outlined above in Section 5.1.2.8, consistent FEMA design criteria specified in 44 CFR §65.10

(9) Conducting the applicable interior drainage studies and operational plans as outlined above in Section 5.1.2.8, consistent FEMA design criteria specified in 44 CFR §65.10

(10) Updating applicable operation and maintenance plans following all repairs and improvements and modifications to ensure the segments of levee along the left bank of the Sacramento River and the right bank of Georgiana Slough are operated and maintained by BALMD in accordance with FEMA, USACE, and CVFPB standards

Note that for items (1) and (2) above, remediations developed as part of this feasibility study were used to develop cost estimates for the shorter sub-reaches of levee along the left bank of the Sacramento River and the right bank of Georgiana Slough (1.6 and 2.3 miles, respectively); costs to remediate the remainder of the levees were developed using remediations from the RACER. For cost estimating purposes, FEMA certification items (7) through (10) noted herein and outlined in more detail within Section 5.1.2.8 are estimated at 5 percent of the total combined cost of items (1) through (6) herein associated with repairing and strengthening the segments of levee within BALMD north of Highway 12, repairing the three DWR FSRP sites north of Highway 12 within BALMD, and constructing a new cross levee along Highway 12. The estimated cost to secure 100-year FEMA certification for the community of Isleton and the portion of BALMD north of Highway 12 ranges from $354,609,000 to $390,923,000 as summarized below in Table 6-6.

Table 6-6. Estimated Range of Costs for 100-Year FEMA Certification for the Portion of BALMD North of State Highway 12

Cost Component	Estimated Cost
1. Repair and Strengthen-in-Place 7.8 Miles of Levee along the Left Bank of the Sacramento River *(See Table 6-3)*	$55,337,000–$58,082,000
2. Repair and Strengthen-in-Place 6.0 Miles of Levee along the Right Bank of Georgiana Slough *(See Table 6-4)*	$76,768,000 - $106,536,000
3. Repair and Strengthen-in-Place 0.3 Miles of Levee along the Right Bank of the Mokelumne River *(See Section 6.2.7)*	$3,660,000–$5,266,000

Cost Component	Estimated Cost
4. Raise and Repair/Strengthen-in-Place RD 556 Cross Levee (0.45 miles – *See Table 6-1)*	$7,191,000–$7,660,000
5. Repair Three DWR FSRP Serious Erosion and Stability Sites *(See Table 6-2)*	$1,797,000
6. Construct a New Cross Levee Along Highway 12 *(Appendix F)*	$192,970,000
7. FEMA Certification (5% of items 1-6 above)	$16,886,000–$18,615,000
Total	$354,609,000–$390,923,000

6.2.12 Secure 100-Year FEMA Certification for the Entire Study Area inclusive of the Community of Isleton (MA 12)

The cost of securing 100-year FEMA certification for the entire study area, inclusive of the community of Isleton, is the summation of all the costs associated with:

(1) Repairing and strengthening the entirety of the perimeter levees (SPFC and non-SPFC levees) to current FEMA standards

(2) Repairing the 6 DWR FSRP critical and serious sites that are not presently authorized for repair located on the right bank of the Mokelumne and San Joaquin rivers and Georgiana Slough and on the left bank of the Sacramento River

(3) Addressing any reaches that contain an immediate freeboard issue (none) or long-term settlement issues (unknown), as outlined above in Section 5.1.2.8, consistent FEMA design criteria specified in 44 CFR §65.10S

(4) Correcting all encroachments (closures, pipelines, and structures) within and/or adjacent to the entirety of the perimeter levee system that pose a threat to the structural and/or operational integrity of the levee system as outlined above in Section 5.1.2.8, consistent FEMA design criteria specified in 44 CFR §65.10

(5) Conducting the applicable interior drainage studies and operational plans as outlined above in Section 5.1.2.8, consistent FEMA design criteria specified in 44 CFR §65.10

(6) Updating applicable operation and maintenance plans following all repairs and improvements and modifications to ensure the entirety of the perimeter levee system is operated and maintained by BALMD in accordance with FEMA, USACE, and CVFPB standards

Note that for item (1) above, remediations developed as part of this feasibility study were used to develop cost estimates for the shorter sub-reaches of levee along the left bank of the Sacramento River and the right bank of Georgiana Slough (1.6 and 2.3 miles, respectively); costs to remediate the remainder of the levees were developed using remediations from the RACER. For cost estimating purposes, FEMA certification items (3) through (6) noted herein and outlined in more detail within Section 5.1.2.8 are estimated at 5 percent of items (1) and (2) herein

associated with repairing and strengthening the entirety of the perimeter levee system and repairing the DWR FSRP critical and serious sites within BALMD that are not currently authorized for repair. The estimated cost to secure 100-year FEMA certification for the community of Isleton and the larger study area ranges from $282,655,000 to $387,508,000 as summarized below in Table 6-7.

Table 6-7. Estimated Range of Costs for 100-Year FEMA Certification for the Entire Study Area, Inclusive of the Community of Isleton

Cost Component	Estimated Cost
1. Repair and Strengthen-in-Place 10.2 Miles of Levee along the Left Bank of the Sacramento River *(See Table 6-3)*	$68,177,000 – $71,642,000
2. Repair and Strengthen-in-Place 6.0 Miles of Levee along the Right Bank of Georgiana Slough *(See Table 6-4)*	$76,768,000 - $106,536,000
3. Repair and Strengthen-in-Place 2.9 Miles of Levee along the Right Bank of the Mokelumne River *(See Section 6.27)*	$35,379,000–$50,879,000
4. Repair and Strengthen-in-Place 2.6 Miles of Levee along the Right Bank of the San Joaquin River *(See Section 6.28)*	$37,523,000–$73,439,000
5. Repair and Strengthen-in-Place 1.35 Miles of Levee along the Left Bank of Sevenmile Slough and Certify Drainage Structures *(including $10M for drainage closure structures – See Section 6.2.9)*	$38,166,000–$52,908,000
6. Raise and Repair/Strengthen-in-Place RD 556 Cross Levee *(0.45 mile - See Table 6-1)*	$7,191,000–$7,660,000
7. Repair Six DWR FSRP Critical and Serious Sites *(See Table 6-2)*	$5,991,000
8. FEMA Certification (5% of items 1-7 above)	$13,460,000–$18,453,000
Total	$282,655,000–$387,508,000

6.2.13 Capital Cost Summary

Table 6-8. Estimated Range of Costs for Management Actions 1-12 Including FEMA Certification

Management Action	**Strengthen-in-Place Levee Repairs**	**Cross Levees or All-Weather Access Road/Flood Fight Berm**	**FEMA Certification**	**Total**
1: Repair DWR FSRP Critical and Serious Sites	$6.0M	**--**	**--**	$6.0M
1A: *Repair Two DWR FSRP Critical Stability Sites on the Right Banks of the Mokelumne and San Joaquin Rivers*	*$3.7M*	--	--	*$3.7M*
1B: *Repair DWR FSRP Serious Erosion Site on the Left Bank of the Sacramento River*	*$1.3M*	--	--	*$1.3M*
1C: *Repair Two DWR FSRP Serious Stability Sites on the Right Bank of Georgiana Slough and One Serious Seepage Site on the Right Bank of the Mokelumne River*	*$1.0M*	--	--	*$1.0M*
2: Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Potential Relief Cut along Georgiana Slough in RD 556	$7.2M-$7.7M	--	--	$7.2M-$7.7M
3: All-Weather Flood Fight Access Road for the Community of Isleton (excluding $3.2M to $4.4M to procure 8,000 ft. of Muscle Wall)	--	$5.9M	--	$5.9M
4: Repair and Strengthen-in-Place SPFC Levee along the Left Bank of the Sacramento River (NULE Segment 378) – 10.2 miles	$68.2M-$71.7M ($6.7M-$7.0M/mile)	**--**	**--**	$68.2M-$71.7M ($6.7M-$7.0M/mile)
4A: *Repair and Strengthen-in-Place 1.6 Miles of Levee along the Left Bank of the Sacramento River Adjacent to Isleton*	*$22.2M-$23.1M*	--	--	*$22.2M-$23.1M*
4B: *Repair and Strengthen-in-Place 4.2 Miles of Levee along the Left Bank of the Sacramento River Between the Westerly Boundary of the Community of Isleton and Highway 12*	*$22.5M-$23.7M*	--	--	*$22.5M-$23.7M*
4C: *Repair and Strengthen-in-Place 2.4 Miles of Levee along the Left Bank of the Sacramento River Between Highway 12 and West Brannan Island Road*	*$12.8M-$13.6M*	--	--	*$12.8M-$13.6M*
4D: *Repair and Strengthen-in-Place 2.0 Miles of Levee along the Left Bank of the Sacramento River Between the Easterly Boundary of the Community of Isleton and the RD 556 Cross Levee*	*$10.7M-$11.3M*	--	--	*$10.7M-$11.3M*

Management Action	**Strengthen-in-Place Levee Repairs**	**Cross Levees or All-Weather Access Road/Flood Fight Berm**	**FEMA Certification**	**Total**
5: Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) – 6.0 miles	$76.7M-$106.5M ($12.8M - 17.8M/mile)			$76.7M-$106.5M ($12.8M - 17.8M/mile)
5A: *Repair and Strengthen-in-Place 0.90 miles of Levee along the Right Bank of Georgiana Slough Between the potential Cross Levee Alignment North of Fertile Acres and 450 feet Downstream of the Isleton Sewer Ponds*	*$13.4M-$15.9M*	--	--	*$13.4M-$15.9M*
5B: *Repair and Strengthen-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Isleton/Oxbow Marina Cross Levee*	*$23.8M-$28.3M*	--	--	*$23.8M-$28.3M*
5C: *Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the Potential Cross Levee Alignment at Jackson Slough Road and Terminous Road* ***(includes 5A and 5B)***	*$28.3M-$33.6M*	--	--	*$28.3M-$33.6M*
5D: *Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment at Jackson Slough Road and Terminous Road and the Mokelumne River*	*$22.4M-$33.8M*	--	--	*$22.4M-$33.8M*
5E: *Repair and Strengthen-in-Place 2.2 Miles of Levee along the Right Bank of Georgiana Slough Between the Potential Cross Levee Alignment North of Fertile Acres and the existing RD 556 Cross Levee*	*$26.0M-$39.1M*	--	--	*$26.0M-$39.1M*
6: Potential Cross Levee System(s) for the City of Isleton				
6A: *Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP*	$47.6M-$53.6M	$59.6M	$5.4M - $5.7M	$112.6M - $118.9M
6B: *Isleton – Oxbow Marina Cross Levee System with Future Optional Multi-Objective Setback Levee at Oxbow Marina (excludes cost of potential future multi-objective component of*	$43.2M-$48.3M	$55.4M	$4.9M - $5.2M	$103.5M - $108.9M

Management Action	**Strengthen-in-Place Levee Repairs**	**Cross Levees or All-Weather Access Road/Flood Fight Berm**	**FEMA Certification**	**Total**
rerouting mainstem of Georgiana Slough northwest of Oxbow Marina				
6C: *Isleton Sphere of Influence Cross Levee System*	$58.4M-$65.7M	$59.9M	$5.9M - $6.3M	$124.3M - $131.9M
7: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the Mokelumne River (NULE Segment 1050) – 2.9 miles	$35.4M-$50.9M ($12.2M-$17.5M/mile)	--	--	$35.4M-$50.9M ($12.2M-$17.5M/mile)
8: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the San Joaquin River (NULE Segment 1049) – 2.6 miles	$37.5M-$73.4M ($14.4M - $28.2M/mile)	--	--	$37.5M-$73.4M ($14.4M-$28.2M/mile)
9: Repair and Strengthen-in-Place 1.35 Miles of Non-SPFC Levee along the Left Bank of Sevenmile Slough (NULE Segment 1048) East of Jackson Slough and Certify Sevenmile Slough Closure Structures (including $10M for two drainage closure structures @ $5M each)	$38.2M-$52.9M ($20.9M - $31.8M/mile)	--	--	$28.2M-$42.9M ($20.9M - $31.8M/mile)
10: State Highway 12 Cross Levee	--	$193M	--	$193M
11: Secure 100-Year FEMA Certification for the Community of Isleton with a Highway 12 Cross Levee Paired with 14.55 miles of Perimeter Levee Improvements North of Highway 12	$143.4M -$178.0M	$193M	$16.8M - $18.5M	$353.2M - $389.5M
12: Secure 100-Year FEMA Certification for the Entire BALMD Study Area inclusive of the Community of Isleton – 23.5 miles	$269.2M -$369.1M	--	$13.5M - $18.4M	$282.7M - $387.5M

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6.3 Trade-Off Analysis of Structural-Related Flood Risk Reduction Management Actions

MAs were compared in a trade-off analysis against the study goal of obtaining 100-year flood protection for the Isleton study area and against the objectives described in Section 4. Other considerations, such as agricultural sustainability, local support, cost, cultural resources, ecosystem, and consistency with existing Delta regulations and policies were also used to compare each of the MAs. The trade-off analyses also incorporate the net reduction in EAD values determined for most structural-based MAs, including net EAD reductions for implementing an all-weather access road/flood fight berm.

6.3.1 Planning Objectives

6.3.1.1 Reducing Risk to Life

A breach within the levee fronting the community could contain high instantaneous floodwater velocities and depths of imminent danger within the community that would most likely result in life loss in Isleton. MAs 4A, 6, 11, and 12 are the only MAs which fortify the levee fronting the community to current FEMA engineering accreditation standards. As a result, these MAs would result in the greatest measurable reduction in life loss.

A levee breach along the Sacramento River downstream of the community of Isleton also has the potential to result in life loss; thus, those MAs which fortify this segment of levee or protect the community against floodwaters resulting from a levee breach along this downstream segment of levee will result in the next greatest measurable reduction in life loss (MAs 4B, 4C, and 10). Other MAs which result in a moderate reduction in life loss include MAs 1, 2, 3, and 5A-5D.

MAs with the lowest reduction in life loss are those that repair and strengthen the left bank of the Sacramento River upstream of the community (MA 4D), the most northerly portion of the right bank of Georgiana Slough levee (MA 5E), the right banks of the Mokelumne and San Joaquin rivers (MAs 7 and 8) and the north or left bank of Sevenmile Slough (MA 9). Considering the no action condition, a levee failure along any of these levee segments is not likely to result in significant life loss to the community since the inundation time to 1 foot in the community of Isleton, as a result of a levee failure on any of these levee reaches, is estimated to be upwards of 200 hours. While fortifying these levees would reduce the probability of flooding, it is expected that inundation to 1 foot in 200 hours is sufficient to avoid life loss in the community and a net reduction in life loss is not expected.

6.3.1.2 Reducing Risk to Property Damage

As previously discussed, EAD represents the annualized expected damages through the consideration of potential flooding conditions and is one of the primary drivers for flood management funding within the Delta and the greater area within the CVFPP planning area. EAD includes potential flood damages to structures, structure contents, land improvements,

adjoining crops, regional infrastructure, and vehicles. Reduction in EAD is a common metric used to evaluate flood risk reduction measures and is used in this feasibility study to evaluate how well each MA meets the objective of reducing risk to property damage. Further details on the EAD analysis performed as part of this study are provided in Appendix E-1 – Expected Annual Damages Technical Memorandum, prepared by HDR Inc., dated August 31, 2021.

As shown previously in Table 3-7, baseline (or without project) EAD for the Isleton study area under existing and future conditions (with climate change adjustments) is estimated at $20.2 and $83.6M, respectively with Georgiana Slough currently presenting a greater risk to flooding than the Sacramento River. Existing without project conditions represent the current level of flood protection within the study area and does not incorporate any new structural or any new proposed non-structural flood risk reduction elements. Future without project conditions represent the current level of flood protection within the study area, does not incorporate any structural or non-structural flood risk reduction elements, and incorporates expected changes to the study area from climate change, sea level rise, and future land uses. Table 6-9 and Table 6-10 below provide the estimated net reduction in EAD to the Isleton study area as a result of implementing MAs 1, 3, 6, 11, and 12 under existing and future conditions, respectively. The net reduction in EAD in each table is formulated by subtracting the estimated EAD value for each impact area, which is estimated assuming a fractional, partial, or full improvement, from the baseline (or without project) EAD. The pay-back period in years (excluding interest) is then calculated using the estimated cost of each MA as well as benefit-cost ratios for the noted MAs.

Overall, the greatest reduction in EAD for the Isleton study area is provided by MA 12 that would secure 100-year FEMA certification for the perimeter BALMD levee system surrounding the entire project study area, inclusive of the entire community of Isleton. As shown in Table 6-9, implementing MA 12 would reduce EAD for the study area by approximately $19M under existing conditions. On an annualized basis, this represents an EAD of approximately $676,000 for the BALMD basin (less the community of Isleton) and an EAD of $367,000 for the community of Isleton. However, at a cost of up to nearly $390M, the flood risk reduction payback period is over 21 years (excluding interest), and there is small benefit-cost ratio of 1.3. Securing FEMA certification for the entire BALMD perimeter levee system under existing conditions results in a similar net reduction in EAD and payback period of 20 years, and a similar benefit-cost ratio of 1.4.

Repairing the five collective DWR FSRP sites within the Isleton study area (MAs 1A, through 1C) result in a very large incremental net reduction in EAD values. By repairing these sites, EAD in the community of Isleton is estimated at $677,000 under existing conditions, with EAD for the larger BALMD basin estimated at $1.3M under existing conditions, presenting a total net reduction to the study area of $18.2M. With an estimated cost of less than $6.0M, the flood risk reduction pay-back period for repairing the remaining DWR FSRP sites is less than a year and there is a very high benefit-cost ratio of 82.

The various proposed cross levee systems (MAs 6A-6C) also provide direct measurable value to the community of Isleton. MA 6 is estimated to result in a net reduction in EAD to the community of Isleton of over $6.0M under existing conditions. On an annualized basis, this represents an EAD of $367,000 for the community of Isleton; however, with an estimated cost of up to $132M, the flood risk reduction payback period for MA 6 could be up to 22 years with a benefit-cost ratio as low as 1.3 depending on the cross-levee system that is implemented. Notably, the proposed all-weather access road/flood fight berm (MA 3) provides significant value to the community of Isleton, with a net reduction in EAD of over $5.7M under existing conditions. On an annualized basis, this represents an EAD of $677,000 for the community of Isleton, and at an estimated cost of $5.9M, the flood risk reduction payback period is only 1 year and there is a very large benefit-cost ratio of 26.4 for the proposed all-weather access road/flood fight berm under existing conditions.

The discussion above regarding key MAs 1, 3, and 6 also applies under future conditions as shown in Table 6-10. The effects of climate change and sea level rise result in both an increase in the baseline EAD for the Isleton study area ($89M increased from just over $20M under existing conditions), and a greater benefit from each of the MAs as seen by the higher net reductions in EAD.

In general, when considering the estimated capital cost to construct or implement each MA, repairing the DWR FSRP serious and critical sites (MA 1) provides the largest incremental value to the community of Isleton and the larger study area. With the implementation of these MAs, the total net reduction in EAD for the Isleton study area is estimated at $18.2M under existing conditions and nearly four times greater at $65.2M under future conditions. Notably, as shown in Table 6-9 and Table 6-10, the all-weather access road/flood fight berm (at an estimated cost of $5.9M) provides large value to the community of Isleton as the EAD value in the community of Isleton is reduced to $0.67M under existing conditions and by more than ten-fold to $8.7M under future conditions. Additionally, the various proposed cross levee systems (with estimated costs ranging from $103 to $132M) are also estimated to provide the same EAD value to the community of Isleton as securing 100-year FEMA certification for the community either through a Highway 12 cross levee system (at an estimated cost of $391M) or repairing and strengthening-in-place the entire perimeter levee system (at an estimated cost of $388M). In these cases, EAD in the community of Isleton is reduced to the levels between $0.37M (existing conditions) and $6.7M (future conditions).

Due to five different SPFC and non-SPFC levee segments within the BALMD study area representing several different levels of flood protection from multiple sources of potential flooding the EAD calculations were limited to only a handful of MAs and were not conducted or budgeted for the non-SPFC levee segments. Thus, supporting data for conducting Expected Annual Damages (EAD) assessments and determining Benefit-Cost Ratios was not easily obtainable for the full suite of MAs 1 through MA 12. The EAD calculations, as presented in Tables 6-9 and 6-10 below, were limited to MAs 1, 3, 6A through 6C, 11, and 12, and did not include any EAD baseline or improved values for stand-alone non-SPFC levee segments.

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Table 6-9. Isleton Study Area EAD Values for Existing Conditions Consistent with the 2022 CVFPP Update

Scenarios for Select Management Actions	Estimated Cost[1]	Isleton SAC 54-Urban EAD	BALMD less Isleton SAC 54-N2 EAD	Total Net Reduction to Isleton Study Area	Flood Risk Reduction Pay Back Period in Years (excluding interest)	Benefit-Cost Ratio[2]
Baseline EAD, SAC 54-Urban (Community of Isleton): **$6,439,000** (1) Baseline EAD, SAC 54-N2 (entirety of BALMD less the community of Isleton): **$13,791,000** (1) Total Baseline EAD for the Isleton Study Area (SAC54-Urban & Sac 54-N2): **$20,230,000** (1) *						
Repair all 5 remaining DWR FSRP Sites in Isleton Project Area: **(MAs 1A, 1B, & 1C)** (3)	Combined Total Cost of MA 1: $5,991,000	$677,000	$1,334,000	$20,230,000 - $677,000 - $1,334,000 = $18,219,000	$5,991,000/$18,219,000 = 0.3 year	82.2
All-Weather Flood Fight Access Road for the City of Isleton **(MA 3),** excluding cost of Muscle Wall (3)	$5,898,000	$677,000	N/A	$6,439,000 - $677,000 = $5,762,000**	$5,898,000/$5,762,000 = 1.0 year	26.4
Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP **(MA 6A)** (4)	$112,602,000 - $118,923,000	$367,000	N/A	$6,439,000 - $367,000 = $6,073,000	$118,923,000/$6,073,000 = 19.6 years	1.4
Isleton – Oxbow Marina Cross Levee System with a Potential Future Setback Levee at Oxbow Marina **(MA 6B)** (4)	$103,498,000 - $108,938,000	$367,000	N/A	$6,439,000 - $367,000 = $6,073,000	$108,938,000/$6,073,000 = 17.9 years	1.5
Isleton Sphere of Influence Cross Levee System **(MA 6C)** (4)	$124,257,000 - $131,938,000	$367,000	N/A	$6,439,000 - $367,000 = $6,073,000	$131,938,000/$6,073,000 = 21.7 years	1.2
Secure 100-Year FEMA Certification for the Community of Isleton with an Elevated Highway 12 Cross Levee Paired with 14.6 Miles of Perimeter Levee Improvements North of Highway 12 **(MA 11)** (4)	$354,609,000 - $390,923,000	$367,000	$1,352,000***	$20,230,000 - $367,000 - $1,352,000 = $18,511,000	$390,923,000/$18,511,000 = 21.1 years (max.)	1.3 (min)
Secure 100-Year FEMA Certification for the Entire BALMD Study Area Inclusive of the Community of Isleton – 25 miles of Perimeter Levee Improvements **(MA 12)** (4)	$282,655,000 - $387,508,000	$367,000	$676,000	$20,230,000 - $367,000 - $676,000 = $19,187,000	$387,508,000/$19,187,000 = 21.5 years (max)	1.3 (min.)

Notes: Levee Performance Data Curve for EAD Values from Appendix E – Table 5: (1)Baseline w/o Improvements; (2)Fractional Improvements; (3)Partial Improvements; (4)Full FEMA Cert. Improvements
MA = Management Action

Values provided for SAC 54-Urban and SAC 54-N2 along with the total net reduction to the Isleton study area are representative of the maximum EAD values between the SAC 54 and SAC 54a index points (SAC 54 @ Georgiana Slough & SAC 54a @ Sacramento River, both upstream of Highway 160 Isleton Bridge)

[1] A range of estimated costs (low-high) are generally provided for each MA concurrent with the costs summarized in Table 6-8

[2] Benefit-Cost Ratio assuming a capital recovery factor of 0.037 (n=50 years, i=2.75%)

* Total baseline EAD for the Isleton study area does not include EAD for RD 556 – Tyler Island (SAC 54_N1)

** Net reduction in EAD to the Isleton study area for MA 3 - Access road/flood fight Berm could be as high as a partially improved condition for SAC 54-Urban

*** The area within the Brannan Andrus Levee Maintenance District north of State Route 12 represents about 50% of BALMD - SAC 54-N2, (excluding the Isleton Urban Area – SAC 54-Urban), and approximately 50% of the damages in SAC 54-N2; thus, this EAD value for the northern area of BALMD was interpolated (or essentially doubled) from $676,000 for all of BALMD to $1,352,000 for just reducing flood risks to the northern half of BALMD

N/A: Due to five different SPFC and non-SPFC levee segments within the BALMD study area representing several different levels of flood protection from multiple sources of potential flooding EAD calculations were limited to only a handful of MAs and were not conducted or budgeted for the non-SPFC levee segments. Thus, supporting data for conducting Expected Annual Damages (EAD) assessments and determining Benefit-Cost Ratios was not easily obtainable for the full suite of MAs 1 through MA 12.

Table 6-10. Isleton Study Area EAD Values for Future Conditions (with climate change adjustments) Consistent with the 2017 CVFPP Update

Scenarios for Select Management Actions	Estimated Cost	Isleton SAC 54-Urban EAD	BALMD less Isleton SAC 54-N2 EAD	Total Net Reduction to Isleton Study Area	Flood Risk Reduction Pay Back Period in Years (excluding interest)	Benefit-Cost Ratio
Future conditions Baseline EAD, SAC 54 - Urban (Community of Isleton): **$35,572,000**[(1)] Future conditions Baseline EAD, SAC 54 - N2 (entirety of BALMD less the community of Isleton): **$53,783,000** [(1)] Future conditions Total Baseline EAD for the Isleton Study Area (SAC54-Urban & Sac 54-N2): **$89,355,000** [(1)] *						
Repair all 5 remaining DWR FSRP Sites in Isleton Project Area: **(MAs 1A, 1B, & 1C)**[(3)]	Combined Total Cost of MA 1: $5,991,000	$8,655,000	$15,549,000	$89,355,000 - $8,655,000 - $15,549,000 = $65,151,000	$5,991,000/$65,151,000 = < 0.1 year	294
All-Weather Flood Fight Access Road for the City of Isleton **(MA 3)** [(3)]	$5,898,000	$8,655,000	N/A	$35,572,000 - $8,655,000 = $26,917,000**	$5,898,000/$26,917,000 = 0.2 year	163
Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP **(MA 6A)** [(4)]	$112,602,000 - $118,923,000	$6,706,000	N/A	$35,572,000 - $6,706,000 = $28,867,000	$118,923,000/$28,867,000 = 4.1 years	6.6
Isleton Oxbow Marina Cross Levee System with a Potential Future Setback Levee at Oxbow Marina **(MA 6B)** [(4)]	$103,498,000 - $108,938,000	$6,706,000	N/A	$35,572,000 - $6,706,000 = $28,867,000	$108,938,000/$28,867,000 = 3.8 years	7.2
Isleton Sphere of Influence Cross Levee System **(MA 6C)** [(4)]	$124,257,000 - $131,938,000	$6,706,000	N/A	$35,572,000 - $6,706,000 = $28,867,000	$131,938,000/$28,867,000 = 4.6 years	5.9
Secure 100-Year FEMA Certification for the Community of Isleton with an Elevated Highway 12 Cross Levee Paired with 14.6 Miles of Perimeter Levee Improvements North of Highway 12 **(MA 11)** [(4)]	$354,609,000 - $390,923,000	$6,706,000	$24,070,000***	$89,355,000 - $6,706,000 - $24,070,000 = $58,575,000	$390,923,000/$58,579,000 = 6.7 years (max.)	4.0 (min.)
Secure 100-Year FEMA Certification for the Entire BALMD Study Area Inclusive of the Community of Isleton – 25 miles of Perimeter Levee Improvements **(MA 12)** [(4)]	$282,655,000 - $387,508,000	$6,706,000	$12,035,000	$89,355,000 - $6,706,000 - $12,035,000 = $70,615,000	$387,508,000/$70,615,000 = 5.5 years (max.)	4.9 (min.)

Notes**:**

Levee Performance Data Curve for EAD Values from Appendix E – Table 6: (1) Future Baseline w/o Improvements; (2) Future Fractional Improvements; (3)Future Partial Improvements; (4)Future Full FEMA Cert. Improvements

Values provided for SAC 54-Urban and SAC 54-N2 along with the total net reduction to the Isleton study area are representative of the maximum EAD values between the SAC 54 and SAC 54a index points (SAC 54 @ Georgiana Slough & SAC 54a @ Sacramento River, both upstream of Highway 160 Isleton Bridge)

[1] A range of estimated costs (low-high) are generally provided for each MA concurrent with the costs summarized in Table 6-8

[2] Benefit-Cost Ratio assuming a capital recovery factor of 0.037 (n=50 years, i=2.75%)

* Total baseline EAD for the Isleton study area does not include EAD for RD 556 – Tyler Island (SAC 54_N1)

** Net reduction in EAD to the Isleton study area for MA 3 could be as high as a partially improved condition for SAC 54-Urban

*** The area within the Brannan Andrus Levee Maintenance District north of State Route 12 represents about 50% of BALMD - SAC 54-N2, (excluding the Isleton Urban Area – SAC 54-Urban), and approximately 50% of the damages in SAC 54-N2; thus, this EAD value for the northern area of BALMD was interpolated (or essentially doubled) from $12,035,000 for all of BALMD to $24,070,000 for just reducing flood risks to the northern half of BALMD

N/A: Due to five different SPFC and non-SPFC levee segments within the BALMD study area representing several different levels of flood protection from multiple sources of potential flooding EAD calculations were limited to only a handful of MAs and were not conducted or budgeted for the non-SPFC levee segments. Thus, supporting data for conducting Expected Annual Damages (EAD) assessments and determining Benefit-Cost Ratios was not easily obtainable for the full suite of MAs 1 through MA 12.

6.3.1.3 Reducing Probability of Levee Failure

MA 1 results in a high reduction in the probability of levee failure through the repair of the DWR FSRP critical and serious sites along the left bank of the Sacramento River and the right banks of Georgiana Slough and the Mokelumne and San Joaquin rivers. Repair of the DWR FSRP critical and serious seepage, stability, and erosion sites would significantly reduce the probability of levee failure along the aforementioned levee reaches since they are currently estimated by DWR to have a moderate to high likelihood of failure due to various vulnerabilities. As documented in the FSRP, it is estimated that repair of the critical and serious sites within BALMD would reduce the recurrence interval associated with each levee reach from 3 to 50 years.

MA 2 raises and repairs/strengthens the RD 556 cross levee at the northern boundary of the study area, upstream of Isleton. This levee is estimated to be vulnerable to through seepage and nearly 90 percent of the levee is levee is estimated to also have freeboard deficiencies. As a result, MA 2 also results in a high reduction in the probability of levee failure.

MA 3 integrates an all-weather flood fight access road and is a non-structural measure which does not modify or improve the existing levee/flood control system. As a result, MA 3 does not result in a net reduction in the probability of levee failure but does reduce the risk to flooding in the community of Isleton.

MAs 4A-4D repair and strengthen various segments of the left bank Sacramento River levee. This levee is currently estimated by DWR to have a moderate likelihood of failure due to vulnerabilities to slope stability, through seepage, and erosion. Consequently, MAs 4A-4D result in a moderate reduction in the probability of levee failure and would significantly reduce infiltration and inflow to the City's adjoining wastewater collection system

MAs 5A-5E repair and strengthen various segments of the right bank Georgiana Slough levee. This levee is currently estimated by DWR to have a high likelihood of failure due to vulnerabilities to underseepage, through seepage, and slope stability. Consequently, MAs 5A-5E result in a high reduction in the probability of levee failure and would significantly reduce infiltration and inflow to the City's adjoining wastewater ponds.

MAs 6A-6C include cross levee systems which incorporate repairing and strengthening a portion of levee along the left bank of the Sacramento River and various segments of levee along the right bank of Georgiana Slough. As discussed above, these levees are currently estimated by DWR to have a moderate (left bank Sacramento River) to high (right bank Georgiana Slough) likelihood of levee failure, and as a result, MAs 6A-6C result in a high reduction in the probability of levee failure and would significantly reduce collective infiltration and inflow into the City's wastewater collection system and wastewater ponds.

MAs 7, 8, and 9 repair and strengthen the right banks of the Mokelumne and San Joaquin rivers, and the left or north bank of Sevenmile Slough, respectively. These levees are currently estimated by DWR to have a moderate (San Joaquin River – MA 8) to high (Mokelumne River

and Sevenmile Slough – MAs 7 and 9) likelihood of failure. Repairing and strengthening these levees would thus result in a moderate (MA 8) to high (MAs 7 and 9) reduction in the probability of levee failure.

MA 10 includes a cross levee along Highway 12. MA 10 in itself does not modify or improve the existing levee/flood control system. As a result, MA 10 does not result in a net reduction in the probability of levee failure but does reduce the risk to flooding in the community of Isleton.

MA 11 includes a cross levee along Highway 12 and repairs and strengthens the SPFC and non-SPFC levees within the study area north of Highway 12. These levees are currently estimated by DWR to have a moderate to high likelihood of levee failure. As a result, MA 11 results in a high reduction in the probability of levee failure.

MA 12 includes repairing and strengthening all of the SPFC and non-SPFC levee reaches surrounding the community and entire study area and includes certification of the entire perimeter levee system to FEMA standards. The collection of improving the entire perimeter levee system and certifying said perimeter levee system would result in the highest reduction in the probability of levee failure of all MAs under consideration.

6.3.1.4 Reduction of High Insurance Premiums

Those MAs which result in 100-year FEMA certification could result in a net reduction in NFIP insurance premiums. MAs 6, 11, and 12 are the only solutions which result in 100-year FEMA certification. However, implementation of the structural elements and non-structural measures as part of the other MAs, in concert with a community- or risk-based insurance program, could also result in a net reduction in flood insurance premiums for the community. *Refer to* Section 5.2.7 and Appendix J for greater discussions and potential options for Isleton and other nearby Delta Legacy Communities to pursue community-based flood insurance programs, including the formation of a Delta Region Geological Hazard Abatement District (GHAD), adopted by the citizens of Isleton on March 29, 2022.

6.3.1.5 Enhancing Resiliency and Reliability of Through-Delta Water Conveyance

MAs 5, 11, and 12 would provide the greatest enhancement of the resiliency and reliability of through-Delta water conveyance by improving 6.0 miles of SPFC levees located along the right bank of Georgiana Slough within the study area, which equates to 24 percent of the non-urban SPFC levees located downstream of the Delta Cross Channel (total of 25 miles) and nearly 10 percent of the total 62 miles of non-urban SPFC levees downstream of Freeport which comprise the freshwater corridor in the North Delta. (*Refer* to Appendix K for further details on the value of improving the SPFC levees systems in the north and central Delta within the SWP and CVP freshwater conveyance corridor that consists of Georgiana Slough.) MA 5 associated with repairing and improving-in-place the right bank levees, and MA 11 which fortifies the right bank Georgiana Slough levees north of Highway 12 also enhances the resiliency and reliability of through-Delta water conveyance. MAs 6A-6C also enhance through-Delta water conveyance

but to a lesser degree. The remaining MAs do not improve the resiliency and reliability of through-Delta water conveyance.

6.3.1.6 Environmental Stewardship and Multi-Benefits

Under MAs 3 and 6, a recreation component could be implemented along with construction of the all-weather flood fight access road or a cut-off levee system, in the form of multi-use trails that would include signage and interpretive information for users regarding the rich history of the area and connect to the central portion of Isleton, which includes the old historic district. The multi-use trails could also be connected to or be a part of the Great California Delta Trail for the Central Delta as contemplated in the DPC's Great California Delta Trail Master Plan of January 20, 2022. For additional information on ecosystem restoration and recreation enhancements opportunities within the study area, particularly associated with MAs 3 and 6, please refer to Sections 5.3.2 and 5.3.3 and accompanying and accompanying Figures 5-19 through 5-21 for environmental multi-benefits that have been identified in connection with the noted MAs 3 and 6. MA 1B also has the potential to provide additional SRA habitat in connection with anticipated water side levee erosion repairs along the Sacramento left bank levee just north of State Highway 12.

6.3.2 Other Considerations

6.3.2.1 Agricultural Sustainability

Under MAs 2 through 4A, 5A-5C, and 6, agricultural sustainability (acreage) is likely to be affected along those segments of levee where seepage, stability, or combination berms could be deployed, since the berms could be as much as 70 feet wide, resulting in displacement of productive permanent crops (vineyards) and seasonal row or field crops. To minimize displacement of valuable agricultural land adjoining the community, it may be advantageous to install vertical cutoff walls in place of landward stability/or combination berms. A new cross levee system in (MA 6) would result in the greatest reduction of permanent vineyards and seasonal field/row crops of all MAs summarized in Table 6-11 below.

Table 6-11. Estimated Displaced Agricultural Acreage when Implementing MAs 1, 3-6, 11, and 12

Management Action	Estimated Displaced Agricultural Acreage: Remediation Alternative 1 (Cutoff Walls)	Estimated Displaced Agricultural Acreage: Remediation Alternative 2 (Seepage, Stability, or Combination Berms)
MA 2: Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Relief Cut along Georgiana Slough	0	1
MA 3: All-Weather Flood Fight Access Road for the City of Isleton	Less than 5 acres	

MA 4A: Repair and Strengthen-in-Place 1.4 Miles of SPFC Levee along the Left Bank of the Sacramento River Immediately Adjacent to Isleton	6	26
MA 5A: Repair and Strengthen-in-Place 0.9 Miles of SPFC Levee along the Right Bank of Georgiana Slough Between the Cross Levee North of Fertile Acres and 450 feet Downstream of the Isleton Sewer Ponds	3	15
MA 5B: Repair and Strengthen-in-Place 1.6 Miles of SPFC Levee along the Right Bank of Georgiana Slough Between the Cross Levee North of Fertile Acres and the Isleton/Oxbow Marina Cross Levee	5	27
MA 5C: Repair and Strengthen-in-Place 1.9 Miles of SPFC Levee along the Right Bank of Georgiana Slough Between the Cross Levee North of Fertile Acres and the Cross Levee at Jackson Slough Road and Terminous Road	6	32
MA 6: Cross Levee System(s) for the City of Isleton	Up to 13	Up to 67

6.3.2.2 Local Support

There is wide-spread support for executing Management Actions 1A, 1,B, and 1C associated with repairing known, and documented DWR FSR sites and document erosion sites that have not yet been authorized for repair. There is also significant support for implementing MA 3 associated with developing the flood fight access road around the edge of the city limits. In June of 1972 a formal flood fight road would have likely saved Isleton from flooding due to a levee breach that occurred along the San Joaquin River, south of State Highway 12. The cross levee configurations (MAs 6A through 6C) also have some support from the community, but less support exists from the nearby, adjoining agricultural community as the cross levees could displace between 13 to 67 acres of productive agricultural acreage as noted above in Table 6-11.

6.3.2.3 Cost

MA 1 (repair of the 6 critical and serious FSRP sites) is the lowest cost solution to reducing flood risk in the study area at nearly $6M. MA 3 (all-weather flood fight access road) and MA2 (raising and repairing/strengthening the RD 556 cross levee) are the next lowest cost solutions to reducing flood risks in the study area at nearly $5.9 and $7.7M, respectively. MA 4 (repairing various segments of levee along the left bank of the Sacramento River) and MA 5 (repairing various segments of levee along the right bank of Georgiana Slough) range in cost from $13M to $24M and from $13M to $39M, respectively. The various cross levee systems (MA 6) range in cost between $104 and $131M. Repairing and strengthening the non-SPFC levee segments along the Mokelumne and San Joaquin rivers and the most 1.35 easterly miles of Sevenmile Slough (MA 7-9) range in cost between $35.4 and $73.4M. The remaining MAs 10 through 12 are the highest cost solutions to reducing flood risk to the Isleton study area. MA 11 (a cross levee system along Highway 12 and all areas north in BALMD to the RD 556 cross levee east of

Isleton) is estimated at approximately $390M. MA 12 (securing FEMA certification for the entire study area) ranges in cost from $281M to $386M, depending on whether seepage/stability/combination berms or cutoff walls are implemented to address the vulnerabilities on each reach of levee.

6.3.2.4 Cultural Resource Considerations

Under all of the MAs, cultural resources could be affected, since installation of a cutoff wall and/or placement of riprap could disturb previously unknown archeological resources and repair/strengthen-in-place remediations (including a stability or combination berm up to 70 feet wide) may require grading or foundational work. However, built-environmental resources, such as historic buildings, on adjacent land would not be permanently affected. Additionally, under MAs 3, 6, 10, and 11, cultural resources could be affected by construction of the foundation of either the all-weather access road/flood fight berm or cross levee.

6.3.2.5 Ecosystem Considerations

Under Management Actions 1A and 1C, it is unlikely that biological resources would be affected for repairing the known FSRP seepage and stability repair since, since either cut-off walls or seepage/stability berms would be installed entirely within the existing levee prism and/or landward of the levee prism, which is fairly clear of vegetation, except for some isolated large trees along the waterward levee slopes. It is likely these repairs could be implemented if appropriate work window restrictions, monitoring, and species and habitat avoidance and mitigation measures are in place. Under Management Action 1B associated with addressing a waterside erosion site along the left bank levee of the Sacramento River within a mile upstream of State Highway 12 there is a chance that biological resources could be affected; however, if planned correctly similar to the erosion site repairs underway by BALMD, opportunities may exist for enhancing the waterside habitat including SRA habitat in connection repairing the erosion site associated with MA 1B. As previously stated in Section 5.3.2 SRA enhancements along the left bank of the Sacramento River could offer greater connectivity to the SRA opportunities previously outlined further upstream along the Sacramento River in the 2014 RFMP.

MAs 4, 5, and 7-9 associated with repairing and strengthening-in-place the existing SPFC and Non-SPFC levee systema are similar to MAs 1A and 1C where it is unlikely that biological resources would be affected since cut-off walls and/or seepage/stability berms would be installed entirely within the existing levee prism and/or landward of the levee prism. It is likely these repairs could be implemented if appropriate work window restrictions, monitoring, and species and habitat avoidance and mitigation measures are in place.

In connection with developing a flood fight access road associated with MA 3 an opportunity exists to create native grassland habitat enhancements along the landward and waterward slopes of said access road/embankment. It is estimated that as much as two acres of native grassland enhancements, adjoining existing upland woodland habitat to the south of 6th Street, could be

created along the 6th Street portion of the flood fight access road. Similar to the embankments of the flood fight access road, any new cross levee systems Associated with MAs 6A, 6B, and 6C with 18 to 20 feet high embankments containing 3:1 (H:V) side slopes there will be greater opportunities to create native grassland enhancements. It estimated that as much as 14.5 acres of native grassland habitat enhancements can take place for every mile of new cross levees that may be constructed. With each potential cross levee configuration, the new cross levees associated with MAs 6A, 6B, or 6C would each total approximately 2.60 miles of new levee slopes, thus at 14.5 acres/levee mile there is an opportunity to create approximately 37.8 acres of native grassland habitat with any one of the cross levee figurations.

For almost all of the MAs associated with a demand for borrow material opportunities exist to utilize or expand upon the 87-acre combined BALMD borrow and mitigation bank site(s) located in project study area. The noted borrow and mitigation site(s) in the project study area are near the San Joaquin River just east of its confluence with Sevenmile Slough. This same area has been identified as Existing Restoration Project (ER-3) in Appendix D – Ecosystem Multi-benefit Opportunities for the Sacramento County Delta Legacy Small Communities Flood Risk Reduction Feasibility Studies.

6.3.2.6 Consistency with Existing Delta Regulations and Policies

As mentioned previously, there are several agencies with regulatory, flood management, and/or land use authority over projects in the Delta, inclusive of the subject Sacramento County Delta Legacy Community of Courtland that is located in the Primary Zone of the Delta. Due to the large number of broad policies and goals contained in the many DPC, DSC, and Conservancy planning documents applicable to the study area, an exhaustive matrix comparing the various proposed flood management elements against the many broad goals and policies of Delta agencies is contained in Appendix G.

Generally, all of the proposed MAs indirectly support the various Delta agencies plans and policies regarding sustainability and viability of the Delta agricultural economy, preservation of the Legacy Community's unique history and sense of place, and opportunities for public recreation and ecosystem enhancement (where feasible). The only MA components that could conflict with existing regulations could be those that propose seepage/stability berms and possibly the access road/flood fight berm, if their final configuration would affect a substantial acreage of important farmland of regional and statewide significance within the study area. Although most restrictions regarding agricultural land conversion address conversion to urban uses, the concept of taking agricultural land out of production due to flood management facilities would need to be explored further before implementation of any MA.

Historically, levee repairs can induce population growth and encourage development within the floodplain. Although levee repairs are proposed under all of the various MAs, development within the Delta is constrained by the Delta Plan and SPA ordinances which limit new residential, commercial, and industrial development, particularly within the Primary Zone of the Delta. Although Isleton is located in an isolated Secondary Zone of the Delta, it is surrounded by

the Primary Zone, which would limit any new urban development beyond the city limits or the City's slightly larger sphere of influence that coincides with the largest cross levee configuration associated with MA 6C. As such, future floodplain development within the study area is not expected to be substantial with the implementation of any of the MA 6 cross levee configurations.

6.3.3 Trade-Off Analysis Summary

A summary of the trade-off analysis is provided in Table 6-12 below.

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Table 6-12. Trade-Off Analysis Summary Table

Management Action	Flood Risk Reduction				Limitation of High Insurance Premiums	Estimated Displacement of Agricultural Acreage (Cutoff Walls/Berms)	Enhancing Resiliency and Reliability of through-Delta Water Conveyance	Local Support	Multi-Benefit, Eco-System Enhancements	Cost
	Reducing Risk to Life	Reducing Risk to Property Damage (EAD Reduction)	Reduced Probability of Levee Failure	Net Reduction in EAD to Isleton Study Area (Existing Conditions/Future Conditions) ($)						
1A	High	**High**	High	N/A	No	Additional analysis needed	No	High	Low	Low
1B	High	**High**	High	$18,219,000–$65,151,000	No		No	High	High	Low
1C	High	**High**	High		No		No	High	Low	Low
2	Medium	**High**	High	N/A	No	0/1	No	Low	Medium	Medium
3	Medium	**High**	None	$5,762,000–$26,917,000	No	Less than 5 acres	No	High	High	Medium
4A	High		Medium	N/A	No	6/26	No	High	Low	High
4B	Medium		Medium	N/A	No	Additional analysis needed	No	Low	Low	High
4C	Medium		Medium	N/A	No		No	Low	Low	High
4D	Low		Medium	N/A	No		No	Low	Low	High
5A	Medium		High	N/A	No	3/15	Yes	Medium`	Low	High
5B	Medium		High	N/A	No	5/27	Yes	Medium	Low	High
5C	Medium		High	N/A	No	6/32	Yes	Medium	Low	High
5D	Medium		High	N/A	No	Additional analysis needed	Yes	Medium	Low	High
5E	Low		High	N/A	No		Yes	Medium	Low	High
6A	High		High	$6,073,000–$28,867,000	Yes	Up to 13/67 (MA 6C)	Yes	High	High	High
6B	High		High	$6,073,000–$28,867,000	Yes		Yes	High	High	High
6C	High		High	$6,073,000–$28,867,000	Yes		Yes	High	High	High
7	Low		High	N/A	No	Additional analysis needed	No	Medium	Low	High
8	Low		Moderate	N/A	No		No	Medium	Low	High
9	Low		High	N/A	No		No	Medium	Low	High
10	Medium		None	N/A	No		No	Low	Medium	High
11	High	High	High	$19,458,000–$75,428,000	Yes		Yes	Low	Medium	High
12	High	High	High	$19,187,000–$70,615,000	Yes		Yes	High	low	High

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7. Recommendations

Section 7 details the suite of MAs recommended for implementation. Stakeholder and public input on these MAs are also provided, along with other non-structural measures that are recommended for implementation. Following these recommendations, right-of-way, and easements considerations, as well as considerations for operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) are discussed, as well as regulatory requirements, funding strategies, financial feasibility, and stakeholder support.

7.1 Recommended Suite of Structural-Related Management Actions

Of the 12 MAs previously identified, MAs 1-4A are recommended for timely, near-term implementation. This includes:

- **MA 1:** Repair of DWR FSRP Critical and Serious Sites within BALMD
- **MA 2:** Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Potential Relief Cut Upstream along Georgiana Slough in RD 556 – Upper Andrus
- **MA 3:** All-Weather Flood Fight Access Road for the Community of Isleton
- **MA 4A:** Repair and Strengthen-in-Place 1.6 Miles of Levee along the Left Bank of the Sacramento River Adjacent to Isleton. This particular MA 4A would significantly reduce the risk to flooding damages and loss of lives by eliminating the risk of potential levee failure from occurring along the Sacramento River directly adjacent to and upstream of the Isleton community to the Isleton bridge. This MA consisting of a seepage cutoff wall would also significantly reduce infiltration and inflow to the City's wastewater collection system.

Additional MAs for long-term consideration:

- **MA 5C:** Repair and Strengthen-in-Place a total of 1.9 Miles of SPFC Levee along the Right Bank of Georgiana Slough immediately opposite the community of Isleton between the potential cross levee alignment at Jackson Slough Road and Terminous Road and the potential cross levee alignment at Jackson Slough Road and Terminous Road. This MA 5C would also contribute towards the multi-benefits of: (1) significantly reducing infiltration and inflow to the City's Wastewater ponds; and (2) improving through-Delta water conveyance reliability and resiliency along the existing SPFC levee system in the north/central Delta. (*See* Appendix K for further details in support of the multi-benefit opportunities identified by the Sacramento County Delta Legacy Communities, including the City of Isleton associated with reducing flood risks combined with improving SWP water conveyance through the Delta.)

- **MA 6:** A Cross levee System (6A, 6B, or 6C) for the City of Isleton providing a 100-yr FEMA certification level of flood protection for the City of Isleton, and significantly reducing infiltration and inflow to the City's wastewater collection system and wastewater ponds.
- **MA 5:** Repair and Strengthen-in-Place Entire Segment of SPFC Levee Along the Right Bank of Georgiana Slough (NULE Segment 40) – 6.0 miles.

MA 5 in its entirety of repairing and improving-in-place six miles of the right bank levee system of Georgiana Slough in the project study area would contribute towards the multi-benefit project to improve through-Delta water conveyance reliability and resiliency along the existing SPFC levee system in the north/central Delta. Provided the community can garner support from in-Delta and South-of-Delta water export interests, including but not limited to, the DCA, DWR, CVP, Metropolitan Water, and State Water Contractors, it is recommended that MA 5 in its entirety be implemented over time to improve and modernize the perimeter levee system along Georgiana Slough that also serves to improve the resiliency and reliability of the through-Delta conveyance system as it currently exists today and into the future with conveyance of water through the Delta downstream of the Delta Cross Channel. In terms of priority of sub-reaches of MA 5 along Georgiana Slough it is recommended that sub-reach 5C be implemented first as this reach is directly opposite the community and it poses the greatest threat to potential flood damages and loss of lives. This same sub-reach, 5C, could also be paired with a cross levee system (MA 6) in advance of improving other sub-reaches upstream or downstream along right bank of Georgiana Slough within the project study area bounded by the BALMD perimeter levee system.

It is also recommended that all of the above recommended structural-based MAs be coupled with the noted suite of non-structural measures identified and prioritized in Section 7.3 below.

A summary of the proposed remediations for each structural-related MA is summarized in Table 7-1 below. With the exception of MAs 4A, 5C, and the potential cross levee configurations MAs 6A through 6C, and MA 10 associated with a potential Highway 12 Cross Levee system, the levee remediation measures were largely developed by DWR based on the assessment performed as documented in the NULE GAR and as provided in the 2011 RACER for the North NULE study area. The potential remediations measures previously developed by DWR in the NULE GAR for the project study area are also further detailed in Table 7-2.

Table 7-1. Summary of Proposed Remediations for Management Actions 1-12

Management Action	Proposed Remediations
1: Repair of DWR FSRP Critical and Serious Sites within BALMD on SPFC and non-SPFC Levee Segments	• 350 feet of rock revetment for the serious erosion site on the left bank of the Sacramento River • Drained stability berms for the two critical stability sites on the right banks of the Mokelumne and San Joaquin rivers, two serious stability sites on the right bank of Georgiana Slough, and the serious seepage site on the right bank of the Mokelumne River
2: Raise and Repair/Strengthen-in-Place RD 556 Cross Levee Coupled with a Relief Cut along Georgiana Slough	• 20-foot-deep cutoff wall or a 15-foot-wide, 23-foot-tall stability berm • 8-foot levee raise for 2,200 feet
3: All-Weather Flood Fight Access Road for the City of Isleton	• 1.5-mile-long all-weather flood fight access road with a 20-foot-wide crown width, 3H:1V landside and waterside slopes, and crown elevation between 2 and 6 feet NAVD 88, assuming Muscle Wall heights of 4 to 8 ft. and a downstream design WSEL of 9 feet NAVD 88 and 1 foot of freeboard
4A: Repair and Strengthen-in-Place 1.6 Miles of SPFC Levee along the Left Bank of the Sacramento River (NULE Segment 378) Adjacent to Isleton	• 30-foot-deep cutoff wall or a 65-foot-wide, 9 feet tall combination berm • 0.5 feet levee raise for 500 feet
4B: Repair and Strengthen-in-Place 4.2 Miles of SPFC Levee along the Left Bank of the Sacramento River (NULE Segment 378) btwn. Isleton and Highway 12	• 20-foot-deep cutoff wall along a portion of the levee to address through seepage vulnerabilities • 4-foot-high drained stability berm along a portion of the levee to address through seepage and stability vulnerabilities
4C: Repair and Strengthen-in-Place 2.4 Miles of SPFC Levee along the Left Bank of the Sacramento River (NULE Segment 378) d/s of Highway 12	• 20-foot-deep cutoff wall along a portion of the levee to address through seepage vulnerabilities • 4 feet high drained stability berm along a portion of the levee to address through seepage and stability vulnerabilities
4D: Repair and Strengthen-in-Place 2.0 Miles of SPFC Levee along the Left Bank of the Sacramento River (NULE Segment 378) upstream of Isleton Bridge	• 20-foot-deep deep cutoff wall along a portion of the levee to address through seepage vulnerabilities • 4-foot-high drained stability berm along a portion of the levee to address through seepage and stability vulnerabilities
5A: Repair and Strengthen-in-Place 0.9 Miles of SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) near City of Isleton	• 75-foot-deep cutoff wall or a 70-foot-wide, 13-foot-tall combination berm • 1.5-foot levee raise along the entire reach
5B: Repair and Strengthen-in-Place 1.6 Miles of SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) near City of Isleton	• 75-foot-deep cutoff wall or a 70-foot-wide, 13-foot-tall combination berm • 1.5-foot levee raise along the entire reach

Management Action	Proposed Remediations
5C: Repair and Strengthen-in-Place 1.9 Miles of SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) (also Includes 5A and 5B) near City of Isleton	• 75-foot-deep cutoff wall or a 70-foot-wide, 13-foot-tall combination berm • 1.5-foot levee raise along the entire reach
5D: Repair and Strengthen-in-Place 1.9 Miles of SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) d/s of Oxbow Marina Drive	• 55-foot-deep cutoff wall to address through seepage, underseepage, and stability vulnerabilities • Levee raise to 13 feet NAVD 88 primarily to address freeboard and geometry deficiencies
5E: Repair and Strengthen-in-Place 2.2 Miles of SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) u/s of West Tyler Island Bridge Road and u/s, north of Fertile Acres Road	• 55-foot-deep cutoff wall to address through seepage, underseepage, and stability vulnerabilities • Levee raise to 13 feet NAVD 88 primarily to address freeboard and geometry deficiencies
6A: Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP	• 1.8-mile-long cross levee at Jackson Slough Road and Terminous Road constructed with a 20-foot-minimum crown width, 3H:1V landside and waterside slopes, and levee crest elevation of 13 feet NAVD 88 assuming a design WSEL of 10 feet NAVD 88 and 3 feet of freeboard • 0.65-mile-long Cross Levee North of Fertile Acres constructed with a 20-foot-minimum crown width, 3H:1V landside and waterside slopes, and levee crest elevation of 19 feet NAVD 88 assuming a design WSEL of 16 feet NAVD 88 and 3 feet of freeboard • Repair/improve-in-place 1.4 miles of the Sacramento River SPFC levee system along the left bank of the Sacramento River with either a 30-foot-deep cutoff wall or a 65-foot-wide, 9-foot-tall combination berm along with a 0.5-foot levee raise for 500 feet within the same 1.4-mile reach of levee to address underseepage, through seepage, and freeboard/geometry deficiencies • Repair/improve in-place 1.9 miles of Georgina Slough SPFC levee system along the right bank of Georgina Slough with either a 75 feet deep cutoff wall or a 70-foot-wide, 13-foot-tall combination berm along with a 1.5-foot levee raise along the entire 1.9-mile reach to address underseepage, through seepage, and freeboard/geometry deficiencies

Management Action	Proposed Remediations
6B: Isleton – Oxbow Marina Cross Levee System with the Potential Future Multi-Objective Setback Levee at Oxbow Marina	• 2.0-mile-long Isleton/Oxbow Marina cross levee constructed with a 20-foot-minimum crown width, 3H:1V landside and waterside slopes, and levee crest elevation of 13 feet NAVD 88 assuming a design WSEL of 10 feet NAVD 88 and 3 feet of freeboard • 0.65-mile-long Cross Levee North of Fertile Acres constructed with a 20-foot-minimum crown width, 3H:1V landside and waterside slopes, and levee crest elevation of 19 feet NAVD 88 assuming a design WSEL of 16 feet NAVD 88 and 3 feet of freeboard • Repair/improve-in-place 1.4 miles of the Sacramento River SPFC levee system along the left bank of the Sacramento River with either a 30-foot-deep cutoff wall or a 65-foot-wide, 9-foot-tall combination berm along with a 0.5-foot levee raise for 500 feet within the same 1.4-mile reach of levee to address underseepage, through seepage, and freeboard/geometry deficiencies • Repair/improve in-place 1.6 miles of Georgina Slough SPFC levee system along the right bank of Georgina Slough with either a 75 feet deep cutoff wall or a 70-foot-wide, 13-foot-tall combination berm along with a 1.5-foot levee raise along the entire 1.6-mile reach to address underseepage, through seepage, and freeboard/geometry deficiencies
6C: City of Isleton Sphere of Influence Cross Levee System	• 1.8-mile-long Isleton/Oxbow Marina cross levee constructed with a 20-foot-minimum crown width, 3H:1V landside and waterside slopes, and levee crest elevation of 13 feet NAVD 88 assuming a design WSEL of 10 feet NAVD 88 and 3 feet of freeboard • 0.60-mile-long Cross Levee North of the Isleton Bridge constructed with a 20-foot-minimum crown width, 3H:1V landside and waterside slopes, and levee crest elevation of 19 feet NAVD 88 assuming a design WSEL of 16 feet NAVD 88 and 3 feet of freeboard • Repair/improve-in-place 1.75 miles of the Sacramento River SPFC levee system along the left bank of the Sacramento River with either a 30-foot-deep cutoff wall or a 65-foot-wide, 9-foot-tall combination berm along with a 0.5-foot levee raise for 500 feet within the same 1.75-mile reach of levee to address underseepage, through seepage, and freeboard/geometry deficiencies • Repair/improve in-place 2.3 miles of Georgina Slough SPFC levee system along the right bank of Georgina Slough with either a 75 feet deep cutoff wall or a 70-foot-wide, 13-foot-tall combination berm along with a 1.5-foot levee raise along the entire 2.3-mile reach to address underseepage, through seepage, and freeboard/geometry deficiencies
7: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the Mokelumne River (NULE Segment 1050) – 2.9 miles	• 19-foot-high drained stability berm and 45-foot-deep cutoff wall along a portion of the levee to address through seepage, underseepage, and stability vulnerabilities • Levee raise to 20 feet NAVD 88 primarily to address freeboard and geometry deficiencies

Management Action	Proposed Remediations
8: Repair and Strengthen-in-Place Non-SPFC Levee along the Right Bank of the San Joaquin River (NULE Segment 1049) – 2.6 miles	• 19-foot-high drained stability berm and 70-foot-deep cutoff wall along a portion of the levee to address through seepage, underseepage, and stability vulnerabilities • Levee raise to 20 feet NAVD 88 primarily to address freeboard and geometry deficiencies
9: Repair and Strengthen-in-Place 1.35 Miles of Non-SPFC Levee along the Left Bank of Sevenmile Slough (NULE Segment 1048) East of Jackson Slough and Certify Two Sevenmile Slough Closure Structures	• 26-foot-high drained stability berm and 70-foot-deep cutoff wall along a portion of the levee to address through seepage, underseepage, and stability vulnerabilities • Levee raise to 27 feet NAVD 88 primarily to address freeboard and geometry deficiencies
10: Highway 12 Cross Levee	• 5.7-mile-long raised and widened cross levee along Highway 12 with a 36-foot-crown-width, 3H:1V landside and waterside slopes, and levee crest elevation of 13 feet, assuming a downstream design WSEL of 10 feet NAVD 88 and 3 feet of freeboard
11: Secure 100-Year FEMA Certification for the Community of Isleton with a Highway 12 Cross Levee Paired with 14.6 miles of Perimeter Levee Improvements North of Highway 12	• Levee improvements as described in MAs 1, 2, 4, 5, and 10 along with addressing all FEMA design criteria and O&M and documentation requirements pursuant to 44 CFR §65.10
12: Secure 100-Year FEMA Certification for the Entire BALMD Study Area inclusive of the Community of Isleton – 25 Combined Miles of SPFC and non-SPFC Levee Improvements	• Levee improvements as described in MAs 1, 2, 4, 5, and 7-9 along with addressing all FEMA design criteria and O&M and documentation requirements pursuant to 44 CFR §65.10

Notes: Reference for MAs 1, 4B-4D, 5D-5E, 7-9, and 11
Source: (URS, 2011b).

Table 7-2. NULE GAR Remediations Previously Developed by DWR for Management Actions 1, 4B-4D, 5D-5E, 7-9, and 11 (URS, 2011a)

Levee Segment Location	NULE Segment	Hazard Remediated	Extent (% of Total Segment Length)	Remedial Alternatives
Left Bank Sacramento River (SPFC Levee Segment – 11.6 miles), with only 10.2 miles within Isleton Study Area of BALMD upstream of West Brannan Island Road	378	T + U + FG	12% @ 1.4 miles (levee segment immediately fronting the community of Isleton)	30-foot-Deep Slurry Wall 9-foot-High Combination Berm
		T	10% @ 1.2 miles	14-foot-High Levee 4-foot-High Drained Stability Berm 20-foot-Deep Slurry Wall
		S	30% @ 3.5 miles	14’ High Levee 4-foot-High Drained Stability Berm
		T	20% @ 2.3 miles	14-foot-High Levee 4-foot-High Drained Stability Berm
		E	20% @ 2.3 miles	14-foot-High Levee
Right Bank Georgiana Slough (SPFC Levee Segment – 6.0 miles)	40	T + U + FG	30% @ 1.8 miles (levee segment adjacent to the community of Isleton)	75-foot-Deep Slurry Wall 13-foot-High Combination Berm
		T + U	10% @ 0.6 miles	13-foot-High Levee 65-foot-Wide Combination Berm 55-foot-Deep Slurry Wall
		U	5% @ 0.3 miles	13-foot-High Levee 70-foot-Wide Seepage Berm 55-foot-Deep Slurry Wall
		T + U	15% @ 0.9 miles	13-foot-High Levee 75-foot-Wide Combination Berm 55-foot-Deep Slurry Wall
		T + U + S	30% @ 1.8 miles	13-foot-High Levee 11-foot-High Stability Berm 55-foot-Deep Slurry Wall
		T + U + S	30% @ 1.8 miles	13-foot-High Levee 70-foot-Wide Combination Berm 55-foot-Deep Slurry Wall
		FG	90% @ 5.4 miles	13-foot-High Levee
Right Bank Mokelumne River (Non-SPFC Levee Segment – 2.9 miles)	1050	T + U + S	60% @ 1.7 miles	20-foot-High Levee 100-foot-Wide Combination Berm 19-foot-High Drained Stability Berm 45-foot-Deep Slurry Wall
		E	10% @ 0.3 miles	20’ High Levee

Levee Segment Location	NULE Segment	Hazard Remediated	Extent (% of Total Segment Length)	Remedial Alternatives
		FG	10% @ 0.3 miles	20-foot-High Levee Geometry Deficiency Only
Right Bank San Joaquin River (Non-SPFC Levee Segment – 2.6 miles)	1049	U + S	30% @ 0.8 miles	20-foot-High Levee 19-foot-High Drained Stability Berm 70' Deep Slurry Wall
		T + U + S	30% @ 0.8 miles	20-foot-High Levee 19-foot-High Drained Stability Berm 70-foot-Deep Slurry Wall
		U + S	30% @ 0.8 miles	20-foot-High Levee 100-foot-Wide Combination Berm 19-foot-High Drained Stability Berm 70' Deep Slurry Wall
Right Bank San Joaquin River (Non-SPFC Levee Segment – 2.6 miles)	1049	U + S	10% @ 0.3 miles	14-foot-High Levee 13-foot-High Drained Stability Berm 70-foot-Deep Slurry Wall
		E	10% @ 0.3 miles	20-foot-High Levee
		FG	15% @ 0.4 miles	20-foot-High Levee Geometry Deficiency Only
Left Bank Sevenmile Slough (Non-SPFC Levee Segment – 4.6 miles)	1048	T + U + S	40% @ 1.8 miles	27-foot-High Levee 26-foot-High Drained Stability Berm 162-foot-Wide Combination Berm 70-foot-Deep Slurry Wall
		U + S	30% @ 1.4 miles	27-foot-High Levee 26-foot-High Drained Stability Berm 162-foot-Wide Combination Berm 70-foot-Deep Slurry Wall
		T	30% @ 1.4 miles	27-foot-High Levee 26-foot-High Drained Stability Berm 20-foot-Deep Slurry Wall
		FG	55% @ 2.5 miles	27' High Levee Geometry Deficiency Only

Notes**:** T = Through Seepage, U = Underseepage, S = Slope Stability, E = Erosion, FG = Freeboard and/or Geometry
Source: (URS, 2011b)[This page left intentionally blank]

7.2 Stakeholder and Public Input on Structural-Related Management Actions and Non-Structural Flood Risk Reduction Measures

The recommended suite of seven management actions were informed by stakeholder and public feedback received following preparation of the draft feasibility study report in December of 2021 and input received from the city residents and Isleton City Council during April-June of 2022. Stakeholders and the public expressed the greatest support for the following immediate and near-term Management Action (MAs): (1) repairing the weakest links in the BALMD perimeter levee system , namely outstanding DWR FSRP repair sites within the Isleton study area (MA 1); (2) construction of an all-weather flood fight access road/berm around the city limits of Isleton primarily along the 6th street and adjoining streets on the west and east sides of Isleton, and procurement/storage Muscle Wall to deploy during future high-water, flood threatening events (MA 3); (3) repairing and strengthening up to 1.6 miles of the Sacramento River left bank levee (MA 4A); (4) repairing strengthening-in-place at least 1.9 miles of the SPFC levee system along the right bank of the Georgiana Slough directly opposite and southeast of Isleton, and adjoining the City's waste-water ponds located between West Tyler Island Bridge Road on the north and the southerly extension of Oxbow Marina Drive where it departs the levee (MA 5C – inclusive of MAs 5A and 5B); The near-term MAs noted above received support to be potentially coupled with the two following long-term MAs: MA 6C – a cut-off/ring levee system that is closely aligned with the City's Sphere of Influence (SOI) lines beyond the immediate city limits lines; and MA 5 associated with repairing and improving-in-place the entirety of the 6-mile long SPFC right bank levee of Georgianna slough that contains the multi-benefits of: (1) significantly reducing infiltration and inflow into the City's wastewater ponds; and (2) improving the reliability and resiliency of conveying SWP and CVP freshwater through the Delta along the SPFC reaches downstream of the Delta Cross Channel.

Between Management Action 3 (an all-weather access road/flood fight berm for Isleton) and Management Action 6 (a cross levee system providing 100-yr. FEMA accreditation for the City of Isleton), the all-weather access road is more favorable and cost-effective to the local residents and business owners of Isleton.

In addition to the long-term management action(s) associated with developing a cross levee system for the City of Isleton, there is strong support by the community to pursue improvement of the entire 6.0-mile reach of Georgiana Slough that has the added multi-benefit of improving the reliability and resiliency of conveying SWP and CVP water through the north/central Delta downstream of the Delta Cross Channel. *See* Appendix K for additional background information related to improving water conveyance through the Delta (including areas downstream of the Delta Cross Channel) in tandem with reducing flood risks to the Delta Legacy Communities within Sacramento County.

7.3 Community Preferred Structural-Related Management Actions

From the recommended suite of structural-based management actions, a suite of community preferred structural-based management actions was developed based on the stakeholder and public input described above in Section 7.2 and summarized below in Table 7.3.

Repairing and strengthening in-place the RD 556 cross levee coupled with a potential relief cut along Georgiana Slough (MA 2), which is not a preferred management action for locals or other key stakeholders, is not included in the near-term suite of community preferred structural-based management actions. Management Action 1 associated with addressing known FSRP critical and serious sites, and Management Action 3 associated with the Flood Fight Access Road/Berm are both recommended and preferred for immediate near-term implementation; Management Actions 4A, 5C are recommended for near-term implementation; and MAs 5D, 5E, and 6C are all recommended for long term implementation.

Note that cost estimates presented below in Table 7-3 for the suite of community preferred structural-based MAs assume they would be implemented in the priority order provided, as funding becomes available. In this context, MA 6C associated with constructing the largest cross levee configuration consistent with the City's Sphere of Influence would include Management Actions 4A and 5C (and a very small, 0.40-mile portion of MA 5E) for repairing and strengthening-in-place the portions of SPFC levee systems along the Sacramento River and Georgianna Slough, respectively. These strengthening-in-place SPFC levee improvements would be located between the two potential cross levees, with one cross levee east or upstream of Isleton, and the other cross levee west or downstream of Isleton as depicted in Figure 5-16. This specifically includes a 1.75-mile segment of the Sacramento River left bank SPFC levee adjacent to and upstream of the community of Isleton (MA 4A & and a small 0.15-mile portion of MA 4D), and the 2.3-mile segment of the Georgiana Slough right bank SPFC levee directly south and opposite of Isleton and partially adjoining the City's wastewater ponds (MA 5C and a small 0.4-mile portion of MA 5E). As such, the cost component associated with repairing the 1.60-mile SPFC levee segment along the Sacramento River and the 2.3-mile SPFC levee segment along Georgina Slough between the potential cross levees adjacent to the community of Isleton have been deducted from the cost estimate for Management Action 6C in Table 7-3 below. Capital costs for these management actions are described further in Section 6.2, and as summarized previously in Table 6-8.

Table 7-3. Community Preferred Structural-Related Management Actions and Associated Costs (MA's 1, 3, 4A, 5C, 6C, and all of 5)

Structural-Based Management Actions	Estimated Costs
Management Action 1 (Near-Term): Repair Remaining DWR FSRP Critical and Serious Sites within Project Study Area - Brannan Andrus Levee Maintenance District (BALMD)	$6.0M
Management Action 3 (Near-Term): All-Weather Flood Fight Access Road (8,000 to 9,000 ft. in length) for the Community of Isleton (excluding $3.2M to $4.4M to procure 8,000 to 9,000 ft. of Muscle Wall)	$5.9M – $6.4M
Management Action 4A (Long-Term): Repair and Strengthen-in-Place 1.6 Miles of Levee along the Left Bank of the Sacramento River Immediately Adjacent to Isleton *(deducted below as portion of MA 6C – City's Sphere of Influence Cross Levee System)*	$22.2M - $23.1M
Management Action 5 (Long Term): Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough (NULE Segment 40) – 6.0 miles (with dual benefit of improving reliability and resiliency of conveying SWP and CVP water through North/Central Delta adjacent to Georgianna Slough	$76.7M - $106.5M ($12.8M - $17.8M/mile)
5A: *Repair and Strengthen-in-Place 0.90 miles of Levee along the Right Bank of Georgiana Slough Between the Cross Levee North of Fertile Acres and 450 feet Downstream of the Isleton Sewer Ponds*	*$13.4M - $15.9M*
5B: *Repair and Strengthen-in-Place 1.6 Miles of Levee along the Right Bank of Georgiana Slough Between the Cross Levee North of Fertile Acres and the Isleton/Oxbow Marina Cross Levee*	*$23.8M - $28.3M*
5C: *Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Cross Levee North of Fertile Acres and the Cross Levee at Jackson Slough Road and Terminous Road (includes 5A and 5B, and deducted below as portion of MA 6C - City's Sphere of Influence Cross Levee System)*	*$28.3M - $33.6M*
5D: *Repair and Strengthen-in-Place 1.9 Miles of Levee along the Right Bank of Georgiana Slough Between the Cross Levee at Jackson Slough Road and Terminous Road and the Mokelumne River*	*$22.4M - $33.8M*
5E: *Repair and Strengthen-in-Place 2.2 Miles of Levee along the Right Bank of Georgiana Slough Between the Cross Levee North of Fertile Acres and the RD 556 Cross Levee (0.4 miles of remediation measures deducted as a portion of MA 6C – City's Sphere of Influence Cross levee System:*	*$26.0M - $39.1M*
Management Action 6C (Long-Term): Isleton Sphere of Influence Cross Levee System *(less the costs for repairing and improving-in-place SPFC levees between the Sphere of Influence Cross Levees included above in MAs 4A and 5C; and a small 0.4-mile portion of segment MA 5E: - $62.4M)*	$65.5M - $65.6M
Totals for Community Preferred Near-Term and Long-Term Structural-Based Management Actions 1, 3, 4A, 5, and 6C	$176.3M - $207.6M

7.4 Non-Structural Measures Recommended for Implementation

Out of the full suite of 15 non-structural measures described in detail in Appendix H, and further discussed in Section 5.2, an all-weather access road/flood fight berm is included as part of the recommended structural-related MAs discussed in the previous Section.

The following non-structural measures identified and numbered as follows in Appendix H, are recommended to be carried forward to reduce flood risks within the Isleton study area include the following:

1. Flood Fight Berm or a Ring Levee System
2. Voluntary Elevations of Structures
3. Wet or Dry Floodproofing
4. Flood Emergency Safety Plans
5. Sacramento County OES Decision Support Tool
6. LHMP and Relief Cuts
7. Alternatives to FEMA NFIP – Private, Community-Based Flood Insurance
8. NFIP Flood Insurance Enhancements *via* AFOTF
9. Mokelumne River Conveyance Improvements & Staten Island Overflow Area
10. Improve FEMA CRS Score for Sacramento County/Isleton
11. Land Use Regulations and Limitations
12. Improved Governance Between Neighboring LMAs/RDs
13. SWIFs & Period Inspections with USACE
14. Public Education/Public Awareness

The only Non-Structural Measure previously identified, but not carried forward are Acquisitions and Relocations (Item No. 4 in Appendix H) and Mokelumne River Conveyance Improvements and Staten Island Flood Easements (Item No. 10 in Appendix H). Acquisitions and Relocations was not carried forward at the request of the Isleton Planning Committee and the majority of Isleton's citizens and business owners. Also, relocating entire communities within the Delta, particularly Delta Legacy Communities such as Isleton, is inconsistent with the goals and objectives of both the Delta Plan and the SSJDNHA designation.

The flow constrictions and resulting high flood stages in the Mokelumne River system upstream of its confluence with Georgiana Slough do not have an impact on the flood stages in the Sacramento River nor in Georgianna Slough, thus there is little or no value to the City of Isleton pursuing hydraulic improvements on the capacity-constrained South and North Forks of the Mokelumne River on either side of Staten Island. However, it should be noted that if there is levee breach onto Tyler Island (RD 563) caused by high stages in the North Fork of the

Mokelumne River, as occurred in 1986, such flooding on the neighboring Tyler Island could pose a flood threat to Isleton and other areas of within BALMD.

The recommended suite of non-structural measures and timeline status are summarized below. Of these, a portion are currently ongoing within the Isleton study area, with the remaining recommended for implementation in the near term and long-term as summarized in Table 7-4.

Table 7-4. Recommended Timeline for Implementation of Other Non-Structural Measures

Non-Structural Measure	Ongoing	Recommended: Near Term (1-6 years)	Recommended: Long Term (> 6 years)
Voluntary Structural Elevation		X	X
Wet or Dry Floodproofing		X	X
Flood Emergency Safety Plans	X	X	X
Sacramento County OES Decision Support Tool	X	X	X
LHMP and Relief Cuts		X	X
Alternatives to NFIP – Community and Flood-Risk Based Insurance Program		X	X
NFIP Flood Insurance Enhancements *via* AFOTF		X	X
Mokelumne River Conveyance Improvements/Flood Easements			X
Improve FEMA CRS for Sacramento County	X	X	
Improved Governance between Neighboring LMAs/RDs & Community		X	X
SWIFs & Periodic Inspections with USACE		X	X
Public Education and Awareness	X	X	X

7.4.1 Voluntary Structural Elevation

It is recommended that voluntary raising of structures, on a case-by-case basis, be carried forward as a non-structural solution for reducing flood risks within the Courtland study area. The County should continue to encourage residential and business owners to participate in the voluntary raising of structures by offering potential cost-sharing incentives (50% or greater cost share reductions) available through federal and state cost-sharing programs.

As described previously, there are a total of 459 structures clustered in the City of Isleton, and an additional 476 structures located in the balance of BALMD for a total count of 935 structures in the entire study area of Isleton. As previously presented in Table 5-16, this represents a cost of at least $78M to elevate all of the structures within the City of Isleton, and at least $159M to

elevate all of the structures in all of BALMD, including the City of Isleton. Note that this cost could be greater when assuming commercial, industrial, and public buildings may be more costly to elevate than single family residential structures currently estimated at $170,000 each.

The cost to raise all structures to these heights may be feasible with federal and state participation but may not be desirable for the entire community. However, elevating structures is encouraged on a case-by-case basis wherever feasible with federal and state assistance. This non-structural solution would need to be voluntary for residential structures as expressed during public outreach meetings, but it could be mandatory for essential, critical facilities in the event the preferred MAs are not fully implemented. This element is recommended for implementation, on a case-by-case basis, in the long term.

7.4.2 Wet or Dry Floodproofing

For a more detailed description of this non-structural measure that would be voluntary in nature for individual homeowners and business owners, similar to voluntary elevation of structures, *refer to* Section 5.2.4. Similar to elevating structures, wet or dry floodproofing would be done a case-by-case-basis and could be implemented during the short- and long-term.

7.4.3 Improved Emergency Response

BALMD is currently utilizing the DWR Delta Flood Emergency Response Grant Round 2 funding to update its Delta Flood ESP. RD 3 is the grantee within the funding agreement which covers plan updates for several RDs in Sacramento County, including BALMD, which encompasses and includes the subject Isleton project study area.

The intent is for the ESP to be consistent with AB 156, FEMA's Comprehensive Preparedness Guide 101, and regional formatting standards. This includes the development of supporting annexes, namely a flood-specific annex that details the RD's field response operations. The written flood annex will be transferred to a Flood Contingency Map annex that is quick to access and easy to interpret during an emergency.

The ESP will also be reviewed for consistency with SEMS and National Incident Management System standards such as appointing an incident commander, assigning specific response actions to objective conditions, and emergency spending authorities. The Emergency Operation Plan's (EOP) format will also be updated to be consistent with regional standards (San Joaquin, Yolo, and Solano County Flood ESPs).

Additional district specific enhancement will include: identifying the gauges listed in the already-developed EOPs that need datum conversions to NAVD 88 (in order to meet grant requirements); identifying any other critical infrastructure and elevations (pump stations, etc.); and evaluating the feasibility of a relief cut(s) where appropriate, with a brief technical memorandum summarizing the conditions in which a relief cut may be a feasible option (*see* Section 7.4.4 below for more information).

Coordination on the plan update began in September 2020 and the final plan update was scheduled for completion before the end of 2021.

It is recommended that the Delta Flood ESP for BALMD be updated every 5 years and/or as needed.

7.4.4 Local Hazard Mitigation Plan and Relief Cuts

Sacramento County began public outreach to update the 2016 LHMP in 2020. The 5-year update to the LHMP was scheduled for completion by late 2021 or early 2022. As part of this update, Sacramento County has the opportunity to reevaluate the impacts of flooding and levee failures to the people and assets of the County planning area, including BALMD, and to establish updated goals and prioritize projects to reduce these impacts on people and property within BALMD. It is recommended that the county continue to update the LHMP every 5 years.

Relief cuts properly executed in the study area could result in a reduction in flood depths in excess of 4 feet. If BALMD is willing, as previously noted, the updated LHMP may be a place to formalize relief cuts that could result in reducing flooding depths that pose a threat to the City of Isleton. As mentioned above, Sacramento County RDs will be updating their ESPs and are looking at incorporating relief cuts where feasible. Preliminary relief cut evaluations for the BALMD basin has shown that a relief cut would be of greatest value if deployed somewhere near or on the southern, downstream end of BALMD. A relief cut upstream of BALMD within RD 556, coupled with levee freeboard and strengthening improvements to the RD 556 south cross (Management Action 2, described herein above in Section 5.1.2.3) could also substantially reduce the risk of flooding to the City of Isleton from a levee breach occurring upstream within the neighboring RD 556 – Upper Andrus Island.

7.4.5 Alternatives to NFIP – Community and Flood-Risk Based Insurance Program

Please refer to Section 5.2.7 and Appendix J – Community-Based Flood Insurance White Paper, (prepared by Kathleen Schaefer, March 2022) for a more detailed description of this non-structural measure of a community-based flood insurance program that has been recommended for implementation for the short- and long-term as a viable supplement and/or alternative to FEMA's current NFIP.

The City of Isleton has already taken the initial steps in June-July of 2021 to formalize a path for property owners within its city limits to aggregate their resources and establish a community-based flood insurance program that can be used to augment and/or replace the current set of NFIP policies held within the City of Isleton. On March 29, 2022, the Citizens of Isleton held an inaugural Geological Hazard Abatement District (GHAD) meeting as an initial step in launching a Delta Region community-based flood insurance program for the Isleton. The GHAD can be easily expanded to include other nearby Delta Legacy Communities as well as other non-urban

and potentially urban areas within the CVFPP planning area beyond the Lower Sacramento – Delta North RFMP planning area.

7.4.6 NFIP Flood Insurance Enhancements via AFOTF

For a more detailed description of this non-structural measure that is an ongoing, long-term non-structural measure that could be beneficial to all unincorporated, agriculturally based areas within Sacramento County including the communities of West Walnut Grove and Ryde, *refer to* Section 5.2.8.

This non-structural measure developed by the AFOTF *via* its Technical Memorandum of December 28, 2016, has recommended as many as seven administrative refinements of the NFIP to sustain agriculture as a wise use of the floodplain in leveed SFHAs. These seven administrative refinements listed below are consistent with other non-structural measures that have been recommended for implementation. The key elements include the following, of which most are applicable to the agricultural-based City of Isleton and the surrounding study area within BALMD:

1. Levee relief cuts with emergency operation plans and floodplain management ordinance
2. Zone X for certified levee reaches: The partial accreditation of a basin or levee reach could potentially lead to lower NFIP insurance rates as portions of levee systems are approved.
3. Wet floodproofing rules for agricultural structures
4. Insurance rates for nonaccredited levees: The AFOTF recommends that FEMA use sound actuarial science to amend its insurance rates to reflect flood protection provided by a non-accredited levee as documented by a civil engineer.
5. Insurance rates for agricultural structures
6. Insurance rates for wet floodproofed structures
7. Add levee risk management activities to FEMA's CRS

7.4.7 Improve FEMA Community Rating System Score for Sacramento County

Please refer to Section 5.2.10 for a more detailed description of this non-structural measure that is an ongoing, long-term non-structural measure that has been beneficial to all unincorporated areas within Sacramento County including the City of Isleton.

Sacramento County, *via* its floodplain administrator program, is a very active participant of the NFIP, and through its county-wide Flood Protection Ordinance the county strives to reduce flood risks throughout the unincorporated areas of the county while also attempting to reduce NFIP

premium policy rates. Through different flood mitigation activities outlined within the NFIP, the county has been able to reduce flood insurance through the FEMA CRS. The county currently has the opportunity to improve their CRS score to achieve the highest possible Class 1 designation by implementing and participating in EAPs and associated Tabletop Exercises for nearby, upstream dams/reservoirs (namely Folsom Reservoir, and possibly others) that could have a sizeable impact on flooding portions of Sacramento County if said reservoir(s) were to fail and cause flooding. This last jump from a CRS Class 2 to Class l designation would result in the last available 5 percent decrease (from 40 to 45%) in NFIP premiums and would place the county as the 2nd highest ranked CRS community in the entire United States, behind Placer County.

7.4.8 Improved Governance between Neighboring LMAs/RDs and Community

For a more detailed description of this non-structural measure that is a long-term non-structural measure that could be beneficial to the City of Isleton as they come together to potentially work with BALMD, *refer to* Section 5.2.11.

7.4.9 Public Education and Awareness

Please *refer to* Section 5.2.12 and Appendix H for a more detailed description of this non-structural measure that includes three ongoing public education and awareness programs for the Delta Legacy Communities. The noted public education/awareness programs are administered by: (1) the DPC *via* their Delta Flood Preparedness Week hosted each fall season prior to the beginning of each flood season; (2) the Sacramento County Program for Public Information increases flood awareness through informational materials (such as the Storm Ready Booklets) and multiple levels of outreach, ranging from radio spots to specific stakeholder engagement; and (3) the DWR Flood Risk Notification Program that includes sending annual notices in advance of the flood season to every property owner who is located behind a SPFC levee within the Delta. The individual notices include the property owner's address and informs the owners their property may be exposed to potential flood risk from the failure of the levee system. The DWR also suggests each property owner visit DWR's Flood Risk Notification and enter their address to get the most up-to-date information on state-federal levees in their area.[18]

These programs all act as an ongoing, long-term conduit of flood risk information and coordination directly with the community members of Isleton and other nearby Delta Legacy Communities protected by a combination of SPFC and non-SPFC levees.

[18] http://water.ca.gov/myfloodrisk

7.5 Right-of-Way and Easement Considerations/Recommendations

Local preference and planning guidelines in the Delta encourage retention of agricultural lands as much as possible; and the Delta Plan encourages preservation of agricultural land and uses *versus* displacement for commercial or residential uses. The structural-based MA components that could conflict with existing, regional regulations of preserving agricultural lands in the Delta could be those that include seepage/stability berms and possibly the access road/flood-fight berm as noted above in Section 6.3.2.1. Table 6-11 in Section 6.3.2.1 provides a summary of each structural-based MA and the corresponding acreage of agricultural lands that may be displaced with seepage/stability or combination berms, a flood-fight access road/berm, or a cross levee systems.

If the final configuration of structural-based MAs would displace or affect a substantial acreage of important farmland of regional and Statewide significance within the study area it may be deemed inconsistent with the Delta Plan and policies as administered by the DSC and DPC. It should be noted any major construction activity within the Delta would be considered a "Covered Action" under the Delta Reform Act of 2009 within Delta and the CEQA lead agency would be required to submit a written certification of consistency with detailed findings as to whether the covered action is consistent with the Delta Plan. Any person who claims that a proposed "Covered Action" is inconsistent with the Delta Plan may appeal a certification of consistency to the Council. (CWC, § 85225.10).

It should be noted that most landowners in the study area adjoining the existing SPFC and non-SPFC levee systems actually own fee-title land under the levee prism and up to the ordinary high-water mark on the waterside of the levee to maintain their riparian water rights to the Sacramento River and adjoining sloughs. The state and the Sacramento-San Joaquin drainage district retain easements for the SPFC levees; and Caltrans and Sacramento County also retain easements in most locations (*vs.* fee title) where highway and or roadway are overlain on the top of the levee crowns.

Right-of-way (ROW) acquisition quantities were estimated for the multitude of structural-based MAs (*see* Appendix F). In addition to determining costs for acquiring fee title or dedicated easements for various MAs, estimates were also developed for any temporary roadways to divert traffic. ROW was estimated based on review of aerial photography of existing land use and visual ground-truthing to confirm some of the different agricultural uses. ROW acquisition costs as summarized below in Table 7-2 only accounts for the required alignment and doesn't include purchase of full parcels.

The impact of known utilities to be relocated is considered minimal to the larger scope of the project. Unidentified utility relocations are assumed part of the allowance for unlisted items costs. Costs do not include removal and relocation of any existing structure on the landside of the levee, including but not limited to pump stations, residences, etc. The impact of utility crossings on the stability of the levee foundation, embankments, and refinements to associated costs for

mitigation and / or relocation of these crossings will need to be considered during the project design phase.

Table 7-5. Permanent Right-of-Way Cost Estimates per Acre and Structure

Permanent Right-of Way (fee title & Structures)	Unit	Cost (2020 Dollars)
Permanent Right-of Way (fee title) - Seasonal Agricultural Field/ Row Crops	AC	$25,000
Permanent Right-of Way (fee title) - Orchard/ Vineyard	AC	$40,000
Permanent Right-of Way (fee title) - Commercial/ Industrial	AC	$240,000
Permanent Right-of Way (fee title) - Residential	AC	$180,000
Residential structures	Ea.	$250,000
Other structures	Ea.	$75,000

7.6 OMRR&R Considerations

O&M is the traditional term used to describe the routine activities necessary for a functioning flood management system. OMRR&R is a more recently developed term used to describe and include the comprehensive set of non-routine activities that realistically need to occur for the system, and also includes rehabilitation, repair, and replacement.

There is limited legal authority defining the terms repair, replacement, and rehabilitation. However, some guidance can be found in 33 CFR 208.10, and USACE ER 110-2-401. The guidance in these legal authorities in addition to regular practice of the state and LMAs, and the expectations of USACE with regard to OMRR&R throughout the years, seems to indicate that the obligation to perform routine O&M did not significantly expand with the explicit requirement to include the terms repair, replacement, and rehabilitation in new assurance agreements. Promulgated in 1944, the requirements of 33 CRF 208.10 form the foundational requirements for O&M prescribed by the Secretary of the Army that non-federal sponsors give assurances to comply with, and in turn are transferred in entirety from the CVFPB to LMAs through local assurance agreements. These requirements are further stated in Standard Operating Manuals for SPFC facilities which also explicitly include certain “repair” and “replacement” obligations required from the non-federal sponsor.

LMAs are not only faced with insufficient funding to conduct the activities needed to maintain and operate SPFC facilities, but they are also working under conditions, design standards, and environmental regulations that have changed since the flood infrastructure was constructed. These changes have complicated OMRR&R and affected the ability to perform necessary activities needed to ensure a fully functioning flood system. Historically, this was not a major issue because federal programs, including PL 84-99 administered by USACE were relied on to fund necessary repairs associated with damages from significant flood events. However, federal

funding is becoming more difficult to obtain and eligibility requirements for post-event assistance through PL 84-99 are becoming increasingly more difficult to meet.

As part of the 2017 CVFPP Update, DWR prepared an OMRR&R cost estimate to account for more stringent USACE O&M standards, additional USACE RR&R responsibilities, increasing mitigation costs, and correcting original system design deficiencies. In the technical memorandum, the state communicates that although the state may provide non-routine investment in levee improvements, repairs, and rehabilitation when necessary and when funding is available, the responsibility for maintenance lies with LMAs. To support the continued increase in O&M and additional burden of RR&R responsibilities, an assessment will likely be necessary.

OMRR&R costs in the Isleton study area will increase in connection with the implementation and OMRR&R of an all-weather access road/flood-fight berm (MA 3). BALMD and the community will not likely pursue this MA unless there is large support and financial assistance from the community beneficiaries, namely the residences and business owners of the Isleton community. The community will need to conduct a benefit assessment for not only the implementation and construction of the perimeter system around the community but also for the long-term OMRR&R of any community perimeter flood defense system. The community beneficiaries of said perimeter system may not be the likely candidate to perform the OMRR&R, but they need to be prepared to compensate BALMD (or another applicable O&M entity) for any incremental cost of OMRR&R over and above what BALMD may incur without the added presence of the all-weather access road/flood fight berm.

No new substantial OMRR&R costs are anticipated by BALMD (and RD 556) with the implementation of MAs 1, 2, 4A or 5C associated with repairing the known FSRP critical and serious sites, raising and repairing the RD 556 cross levee, and repairing and strengthening-in-place the existing levee system immediately adjacent to the community.

7.7 Regulatory Requirements

Environmental requirements associated with implementation of the preferred MA would include preparation of a CEQA/NEPA document, permits, endangered species consultations, Tribal consultation, and cultural resource assessments and consultations.

The level of CEQA/NEPA documentation required for the preferred MA is dependent on many factors, including the project extent and severity of associated environmental impacts including biological and cultural resources, and air quality and greenhouse gas emissions. Under CEQA, if all impacts can be avoided or mitigated for, then a Mitigated Negative Declaration would suffice for the project. However, in areas where extensive habitat or air quality impacts are unavoidable, then an EIR would need to be prepared. More extensive CEQA documentation would result in a higher cost for analysis and preparation. The required level of NEPA documentation generally

follows CEQA, but in certain instances, a less extensive analysis may be appropriate, depending on the lead federal agency.

Permits such as Clean Water Act Section 404 and 401 permits, approvals under the federal Endangered Species Act and California Endangered Species Act, and a Streambed Alteration Agreement from the CDFW (Section 1600 permit) will be needed, depending on what levee elevation is affected (is work below Mean High Water or Ordinary High Water) and if upland work is conducted in sensitive areas. Prior to beginning the regulatory process for implementation of a proposed element, the following studies would be needed: a wetland delineation of the study area in accordance with the 1987 USACE Wetland Delineation Manual and Sacramento District standards, and focused habitat classification and assessments to determine the potential impacts of the project on special-status species. Conducting the delineation and focused surveys incurs a cost as may any avoidance or minimization measures that may need to be incorporated into project design. Additionally, mitigation for unavoidable effects to sensitive vegetation and wildlife would likely incur a cost associated with on-site or off-site mitigation.

The Districts currently conduct some maintenance activities (repairs affecting up to 100 feet of levee) under a Routine Maintenance Agreement (RMA) with CDFW. The RMA covers maintenance activities for 5 years from the date of issuance, but can often be extended indefinitely, with periodic "touch-up" biological surveys. Depending on project activities, this agreement may be used or a separate 1600 may be required from CDFW. There are several CDFW staff familiar with project activities common to Delta levees maintenance and repairs covered under the Subventions program, and this helps with timely project permitting and implementation.

As described previously, a total of 13 cultural resources were identified during the records search and from information provided by the county of Sacramento. Of those 13 sites, three are historical era archeological sites, one is a tribal cultural landscape, and nine are built environment resources dating to the historic era. Many of the identified resources are along the Sacramento River levee and within the City of Isleton, and therefore near to elements of the proposed MAs, including remediation of levees along the Sacramento River and the flood fight access road. Further evaluation of these resources would need to be conducted to inform final project design and implementation. *See* Appendix C for additional information on cultural resources within the study area.

In addition to complying with environmental regulations, any geotechnical investigations, and subsequent modifications on or within 15 feet landward of any SPFC levee system will require a USACE Section 408 permit approval initiated by the local sponsor through the CVFPB. The sponsor's application must be developed by the local LMA or RD (BALMD) prior to submittal to the CVFPB. Upon receipt by the CVFPB it can take 90 to 120 days to receive approval and a mandatory endorsement by the CVFPB prior to their submittal to the USACE. Upon receipt of the Section 408 application by the USACE it can take at times up to 18 months or more to issue

the Section 408 approval. Thus, it may take up to two years for the local sponsor to gain Section 408 approval after submitting an application to the CVFPB.

7.8 Federal, State and Local Funding Sources and Financial Strategies

The potential federal, state, and local funding sources for the flood risk reduction MAs and non-structural measures identified for the Delta Legacy Community of Isleton identified below in Sections 7.8.1 through 7.8.1 are largely excerpted and updated from the suite of funding sources previously identified in the 2014 Lower Sacramento/Delta North RFMP and the 2017 CVFPP Update. One new additional key federal funding source is FEMA's Building Resilient Infrastructure and Communities (BRIC) program that can channel competitive funds to the small Delta Legacy Communities through the California Governor's Office of Emergency Services (Cal OES) for both structural and non-structural flood risk reduction measures.

Section 7.8.4 also provides a new potential financial strategy identified in May of 2018 by the DPC's Assessment District Feasibility Study and Delta Levees Financing Options. The noted study conceptually identifies feasible funding mechanisms to assess SWP/CVP conveyance fees and potential Delta flood prevention fees associated with improving the outdated Delta levee systems that provide state-wide and regional benefits beyond the Delta Legacy Communities and adjoining agricultural interests.

7.8.1 Federal Funding Sources

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, which evaluate various criteria and generally emphasize the flood damage-reduction benefits typically associated with larger urban area projects. Unfortunately, the small communities and rural areas generally lack the necessary flood risk reduction benefits alone to justify a significant federal interest, unless there are sizeable multi-objectives/benefits that can also be attached to the smaller benefits normally associated with small, rural communities that exist in the North Delta. One sizeable multi-benefit component that has been identified in most all the Sacramento County Delta Legacy communities is repairing and strengthening-in-place the SPFC levee system along the North Delta's freshwater conveyance corridor (Isleton's structural-based MA 5) which will also improve the reliability and resiliency of the through-Delta conveyance of SWP and CVP water through the Delta. Given the constrains of the current approach for evaluating and garnering federal investment for stand-alone flood risk reduction projects, coupled with constrained federal budgets, it may be difficult to secure significant federal investment in the region through the USACE. Furthermore, the evaluation, project identification and appropriation process for USACE projects can be protracted, expensive and can lead to higher project costs that may, in some cases, not be in the best economic interest of local project proponents.

Greater opportunities for federal funding may exist *via* FEMA's emerging BRIC program that can channel competitive funds to small communities through Cal OES. FEMA's BRIC program supports flood risk reduction programs and projects for small, rural communities with smaller, local cost-sharing requirements, particularly for disadvantaged communities. It also enables large multi-benefit infrastructure projects that could possibly be combined with reducing flood risks in the noted North Delta Legacy Communities, including the benefit of improving the long-term reliability and resiliency of through-Delta conveyance of SWP and CVP water through the Delta adjoining the communities. This is particularly applicable for the federal- and state-authorized SPFC levee system in the North Delta adjoining the chain of six Delta Communities, namely Hood, Courtland, Locke, Walnut Grove (East and West) directly adjacent to the Sacramento River SPFC levee system, and the City of Isleton adjacent to the Georgiana Slough SPFC levee system.

Table 7-6 provides a summary of potential federal funding sources to fund both structural-based management improvements and non-structural flood risk reduction measures. The table outlines the general uses of the funding source and the attributes and applicability of the mechanism for flood management.

Table 7-6. Potential Federal Funding Programs

Agency	Program Name (Acronym)	Program Summary	Status	Who is Eligible to Apply	Cost Share Range
FEMA	Building Resilient Infrastructure and Communities (BRIC)	The BRIC program supports hazard mitigation projects, reducing the risks faced from disasters and natural hazards. (Approximately $919M available for local projects spread across entire nation for fiscal year 2021)	Relatively New	Federally recognized Native American Tribes, state governments; city or township governments, county governments *via* Cal OES	Varies 75-90% Highest for small disadvantaged communities (DACs)
FEMA	Flood Mitigation Assistance (FMA)	The FMA grant program provides funding to reduce or eliminate the risk of repetitive flood damage to buildings and structures insurable under the National Flood Insurance Program (NFIP).	Ongoing	Federally recognized Native American Tribes, state governments; city or township governments, county governments *via* Cal OES	Varies 75-100%
FEMA	Pre-Disaster Mitigation (PDM)	The PDM Grant Program is designed to implement a sustained pre-disaster natural hazard mitigation program to reduce overall risk from future hazard events, while also reducing reliance on federal funding from future disasters.	Ongoing	Federally recognized Native American Tribes, state governments; city or township governments, county governments *via* Cal OES	75% 90% for small DACs
USACE/State	USACE/CVFPB Feasibility Studies (USACE FS)	A feasibility report is developed to identify the recommended plan: project scope, economic benefit, and an accurate cost and schedule baseline identified with potential project risks.	Ongoing	CVFPB with a local Sponsor	50% USACE, 50% state and Locals Split
USACE/State	USACE/CVFPB Civil Works Projects (USACE CW)	Upon completion of a USACE feasibility study a Chief's Report is provided to congress. If the Chief's Report is authorized by Congress a local agency can advance a project with the USACE upon securing federal appropriations.	Ongoing	CVFPB with a local Sponsor, 25%	35% Split between CVFPB and local Sponsor
USACE	Sacramento River Bank Protection Project (SRBPP)	The SRBPP is a long-term flood risk management project designed to enhance public safety and help protect property along the Sacramento River and its tributaries.	Phasing Out	Project Levees authorized in the SRFCP	0%

7.8.2 State Funding Sources

In the near term, the State plans to utilize the remaining Proposition 1E bonds authorized to fund projects consistent with the CVFPP last adopted in July 2017 and being updated at 5-year intervals with the next update scheduled for 2022. Within the latest 2017 CVFPP updates, the state identified remaining Proposition 1E and 84 bond funds were not sufficient to meet all the flood protection goals and identified an ongoing need for flood risk reduction within the Central Valley. Additional bond authorizations and greater utilization of state general funds will be needed to meet the goals identified in the CVFPP, particularly for the SCFRRP flood risk reduction components. The SCFFRP component measures for the entire CVFPP study area were estimated between $1.5 to $1.9 billion in the 2017 CVFPP update for the Sacramento Basin alone compared to only $310 to $370M for the San Joaquin Basin. The state Legislature will need to play a significant role, with respect to how state and local funding can be generated particularly within the Delta region, as it considers legislation associated with planned updates to the CVFPP and the associated financing/funding plan recommendations.

Below is an abbreviated excerpt from Section 3.13.1 of California's Flood Future Report of November 2013[19] that suggests levee improvements in the Delta should be orchestrated with improving the conveyance of SWP and CVP water through the Delta to areas south of the Delta where water demands are significantly greater than available water supplies south of the Delta.

> The Sacramento-San Joaquin Delta provides a major source of water supply to more than 60 percent of California residents and is a vital source of water supply for agriculture. The Delta is a unique place defined by its ecological value as the transitional ecosystem from fresh to salt water and by its extensive levee system *(including SPFC levees in the north Delta and several non-SPFC levees in the central and south Delta that convey water to the SWP and CVP pumps in the south Delta)*. The Delta consists of approximately 70 major islands and tracts encompassing approximately 700,000 acres located behind levees. Virtually all assets and attributes of the Delta are dependent upon this large levee system. The levees reduce flood risk to land areas near and below sea level and provide for a network of channels that direct movement of *(SWP and CVP)* water across the Delta. The state of California has significant interest in the benefits provided by Delta levees, which have been legislated in the CWC (§ 12981, for example).
>
> The Delta is unique, not only as a levee system but also as an influence on existing DWR flood management programs within the Delta. The Delta is a prime example of why Integrated Water Management (IWM) is important in California. Due to its location, importance for much of California's water supply, deteriorating ecosystem conditions, questions about levee integrity and feasibility for improvements, and other issues, flood management cannot be considered in isolation of other resource needs. The importance of

[19] 2013 California's Flood Future: Recommendations for Managing the State's Flood Risk – Statewide Flood Management Planning Program – Flood SAFE California - Nov. 2013 https://cawaterlibrary.net/wp-content/uploads/2017/05/California_Flood_Future.pdf

the Delta and its levees to the state has been included many times in legislation and codes. In addition, multiple federal and state processes are underway to solve a variety of resource management problems in the Delta, and several include consideration of levee improvements or other flood MAs. These plans, *including the DCA's current efforts that consider a single-purpose isolated conveyance facility* and the Delta Stewardship Council (DSC) Delta Plan, *may* alter Delta conditions and will influence the future of IWM in the Delta. Implementation of these programs would alter ecosystem conditions and water infrastructure, which would influence Delta flood risk; therefore, flood management in the Delta needs to be considered as part of these larger planning efforts.

Given the above perspective within California's Flood Future Report there should be a larger financial interest in reducing flood risks in the Delta by the USACE, United States Bureau of Reclamation, FEMA, DWR, CVFPB, and Delta water users south of the Delta. This holds true particularly for improving the SPFC levees in the subject north Delta Legacy Community study areas adjoining the SWP and CVP freshwater conveyance corridor along the Sacramento River upstream of the Delta Cross channel, and portions of both Snodgrass and Georgiana sloughs immediately downstream of the Delta Cross Channel.

Other policy efforts that could potentially generate future state funding include the recommendations presented within the current Governor's Water Resiliency Portfolio Water Action Plan. These recommendations include providing support and expanding funding for IWM Planning and Projects, creating incentives for multi-benefit projects, providing assistance to disadvantaged communities, and prioritizing funding to reduce flood risk and improve flood response. In addition to recommendations that could direct state funding to the region, the former Governor's Water Action Plan also identified recommendations that could make it easier to generate local funding including removing barriers to local and regional funding for water projects. One of the key concepts in the Water Action Plan called for the development of a water financing strategy that leverages various sources of water-related project funding and proposes options for eliminating funding barriers, including barriers to co-funding multi-benefit projects.

Table 7-6 provides a summary of potential state funding sources applicable to Delta Legacy Communities protected by SPFC levees. The state funding programs can fund both structural-based management improvements and non-structural flood risk reduction measures. The table outlines the general uses of the funding source and the attributes and applicability of the mechanism for flood management.

Table 7-7. Potential State Funding Programs

Agency	Program Name (Acronym)	Program Summary	Status	Who is Eligible to Apply	Cost Share Range
DWR	Delta Special Projects (DSP)[1]	Cost share grant program for levee maintaining agencies in the Delta to rehabilitate non-SPFC and eligible SPFC levees.	Ongoing	LMA's within the Primary and Secondary Zones of the Legal Delta and limited areas within the Suisun Marsh.	75 to 95% Up to 100% for Habitat Projects
DWR	Delta Levees Subventions (DLS)	Cost share program for the maintenance and rehabilitation of non-SPFC and eligible SPFC levees in the Delta.	Ongoing	LMA's within the Primary and Secondary Zones of the Legal Delta.	Up to 75%
DWR	Flood System Repair Projects (FSRP)	Evaluate (feasibility), design, and construct repairs of non-urban SPFC Facility (levees, channels, structures, etc.) deficiencies	Phasing Out	Eligible applications are local public agencies or Joint Powers Authority	50 to 90%
DWR	Small Community Flood Risk Reduction Program (SCFRRP)	Projects to reduce flood risk in small, rural, and agricultural communities in the Central Valley. Funds support non-routine O&M, O&M plan updates, evaluations, feasibility studies, design, and construction of proactive repairs to flood control facilities of the SPFC and appurtenant non-SPFC levees.	Current	Local agencies: evaluate SPFC facilities must protect small and rural communities in the Central Valley designated by the CVFPP to have a High or Moderate-High Flood Threat Level.	50 to 90%
California Natural Resource Agency	California River Parkways Program (CRPP)	The Proposition 50 California River Parkways Grant Program in the Resources Agency is a competitive grant program for river parkways projects.	Ongoing	Public Agencies and California Nonprofit Organizations	50 to 90%
DWR	Proposition 68	Proposition 68 authorizes $4.1 billion for state and local parks, natural resources protection, climate adaptation, water quality, and flood protection.	Ongoing	Public agencies, non-profit organizations, public utilities, Native American Tribes, and mutual water companies	50% Up to 100% for DACs
DWR	Flood Maintenance Assistance Program (FMAP)	Program that provides state funds for eligible maintenance activities to Local Maintaining Agencies (LMAs) and Maintenance Areas.	Ongoing	LMAs	50 to 75%
IRWM	Integrated Regional Water Management (IRWM)	Grant funds for development and revisions of IRWM Plans, and implementation of projects in IRWM Plans. Goals of Projects: to assist local public agencies to meet long- term water management needs of the state.	Ongoing	Applicant must be a local public agency or nonprofit representing an accepted IRWM Region. Other IRWM partners may access funds if their projects are identified in the Applicable IRWM Plan	Up to 75%

Note: [1] http://www.water.ca.gov/floodsafe/fessro/levees/special_projects/special_projects.cfm

7.8.3 Local Cost Share Funding Sources and Assessment Strategies

The cities, counties, LMAs and the regional flood management agencies have played a significant part in funding the local share of flood management improvements and operations and maintenance. Funding by local agencies within the region is largely limited due to constitutional and statutory constraints to the way local governments can fund and finance capital improvements and services. As noted previously, Attachment I to California's Flood Future Report provides a detailed description of funding mechanisms available to local agencies to fund flood management improvements. In general, revenues for flood management within the North Delta are generated mostly by RDs or LMAs from property-based taxes, fees, and assessments. In California, a local agency's ability to provide ongoing services and invest in its infrastructure is limited by voter-approved initiatives, such as Proposition 13 (1978) (limiting property tax increases) and Proposition 218 (1996) (requiring voter approval for new assessments) as previously discussed above in Constraints Sections 3.3.1 and 3.3.2.

Limited Availability of Local Funding Sources

Presently the RDs and LMAs in the North Delta largely assess O&M and repair of the levee systems on an agricultural acreage basis, and do not necessarily assess on a land improvement basis that accounts for residential, commercial, or industrial structures. The acreage-based only assessment approach is in large part due to the assessment constrictions presented by Proposition 218 as further discussed above in Section 3.3.2. An exception to the acreage-only assessment in the North Delta is RD 563 – Tyler Island who experienced flooding in 1986 and has had subsequent flood fights in 2007 and 2017. RD 563 (encompassing a portion of the East Walnut Grove study area) successfully executed a Proposition 218 benefit assessment in the early 2010's. Following their detailed Proposition 218 benefit assessment study RD 563 now assesses anywhere from $45 to $65/year for agricultural acreage, $550 to $600/year for residential structures, and anywhere from $1,000 to $1,500/year for commercial/industrial groupings of multiple structures, all dependent upon the benefit received from maintenance, repair and improving the levee system designed to eliminate or reduce variable flood depths within RD 563. To improve the local cost-sharing participation by the Delta Legacy Communities for smaller community-specific flood risk reduction measures such as a flood fight berm or a cutoff levee system for the community of Isleton within the larger BALMD basin, it is recommended that the community of Isleton assess themselves on a combined acreage- and structural-benefit basis, similar to RD 563. A benefit assessment study to support improvements that only benefit the community and not the balance of the larger study area will be likely be required; and it is advisable for the community to consider further advancement of GHAD initiated in March of 2022 that could also incorporate a community-based flood insurance program. The community-based flood insurance program coupled with the suggested structural-improvement assessment approach can further enhance the community's ability to buy-down known flood risks (*see* Appendix J regarding a community-based flood insurance program for the Delta Legacy Communities in Sacramento County coupled with a community benefit assessment to generate local cost-share funds and assist with financing flood risk reduction measures).

Table 7-8 provides a summary of the local funding methods used by many agencies in California and the region to fund flood management improvements and services. The table describes the general uses of the funding source and the attributes and applicability of the mechanism for flood management. Included within these sources, many LMAs and RDs within the Delta, such as BALMD where the community of Isleton is located, fund ongoing O&M and repairs of levees *via* the Delta Levee Subventions program and/or the Delta Levees Special Projects, both of which are administered by DWR. These programs are reimbursement-based administered by DWR and have minimum deductible cost per levee mile, and can include substantial local, up-front cost-share cashflow requirements. Thus, it is important to the communities within the existing RDs to know that they may need to assist with said RD levee improvements that provide direct and/or indirect flood risk reduction benefits to the community.

Table 7-8. Potential Local Funding Programs and Assessment Strategies

Potential Local Funding Programs and Assessment Strategies						Pros, Cons, and Notes		
Item	**Use**	**Voter Approval**	**Bonds Allowed**	**Long/ Short Term**	**Entity**	**Pro**	**Con**	**Notes**
Geological Hazard Abatement Districts (GHAD)	O&M/ Capital Improvements	50% of Property Assessed	Yes	Long-Term	Independent District / Community	Broad scope of works, locally autonomous, Simple Majority Approval, Ongoing Funding Source. Some CEQA exemptions	Must prepare Plan of Control. Creates new responsible independent entity (similar to JPA), Prop 218 applies with respect to assessments levied.	Alternative to RD. Can fund reserves & Community-Based Insurance Program
Various Water Code Sections	O&M/ Capital Improvements	50% by Property Assessed	No	Long-Term	RDs & Community	Simple Majority Approval, Ongoing Funding Source	Applicability of Prop 218 - Must Show Benefit	Can fund maintenance or capital works. Can be used to finance improvements.
Benefit Assessment District Act of 1982	O&M/ Capital Improvements	50% of Property Assessed	No	Long-Term	Flexible	Simple Majority Approval, Ongoing Funding Source	Must Show Benefit Improvements /Services must be within the Boundary	Could provide some reimbursement of Advance Funding
Municipal Imprvmt. District Act of 1913 /1915	Capital Improvements	50% of Property Assessed	Yes	Long-Term	Flexible	Simple Majority Approval, Ongoing Funding Source	Must Show Benefit Improvements /Services must be within the Boundary	Could provide some reimbursement of Advance Funding

Community Facilities Districts	O&M/ Capital Improvements	2/3's (*See* Note)	Yes	Long-Term	Flexible	Benefit not Needed, Flexible in Forming District, Improvements located anywhere	2/3 Approval Difficult to Obtain	Voting requirements change depending on presence of registered voters within boundary.
Advance Funding	Planning & Capital Improvements	NA	NA	Short-Term	N/A	Can cover upfront planning and operations costs	Limited/Uncertain Availability	Could be subject to reimbursement from various sources over time.

7.8.4 Potential Financial Strategy Identified by Delta Protection Commission (DPC) for Delta Levee improvements – May 2018

In May of 2018 the DPC[20] conducted a study that identified a potential financial strategy, inclusive of potential mechanisms to have out-of-Delta beneficiaries such as the SWP/CVP water contractors pay for levee maintenance and improvements that enhance the reliability and resiliency of the Delta levee system(s) that help convey freshwater through the Delta.

Below are excerpted acknowledgments and conclusions of the Delta Flood Risk Management Assessment District Feasibility Study conducted by consultants to the DPC in May of 2018.

The noted financial strategy acknowledges that "*only local landowners pay directly for levee improvements and maintenance by assessments or taxes paid on their property. Other beneficiaries of Delta levees are not explicitly recognized, and only pay indirectly for levee benefits to the extent that their taxes contribute to the General Fund. To move to a beneficiary-pays approach, the State would need to estimate the different public and private benefits and collect fees or taxes from the beneficiaries where administratively feasible. As a result, some beneficiaries that currently receive private benefits but do not directly pay for levees could be required to pay. These include water suppliers and users, as well as owners and users of cross-Delta infrastructure*."

The study conducted by the DPC *"demonstrates that no single financing mechanism is likely to generate sufficient revenues to pay for the Delta's flood risk management needs consistent with the beneficiary-pays principle. In addition, none is consistent with the recommendation in the Delta Plan to establish a Delta Flood Risk Management Assessment District."* The DPC's *"study illustrates the complex challenges of developing revenue-raising approaches within California's existing web of legal and regulatory constraints on fees, taxes, and assessments. These challenges include identifying the beneficiaries, determining the economic values of their benefits, and finding the best set of financial mechanisms that can collect revenues. The new mechanisms identified" ……"were evaluated at a high level, sufficient to draw broad conclusions about feasibility, but lacking sufficient details to be considered more than*

[20] Delta Protection Commission (DPC). May 17, 2018. Delta Flood Risk Management Assessment District Feasibility Study and Delta Levee Financing Options. Available at: https://delta.ca.gov/levees/

conceptual at this point. Additional challenges lie ahead if the State moves forward with further development and evaluation - these include determining the levee improvements needed and associated costs, the benefits derived from such improvements, the time frame of the investments and revenue stream needed to pay for those investments, how to disburse revenues in a manner that ensures those that paid receive benefits commensurate with their level of contribution, and the appropriate government agencies to implement the various financial mechanisms.

Although the principle of "beneficiary-pays" has long been discussed as a basis for paying for water infrastructure "……, "the State has not adopted policies or principles for an alternative to bond funding for Delta levees." The DPC's study "describes the concept of a beneficiary-pays funding system, with a focus on legal constraints and cost allocation issues, and identifies feasible financial mechanisms for further study."

Figure 7-1 below, excerpted from the DPC's levee financing feasibility study, shows the current financing approach with the existing mechanisms as they apply to the main categories of beneficiaries. Figure 7-2, also excerpted from the same feasibility study, shows how a beneficiary-pays system could add one of three new fees to the current financing approach to cover more beneficiaries directly. The DPC's study indicates *"further quantitative analysis and deliberation among stakeholders will be needed to determine the most appropriate portfolio of mechanisms and how they should be implemented"*.

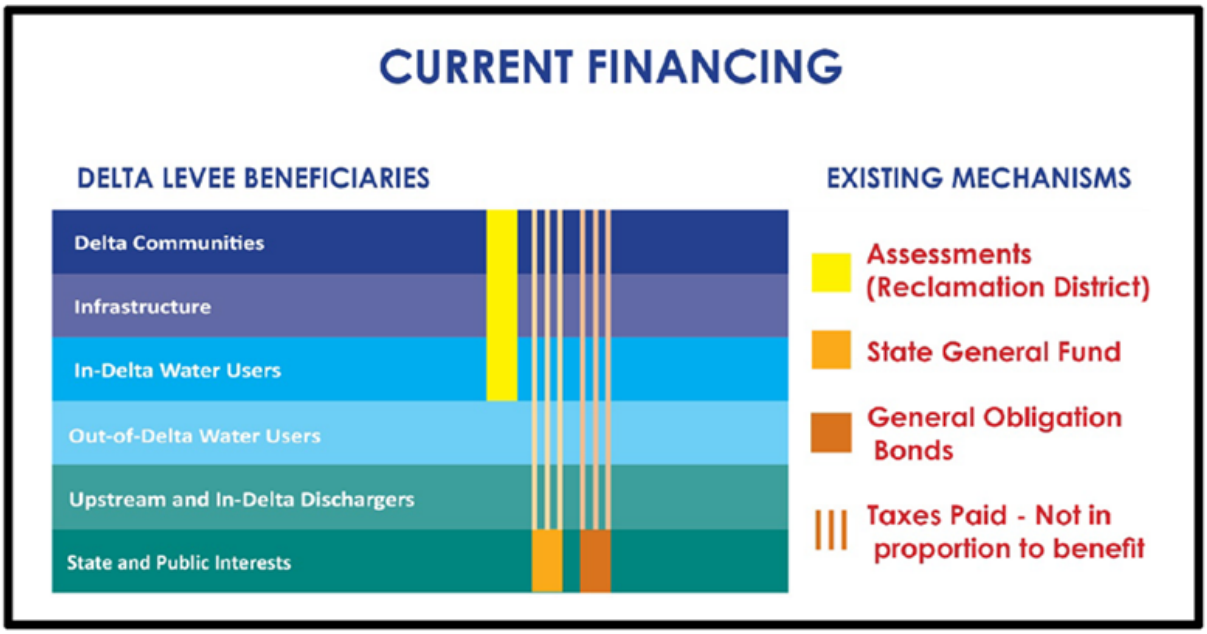

Figure 7-1. Current Financing Strategy for Delta Levee Improvements with Existing Mechanisms Identified by Delta Protection Commission

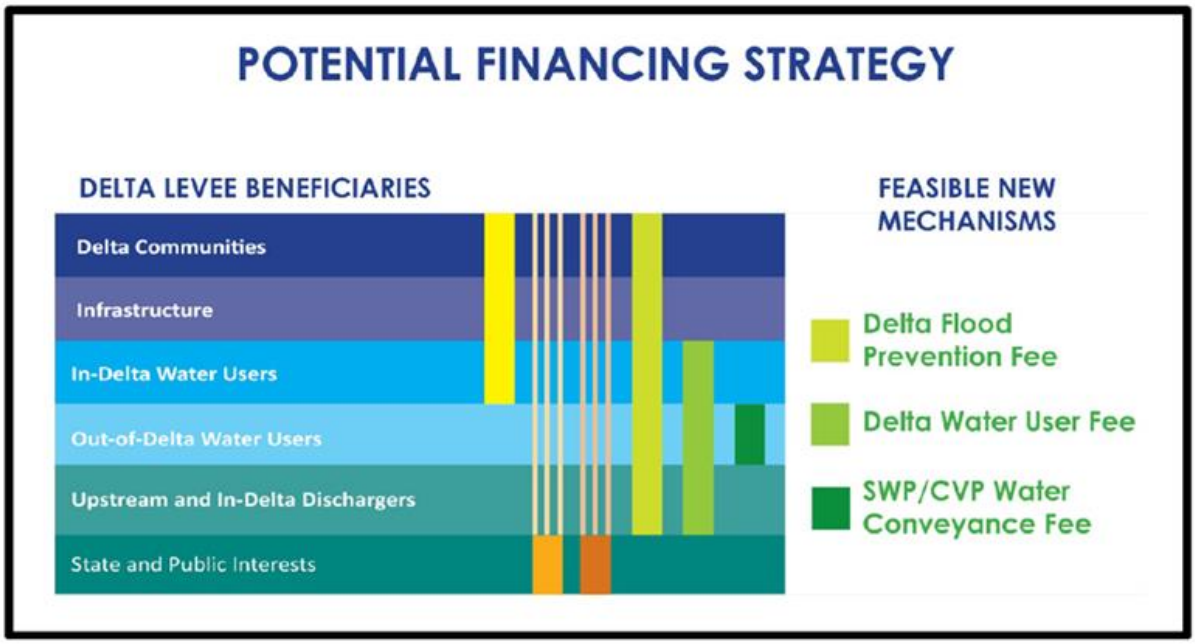

Figure 7-2. Potential Financing Strategy for Delta Levee Improvements with Feasible New Mechanisms Identified by Delta Protection Commission

7.9 Financial Feasibility and Local Cost Share Requirements for Key Management Actions

7.9.1 Financial Feasibility Summary Utilizing EAD Evaluations

The net reductions in EAD and financial feasibility values (in pay-back periods) and Benefit-Cost Rations for most of the key recommended short-term and long-term structural-based MAs are described above in Section 6.3.1.2. The evaluations, inventory values, and methodology are presented in Appendix E.

The summary of the EAD results indicating net reductions in EAD values and the return period(s) of investment (in years) for various structural based MAs are summarized in Table 6-9 for existing conditions without climate change adjustments, and Table 6-10 for future conditions that include adjustments for climate change.

The EAD values in Table 6-9 under existing conditions indicate there is a great net reduction in EAD values in the amount of $18.2M that could result from MAs 1B and 1C alone by repairing the outstanding FSRP serious repair sites in the amount of $2.3M, indicating a short payback period of less than 2 months. MA 3 consisting of an all-weather flood fight access road around the community of Isleton in the amount of up to $5.9M will result in a net reduction in EAD in the amount of $5.7M for the entire study area, also indicating a short payback period of around 1 year. The challenge with implementing MAs 6, 11, and 12 with longer payback periods well beyond 10 years is the benefit area(s) coming up with the local cost-share components from not

only BALMD, but also from the limited amount of citizens and businesses residing in the community of Isleton who will benefit from said repairs or improvements.

7.9.2 Conceptual Local Cost Share Financing and Assessment Strategies

Implementing any of the above MAs, including the flood risk reduction measure of implementing a simple access road/flood fight berm around the community (MA 3) with a payback period estimated at 1 year, will still require a local cost share of at least 5 to 10 percent. This could be a large challenge, particularly if said MAs do not provide a direct benefit to the balance of the larger 12,800-acre study area beyond just the immediate community area of Isleton encompassing only 190 acres. Assessments can only be levied where there is direct benefit received from anyone of the proposed MAs.

For MAs benefiting the entirety of the study area totaling approximately 12,800 acres there still is a challenge with developing the required local cost share to participate in the noted federal and state grant programs identified above in Sections 7.8.1 and 7.8.2. Assuming that 80 percent of a local cost-share could be financed with the other 20 percent acquired in accumulated proceeds from an assessment, only 1 to 2 percent of the total cost of each MA will be required from BALMD, the community of Isleton, or some combination thereof for those MAs which reduce flood risk for the larger BALMD basin. As described above in Section 7.8.3, this local cost share could be generated through a conventional acreage-based assessment deployed by either the City or BALMD, as well as a structural benefit basis, similar to what RD 563 accomplished on Tyler Island in the early 2010's with their Proposition 218 benefit assessment to fund substantial levee repairs/improvements.

Provided below in Table 7-9 is a conceptual analysis of local cost-share assessments and corresponding local pay-back periods for select MAs. A simple conventional agricultural assessment of $15 per acre over the entire BALMD basin could generate up to $192,000 per year. Without any additional structural assessments and/or assessment developed separately by the community of Isleton, the total number of years for the RD to acquire cash and secure financing for a 5 percent cost share and pay back the financed amount to repair the DWR FSRP serious erosions site (MAs 1B and 1C) is estimated at 7 months. If a cost-share of 10 percent was required, the entire payback period could be doubled to 1.5 years utilizing the acreage-based only assessment. However, if there was a structural benefit assessment implemented the payback could be shortened.

The local cost share for the all-weather flood fight access road (MA 3) could be generated through a similar acreage assessment paired with a structural benefit assessment within the immediate community of Isleton. By assessing the total acreage (190 acres) just within the community of Isleton at $80 per acre, an estimated $15,200 per year could be generated. Similarly assessing residential, commercial, and industrial structures just within the community, at $300 per residential structure and $400 per commercial or industrial structure (to be refined in more detailed during a benefit assessment study), could generate up to $140,200 per year. With

these assessments totaling $155,400 per year, it would take less than 5 months to acquire cash to secure local cost share financing for the all-weather access road/flood fight berm, and another 1.5 years to pay back the financed amount. Again, these payback periods could be doubled if a 10 percent cost share requirement is needed instead of the nominal 5 percent local cost-share scenario that is presented in Table 7-9.

Assessing all of the acreage in the RD 3 basin at $15 per acre along with all of the residential, commercial, and industrial structures in the basin (at $300 per residential structure and $400 per commercial or industrial structure) could be used to generate local cost-share for the more basin-wide, comprehensive MAs 5 and 12. These assessments could generate up to $470,000 per year, of which a portion of the residential assessment would be borne by the community of Isleton and the remainder would be borne by BALMD as shown below in Table 7-9. At an estimated cost of $106M to repair and strengthen the entire 6.0 miles of SPFC levees along Georgiana Slough between the boundary with RD 556 and the Mokelumne River (Multi-Benefit MA 5), it could take just over 2 years to accumulate enough assessment to secure local cost-share financing and up to 9 years to pay back the financed amount. This assumes there is only a small 5 percent cost share requirement, and the assessments remain as indicated in Table 7-9. To certify the entire perimeter levee system to FEMA's current 100-year levee accreditation standards for the entire Isleton study area (MA 12) using only the assessments described above, it could take approximately 8 years to just acquire cash to the secure local cost-share financing. Similarly, securing 100-year FEMA certification by repairing and strengthening the levees along the left bank of the Sacramento River and the right bank of Georgiana Slough within the study area north of Highway 12 in concert with a cross levee along Highway 12 could require nearly 30 years to just acquire cash to secure local cost-share financing. Thus, there needs to be a long-range financial plan developed by the community of Isleton and the greater North Delta interests on how they can seek additional funds to partner with other benefiting agencies, particularly for the multi-benefit MA 5 associated with improving the resiliency and reliability of conveying SWP and CVP water adjacent to the SPFC levee system in the North Delta, but also for improving all of the collective study area SPFC and non-SPFC levee segments if it is ultimately desired to have the entire study area meet FEMA's current 100-year levee accreditation standards.

Table 7-9. Conceptual Analysis of Isleton Local Cost-Share Assessments and Local Pay-Back Periods for Select Management Actions

		Management Action (MA)							
		Repair all 5 remaining DWR FSRP Sites in Isleton Project Area: **(MAs 1A, 1B, & 1C)**	All-Weather Flood Fight Access Rd. for the City of Isleton **(MA 3)**	Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough **(MA 5C, 5D, 5E)**	Larger Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP **(MA 6A)**	Smaller Cross Levee System with a Potential Multi-Objective Setback Levee at Oxbow Marina **(MA 6B)**	Isleton Sphere of Influence Cross Levee System **(MA 6C)**	Secure 100-Year FEMA Certification for the Community of Isleton with an Elevated Highway 12 Cross Levee Paired with 14.6 Miles of Perimeter Levee Improvements North of Highway 12 **(MA 11)**	Secure 100-Year FEMA Certification for the Entire BALMD Study Area Inclusive of the Community of Isleton – 25 miles of Perimeter Levee Improvements **(MA 12)**
Estimated Cost (Low)		$2,336,000	$5,898,000	$76,768,000	$112,602,000	$103,498,000	$124,257,000	$354,609,000	$282,655,000
Estimated Cost (High)		$2,336,000	$5,898,000	$106,536,000	$118,923,000	$108,923,000	$131,938,000	$390,923,000	$387,508,000
Net Reduction in EAD to Isleton Study Area, Existing Conditions		$18,219,000	$5,762,000	--	$6,073,000	$6,073,000	$6,073,000	$19,458,000	$19,187,000
Net EAD Reduction in EAD to Isleton Study Area, Future Conditions		$65,151,000	$26,917,000	--	$28,867,000	$28,867,000	$28,867,000	$75,428,000	$70,615,000
Flood Risk Reduction Payback Period (in Years: Future – Existing Conditions)		< 0.1 - 0.3 Years	0.2 - 1.0 Years	--	4.1 – 20 Years	3.8 – 17.9 Years	4.5 – 22 Years	6.7 – 21 Years	5.4 – 22 Years
Local Responsibility (Lead **Assessed**/Support)		**BALMD**	**Community of Isleton**	**BALMD**/ Community of Isleton	**BALMD**/ Community of Isleton	**BALMD**/ Community of Isleton	**BALMD**/ Community of Isleton	**BALMD**/ Community of Isleton	**BALMD**/ Community of Isleton
Local Cost Share	5% of Total Cost	$300,000	$295,000	$5,327,000	$5,946,000	$5,447,000	$6,597,000	$19,546,000	$19,194,000
	80% Local Financed (4% Total Cost of MA)	$240,000	$236,000	$4,261,000	$4,757,000	$4,358,000	$5,278,000	$15,637,000	$15,355,200
	20% Local Cash Needed (1% Total Cost of MA)	$60,000	$59,000	$1,065,000	$1,189,000	$1,089,000	$1,319,000	$3,909,000	$3,839,000.00
Acreage Assessment[1]		$192,000	$15,200	$192,000	$86,400	$60,800	$88,000	$76,800	$192,000
Residential Assessment[2]		--	$105,000	$105,000 (Isleton) $116,700 (BALMD)	$105,000	$105,000	$105,000	$46,680	$105,000 (Isleton) $116,700 (BALMD)

	Management Action (MA)							
	Repair all 5 remaining DWR FSRP Sites in Isleton Project Area: **(MAs 1A, 1B, & 1C)**	All-Weather Flood Fight Access Rd. for the City of Isleton **(MA 3)**	Repair and Strengthen-in-Place SPFC Levee along the Right Bank of Georgiana Slough **(MA 5C, 5D, 5E)**	Larger Cross Levee System Adapted from the 2012 CVFPP and 2014 RFMP **(MA 6A)**	Smaller Cross Levee System with a Potential Multi-Objective Setback Levee at Oxbow Marina **(MA 6B)**	Isleton Sphere of Influence Cross Levee System **(MA 6C)**	Secure 100-Year FEMA Certification for the Community of Isleton with an Elevated Highway 12 Cross Levee Paired with 14.6 Miles of Perimeter Levee Improvements North of Highway 12 **(MA 11)**	Secure 100-Year FEMA Certification for the Entire BALMD Study Area Inclusive of the Community of Isleton – 25 miles of Perimeter Levee Improvements **(MA 12)**
Commercial/Industrial Assessment[3]	--	$35,200	$35,200 (Isleton) $21,200 (BALMD)	$35,200	$35,200	$35,200	$8,480	$35,200 (Isleton) $21,200 (BALMD)
Total Annual Assessments	$192,000	$155,400	$470,100	$226,600	$201,000	$228,200	$131,960	$470,100
Number of Years to Acquire Cash to Secure 5% local Cost-Share Financing	0.3 Years	0.4 Years	2.3 Years	5.2 Years	5.4 Years	5.8 Years	29.6 Years	8.2 Years
Number of Years to Pay Back Financed Amount	1.3 Years	1.5 Years	9.1 Years	21.0 Years	21.7 Years	23.1 Years	118.5 Years	32.7 Years
Total Payback Years	1.6 Years	1.9 Years	11.4 Years	26.2 Years	27.1 Years	28.9 Years	148.1 Years	40.9 Years

Notes: The assessed values indicated below are very preliminary in nature per acre and/or per the various structures. A full benefit assessment study will be needed to determine actual assessment values. Changing the acre-assessed values and and/or the structure benefit-assessed values will obviously impact the estimated pay back periods presented herein.

[1] Acreage assessment assessed at $15/acre for RD BALMD (12,800 acres); and $80/acre for the community of Isleton (190 acres)

[2] Residential assessment utilizes the total number of residential structures located within the community of Isleton from the 2022 CVFPP Update, assessed at $300 per structure

[3] Commercial/industrial assessment utilizes the inventory of structures from the 2022 CVFPP Update, assessed at $400 per commercial and industrial structures (to be refined later based upon benefit values, that can be partially based upon sq. feet and elevation of structures, and maximum potential depth of flooding)

8. Implementation Recommendations

8.1 Implementation Schedule including Roles and Responsibilities

The community of Isleton, with support from BALMD, has the opportunity to significantly reduce flood risks to the community and the larger study area including BALMD. Isleton and BALMD intend to accomplish this by: (1) repairing and strengthening-in-place the greatest known DWR documented weaknesses in the perimeter SPFC levee system along the left bank of the Sacramento River and along the right banks of Georgiana Slough, and the Mokelumne and San Joaquin rivers protecting the Isleton study area and, (2) potentially constructing an all-weather access road/flood-fight berm to further protect the community of Isleton in the event a levee breach were to occur in the study area but outside of the community.

As its highest priority (MA 1), the community of Isleton would prefer to see the well documented DWR FSRP critical and serious sites repaired with support from DWR and BALMD within the next few years, by 2024. The repair of the DWR FSRP critical and serious sites (estimated at $5.9M) will result in a net reduction in EAD of approximately $18.2M for the entire study area under existing conditions. The benefit of these projects is nearly four-fold under future conditions with an estimated net reduction in EAD for the entire study area of over $65M as a result of the effects of inland climate change and sea level rise.

Following remediation of the noted FSRP sites, the community would like to see the 1.4 to 1.6 miles of SPFC levee immediately adjacent to the City of Isleton (downstream of the Isleton Highway 160 bridge crossing) fortified within the next 5 to 10 years to meet current FEMA accreditation standards (MA 4A) at a cost of approximately of $20M. This action alone would not represent a substantial, incremental reduction in EAD values within the study area, but it would substantially reduce the potential for life loss if a levee breach were to occur anywhere along this SPFC levee segment along the left bank of the Sacramento River adjacent to the community of Isleton. This MA, inclusive of a seepage cutoff wall, would also have the multi-benefit of significantly reducing infiltration and inflow to the City's wastewater collection system.

To achieve the noted reductions in flood risk the following recommendations include full development of the structural-based MAs, including improving the SPFC levee system to meet current, FEMA 100-year accreditation standards, advancing non-structural measures, and developing multi-benefits that will improve the reliability and resiliency of conveying SWP and CVP water in the North Delta downstream of the Delta Cross Channel. They are outlined below and are planned to secure financial assistance and concurrence with DWR, the CVFPB, the USACE, and the Conservancy. They are also developed to confirm consistency with Delta Plans administered by the DPC and the DSC to reduce known flood risks in the North Delta. The following recommendations can be sequenced or phased in the order as listed below or amended

based upon variable funding sources. However, it is recommended the first two recommendations take priority for initiating all immediate, short-term structural-based MAs, with all other recommendations not tied to any specific phasing or prioritization, with several non-structural measures already partially implemented.

1. In connection with executing repairs to the known FSRP critical and serious sites throughout BALMD (structural-based MA 1), BALMD is executing these projects with some State assistance based on their limited annual budgets for repairs either through Delta Levees Special Projects and/or Subventions.
2. Consistent with the approach outlined above for correcting the known FSRP sites associated with MA 1, BALMD should also earmark nominal funds, with the possible assistance from DWR and the community of Isleton, to address the extent of erosion repairs on the SPFC levee system along the left bank of the Sacramento River and the right bank of Georgiana Slough. Funds should also be earmarked by BALMD and the City to fund the design, permitting and CEQA/NEPA documentation for the applicable repairs so the repairs are shovel-ready when larger funding sources become available either through Delta Levees Special Projects and/or Subventions in addition to other grant programs that may be available.
3. The community of Isleton, with support from BALMD and the State, should seek funds *via* community block grants funds or other sources to fund a Proposition 218 election that may be required to raise local cost-share funds for developing the applicable local cost share for flood risk reduction actions that have community-specific benefits over and above those that are more beneficial to the larger BALMD basin and the Isleton study area. The community-specific flood risk MAs that could significantly reduce life loss and potential damages in Isleton due to flooding in the community include strengthening-in-place the Sacramento River and Georgiana Slough SPFC levees immediately fronting/adjacent to the community (MAs 4 and 5, respectively). These community-specific levee improvements could be paired, as recommended, with an accompanying all-weather access road/flood-fight berm (MA 3), which would require planning and financing beyond the current responsibilities of BALMD. The local cost share of said community-specific flood risk reduction measures could also be partially funded *via* a GHAD, and/or community-based flood insurance program as another relatively near-term non-structural measure, as noted further below.
4. To implement MAs 4 and 5, geotechnical explorations will be required in advance of preparing preliminary designs and advancing permits and supporting CEQA/NEPA documentation. It is recommended that that the communities, with the support of Sacramento County and others, work with BALMD to identify potential funding sources and advance said geotechnical explorations, remediation designs, and environmental documents so this MA is closer to shovel-ready when funds may become more readily available.

5. The community of Isleton should work closely in the near-term with other Delta Legacy Communities in Sacramento County, particularly other DWR SCFRRP participants, fellow agency members of the Lower Sacramento - Delta North RFMP, and DWR to establish a GHAD or HOA to advance a private, community-based flood insurance program that would effectively provide relief from the ever-increasing high NFIP rates and possibly support the implementation of the access road/flood-fight berm (MA 3). The City of Isleton has taken the initial steps in developing a community-based flood insurance program, and it will be more cost effective (resulting in significantly lower insurance premiums than offered by the NFIP) if there were more nearby communities pooling their resources together and aggregating or spreading their potential flood losses over a larger pool of insureds. The timely development of said GHAD or HOA would not only serve to substantially reduce flood insurance rates, but it could serve as a vehicle to generate local cost-share funds to buy-down flood risks within the community that is currently assessed by BALMD on an acreage only basis, *versus* a flood risk value tied to structure improvements and content values. The private, community-based flood insurance program could also fund regional programs or local cost-share requirements to buy-down risks at the regional level, including larger, long-term multi-objective components such as improving the portion of the SPFC levee system along the right bank of Georgiana Slough (MA 5).

6. In connection with implementing the multiple-benefit project of improving the 6.0 miles of SPFC levee in the project area that will also improve the reliability and resiliency of conveying SWP and CVP water in the North Delta (MA 5) it is recommended that community representatives pool their resources together with other participating Delta Legacy Communities in the North Delta. Improving the SPFC levees to current, modern FEMA standards to address seepage, under seepage, and stability will also serve to improve the reliability and resiliency of conveying SWP and CVP water through the North Delta with or without the DCA's current tunnel and intakes proposal. The noted communities and regional stakeholders have been approached by the DCA regarding their Communities Benefits Program, and the Delta Legacy Communities have suggested improving the SPFC levee system, particularly upstream of the Delta Cross Channel is necessary with or without the proposed DCA. It is suggested that the City of Isleton, and its neighboring Delta Legacy Communities particularly in Yolo and Sacramento Counties, work with RFMP representatives, including Sacramento Area Flood Control Agency, the West Sacramento Flood Control Agency, the CVFPB and DWR MA 9 to share and ideally implement their preferred alternative of how improving the limited number of SPFC levee miles in the North Delta along the Sacramento River corridor in the North Delta will also improve the reliability and resiliency of conveying SWP and CVP water through the entire Delta, with or without an independent isolated conveyance facility. *See* Appendix K for further details in support of the multi-benefit opportunities associated with MA 5 identified by the Sacramento County Delta Legacy Communities associated with reducing flood risks combined with improving SWP water conveyance through the Delta.

7. Concurrently with implementing the near- and long-term structural-based MAs, the community of Isleton, with assistance from Sacramento County, BALMD, and others, can implement the following non-structural measures to further reduce residual flood in the Isleton study area. All of the non-structural measures for implementation are described in more detail in Sections 5.2 and 7.3. The following non-structural solutions are highly recommended for implementation, some of which are already in the early stages of implementation:
    1. Flood Fight Access Road
    2. Voluntary Elevation of Structures
    3. Wet or Dry Floodproofing
    4. Flood Emergency Safety Plans
    5. Sacramento County OES Decision Support Tool
    6. Local Hazard Mitigation Plan and Relief Cuts
    7. Alternatives to FEMA's NFIP – Private, Community-Based Flood Insurance
    8. NFIP Flood Insurance Enhancements *via* AFOTF
    9. Improve FEMA's CRS Score for Sacramento County/Isleton
    10. Land Use Regulations and Limitations
    11. Improved Governance Between Neighboring LMAs/RDs
    12. SWIFs & Periodic Inspections with USACE
    13. Public Education/Public Awareness

8.2 Delta Regulatory Compliance, Delta Investment Priorities, and Additional Studies & Plans

8.2.1 DSC Consistency Determination Required with Delta Plan and Qualifying Covered Actions

The Sacramento-San Joaquin Delta Reform Act of 2009 (Delta Reform Act) established a certification process for demonstrating consistency with the Delta Plan. The Delta Reform Act requires any state or local agency proposing to undertake a qualifying action (covered action) must submit to the Delta Stewardship Council (DSC) a written certification of consistency with detailed findings as to whether the covered action is consistent with the Delta Plan (Wat. Code, § 85225). ***The certification of consistency needs to demonstrate the project or covered action is consistent with the Delta Plan's co-equals goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals are to be achieved in a manner that protects and enhances the unique cultural, recreational, natural resources and agricultural values of the Delta as an evolving place.***

As a component of demonstrating consistency of covered actions with the Delta Plan all levee projects must evaluate and where feasible incorporate alternatives, including the use of setback levees, to increase floodplains and riparian habitats. ***Evaluation of setback levees in the Delta shall be required along the Sacramento River between Freeport and Walnut Grove and other locations as shown in Appendix 8 of the Delta Plan.*** This Delta Plan policy considers construction of new levees or substantially rehabilitate or reconstruction of existing levee systems as covered actions. This policy language relative to expanding floodplains and riparian habitats in levee projects within the Delta was last amended by the DSC and included in the California Code of Regulations in 2019. Thus, prior to undertaking any substantial levee rehabilitation projects located between Freeport and Walnut Grove the project proponent, whether it is a local community, RD, LMA, or any other local/state entity, it should consult early with the DSC regarding the applicability of evaluating setback levee alternatives in tandem with substantial levee rehabilitation efforts as considered in this Feasibility Study Report; and then the project proponent should be prepared to file a consistency determination upon completion and adoption of the applicable final CEQA/NEPA documents.

8.2.2 Alignment with DSC's 3x3 Prioritization of State Investments in Delta Levees and Flood Risk Reduction

As previously highlighted in Section 4.3.2, the Delta Legacy Communities and their cost-share partners investing in substantial levee repairs, improvements, and rehabilitation efforts, including increased OMRR&R expenditures, should be structured as outlined in this feasibility study report, to be most responsive to the DSC's 3x3 Prioritization of State Investments in Delta Levees and Risk Reduction. The 3x3 prioritization table for levee investments is presented in Section 4 and is highlighted below in Table 8-1. The 3x3 table is highlighted below in five of the nine cells indicating that most structural-based management actions and non-structural measures proposed for implementation for the community of Isleton are most responsive to the DSC's Prioritization of State Investments in Delta levees and risk reduction. Isleton's Management Action 5, consisting of the multi-benefit project of repairing and strengthening-in-place 6.0 miles of the SPFC right bank levee of Georgiana Slough within the BALMD-Isleton project study area also has the added benefit of improving the resiliency and reliability of the freshwater conveyance corridor aqueduct that conveys SWP and CVP water through the Delta.

See Section 3.1.3, Figure 3-3, Section 3.2.4, and Appendix K for further details in support of the multi-benefit opportunities associated with Management Action 5 identified by the Isleton and the Sacramento County Delta Legacy Communities associated with reducing flood risks combined with improving SWP water conveyance through the Delta.

Although not fully exhausted through this current feasibility study effort, it is recommended that Isleton and its cost-sharing partners further explore ecosystem conservation opportunities that may protect existing and provide net enhancements to floodplain habitat.

Table 8-1. 3x3 Goals of the DSC for State Investment in Delta Integrated Flood Management

Goals	Localized Network	Levee Network	Ecosystem Conservation
1	Protect existing urban and adjacent areas by providing 200-year flood protection.	Protect water quality and water supply conveyance in the Delta, especially levees that protect freshwater aqueducts and the primary channels that carry fresh water through the Delta.	Protect existing and provide for a net increase in channel-margin habitat.
2	Protect small communities and critical infrastructure of statewide importance (located outside of urban areas).	Protect floodwater conveyance in and through the Delta to a level consistent with the SPFC for project levees.	Protect existing and provide for net enhancement of the floodplain habitat.
3	Protect agriculture and local working landscapes.	Protect cultural, historic, aesthetic, and recreational resources (Delta as Place).	Protect existing and provide for net enhancement of wetlands.

8.2.3 Additional Ongoing Studies and Plans

CVFPP and Lower Sacramento-Delta North Regional Flood Management Plan (RFMP) Updates

As recommended above in Section 8.1 the Community of Isleton, including BALMD, and the greater collection of Delta Legacy Communities in the north Delta need to be more engaged within the ongoing Lower Sacramento-Delta North Regional Flood Management Plan (RFMP) planning efforts that will feed into subsequent CVFPP updates beyond 2022. To secure funding from regional, state, and federal interests to reduce Isleton's flood risks the community representatives and Sacramento County floodplain administrators need to be included and be a part of the Lower Sacramento-Delta North RFMP planning efforts. This is particularly important in light of receiving federal and state funds that could potentially be channeled through the CVFPP and CVFPB for structural-based management actions and/or non-structural measures that could be authorized by the USACE and provide multi-benefits to not only the community of Isleton but to the greater Delta region and statewide interests. As previously stated, improving the SPFC levees to current, modern FEMA engineering standards to address seepage, underseepage, and stability will also serve to improve the reliability and resiliency of conveying SWP and CVP water through the North Delta with or without the DCA's current tunnel and intakes proposal. It is suggested that the community of Isleton and its neighboring Delta Legacy Communities, particularly in Yolo and Sacramento Counties, work closely with RFMP representatives, including SAFCA, WSAFCA, DWR MA 9, and the CVFPB to share and ideally implement their preferred alternatives of improving the limited number of SPFC levee miles in the North Delta along the Sacramento River in the North Delta will also improve the reliability and resiliency of conveying SWP and CVP water through the entire Delta. This approach needs to be integrated into the ongoing planning efforts within the Lower Sacramento-Delta North

RFMP, which has and will continue to be a vehicle for implementing projects through the CVFPP's reoccurring 5-year updates that are adopted and implemented by the CVFPB.

Relief Cut Updates via Local Hazard Mitigation Plans (LHMP) and Flood Emergency Safety Plans (ESPs)

As noted above in Section 5.2.6 - Local Hazard Mitigation Plans and Relief Cuts, Sacramento County is in the process of updating its 2016 LHMP and is scheduled for completion by early 2022. As part of this update, Sacramento County, BALMD, and the City of Isleton has the opportunity to reevaluate the impacts of flooding to the people and assets of the Sacramento County planning area, including BALMD and Isleton. The LHMP can establish updated goals and prioritize projects to reduce these impacts to BALMD, including the Delta Legacy Community of Isleton.

It is recommended that Sacramento County, BALMD and Isleton continue to update the LHMP every 5 years and formalize potential relief cuts for the noted RDs. Formalized relief cuts could potentially reduce the duration and depth of flooding in Isleton in the event a levee breach was to occur anywhere within BALMD. Sacramento County and BALMD, as a component of the LHMP, will be updating their Flood Emergency Safety Plans (ESPs) and are looking at incorporating relief cuts wherever feasible.

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Appendix A: Geotechnical Data and Assessment Reports

Appendix B: Biological Resources Constraints Assessment for the Community of Isleton

Appendix C: Cultural Resources Records Search Results for Isleton, California

Appendix D: Ecosystem Multi-Benefit Opportunities for the Sacramento County Delta Legacy Communities Small Communities Flood Risk Reduction Feasibility Studies, Including Isleton

Appendix E-1: Expected Annual Damages (EAD)Analysis for Sacramento County/Isleton Communities – HDR Engineering, August 2021

Appendix E-2: 2022 CVFPP Update to SPFC Levee Fragility Curves; and Hazard Level Categorization for Sacramento County SCFRRP SPFC and non-SPFC Levees Technical Memorandum - AECOM, November 2020, including Addendum of December 2020

Appendix F: Cost Estimates of Flood Risk Reduction Management Actions for Isleton's Flood Risk Reduction Feasibility Study

Appendix G: DPC, DSC and Delta Conservancy Master Comparison Matrix

Appendix H: Identification of Non-Structural Measures for the North Delta Legacy Communities of Hood, Courtland, Locke, East Walnut Grove, West Walnut Grove/Ryde, and City of Isleton Flood Risk Reduction Feasibility Studies

Appendix I: Hydrology and Hydraulics Technical Memorandum for the North Delta Legacy Communities of Hood, Courtland, Locke, Walnut Grove (East), Ryde/Walnut Grove (West), and Isleton

Appendix J: Community-Based Flood Insurance Program White Paper – Kathleen Schaefer, March 2022

Appendix K: Multi-Benefit Project Opportunities Identified the Delta Legacy Communities to Reduce Flood Risks and Improve SWP Water Conveyance Through the Delta

Introduction to Appendix K:

The following PowerPoint Presentation(s) were largely developed November 2020 - April 2021 by the Sacramento County Delta Legacy Communities participating in the DWR SCFRRP grant program focused on reducing flood risks along the Sacramento River Corridor. The Sacramento County Delta Legacy Communities and the Sacramento River Corridor collectively coincide with the freshwater conveyance corridor of SWP and CVP deliveries through the North Delta.

A common theme shared amongst all the Sacramento County Legacy Communities includes improving the entirety of the State Plan of Flood Control (SPFC) levee system to current FEMA engineering accreditation standards along both banks of the Sacramento River also provides the multi-benefit of improving the Delta water conveyance corridor between Freeport and the USBR Delta Cross Channel in Walnut Grove.

PPT slides 2 through 12: Provide a brief explanation of the SCFRRP program and identification of flood risks and vulnerabilities to the Sacramento County Delta Legacy Communities.

Slides 13 – 38: Provide a summary of key structural-based Management Actions (MAs). Cost summaries are also included for levee improvements that would result in: (1) FEMA accreditation for the communities located within the larger RDs: (2) improving the entirety of the RD perimeter levee systems to current FEMA accreditation standards; or (3) just improving the SPFC levee system(s) along the Sacramento River Corridor to current engineering standards.

Slides 39 – 49: Present the Delta Legacy Communities' proposal of improving the levees along Sacramento River conveyance corridor to current FEMA engineering standards that includes the multi-benefit of improving reliability and resiliency of conveying water through the North Delta. The Communities' proposal can possibly serve as a more cost-effective alternative to the DCA's current single-purpose proposal with intakes and tunnels in the North Delta.

Slides 50 – 52: Present the need to collaborate and include multi-beneficiaries in developing and financing levee improvements in the Delta, including identification of funding mechanisms to implement levee improvements that are also beneficial for greater reliability and resiliency of through-Delta water conveyance. (Per California's Flood Futures Recommendations of Nov. 2013, and the DPC's Levee Financing Options Feasibility Study of May 2018.)

Slides 53 - 71: Present the latest cost comparisons, and science behind improving said levee system(s) in the North Delta also has the multi-benefit of improving the reliability and resiliency of conveying SWP and CVP water through the Delta w/ or w/o a modified DCA proposal. The latter slides also suggest improving the levees in the conveyance corridor of the North Delta Region will not result in a stranded investment.