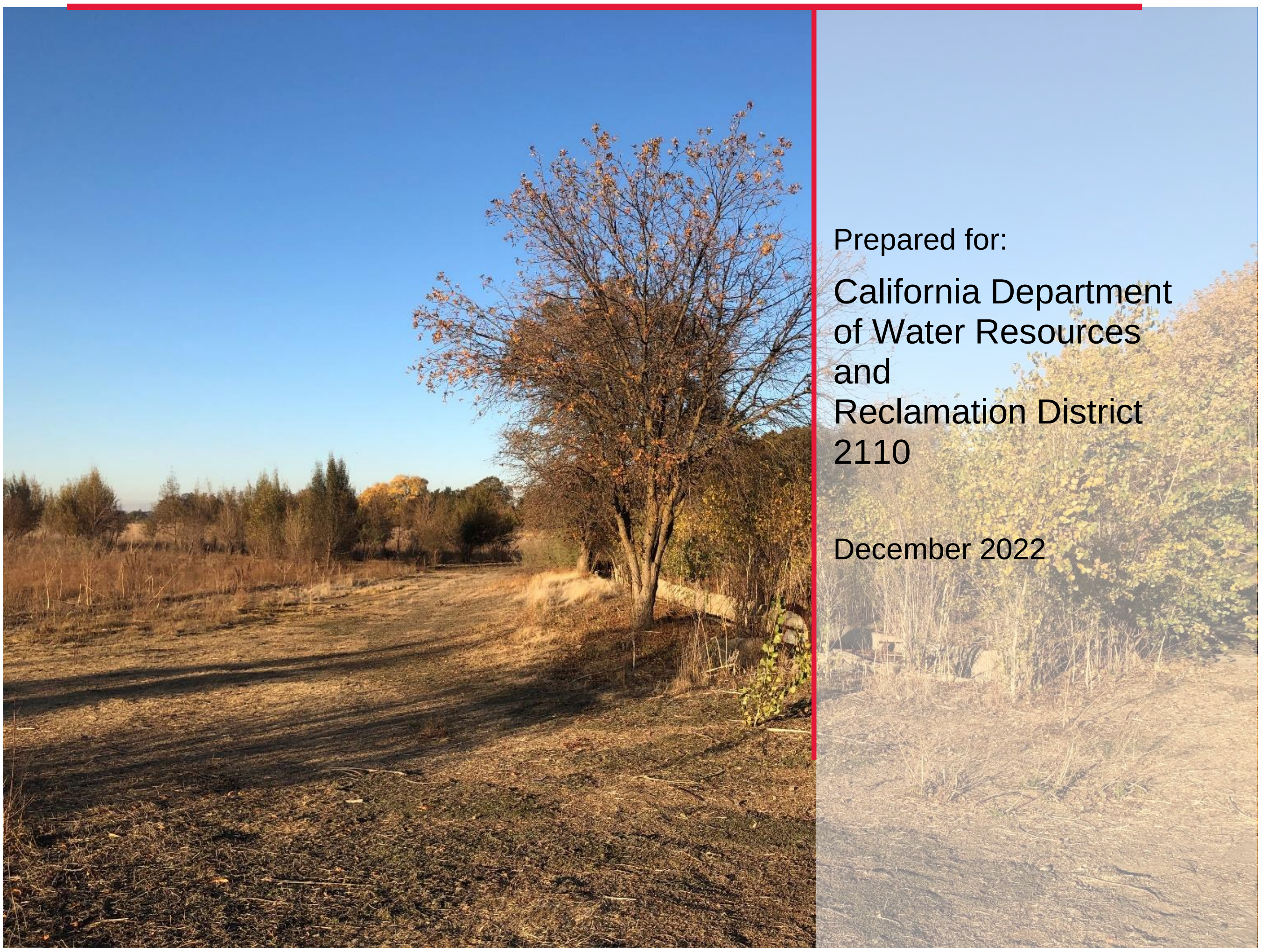
Draft Adaptive Management Plan

McCormack-Williamson Tract Levee Modification and Habitat Restoration Project Phase B



Prepared for:

California Department of Water Resources and Reclamation District 2110

December 2022

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Consulting Engineers and Scientists

in Collaboration with
ESA Associates, Inc.

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Prepared for:

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Abbreviations and Acronyms

BLM	Bureau of Land Management
CalGEM	California Geologic Energy Management, a Division of the California Department of Conservation
CCR	California Code of Regulations
CDBW	California Department of Boating and Waterways
CDFW	California Department of Fish and Wildlife
CNDDB	California Natural Diversity Database
CRP	Cosumnes River Preserve
DCC	Delta Cross Channel
DWR	California Department of Water Resources
EIR	Environmental Impact Report
ESA	Endangered Species Act
GEI	GEI Consultants, Inc.
H:V	horizontal:vertical
HSA	Hazardous Substances Assessment
LiDAR	Light Detection and Ranging
LTMP	Long-Term Management Plan
MBK	MBK Engineers
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MWT	McCormack-Williamson Tract
MWT Project	MWT Levee Modification and Habitat Restoration Project
NAVD88	North American Vertical Datum of 1988
North Delta Project	North Delta Flood Control and Ecosystem Restoration Project
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PG&E	Pacific Gas and Electrical
RD	Reclamation District
RSP	rock slope protection
SAV/FAV	submerged aquatic vegetation/ floating aquatic vegetation
SFEI	San Francisco Estuary Institute
SEIR	Supplemental Environmental Impact Report
SMUD	Sacramento Municipal Utility District
SRA	shaded riverine aquatic
tbd	to be determined
TNC	The Nature Conservancy

U.S.	United States of America
VELB	Valley elderberry longhorn beetle
WSE	Water Surface Elevation

Chapter 1. Introduction

1.1 Project Background

The McCormack-Williamson Tract (MWT) Project ("MWT Project" or "Project") will provide flood control benefits and restore and enhance freshwater emergent tidal wetlands, seasonal floodplains, and valley foothill riparian across a 1,654-acre site. The MWT is situated at the intersection between the historical north and central Delta, at the downstream end of the Mokelumne River delta, and at the upper range of tidal influence. The Project site is located in southern Sacramento County, east of the Sacramento River, in the primary zone of the Delta (Figure 1). The Nature Conservancy (TNC) acquired the MWT property in 1999 and the property was subsequently transferred to Department of Water Resources (DWR) ownership in 2019.

The MWT Project is a component of the North Delta Flood Control and Ecosystem Restoration Project (North Delta Project), which consists of various flood control and habitat improvements in the northeast Delta region where the Mokelumne River, Cosumnes River, Dry Creek, and Morrison Creek converge. The intent of the North Delta Project is to reduce regional flood risk and provide tidal wetlands and floodplain habitat. Another component of the North Delta Project is the Grizzly Slough Floodplain Restoration Project, located upstream of the MWT on the lower Cosumnes River, which is ready for implementation once an agreement with the California Department of Fish and Wildlife is reached.

Because of the size and complexity of the MWT Project, it was designed to be implemented in two phases, Phase A and Phase B. Phase A was completed in 2019 and included internal levee modifications to prepare the tract for flooding. A protective ring levee (approximately 4,950 feet long) was constructed around a transmission tower located in the northwest corner of the MWT to protect the tower from tidal and floodplain inundation, and approximately 18,000 linear feet (3.38 miles) of landside levee resloping occurred at various locations around MWT to stabilize the levees and provide a planting bench at elevations suitable for riparian restoration.

The MWT Phase B Project improvements include levee degrades, additional landside resloping of approximately 5,230 linear feet of levee, interior site grading for habitat restoration, land management, and focal plantings to promote restoration and establishment of floodplain riparian and tidal marsh habitats on the MWT. Related activities that will be implemented on or near MWT prior to restoration include the relocation of several sections of Sacramento Municipal Utility District (SMUD) transmission lines, treatment/(re-)abandonment of several gas wells located in the interior of the tract, and other minor maintenance activities that are necessary to keep MWT flood control infrastructure functioning properly.

The purpose of the Project is to allow the passing of flood flows through MWT, in a manner that minimizes flood impacts to the surrounding areas and provides benefits to ecosystem processes and native species by recreating tidal wetlands, seasonal floodplain, and riparian habitats.

1.2 Purpose of Document

The MWT Project is part of the North Delta Project, which DWR has determined is a covered action under the Delta Plan. A state or local agency that proposes to undertake a covered action must submit a Certification of Consistency with the Delta Plan to the Delta Stewardship Council, with detailed findings demonstrating that the covered action is consistent with the Delta Plan (Water Code Section 85225). Specifically, 23 California Code of Regulations (CCR) Section 5002(b)(4) requires that ecosystem restoration and water management covered actions must include adequate provisions, appropriate to the scope of the covered action, to assure continued implementation of adaptive management. This requirement can be accomplished by describing how adaptive management for the project will be implemented in a manner consistent with the Delta Plan's adaptive management framework (i.e., Delta Plan Appendix 1B).

This document builds upon and is informed by the Draft Adaptive Management Framework previously prepared for the North Delta Project consistency determination in September 2018, which assumed the project design described in the North Delta Project Final Environmental Impact Report (EIR; DWR 2010) would ultimately be implemented. The September 2018 consistency determination was not appealed and is now final. The project design has since been refined and updated, and a Supplemental Environmental Impact Report (SEIR) for the updated MWT Phase B Project was adopted in September 2022 (DWR 2022). This Draft Adaptive Management Plan has been updated from the 2018 version for the North Delta Project to reflect the current site conditions on MWT in more detail, reflect refined project description, project goals and objectives specific to MWT, and some updates and additions to monitoring measures, metrics, and adaptive management triggers and responses. Where appropriate, elements from the 2018 Consistency Determination for the North Delta Project and associated Adaptive Management Plan have also been refined. Specifically, refinements of monitoring measures and metrics were informed by the detailed San Francisco Estuary Institute (SFEI) report, "*Resources for Monitoring, Research, and Adaptive Management at the McCormack-Williamson Tract*" (Robinson et al. 2018).

The main purpose of this draft adaptive management plan is to document the background information used to guide the design of the MWT Project and to provide a detailed structure for future monitoring and long-term management of the Project. This document should not be viewed as a rigid prescription, but rather as a conceptual construct for future monitoring and adaptive management of the Project site.

Figure 1. Project Location

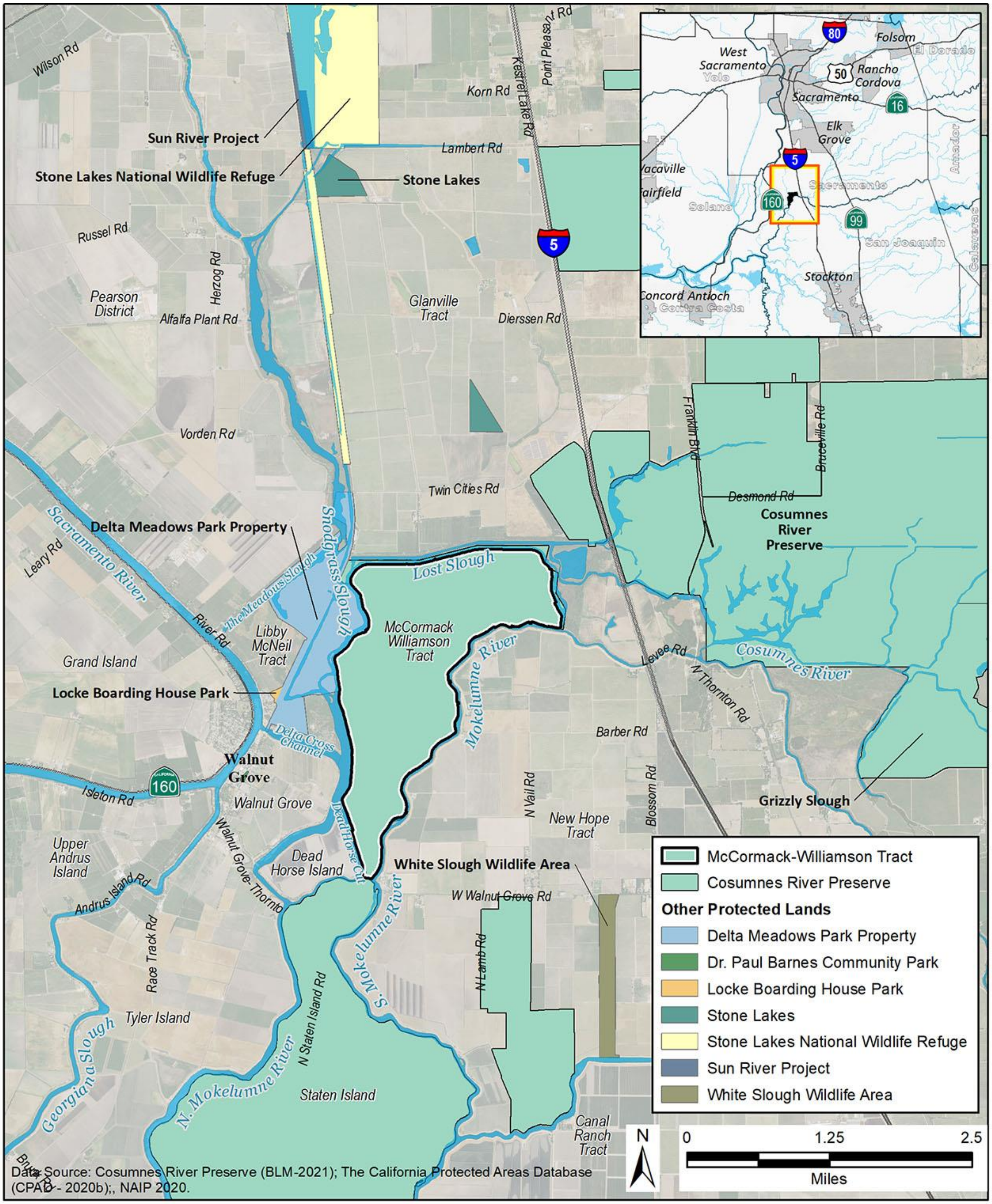

Figure Source: GEI Consultants, Inc. 2022.

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1.3 Goals and Objectives

The current MWT Project-specific objectives, organized by the two overarching goals (i.e., flood management and ecosystem restoration), are as follows:

1. Flood Management
    a. Convey flood flows to the San Joaquin River without substantial increases in river stage
    b. Reduce the risk of catastrophic levee failures
    c. Design MWT floodplain to minimize “surge” effect
2. Ecosystem Restoration
    a. Restore ecologic, hydrologic, geomorphic, and biologic processes and self-sustaining habitats, including riparian, freshwater tidal marsh, and seasonal floodplain habitats
    b. Support native and special-status species
    c. Manage invasive species and prevent/limit their establishment
    d. Promote food web productivity
    e. Promote natural flooding processes and tidal action
    f. Promote processes to increase land surface elevations in areas of subsidence

Flood Management. The MWT Project goal to attenuate regional flood effects has been a primary focus of modeling efforts, including iterations on designs and sensitivity analyses, to optimize design of the levee degrades to provide flood benefits upstream and downstream of the MWT.

Ecosystem Restoration. The focus of this document are the MWT Project ecosystem restoration goals and objectives for the MWT, and the methods proposed to achieve them. The proposed site grading and levee modifications are designed to restore natural tidal and fluvial hydrology and create self-sustaining habitats that in turn support special-status species, and the larger suite of plant, fish, and other aquatic and terrestrial wildlife species native to the region. The MWT Project is expected to restore approximately 600 to 900 acres of freshwater tidal marsh habitat, 400 to 600 acres of subtidal aquatic open water habitat, and approximately 95 to 185 acres of supratidal habitats including riparian scrub, riparian forest, valley oak woodland, and seasonal wetlands, in addition to preservation and enhancement of approximately 95 acres of extant riparian habitat on the project site. The restoration of the MWT to a natural self-sustaining, dynamic, and heterogeneous tidal-fluvial-terrestrial ecosystem will significantly enhance local food web productivity and greatly increase the extent, quality, and connectivity of native habitats in the region. The MWT project will thus further implementation of the Delta Plan’s Chapter 4 by restoring hydrologic, geomorphic, ecological processes and self-sustaining habitats near the Cosumnes River-Mokelumne River confluence, one of the Delta Plan’s six Priority Habitat Restoration Areas.

Recreation. Enhancement of public recreation opportunities also remains a goal for the MWT Project, but any specific recreation infrastructure that may be incorporated in the future is not prescribed as part of MWT Phase B Project implementation. Regardless, excavating the tidal channel network from the southwest levee degrade into the restored open water and tidal marshplain will nevertheless create enhanced opportunities for recreational boaters and paddlers who may access it from the nearby Delta Meadows State Park and other local boat launch facilities.

1.4 Partners and Roles

The MWT Project site is within the Cosumnes River Preserve (CRP). The CRP is cooperatively managed by a partnership of the Bureau of Land Management (BLM), DWR, California Department of Fish and Wildlife (CDFW), State Lands Commission, Sacramento County, The Nature Conservancy (TNC) and Ducks Unlimited.

Current management of the MWT is subject to the CRP Long Term Management Plan ("CRP Management Plan") (Kleinschmidt 2008). The CRP Management Plan is in the process of being updated, but the land management practices that would apply to MWT, such as weed control, are expected to remain the same. In addition to its dedicated staff, the Preserve manages volunteers who assist with routine maintenance such as weed control and trash pick-up on parts of the reserve.

1.5 Adaptive Management Approach

The design and implementation for the MWT Project is consistent with the Delta Plan's 9-step adaptive management approach (Delta Plan Appendix 1B).

1. **Define the Problem(s)** – The lack of channel capacity makes the northeast Delta region vulnerable to flooding. A particular phenomenon associated with levee failure on MWT is the "surge effect" created by the sudden rush of water through the southern tract levee when the levee breaches or is overtopped; this surge can be extremely destructive for downstream areas by displacing mobile homes, damaging infrastructure, and destroying boats in marinas. At the same time, the leveeing and reclaiming of the Delta that occurred starting in the 1850s resulted in conversion of the vast majority of historical tidal wetland and riparian habitats that historically characterized the region to agricultural and urban uses, which has severely degraded ecosystem function and resilience of Delta species and habitats. Restoration of tidal wetlands in the Delta has become increasingly difficult as a result of severe land subsidence from peat soil oxidation and compaction on many Delta tracts.

2. **Goals and Objectives** – The goal is to restore and enhance seasonal floodplain and tidal wetland habitat to reduce flood risk vulnerabilities in the north Delta in a manner that provides benefits to native fish and wildlife. Objectives for the MWT Project include: reduce flood risk upstream and downstream of the Project site, including the elimination of the "surge effect"; restore a seasonally flooded shallow-water floodplain and tidal wetlands to provide habitat for native fish and wildlife; reconnect the Mokelumne River to its historical floodplain to restore natural hydrologic and geomorphic processes.

3. **Model Linkages** – The Project has a strong science foundation, and is based on hydrologic records and modeling, tidal wetland and floodplain conceptual models, and native fish conceptual models. The SFEI prepared a document titled "Landscape Patterns and Processes of the McCormack-Williamson Tract and Surrounding Area: A Framework for Restoring a Resilient and Functional Landscape" which provides conceptual models for restoration of MWT based on existing conditions and the historical ecology of the northeast Delta (Beagle et al. 2013). The MWT is ideally situated for tidal and floodplain riparian restoration due to its location at the interface of the fluvial-tidal zone in the northeast delta and elevation relative to most other leveed Sacramento-San Joaquin Delta islands.

4. **Select Actions, Develop Performance Measures** – The Project will degrade two portions of existing levee on the northeast portion of the tract to function as hardened weirs to allow flood flows

to inundate the site at a frequency and duration suitable to support seasonal floodplain habitat. The levee on the Dead Horse Cut will also be degraded to allow flood flows to pass out of the tract without creating a surge effect and allow tidal flows to enter the tract to restore tidal wetlands.

5. **Design and Implement Actions** – The Project design is currently being refined to accommodate gas well (re-)abandonment requirements and reflect permit negotiations. Implementation is expected to begin in late summer of 2023 and last for at least two consecutive construction seasons.

6. **Monitoring** – This draft plan outlines metrics and methods to evaluate whether the Project is functioning as expected and making progress towards goals and objectives, as outlined above.

7. **Analyze, Synthesize, and Evaluate** – Monitoring results will be used to refine expected outcomes and inform land managers about observed trends. This draft plan provides preliminary monitoring metrics, targets, management triggers, and potential management responses. Once the Project design is finalized and project permitting completed, the plan will be finalized. Additional refinements may be made based on post construction monitoring and observations.

8. **Communicate** – Findings from monitoring will be summarized by MWT land managers and scientists in annual reports that will be submitted to DWR and CRP managers and made available to the public through DWR's website and other forums.

9. **Adaptive Management** – Information from monitoring will be used to guide current and future adaptive site management. Lessons learned from the Project may also benefit future floodplain and tidal wetland restoration projects.

Chapter 2. Site Conditions

2.1 Setting

The MWT is a 1,654-acre agricultural tract in the North Delta region, located 15 miles south of the city of Sacramento and 1 mile east of the town of Walnut Grove in Sacramento County (**Figure 1**). The tract is bounded by 8.8 miles of restricted-height levees along the Mokelumne River to the east, Snodgrass Slough to the west, Lost Slough to the north, and Dead Horse Cut to the south. Regionally, the MWT is located immediately downstream of the confluence of the Cosumnes and Mokelumne rivers, downstream and south of the Point Pleasant, Franklin Pond, and Stone Lakes National Wildlife Refuge areas, downstream and southwest of the main portion of the CRP, west of New Hope Tract, east of Delta Meadows State Park and Walnut Grove, and immediately upstream of Dead Horse, Tyler and Staten Islands (**Figures 1 and 2**).

The MWT is part of the CRP, which extends northeast and upstream of the MWT approximately 13 miles (**Figures 1 and 2**). The CRP also includes the Grizzly Slough property east of MWT and Staten Island to the south, which were originally part of the North Delta Project. The CRP consists of over 50,000 acres of wildlife habitat and agricultural lands owned by seven land-owning partners. The CRP includes extensive high-quality riparian forest habitats, seasonal and permanent wetlands, oak savannah, vernal pool grasslands, and agriculture managed for wildlife benefits.

2.2 Historical Ecology

The MWT is located at the intersection of the Northeast and Central Delta regions, at the foot of alluvial fans formed in the Pleistocene by the Cosumnes and Mokelumne rivers, and at the upper range of tidal influence in the Northeast Delta (Brown and Pasternak 2004; Beagle et al. 2013). Through much of its geologic history, the MWT was an upper deltaic nontidal floodplain dominated by riverine processes; soil cores reveal that soil on the MWT originated primarily from deposited inorganic sediment from fluvial processes with only a thin layer of peat in some areas (Brown and Pasternak 2006). In more recent geologic history (~2,500 years ago), tidal waters encroached further inland and the lower elevations of the MWT came under tidal influence, leading to the development of freshwater emergent tidal marshes on much of the site (Brown and Pasternak 2004, 2006; Beagle et al. 2013).

Figure 3 shows a reconstruction by Beagle et al. (2013) of the historical habitat types on and around the MWT in the early 1800s, before the hydrology and habitats of the Delta were significantly altered by human activities. The site at that time was primarily vegetated with tidal freshwater emergent marsh, with tidal sloughs and channels crossing the tract that were formed by both tidal and fluvial influences from the bordering Mokelumne River and Snodgrass Slough. Substantial natural levees formed by the Mokelumne River supported wide areas of riparian and valley oak forest habitat along the eastern edge of the site (Beagle et al. 2013; **Figure 3**).

Figure 2. Northeast Delta Landscape Conservation Planning Context

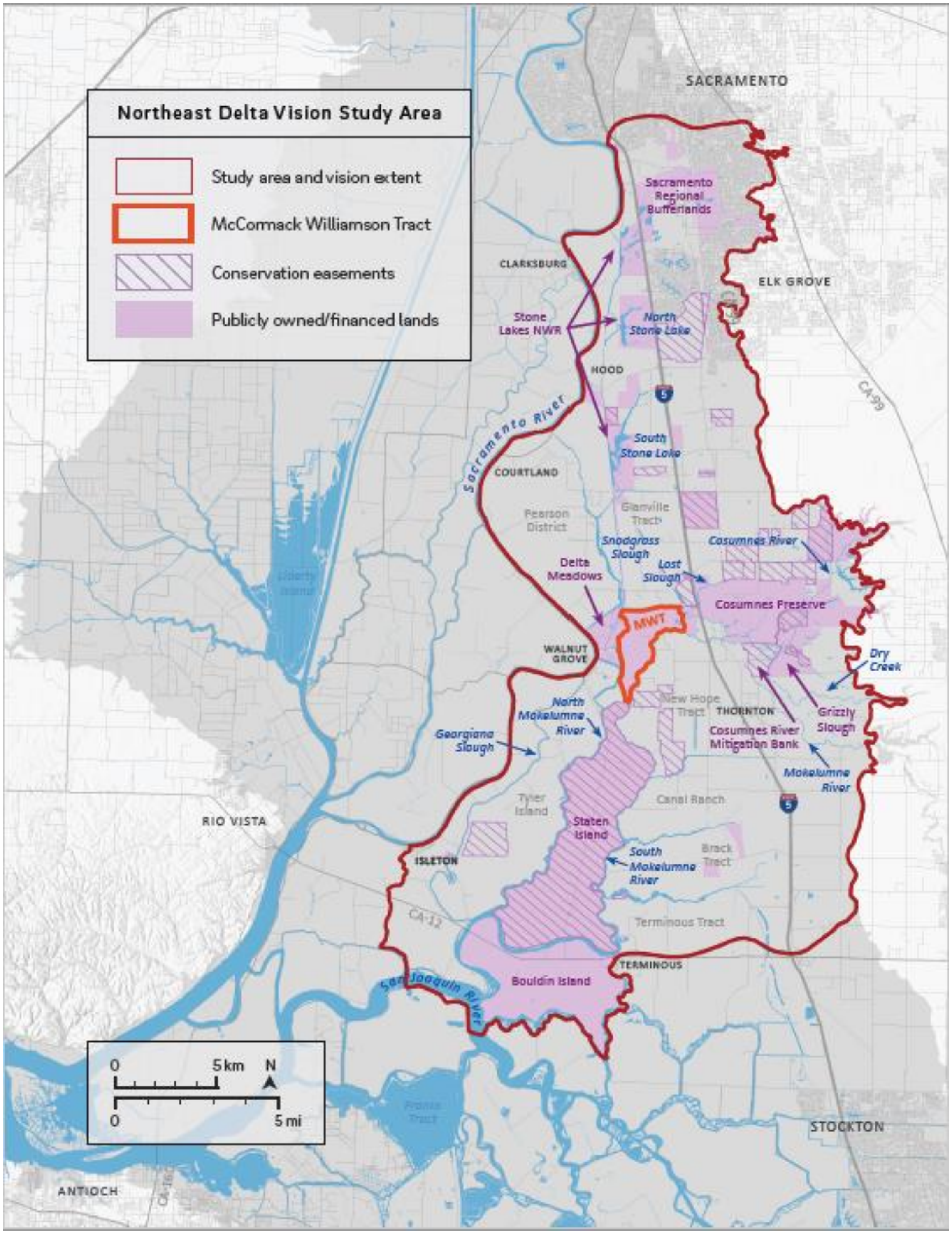
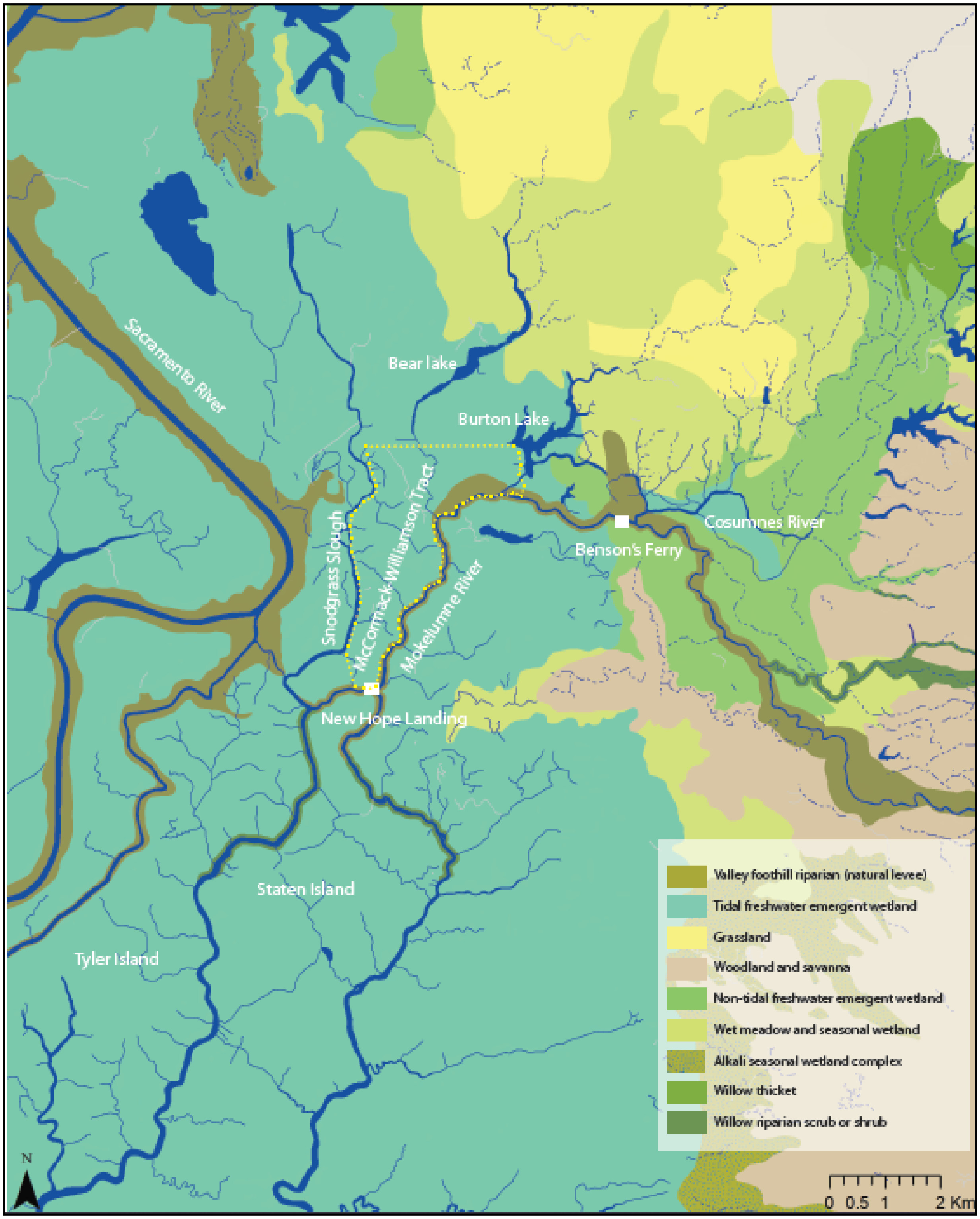


Figure Source: Safran et al. 2018; used by permission from SFEI-ASC.

Figure 3. Historical Habitat Types



Notes: Reconstruction of historical habitat types in the vicinity of MWT in the early 1800s.
Figure Source: Beagle et al. 2013; used by permission from SFEI-ASC

Because the MWT was formed by dynamic fluvial flooding processes and continued to experience frequent flooding from the Mokelumne River until the tract was leveed in 1919, the MWT was topographically very heterogenous compared to most areas in the nearby Central Delta region (Brown and Pasternak 2004; Beagle et al. 2013). Even within the marshplain, where accumulated peat deposits from vegetation growth and sediment deposition within intertidal habitats naturally cause topography to become more homogeneous over time, regular continual flooding maintained topographic heterogeneity, and willows and other wetland-associated species grew on areas of slightly higher ground within the tule-dominated marshplain, creating a complex mosaic of habitats (Beagle et al. 2013). Masses of tree snags and other woody debris, called "rafts," were frequently documented along the Mokelumne River and would have lodged on the MWT during flood events, likely causing backwater areas to form and further increasing habitat diversity (Beagle et al. 2013).

2.3 Existing Land Uses

The MWT was leveed and reclaimed for agricultural use in 1919 (Beagle et al. 2013). Since the tract was leveed it has been farmed, in recent decades supporting field crops including corn and other grains, tomatoes, and safflower. Since the site most recently flooded in 2017, the agricultural fields onsite have remained fallow. However, they were recently planted in winter wheat during November 2022 for harvest in summer 2023, and portions of the tract may be planted for one additional season in 2023.

The MWT is zoned agricultural cropland in the 2030 Sacramento County General Plan (Sacramento County 2011). Based on the Zoning Consistency Matrix of the General Plan, a "natural preserve" is a fully acceptable use within this land-use designation. The MWT is also designated by the General Plan as a Recreation Zoning District, within the category "O" including areas that provide public park facilities or wildlife preserves. The MWT Project will improve wildlife habitat and may provide recreational opportunities in the future and would be consistent with Sacramento County's recreational zoning designation for the site. The General Plan also has several policies encouraging habitat enhancements and establishment of preserves, and the proposed MWT Project is consistent with all General Plan policies.

The MWT is subject to a Williamson Act contract (California Government Code § 51200 et seq.) entered into by the previous landowner in 1976, which remains binding to current and/or future landowners. In November 2015, TNC submitted a Notice of Non-Renewal to the contract, starting the 9-year non-renewal period. Under conditions of the Williamson Act contract, the landowner can continue with ongoing agricultural activities, levee rehabilitation, and fish and wildlife enhancement and preservation. Sacramento County confirmed in a letter to TNC that the MWT Project and resulting land use changes are consistent with the terms of the existing Williamson Act contract (Sacramento County 2015). Thus, the Williamson Act contract will not present an obstacle to Project implementation, even if implementation occurs before the 9-year non-renewal period is complete.

2.3.1 Utilities and Infrastructure

A large communications tower owned by KCRA is located in the northwest corner of the MWT. The tower site is leased to KCRA by TNC under a 50-year lease agreement (until 2032). In 2018, as part of the Phase A portion of the MWT Project, a protective levee was constructed around the tower and tower guy line anchor points to protect the tower from inundation with anticipated restored tidal and fluvial hydrology (**Figure 4**). Access to the tower needs to be retained at levels equivalent to current conditions. Because the area will not passively drain once tidal hydrology is restored to the rest of the MWT, the Reclamation District (RD) 2110 also will need to occasionally maintain infrastructure and pump water from the area protected by the tower ring levee to maintain sufficiently dry access roads on the interior of that levee. These activities will generally take place as part of routine maintenance and are not necessarily directly related to the MWT Project.

The MWT had agricultural water management infrastructure in place, including a network of supply and drainage ditches across the tract, five irrigation intake pumps and siphons that draw water out of adjacent waterways for irrigation purposes under existing water rights for the property, two drainage pumps that return excess water to the surrounding waterways, and a domestic well pump (**Figure 4**). Most of this infrastructure was decommissioned and removed during the fall of 2022 and only the river slant pump at Station 014+00 and the slant irrigation pump at Station 081+00 remain at this time. These pumps could potentially be repurposed and used for irrigation during habitat development for the Project, but would ultimately be decommissioned as well, either following the vegetation establishment phase, or prior to or during site grading if determined to not be useful during vegetation establishment.

A small area of high ground on the eastern side of the tract historically housed a small farm residence, and farm equipment storage tanks and buildings All structures and stored equipment associated with the farm residence and storage were removed in 2018 and disposed of off-site in preparation for Phase A construction. The drinking water well at the site was properly abandoned.

Pacific Gas and Electrical (PG&E) holds several abandoned underground gas pipelines and easements on the property; DWR and RD 2110 are actively consulting with PG&E about quitclaiming easements. The specific locations of abandoned gas lines that could be affected by grading have been surveyed, and the proper treatment of abandoned gas lines, gas wells, and associated infrastructure is currently being assessed.

Twelve inactive abandoned natural gas wells are also located on the MWT. These well locations have recently been re-located and assessed for the need to be properly (re-)abandoned due to the introduction of tidal inundation. RD 2110 and DWR are currently in the process of coordinating with the California Geologic Energy Management (CalGEM) Division of the California Department of Conservation, the agency regulating abandoned wells on the proper methods to address all gas wells. Abandoned gas wells are required by law to be properly plugged and abandoned as required by CCR Title 14, Division 2, Chapter 4; and PRC Section 3208 (as administered by CalGEM). During the consultation process it was determined that access to select wells may need to be maintained indefinitely. These requirements are currently being incorporated into the 90% design plans.

SMUD is the owner and operator of all power transmission lines and associated easements that serve the MWT (e.g., communications tower) and Dead Horse Island, Walnut Grove/Locke, and the property east of MWT. Any SMUD poles located in areas that would become tidal marsh or open water under Project designs require relocation. Rerouting power to locations that currently are serviced by lines running through the interior of the MWT will include rerouting a portion of a utility line connection through the tower ring levee area, as well as two off-site line connection to reroute power to areas near Interstate 5 east of the Project site, and to provide power to Deadhorse Island. One of these relocation projects (along Bean Ranch Road) was completed in fall 2022 with all other pole relocations expected to be implemented in 2023. Where utility lines will remain in place on the tract (e.g., on the west levee), SMUD would maintain vegetation underneath and within 15 feet of the overhead utility lines to keep vegetation at or below 12 feet in height, according to SMUD's vegetation management guidelines.

Figure 4. Existing Infrastructure and Utilities on MWT

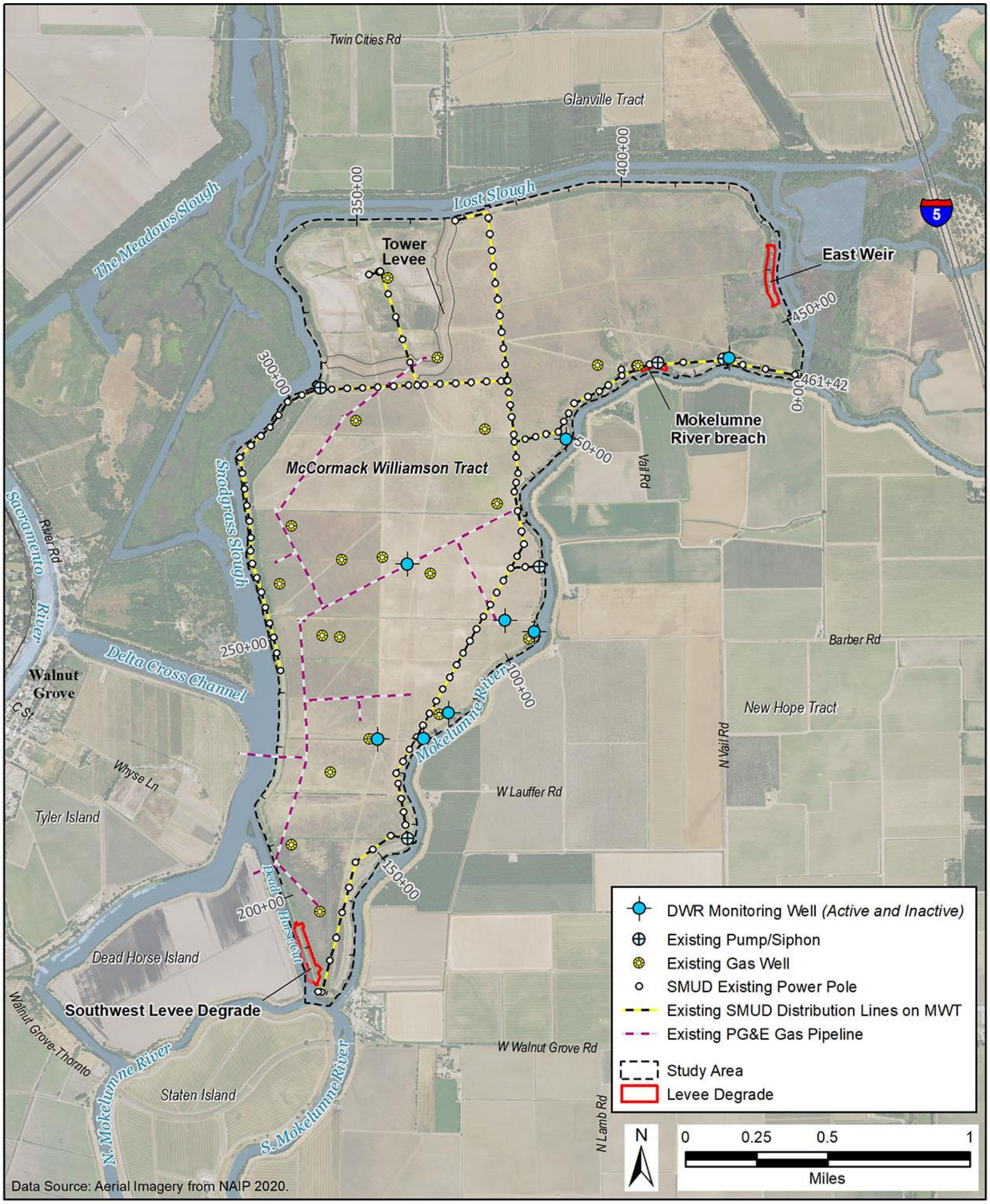


Figure Source: GEI Consultants, Inc. 2022.

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2.4 Existing Topography

All elevations described in this document are referenced to the North American Vertical Datum of 1988 (NAVD88).

Current topography of the MWT, including the recently constructed tower protection levee and the Phase A landside levee resloping Project, is shown on **Figure 5**. This site topography map uses the most recent available Delta Light Detection and Ranging (LiDAR) data (DWR 2017) flown in 2017, combined with the as-built topography for the completed Phase A tower ring levee construction and landside levee resloping (MBK Engineers [MBK] 2018, 2019).

Tract Interior

The MWT is less subsided than most other Central Delta islands. This is due to its location on the eastern edge of the historical Delta at the confluence of the historical deltas formed by the Cosumnes and Mokelumne rivers, a soil profile dominated by inorganic sediment rather than peaty soils (Brown and Pasternak 2006), and the presence of substantial natural levees that historically formed along the Mokelumne River along the eastern edge of the site, which remain evident in the site topography today (**Figure 5**).

The interior of the MWT has been leveled for agriculture and is relatively flat; the tract is portioned into fields graded precisely to facilitate farming and drainage of each field to primarily east-west oriented drainage canals running across the tract, which in turn drain to the drainage pump located on the southeast levee of the tract (**Figures 4 and 5**). Lowest elevations on the tract (0 to2 feet NAVD88) occur at the southern portion of the tract where recent subsidence rates were highest and the tract gently slopes upwards to higher ground (3-5 feet) in the central and northern portions of the interior, and up to 6- to 9-foot elevation range on remnants of natural levee deposits along the Mokelumne River.

Without planned Project grading and expected bioaccretion and sediment deposition following restoration of fluvial and tidal hydrology, much of the existing tract would become permanent shallow subtidal open water. Intertidal site elevations occur on the central-eastern and northern portions of the tract, and supratidal riparian and upland floodplain elevations occur on the highest elevation areas on the northeastern portion of the tract, and on tract levees. Without conducting any landform grading of the tract to elevate more of the site into intertidal and supratidal elevations, approximately 850 acres of the tract would be projected to become subtidal open water habitat.

A scour pond feature which sometimes holds shallow open water and is surrounded by wetland and riparian vegetation is located in the northeast corner of MWT. This scour pond and associated adjacent low areas were created by scouring that occurred during a levee overtopping and breaching event that occurred in 1997. The extent and duration of ponding at this feature has been variable by year and season. However, after farming and irrigation activities ceased on the MWT in 2017 following flooding, the scour pond has mostly dried out. Similarly, a flood event in 2017 created another very small scour pond and sand-splay feature along the east levee at the breach site on the Mokelumne River levee. Along the western levee of the tract, south of the

Figure 5. Existing Site Topography

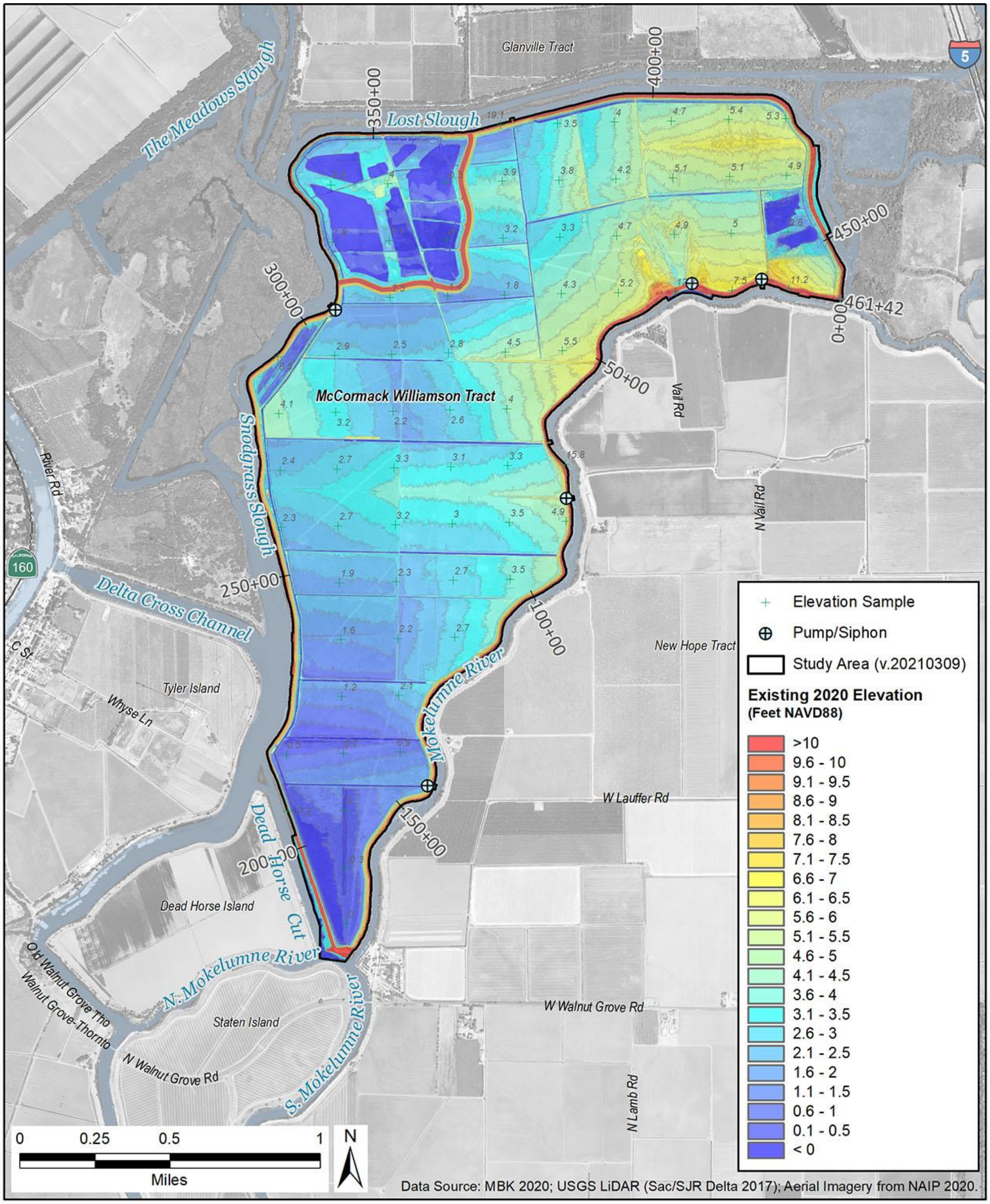

Figure Source: GEI Consultants, Inc.2022.

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tower protection ring levee, an area of lower ground relative to the surrounding tract is present. This area was used as a soil borrow site for previous levee repair work conducted in the early 1990s (Gilbert Cosio, MBK *pers. comm.*). The low elevations and high-water table in the former borrow area have led to the natural recruitment of primarily cottonwood forest and freshwater marsh vegetation since the borrow activities occurred.

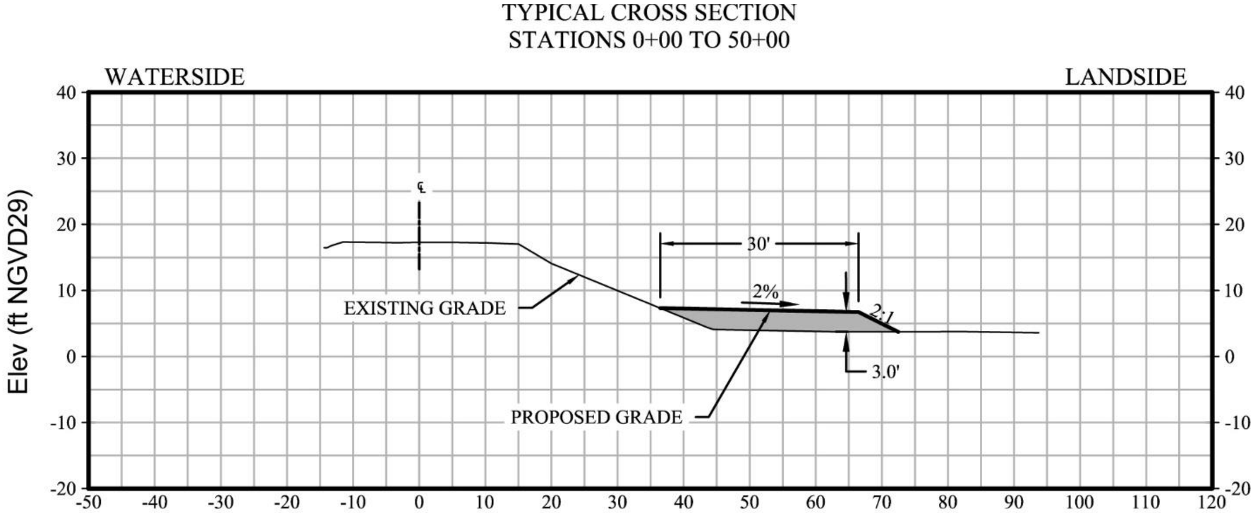
Tract Levees

The MWT perimeter levees are legally restricted in height to allow overtopping when needed for regional flood control and range from approximately 17 to 22 feet elevation NAVD88 at the levee crest. Where the tract levees were overtopped and breached during a flood event in 2017, the breaches were repaired to a lower height to accommodate requests of adjacent landowners. Short sections of levee crest were repaired to only 10 feet elevation at the west levee, 11 to 12.5 feet at the Mokelumne River levee, and 12 feet at the southwest levee.

Most sections of the MWT tract levees were steep, composed primarily of silt and sand, and susceptible to seepage, erosion, and breaching; the Phase A landside resloping of the MWT levees was conducted to maintain levee stability and provide adequate erosion protection for the existing riparian habitat. The design for levee resloping was developed to decrease wind-wave erosion during and after intentional or unintentional tract breaching, while also providing habitat diversity and bank stabilization along the levee. The Phase A portion of the MWT Project included broadening and resloping landside levee slopes to reduce wind-wave erosion potential and create more riparian and tidal marsh habitat enhancement opportunities. Additional resloping of the east and southwest levee sections will be undertaken as part of the MWT Project. Resloped landside levees are broadened at the landside levee toe and incorporate gradual lower levee slopes that are expected to support tidal marsh and benches at elevations that are expected to support riparian habitats (**Figure 6a-c**). These resloped levees will benefit wildlife by reestablishing riparian ecological functions and native species habitat, creating habitat buffers/refugia during sea level rise, and providing connectivity between aquatic wetland and terrestrial upland habitats.

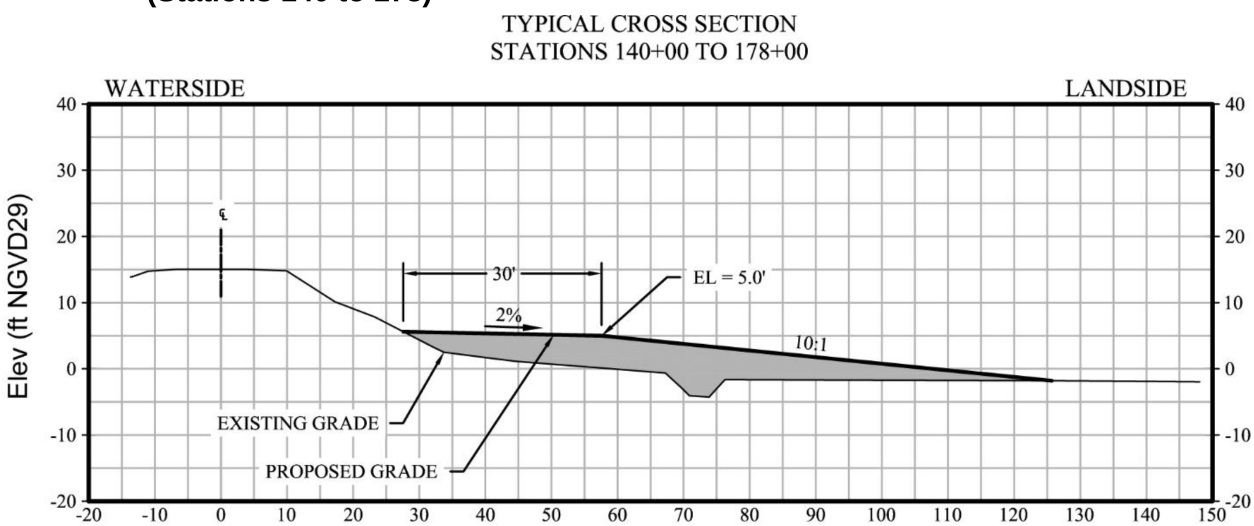
The Phase A Project also included construction of a protective levee around the transmission tower in the northwest corner of the tract. This levee was constructed in 2018 and will protect access to the tower during most flood events and during regular tidal inundation after the MWT is breached. The levee crest is at approximately 18.5 feet elevation NAVD88 and the levees have a 4:1 slope on the top portion, sloping down to a 20-foot-wide bench at elevation 7.5 feet, grading down at a 7:1 slope to the tract interior grade (**Figure 6d**). There is a culvert with a headwall and screw gate through the southern tower ring levee that currently allows the tower area to passively drain into the tract interior. The area around the transmission tower that is protected by the tower ring levee was used as a borrow site for the Phase A Project, and averages approximately -1 to -2-foot elevation in the borrow areas.

Figure 6a. As-Built Typical Cross Section of Phase A Landside Levee Reslope (Stations 0 to 50)



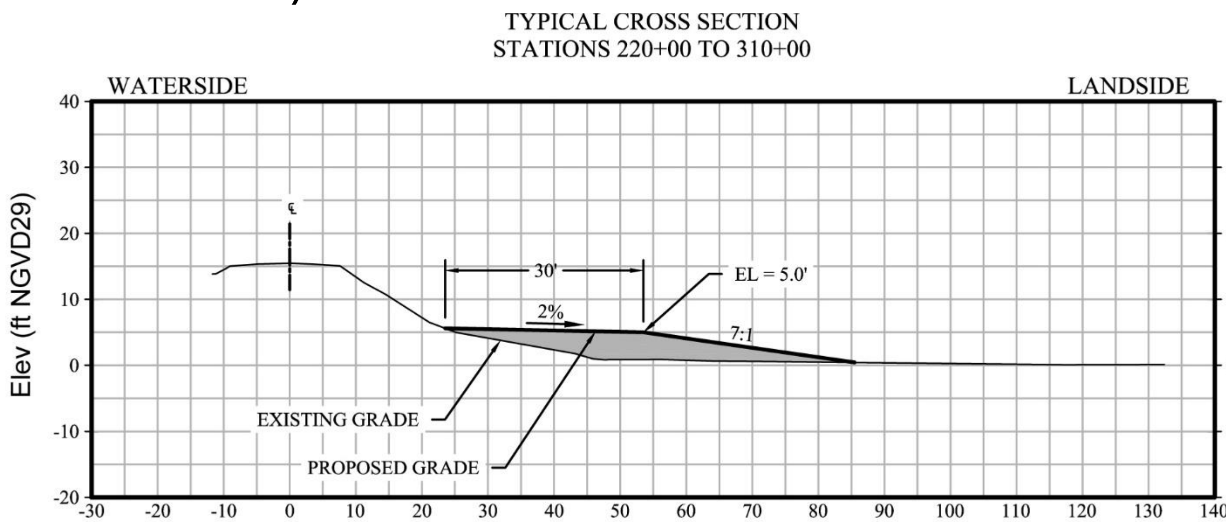
Source: MBK Engineers, Inc.
Note: Elevations shown are in NGVD29. To convert to NAVD88, add 2.5 ft.

Figure 6b. As-Built Typical Cross Section of Phase A Landside Levee Reslope (Stations 140 to 178)



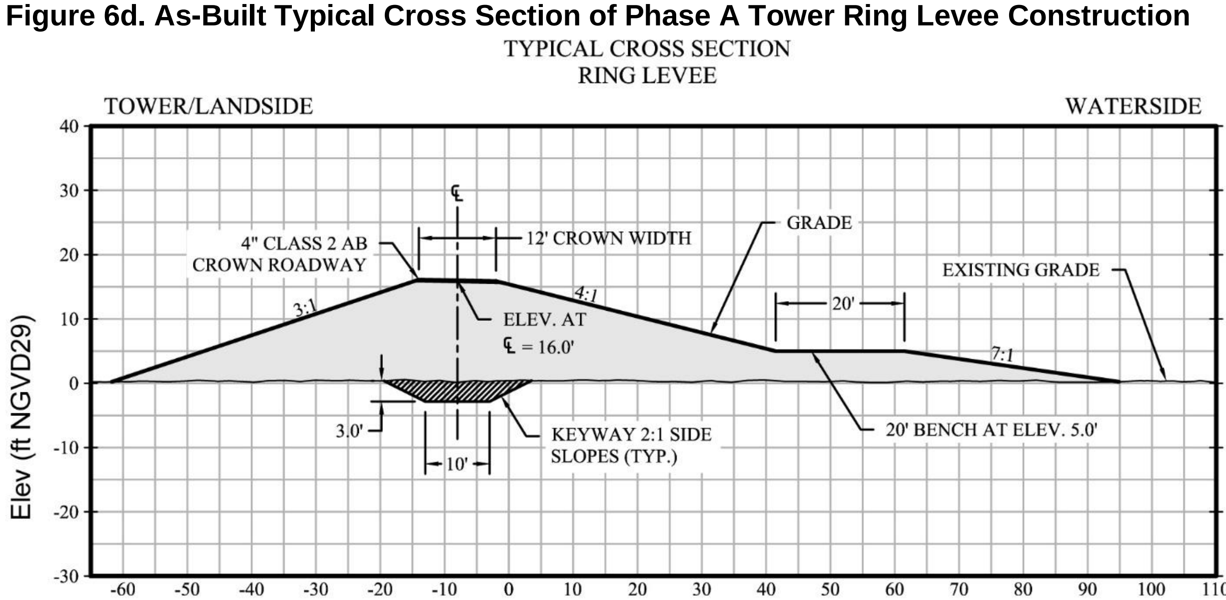
Source: MBK Engineers, Inc.
Note: Elevations shown are in NGVD29. To convert to NAVD88, add 2.5 ft.

Figure 6c. As-Built Typical Cross Section of Phase A Landside Levee Reslope (Stations 220 to 310)



Source: MBK Engineers, Inc.
Note: Elevations shown are in NGVD29. To convert to NAVD88, add 2.5 ft.

Figure 6d. As-Built Typical Cross Section of Phase A Tower Ring Levee Construction



Source: MBK Engineers, Inc.
Note: Elevations shown are in NGVD29. To convert to NAVD88, add 2.5 ft.

2.5 Existing Hydrology

The MWT is in a hydrologically and hydraulically complex region of the North Delta with hydrology driven by both fluvial and tidal influences. The MWT is situated at the intersection between two historical deltas, at the southern end of the historical Sacramento River flood basin and on the western edge of the Mokelumne-Cosumnes deltaic plain, and currently receives riverine flows from four drainage basins: Mokelumne River, Cosumnes River, Dry Creek, and Morrison Creek (Beagle et al. 2013). Flows from the Mokelumne River basin are regulated by multiple reservoirs and dams upstream, while the Cosumnes River, Dry Creek and Morrison Creek watersheds have no significant flood control structures upstream and the annual hydrograph from these watersheds closely follows the seasonal precipitation pattern (DWR 2007). In the MWT region, the Cosumnes River is the primary driver of peak flood flows. Though historically MWT was also part of the Sacramento River watershed, constructed levees now impede connectivity and the MWT is currently connected to the Sacramento River primarily via the Delta Cross Channel (DCC). The DCC is a federally operated controlled diversion channel that diverts water from the Sacramento River to Snodgrass Slough and the eastern Delta for water conveyance, and is typically closed between December 1 and May 20, and intermittently outside of that period during periods of high flows on the Sacramento River, or as needed for maintenance or to provide beneficial fish migration conditions (DWR 2010; Reclamation 2021).

The MWT is bordered by the Mokelumne River (immediately downstream of its convergence with the Cosumnes River) to the east, Snodgrass Slough to the west, Dead Horse Cut to the south, and Lost Slough Cut (or Middle Slough) to the north. Below the southeast (downstream) corner of the MWT, the Mokelumne River splits into North and South Forks around Staten Island, and these forks converge again below Staten Island before flowing into the lower San Joaquin River (**Figures 1 and 2**).

2.5.1 Flooding and Hydraulics

The MWT was one of the last delta tracts to be reclaimed, and due to concerns of surrounding landowners at the time about the floodway, MWT levees were built to legally restricted lower crest elevations than surrounding tracts. For that reason, the MWT is one of the more frequently flooded Delta islands; since its reclamation in 1919 it has flooded in 1938, 1950, 1955, 1958, 1964, 1986, 1997 (Beagle et al. 2013), and most recently in 2017.

Historically, peak flood flows around the MWT would have been driven by the Mokelumne River before it was dammed at multiple upstream locations. Today, flood flows to the MWT currently come primarily from the Cosumnes River, which is the largest unregulated river west of the Sierra Nevada crest. During peak flow flood events, the flows converging from the Cosumnes and Mokelumne rivers can become confined by a floodway bottleneck created by restricted channel capacities in the vicinity of MWT. This creates a backwater effect that increases inundation depths of floodplain areas upstream of MWT, including much of the CRP, Franklin Pond, and Point Pleasant areas. When water levels rise to the height where an upstream MWT levee is overtopped, the MWT fills with floodwaters which begins to alleviate some flood effects upstream. However, the pressure of rising water levels within the tract on the downstream MWT levees causes some portion or portions of those levees to eventually fail and breach, which in past events (e.g., 1986 and 1997) has sent a surge of floodwater down the North and South Forks of the Mokelumne River. This "surge effect" caused by uncontrolled levee failure of the downstream MWT levee has repeatedly caused significant damage to downstream properties both due to increased floodwater momentum and rapid increases in water surface elevations (WSEs), including causing additional downstream levee failures as were observed during the 1986 and 1997 flood events (cbec 2021a; DWR 2010). The surge effect can cause additional damage by causing boats to become unmoored from nearby marinas and to collect as "debris dams" on New Hope and Miller Ferry bridges, which in turn create additional flow constriction points and sometimes secondary surge effects when these debris dams dislodge (DWR 2010; Hopf 2011). The MWT Project goal to attenuate flood effects in this region will be achieved by conveying flows through the tract in a more controlled manner via the planned levee degrades to reduce flood stages in the region and eliminate the surge effect.

Detailed updated hydrologic and hydrodynamic modeling of WSEs and velocities under current conditions for 10- and 100-year recurrence interval floods in the MWT region was conducted for the Project, and details of that modeling are summarized in the MWT Phase B SEIR and associated technical reports (cbec 2021a, 2021b; DWR 2022). During the modeled 100-year flood event, the maximum WSE adjacent to the MWT reaches 20.75 feet NAVD88 at Benson's Ferry, which is located immediately upstream from the MWT; during historical flood events, MWT upstream levees have generally overtopped and failed when WSE exceeded 19.5 feet (cbec 2021a). During 10-year flood events under current conditions, maximum WSEs in the vicinity of the MWT are modeled to reach 17.8 feet at the Benson's Ferry gauge location (cbec 2021a).

During the 2017 flood event, and because of concerns over a potential catastrophic levee failure on the MWT southwest levee and resultant surge effect, RD 2110 and a group of downstream landowners and RDs made the decision to intentionally degrade a portion of a downstream levee (opposite the DCC) on MWT before flood waters built up to a significant level due to overtopping of the Mokelumne River levee. The intentional degrade was not wide enough to prevent the southwest levee from overtopping and breaching but did prevent a surge effect downstream. The three levee breaches that occurred during the 2017 flood event were only repaired to partial height (from 10 to12.5 feet NAVD88 crest elevation), so the MWT levees are subject to overtopping during relatively frequent (<5-year) flood events until the full repairs occur during Project construction.

2.5.2 Tidal hydrology

The MWT is located near the eastern margin of tidal influence within the Delta, and waterways around the MWT are tidal. During low flow conditions, tidal influences dictate local site hydrology. The tidal range, or vertical difference in elevation between the high tide line at mean higher high water (MHHW) and low tide line at mean lower low water (MLLW) in the vicinity of MWT, is a little over 3 feet. Tidal datums near the MWT are summarized in **Table 1**, below.

Table 1. Existing Tidal Datums – South Mokelumne River at New Hope Landing

Tidal Datum	Elevation NOAA (ft, STND)[1,2]	Elevation PWA (ft, NAVD88)[3]
Mean Higher High Water	6.2	6.0
Mean High Water	5.7	5.6
Mean Tide Level	4.5	4.4
Mean Low Water	3.3	3.3
Mean Lower Low Water	2.9	2.8

Notes: [1]Tidal datums at New Hope Landing Gage (DWR B94150), as calculated by the National Oceanic and Atmospheric Administration (NOAA) using a tidal epoch of 1983-2001.

[2] STND = station datum. NOAA is unable to confirm the station datum correction to NAVD88. NOAA reported, "There are 4 survey benchmarks with NAVD88 elevations recorded. Our records leveling them to our station shows differences in the NAVD88 to station relationships. The four measured relationships are: +0.048m, -1.036m, +0.180m, and +0.064m. Our standards require a maximum of 0.009m difference between the relationships at the different marks."

[3] Tidal datums calculated for the *MWT Habitat Friendly Levee Design* (PWA, 2005), which was used to inform the construction of the levee reslopes, for comparison.

Source data: cbec 2021a; NOAA 2021; PWA 2005.

2.5.3 Groundwater

The MWT is located within the South American subbasin of the Sacramento Valley Groundwater Basin (DWR 2004). The site is in a region with relatively shallow groundwater; groundwater levels in the region typically range between approximately 2 to 8 feet below the ground surface (DWR 2010). In this subbasin, surface waters (i.e., rivers and sloughs) are hydrologically connected with the underlying aquifer. Though there has been a long-term trend of declining groundwater tables in some portions of this subbasin to the north of the MWT, land subsidence due to groundwater overuse has not occurred in this region (DWR 2004). Groundwater levels within the Sacramento Valley basin historically also decline during extended drought periods but tend to recover to pre-drought conditions following wetter water years (DWR 2004).

A seepage monitoring network was developed during the interim North Delta Program, with shallow and deep groundwater level observation wells placed and regularly monitored throughout the region. The North and South Delta Seepage Well Monitoring Network Update (DWR 2015a) summarizes results of this monitoring effort, which show seasonal variation in groundwater levels throughout the region but no obvious long-term trends. One of these monitoring wells is located approximately 500 feet from the Mokelumne River levee on MWT and confirms relatively shallow depth to groundwater on MWT (similar to nearby tracts). Monitored depth to groundwater at this well on MWT ranged from approximately 2 to 9 feet deep, depending primarily on the time of year sampled (DWR 2022; DWR 2015a).

2.5.4 Agricultural Water Supply and Drainage

The MWT has been hydrologically connected to surrounding waterways by multiple pumps and siphons that have been used for agricultural water diversions and site drainage (**Figure 4**). The tract is portioned into fields that have been precisely graded to facilitate gravity irrigation and drainage of each field, with supply and drainage ditches running across the tract (primarily east-west oriented), which in turn flow to north-south oriented ditches that lead to drainage pumps at the southern end of the tract (**Figure 4**). Since the agricultural fields have been fallowed following the 2017 flood, only the primary drainage pump has been used. MWT was recently planted in winter wheat in the late fall of 2022, with harvest expected in summer 2023. One additional planting and harvest cycle may occur in 2023 on portions of the tract, under a recent lease agreement between DWR and a local farmer.

2.6 Soils

Soils on the MWT have been mapped by the Natural Resources Conservation Service (NRCS) to the following soil types (USDA-NRCS 2019; **Figure 7**), listed below in order of their prevalence on the tract:

- Egbert clay, partially drained, 0-2% slopes
- Cosumnes silt loam, partially drained, 0-2% slopes
- Columbia sandy loam, clayey substratum, partially drained, 0-2% slopes
- Columbia sandy loam, partially drained, 0-2% slopes
- Dierssen clay loam, deep, drained, 0-2% slopes

The majority of the tract area that had been tidal marsh habitat before the tract was leveed and reclaimed is mapped as Egbert clay, while the areas of slightly higher ground on the tract that experienced more fluvial influence and sediment deposition along natural levees of the Mokelumne River are characterized by Cosumnes silt loam and Columbia sandy loam soil types (USDA-NRCS 2019; **Figure 7**). Soil cores on the MWT reveal a complex depositional history, and soil profiles have been additionally altered by leveling and farming operations (Brown and Pasternak 2006). Generally, the soil types on the MWT are deep and slow to drain, and characteristic of naturally occurring tidal marsh and riparian habitats throughout the Delta, and thus appropriate for the restoration of these habitats (which were also supported historically on the tract).

Soil cores collected from southern, central, and northern locations on MWT as part of a paleogeomorphology study showed a consistent and relatively high abundance of mercury relative to levels reported for Sacramento Valley sloughs and for most reported Sacramento-basin streambed sediments (Brown and Pasternak 2006), that would have been deposited due to past mercury and gold mining operations upstream. While soil core analyses revealed low organic content and minimal evidence of peat deposits, indicating soils on the site were historically formed mostly by inorganic sediment deposition via fluvial processes, analyses also indicated relatively high Phosphorus availability in MWT soils (Brown and Pasternak 2006).

Figure 7. Project Site Soils

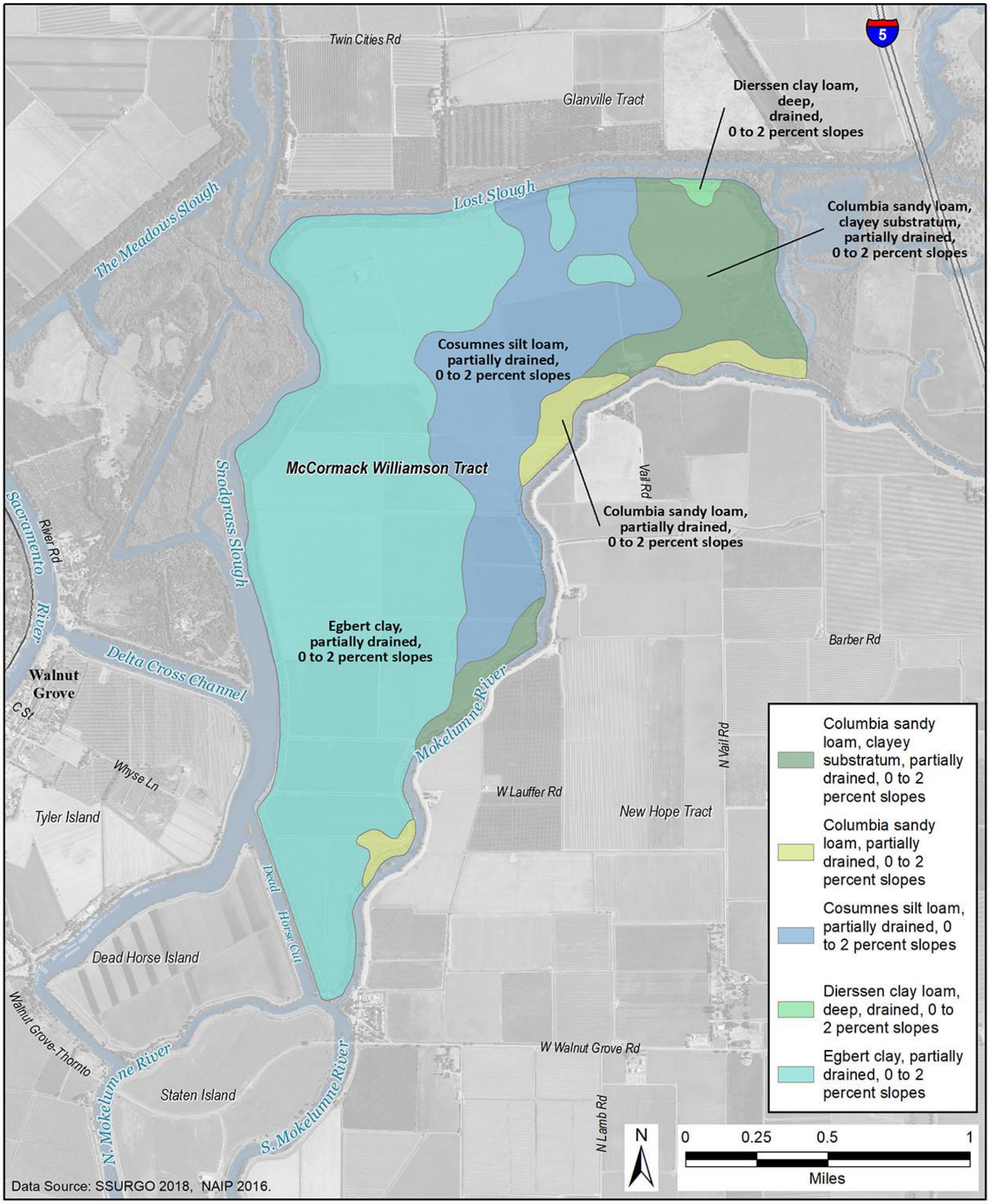


Figure Source: GEI Consultants, Inc. 2022.

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2.7 Vegetation and Wetlands

2.7.1 Plant Communities

Updated vegetation mapping for the MWT was completed in December 2020 by GEI Consultants, Inc. (GEI). The location and extent of plant communities on the tract are shown in **Figure 8** and acreages of each vegetation type within the MWT Project site study area boundary are presented in **Table 2**.

The majority of the MWT consists of recently fallowed (following the 2017 flood event) agricultural fields that have not been farmed since the 2017 flood event. These fields are currently vegetated with primarily nonnative annual grassland and ruderal vegetation. Species composition in annual grassland/ruderal vegetation (comprising approximately 1,435 acres of the MWT) varies somewhat, but the most commonly observed species include bristly ox-tongue (*Helminthotheca echioides*), willowherb (*Epilobium brachycarpum*), barley (*Hordeum murinum*), wild oats (*Avena barbata*), soft chess brome (*Bromus hordeaceus*), rabbitsfoot grass (*Polypogon monspeliensis*), bull thistle (*Cirsium vulgare*), curly dock (*Rumex crispus*), poison hemlock (*Conium maculatum*), black mustard (*Brassica nigra*), prickly lettuce (*Lactuca serriola*), Canadian horseweed (*Erigeron candadensis*), cheeseweed (*Malva parviflora*), bermudagrass (*Cynodon dactylon*), milk thistle (*Sylibum marianum*), and Spanish clover (*Acmispon americanus*).

Some recent cottonwood and willow recruitment occurred on fallowed agricultural fields following the 2017 flood event, which has been allowed to persist with the cessation of active cultivation, particularly near the Mokelumne River breach site. These areas, which are mapped as early successional valley/foothill riparian woodland (**Figure 8**), support dense stands of young cottonwood saplings (*Populus fremontii* ssp. *fremontii*), as well as saplings of sandbar willow (*Salix exigua*), Goodding's willow (*Salix gooddingii*), and occasional Pacific willow (*Salix lasiandra*). Some scattered black locust (*Robinia pseudoacacia*) saplings also recruited in the tract interior following the 2017 flood.

In areas around the fringes of the tract that have not been actively farmed in recent decades, a mix of valley/foothill riparian woodland, valley/foothill riparian scrub, valley oak woodland, and nonnative riparian scrub (dominated by Himalayan blackberry, *Rubus armeniacus*) occurs, with some scattered patches of annual grassland/ruderal vegetation and nonnative riparian woodland (dominated by black locust). These vegetation types for the most part do not sort out by elevation on tract levees but occur in a patchy mosaic around the tract. Valley/foothill riparian woodlands include Fremont cottonwood, valley oak (*Quercus lobata*), arroyo willow (*Salix lasiolepis*), box elder (*Acer negundo*), Northern California black walnut (*Juglans hindsii*), California sycamore (*Platanus racemosa*), Goodding's willow, Pacific willow, Oregon ash (*Fraxinus latifolia*), with Santa Barbara sedge (*Carex barbarae*), wild rose (*Rosa californica*), and wild grape (*Vitis californica*) common in the woodland understory. Areas mapped as valley oak woodlands share similar species composition to areas mapped as valley/foothill riparian woodland, but are more heavily dominated by valley oaks, with oak canopy cover comprising at least 50 percent of the tree canopy (Sawyer et al. 2009). Valley/foothill riparian scrub was mapped in areas dominated by shorter stature native woody riparian species including willows such as sandbar, arroyo, and

Pacific willow, as well as blue elderberry (*Sambucus nigra* ssp. *caerulea*), wild rose, and buttonbush (*Cephalanthus occidentalis*).

Table 2. Existing Vegetation and Land Cover Acreages on the MWT

Vegetation Type	Acres[1]
Annual Grassland/Ruderal	1410.2
Valley/Foothill Riparian Woodland	52.9
Early Successional Valley/Foothill Riparian Woodland	38.3
Perennial Native Grassland (Seeded in Phase A)	20.7
Valley/Foothill Riparian Scrub	18.4
Developed/Road	17.6
Valley Oak Woodland	15.0
Nontidal Emergent Freshwater Wetland	13.1
Nonnative Riparian Scrub	10.7
Tidal Perennial Aquatic	7.8
Seasonal Wetland	3.4
Nonnative Riparian Woodland	1.6
Barren	1.2
Ornamental Plantings	0.2
Tidal Emergent Freshwater Wetland	0.1
Phase A Riparian Planting Areas[2]	25.8
Total Acreage of MWT Study Area	**1,636.8**

Notes:
[1] Acreages are totals mapped within MWT study area boundary, which is generally defined by the exterior levee crest, but includes potential waterside work areas and the interior of the tower ring levee.
[2] Phase A riparian planting areas were planted with riparian vegetation between December 2020 and December 2021.
Source data: GEI Consultants, Inc. 2020.

The historical scour pond/borrow site feature adjacent to the east levee supports nontidal emergent freshwater marsh dominated by common tule (*Schoenoplectus acutus*) and cattails (*Typha latifolia* and *T. angustifolia*), as well as some patches of valley/foothill riparian woodland, riparian scrub, and valley oak woodland. Prior to cessation of agriculture and active irrigation, the scour pond area supported persistent ponded open water, but has since dried down to become ponded only during wet periods and supports sparse seasonal wetland vegetation, including nodding smartweed (*Persicaria lapathifolia*), stinging nettle (*Urtica dioica*), willowherb, and poison hemlock. The other historical borrow area adjacent to the west levee south of the tower ring levee supports valley/foothill riparian woodland (dominated by Fremont cottonwood) and a small area of nontidal emergent marsh.

The tower ring levee and Phase A landside levee reslope areas were seeded with native perennial grasses following completion of grading activities in 2018 and 2019, respectively. Additionally, approximately 25 acres of existing levee slope were planted with native riparian scrub-shrub and riparian woodland plants, with a temporary irrigation system, as part of the Phase A Project. These areas were planted in December 2020, with a second phase of planting and seeding completed November through December 2021 (**Figure 8**).

Figure 8. Existing Site Vegetation

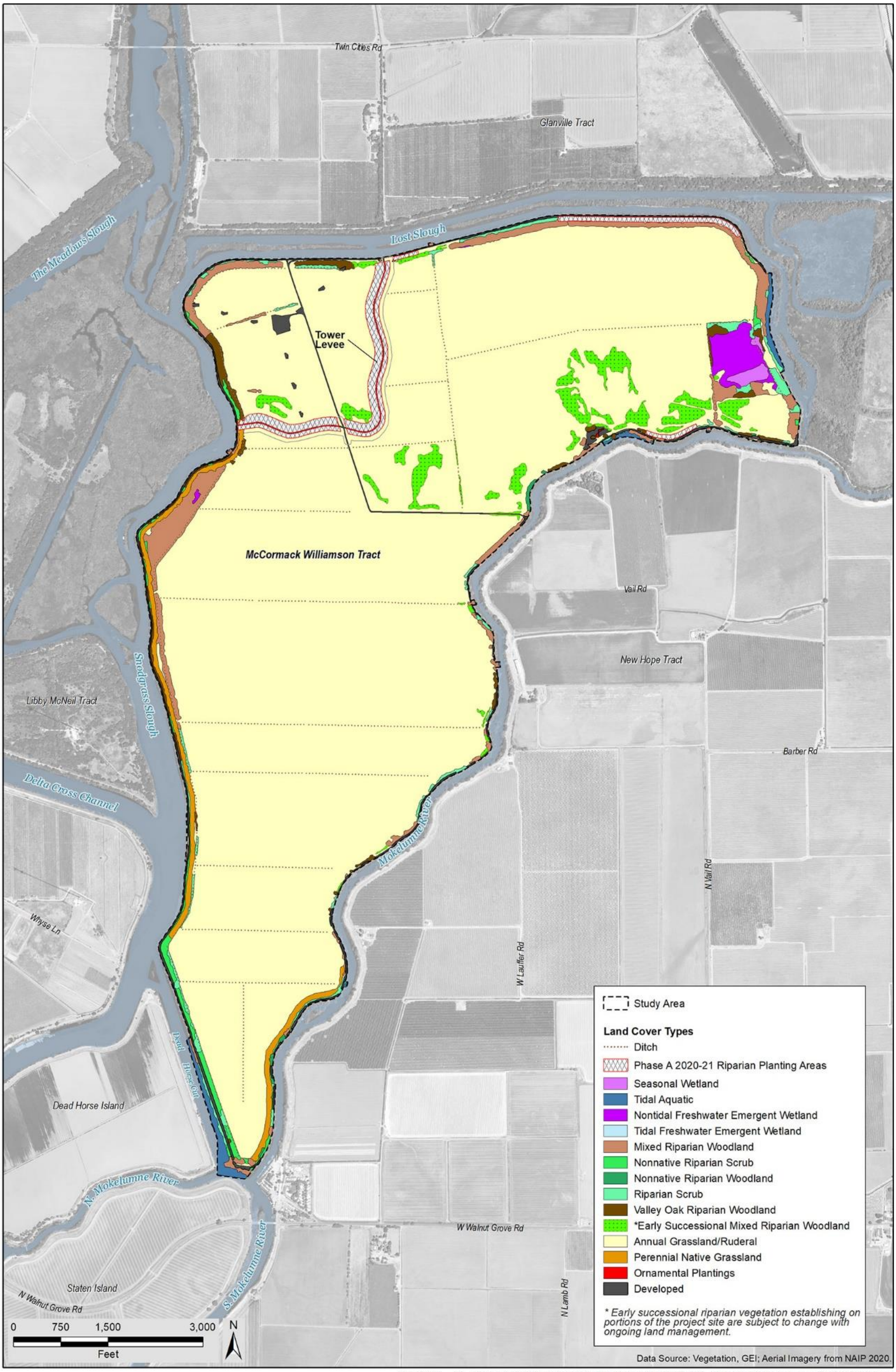

Figure Source: GEI Consultants, Inc. 2022.

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2.7.2 Jurisdictional Wetlands and Waters

In 2015, DWR conducted a delineation of waters of the United States (U.S.) in the interior portion of MWT. This delineation identified approximately 53 acres of waters of the U.S., including approximately 25 acres of wetlands, all of which also qualify as waters of the state. Jurisdictional wetlands and waters mapped on the MWT include the area of emergent wetland and open water/seasonal wetland on the northeast corner of the tract, the small emergent marsh mapped in the borrow site south of the tower ring levee, and permanently inundated agricultural ditches within MWT (DWR 2015b). Site conditions have become drier on the MWT since irrigation activities ceased; the perennial open water 'scour pond' feature has transitioned to seasonal wetland and most agricultural ditches on the site no longer support open water. All aquatic features along the exterior boundary of MWT (i.e., waterside of levees around MWT) are also waters of the U.S. and waters of the state.

2.7.3 Special-Status Plant Species

The potential for the site to support special-status plants is described in detail in the North Delta Project EIR (DWR 2010) and the MWT Phase B SEIR (DWR 2022). Special status plant species include species listed, proposed or candidates for listing under the federal Endangered Species Act (ESA) or the California ESA, and plants ranked as rare or endangered by the California Native Plant Society (CNPS).

Ten special-status plant species were determined to have the potential to occur within the MWT Project site: Mason's lilaeopsis (*Lilaeopsis masonii*), Sanford's arrowhead (*Sagittaria sanfordii*), Delta mudwort (*Limosella subulata*), Delta tule pea (*Lathyrus jepsonii*), Suisun marsh aster (*Symphyotrichum lentum*), bristly sedge (*Carex comosa*), marsh skullcap (*Scutellaria galericulata)*, side-flowering skullcap (*Scutellaria lateriflora*), Bolander's water-hemlock (*Cicuta maculata* var. *bolanderi*), and rose-mallow (*Hibiscus lasiocarpos* var. *occidentalis*). As shown in **Figure 9**, some occurrences of special-status wetland plants are known from the MWT Project vicinity, including on the exterior of the MWT levees. Rare plant surveys conducted in 2014 and 2018 in the Phase A Project areas did not detect any special-status plant occurrences on the MWT (Stillwater 2018). To date, Delta mudwort is the only species that has been reported from the Project site. One plant of this species was reportedly observed in September 2009, along Dead Horse Cut in the MWT southwest levee degrade footprint; however, this occurrence is ranked as poor in the California Natural Diversity Database (CNDDB). Current presence or absence of special-status plants in the levee degrade areas will be determined when focused surveys of those areas are conducted closer to the construction period.

In general, implementation of the MWT Project will incorporate appropriate avoidance and minimization measures to reduce or eliminate negative construction-related effects on any special-status species that have potential to occur onsite. The special-status plants with potential to occur on the MWT are associated with freshwater tidal marsh margins, mudflats, and/or riparian scrub habitats. Reestablishing tidal hydrology on the tract will provide suitable habitat for these species where none currently exists, thus resulting in potential benefits for these species. Introducing special-status plant propagules to appropriate habitats onsite after restoration has occurred could be a future permitted activity undertaken by RD 2110/DWR, the CRP manager, or other entity, if deemed appropriate by the United States Fish and Wildlife Service and CDFW.

Figure 9. Special-status Plant Occurrences within 0.5 mile of MWT

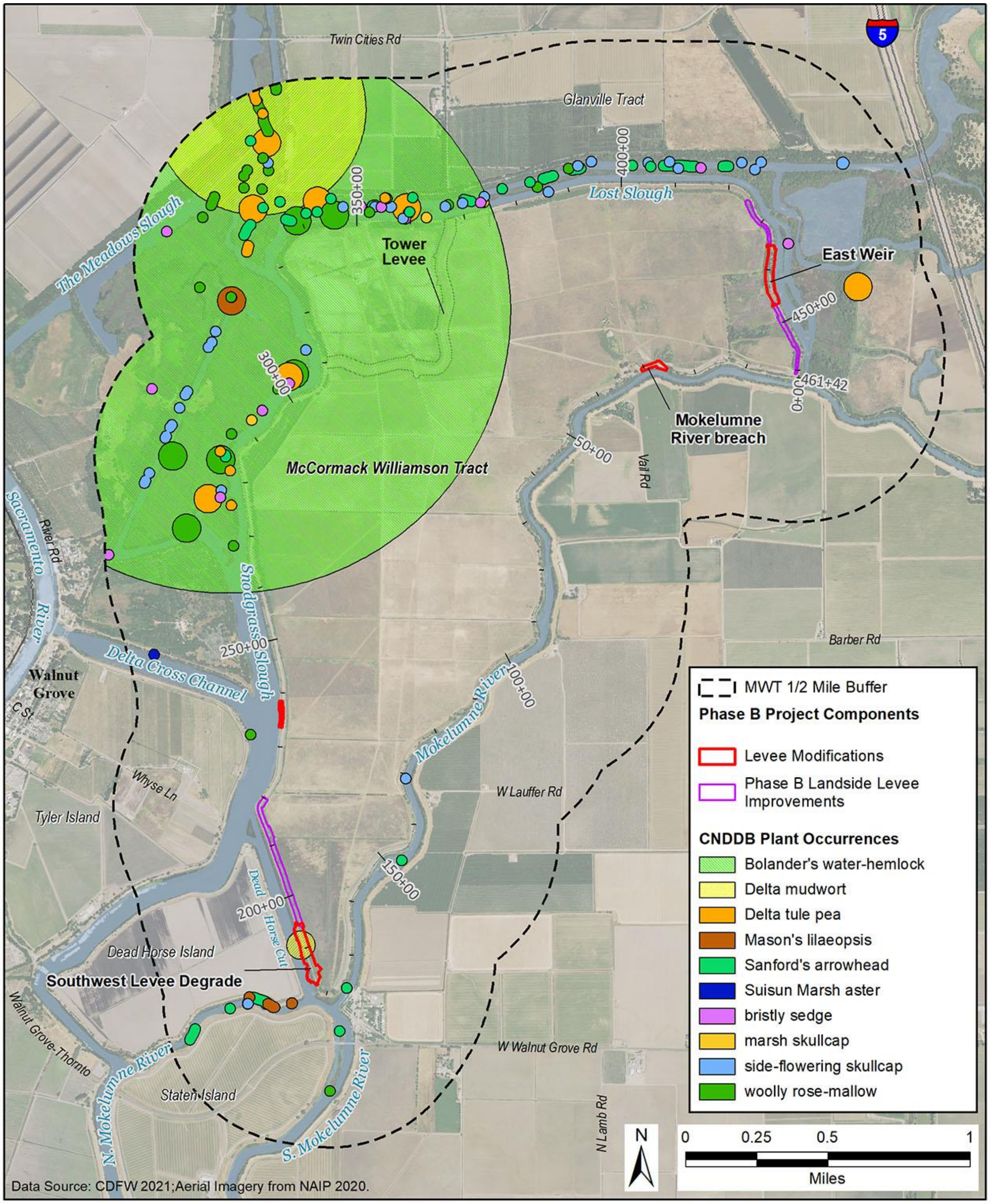

Figure Source: GEI Consultants, Inc. 2022.

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2.8 Fish and Wildlife

Many native fish and wildlife species are present on and around the MWT, most of which will benefit from the planned restoration Project.

Currently, the MWT supports terrestrial wildlife primarily associated with grassland/ruderal habitats, and riparian forest and scrub. Western pond turtle (*Actinemys marmorata*) has been observed onsite but is less likely to occur onsite now that most open water features are absent with the cessation of agricultural irrigation activities. Abundant elderberry shrubs are present on tract levees, which have the potential to support Valley elderberry longhorn beetle (VELB; *Desmocerus californicus dimorphus*). Swainson's hawk (*Buteo swainsoni*) has been documented nesting in riparian vegetation on MWT levees and is commonly observed in the local vicinity. Point Reyes Bird Observatory conducted a riparian bird monitoring program during the 2000 and 2001 breeding seasons on the MWT and documented occurrences of a number of common riparian songbird species on MWT levees but found lower species diversity and abundance at MWT than in more extensive riparian habitats elsewhere in the CRP (Wood et al. 2004).

Crain et al. (2001) conducted fish surveys within the waterways around MWT on a quarterly basis for 2 years to provide baseline information supporting design for the MWT Project. The nonnative fishes bluegill, redear sunfish, and largemouth bass made up 70 percent of the number of fish caught in samples; Sacramento sucker was the most prevalent native fish sampled, making up 4 percent of captured fish (Crain et al. 2001). Additional site-specific data collection and analyses related to fish resources at MWT have been conducted in recent years. This includes fish sampling and salvage associated with the 2017 levee breach. Approximately 168,000 fish were rescued and relocated from agricultural ditches on MWT following the breach, including five native species and 16 nonnative species (DWR 2022). Sampling occurred as feasible but avoided ditches with a higher proportion of native species and, therefore, may have resulted in a slight under-representation of the total proportion of native fish. Four nonnative species accounted for more than 70 percent of the fish in the 2017 samples: black crappie (*Pomoxis nigromaculatus*), threadfin shad (*Dorosoma petenense*), golden shiner (*Notemigonus crysoleucas*), and brown bullhead (*Ameiurus nebulosus*). Three native species were identified during salvage sampling but accounted for less than 1 percent of the total number of fish in the samples: Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), and prickly sculpin (*Cottus asper*). Two additional native species, Sacramento splittail (*Pogonichthys macrolepidotus*) and Sacramento blackfish (*Orthodon microlepidotus*), were observed during salvage efforts but not encountered during salvage sampling. Crain et al. (2001) suggested seasonally inundated floodplain habitat will provide the greatest direct habitat benefits for native fishes currently occurring in the vicinity of MWT.

2.8.1 Special-Status Species

The potential for the site to support special-status fish and wildlife species is described in detail in the North Delta Project EIR (DWR 2010) and the MWT Phase B SEIR (DWR 2022). Special-status fish and wildlife species include species listed, proposed or candidates for listing under the federal ESA or the California ESA; and animals listed as "fully protected" or a "species of special concern" by CDFW.

Figure 10 shows CNDDB occurrences and other recent observations of special-status animals on and within 0.5 mile of the Project site. Special-status wildlife species that are known to occur or have potential to occur in the MWT Project site include: VELB, giant garter snake (*Thamnophis gigas*), western pond turtle, California tiger salamander (*Ambystoma californiense*), Swainson's hawk, greater sandhill crane (*Antigone canadensis tabida*), song sparrow “Modesto” population (*Melospiza melodia*), western burrowing owl (*Athene cunicularia*), the western distinct population segment of yellow-billed cuckoo (*Coccyzus americanus occidentalis*), bald eagle (*Haliaeetus leucocephalus*), American peregrine falcon (*Falco peregrinus*), tricolored blackbird (*Agelaius tricolor*), and California black rail (*Laterallus jamaicensis coturniculus*) (DWR 2010; DWR 2022).

Special-status fish species that are known to occur or have potential to occur in the MWT Project vicinity include: Central Valley Chinook salmon (fall/late fall-run, spring-run, and winter-run; *Oncorhynchus tshawytscha*), steelhead (Central Valley Distinct Population Segment; *O. mykiss*), delta smelt (*Hypomesus transpacificus*), longfin smelt (San Francisco Bay-Delta Distinct Population Segment; *Spirinchus thaleichthys*), green sturgeon (southern Distinct Population Segment, *Acipenser medirostris*), Pacific lamprey (*Entosphenus tridentatus*), and Sacramento splittail (*Pogonichthys macrolepidotus*) (DWR 2010; DWR 2022).

In general, implementation of the MWT Project will incorporate appropriate avoidance and minimization measures to reduce or eliminate negative construction-related effects on any special-status fish and wildlife species that have potential to occur onsite. While construction-related impacts could have temporary adverse effects on resident and migratory fish and wildlife species, the restoration of extensive riparian, floodplain, tidal marsh and shallow-water habitats will provide increased habitat quantity and quality, regional habitat connectivity, and food web benefits for most special-status fish and wildlife species with potential to occur on or in the vicinity of the MWT.

Figure 10. Special-status Wildlife Occurrences within 0.5 mile of MWT

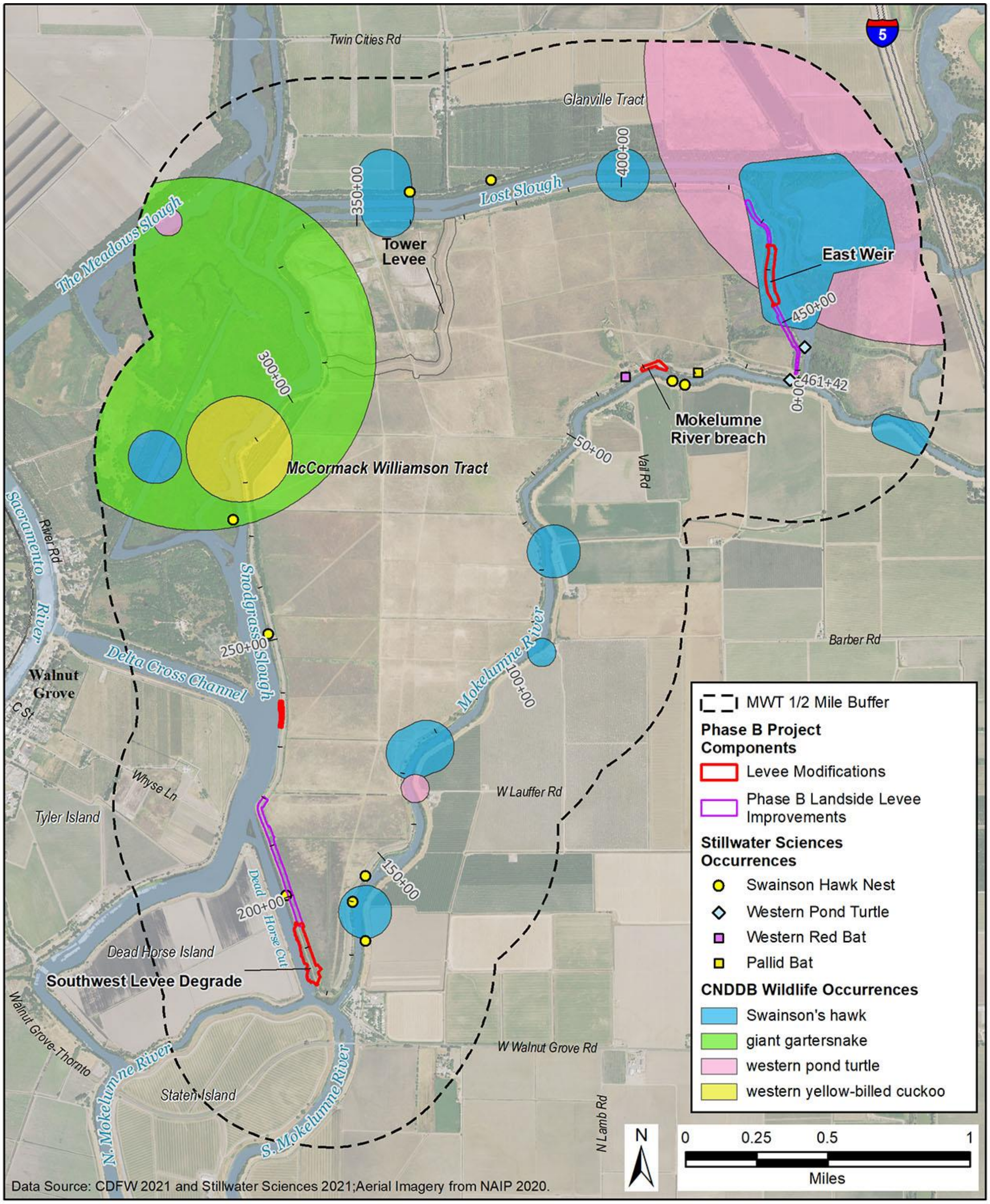

Figure Source: GEI Consultants, Inc. 2022.

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2.9 Cultural Resources

A Draft Cultural Resources Inventory and Evaluation Report was prepared for the MWT site in 2015 to investigate whether cultural or archaeological resources could be found or would be likely to be present in the MWT Project area (AECOM 2016). Cultural records searches, tribal consultation, and searches of archival and secondary research sources were conducted prior to field investigations. An intensive pedestrian archaeological field survey and a field survey by an architectural historian were conducted, as was a geoarchaeological investigation which included excavating a total of 13 backhoe test pits in areas where Project impacts could potentially encounter buried archaeological deposits (AECOM 2016). No cultural, archaeological, or historically significant architectural resources were identified in the Project area as a result of the investigations and field surveys (AECOM 2016). Given the findings of the investigations, the report indicated that it is unlikely that any buried archaeological resources would be affected or encountered during Project construction (AECOM 2016). If any unrecorded cultural resources are discovered during Project implementation, work would be stopped in the vicinity of the discovery until the significance of the resource can be assessed by a qualified archaeologist (DWR 2022).

A pedestrian survey was conducted in the summer of 2022 for one of the SMUD relocation projects. The results of the survey were documented in a technical memorandum. No sensitive resources were located.

2.9.1 Hazardous Substances

A Hazardous Substances Assessment (HSA) Report was prepared for the MWT in 2015 to investigate any issues or concerns associated with hazardous, toxic, or radioactive waste that could be located on the MWT Project site (AECOM 2015). Samples were collected from stained soil locations, including beneath one of the onsite above-ground diesel storage tanks, under a used motor oil above-ground storage tank, and inside a pesticide mixing shed. The results of limited soil sampling indicated that elevated levels of volatile organic carbons, petroleum hydrocarbons, metals, and pesticides were present. Groundwater samples were not obtained. Since the HSA was prepared, additional Phase A levee work was performed, and the onsite pesticide mixing shed and above-ground storage tanks were removed. The contaminated soil has been capped with approximately 3 feet of clean fill dirt. Since the full extent of contamination has never been defined, it remains possible excavation associated with could encounter previously unidentified extents of the contaminated soil. The SEIR for the MWT Phase B Project (DWR 2022) mandates that if evidence of contaminated materials is encountered during construction, construction will cease immediately and applicable requirements of the Comprehensive Environmental Response and Liability Act and California Code of Regulations Title 22 regarding the disposal of waste will be implemented. Additionally, a contingency plan will be prepared in advance to address actions that would be taken should any contaminated soil or groundwater be discovered. The plan will include health and safety considerations, instructions on handling and disposal of wastes, reporting requirements, and emergency procedures (DWR 2022).

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Chapter 3. Conceptual Models and Science Basis

The Project will restore wetland and riparian habitat by reintroducing tidal and seasonal flooding and establishing native vegetation. The site is a rare place where elevation, unregulated flows, intact sediment supply, and ownership provide opportunities to readily restore tidal and floodplain processes and habitats (Beagle et al. 2013).

The Project has a strong foundation in landscape ecology, tidal wetland and floodplain restoration science, hydrodynamics, and lessons learned from nearby restoration projects. The design described in the North Delta EIR was refined with expert opinion from the North Delta Science Advisory Committee (DWR 2010). The hydrologic and hydraulic models have been updated and refined and additional input was received from a focused MWT Technical Advisory Committee in 2018. Project grading plans are to a level of 65 percent design and the Restoration Plan detailing restoration basis of design, vegetation establishment approach, and establishment performance monitoring has been finalized.

3.1 Hydrology and Physical Processes

As reviewed by SFEI (Beagle et al., 2013, SFEI-ASC 2016), MWT is situated in a unique position at the intersection between the historical north and central Delta, at the downstream end of the Mokelumne River delta, and at the upper range of tidal influence. Unlike most of the Delta, much of MWT is not severely subsided and has the potential for tidal wetland restoration.

Because of its location and elevation, MWT has been viewed as a prime site for restoration of tidal freshwater marsh, seasonal wetlands, and riparian forest, and reconnecting the tract as a floodplain to the Mokelumne River will play an important role in improving flood control.

Current maps (**Figure 5**) illustrate remnants of some topographic features that were present historically, including wide natural levees along the Mokelumne River and low spots along Snodgrass and Lost Sloughs where tidal inlets or channels existed. The MWT was separated from surrounding channels by levees after a reclamation project conducted in the late 1890s. As one of the last islands to be reclaimed and with levee heights restricted by the Reclamation Board to elevations lower than adjacent islands, the MWT flooded more frequently than surrounding islands. As the MWT was farmed over decades, appreciable subsidence of the peat soils occurred in the southern half of the tract.

Breaching levees and reconnecting Mokelumne River flows onto MWT would facilitate flooding areas historically associated with a riverine system. The MWT would have fluvial and tidal hydrology reintroduced, to function as a floodplain of the Mokelumne River during high flow events – providing opportunities for tidal processes to dominate during the summer and fall. Levee modifications to reestablish hydrologic processes is a well-supported restoration approach for tidal wetlands and riparian floodplain systems (Beagle et al. 2013, SFEI-ASC 2016, Opperman et al. 2017). The expected hydrologic regime is appropriate for tidal freshwater wetlands, transitioning to riparian shrub-scrub and forest above MHHW. Due to the subsided elevations at the southern end of the tract, breaching MWT will result in areas of shallow open water in areas with subtidal elevations.

Degrading the southwest levee to interior grade elevations for a 1,000-foot-width allows for significant tidal connectivity of the tract but very slightly mutes tides relative to a full levee degrade. The reduction of the southwest levee degrade was intended as a conservative measure to minimize potential salinity effects off-site while maintaining Project objectives for flood protection and habitat restoration (DWR 2022). Tidal inundation of the MWT interior post-breach is determined by the southwest levee degrade width and invert (i.e., lowest elevation of degrade cross section), as well as tidal channel design. Modeling of tidal hydrology on the 30 percent grading plans was conducted to inform landform grading design revisions, including widening tidal channels and matching marshplain elevations to meet or exceed modelled MLLW elevations. The MWT southwest levee degrade is modeled to result in slight dampening of tidal range in the waterways immediately surrounding the MWT, due to distribution of the available tidal prism volume over a slightly wider area in the local vicinity (cbec 2022), and tides are also muted from south to north within the tract. While MHHW elevation is modeled to be relatively consistent throughout the MWT post-breach, the modeled MLLW elevation ranges from approximately 3.5 to 3.9 feet NAVD88 from the southern end to the northern end of the tract (**Table 3**). Tidal hydrology and final grading of the tract interior will dictate the extent of subtidal open water habitat (areas laying below MLLW), tidal freshwater marsh habitat (land areas between MLLW and MHHW elevations), and riparian habitats (occurring above MHHW elevation).

Table 3. Modeled Post-Project Tidal Elevations on MWT

Tidal Datum	1 *. (near Southwest degrade)	2 *	3 *	4 *	5 *	6 *	7 *	8 * (near East Weir)
Mean Higher High Water	5.7	5.7	5.7	5.7	5.6	5.6	5.6	5.6
Mean High Water	5.4	5.4	5.4	5.4	5.3	5.3	5.3	5.3
Mean Tide Level	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7
Mean Low Water	3.8	3.8	3.8	4.0	4.1	4.1	4.1	4.1
Mean Lower Low Water	3.4	3.5	3.5	3.7	3.8	3.8	3.9	3.9

Notes: Modeled Post-Project tidal datums on MWT interior from southern most extent (Index Point 1, near Southwest Levee Degrade) to northernmost extent (Index Point 8, near East Weir).

*. Modeled Datums Post-Project at MWT Interior Index Points (Elevation ft NAVD88)

Source data: cbec 2022.

The levee degrade planned on the Mokelumne River levee and the east levee flood weir would restore fluvial hydrology, sediment deposition processes, and regular riverine floodplain inundation to the interior of the MWT. The Mokelumne River breach invert is at elevation 7 feet NAVD88, which is just above modeled MHHW (5.6 feet) for the site, so it will activate very regularly to convey any flood flows onto the MWT and provide habitat and sediment connectivity of the Mokelumne River to the MWT during any fluvial events exceeding low flow conditions. Fluvial flows would additionally be conveyed through the MWT over the East Weir during moderate river stages when flows exceed approximately 11 feet elevation at the weir. Based on historical data (1983-2019), the East Weir has a 25 percent probability of being activated in any given year, but the weir would only be expected to be activated about 1 percent of the time. Using the historical gage record, it is estimated the East Weir would have been activated for approximately 12 days in 2017, 6 days in 1997, and 5 days in 1986.

3.2 Tidal Wetlands

Much of the MWT is currently within the intertidal range. Once tidal influence is re-introduced to the site, a large portion of MWT is expected to be restored to tidal freshwater wetland habitat.

Tidal exchange is the driving process that creates and sustains tidal wetlands (Siegel et al. 2010). Key elements include inundation regime, sediment delivery (erosion, deposition), and exchange of nutrients. At the most fundamental level, the frequency, magnitude, and duration of tidal inundation exerts the single greatest control on tidal wetland functions and processes. Inundation regimes are controlled through the interaction between relative marsh elevation and tidal action. Tidal networks form as a function of the tidal regime, vegetation type, sediment characteristics, and marsh elevations. It is expected that a dendritic network of intertidal channels will form within MWT naturally through tidal action. A dendritic intertidal wetland system can benefit native fish species by providing a maximum amount of edge habitat.

Project restoration design was tailored to maximize ecosystem benefits for native fish species by maximizing floodplain and aquatic habitat quantity, quality, and complexity. In tidal marsh habitats, this was achieved by increasing shaded riverine aquatic (SRA) habitat adjacent to tidal marsh and subtidal open water habitats, reducing riparian vegetation clearing to retain approximately 30 acres of flooded forest features, increasing vegetated tidal marsh acreage, maximizing tidal channel-marsh edge lengths, minimizing fish stranding risks, and designing channels for long-term accessibility for management of aquatic invasive plants. Increasing the amount of interface between terrestrial and aquatic habitats and SRA habitat increases allochthonous organic matter inputs to aquatic systems, which in turn support phytoplankton and zooplankton productivity (SFEI-ASC 2014, Jeffres et al. 2020). Densely vegetated shorelines within the tract, as well as flooded forest features, will provide high quality refugia and food sources for fishes. Design features that add habitat complexity and heterogeneity should additionally reduce nonnative predator search efficiencies on native fishes (SFEI-ASC 2016; Opperman et al. 2010; Safran et al. 2018).

Restoration of tidal wetlands is hypothesized to support native fish species by increasing the production of nutritionally valuable phytoplankton, zooplankton and other invertebrates. Incoming tides bring nutrients, organic matter, sediment and organisms onto tidal wetlands to drive productivity. The vegetation, plankton, microbes, and macroinvertebrates produced within tidal wetlands can become subsidies for the food web of adjacent water bodies when transported to these water bodies on ebb tides (Kneib et al. 2008). Primary production of diatoms, green algae and chrysophyte phytoplankton in tidal wetlands provides food resources for calanoid copepods that are, in turn, important food for juvenile fish (IEP MAST 2015).

Many of the Delta’s freshwater tidal wetlands are dominated by clonal perennial plants, in particular tules, and to a lesser extent cattail. These species are emergent macrophytes, large rhizomatous plants rooted in the substrate with stems above the water surface. Once established, emergent macrophytes have rapid growth rates and accumulate organic matter from abscised plant parts and trapped sediment, raising marsh elevation.

3.3 Riparian Vegetation

Re-establishing wide, continuous riparian forests and scrub with connections to off-channel habitats benefits riparian wildlife (SFEI-ASC 2016). Several riparian patches at the CRP were established in the late 1990s when levee breaching in 1995 and 1997 reconnected floodplains with flows and sediment (Florsheim & Mount 2002, Swenson et al. 2003, Nichols & Viers 2017). This Project will improve upon the existing riparian corridor that exists along the Mokelumne River.

Riparian plant communities follow zones of hydroperiod, soils, and flood disturbance (Stella et al. 2013). The recruitment box model (Mahoney & Rood 1998) suggests cottonwoods will establish on sediments inundated in April, but exposed and moist during May-June seed dispersal.

Monitoring of the 1995 Cosumnes breach found a diverse mosaic of vegetation, with trees on higher elevation (Trowbridge 2007). Over the years, this floodplain has trended toward dominance of mostly native woody species. Lessons learned from recent riparian restoration projects (TNC Oneto-Denier; Cosumnes River Preserve; Westervelt Ecological Service's Cosumnes Floodplain Mitigation Bank) have informed the MWT Project restoration approach (GEI 2022).

The high variability in fluvial hydrology at the MWT is relatively unique for the Delta and is driven primarily by unregulated flows from the Cosumnes River, which holds the distinction of being the largest unregulated river west of the Sierra Crest (Florsheim et al. 2006). The Cosumnes River and other smaller unregulated tributaries create a naturally variable hydrograph at the MWT, including annual winter and spring flood pulses that drive scour and deposition processes, which in turn increase floodplain topographic and habitat heterogeneity (Florsheim et al. 2006; Florsheim and Mount 2002; Opperman et al. 2010). Fluvial disturbance creating habitat mosaics of differing vegetation composition, density, and successional age will, in turn, result in greater quality habitat for many riparian bird species and other wildlife (Golet et al. 2008; Swenson et al. 2012; Dybala et al. 2018).

Similarly, fluvial scour and channel avulsion disturbances to tidal marsh and floodplain habitats is expected to create habitat diversity benefits for multiple other species guilds including waterfowl and shorebirds that prefer open wetland habitat over dense stands of tules and cattails (Dybala et al. 2020), riparian birds that prefer riparian habitats with early successional patches and stand openings (Dybala et al. 2018), and native fishes by increasing aquatic habitat heterogeneity (SFEI-ASC 2016; Opperman et al. 2010; Safran et al. 2018).

3.4 Seasonal Floodplain

Floodplains serve as an interface between the terrestrial and aquatic environments during inundation events. The timing and predictability of flooding are important ecological variable that shape floodplain ecosystems and native Delta species have adapted to using seasonal floodplains (Opperman et al. 2017). In California, flooding tends to predictably occur within the winter and spring seasons, although the exact timing and extent of flooding vary tremendously between years (Opperman et al. 2017).

Floodplain inundation activates aquatic food webs (Ahearn et al. 2006) as flows slow and residence time increases (Whipple et al. 2012). Flooding that occurs during late winter and early spring and persists at least 2-3 weeks supports native fish spawning (Sacramento splittail) and rearing (Chinook salmon) (Sommer et al. 1997, Moyle et al. 2007, Jeffres et al. 2008). A floodplain that drains by May favors native fish over nonnative species (Moyle et al. 2007).

Native fish (salmon, splittail) respond to hydrologic cues during flood recession to leave flooded areas and avoid stranding, unlike warmwater fish (e.g., carp) that spawn later (Jeffres 2017).

3.5 Fish

Native fishes that are expected to be present in the vicinity of the Project site include fall-run Chinook salmon, Sacramento splittail, and steelhead. Fall-run Chinook salmon migrate upstream through the Delta during fall to spawn in the Mokelumne and Cosumnes Rivers and juveniles out- migrate from the rivers during spring, heading through the Delta and back to the Pacific Ocean. (The winter-run Chinook salmon and spring-run Chinook salmon are restricted to the Sacramento River Basin and are unlikely to occur in the Project area.) Shallow water of freshwater tidal marshes and floodplains provide feeding and rearing habitat for juvenile anadromous fish Riparian vegetation on Delta levees is important to provide insects as a food source to rearing juvenile fish.

Sacramento splittail migrate upstream in January-February and spawn on seasonally inundated floodplains in March-April (Moyle et al. 2004). They migrate back downstream in May and rear in shallow, brackish water habitat for one to two years before beginning the migratory cycle again. Physical elements important to the success of splittail include flooded floodplains for spawning, safe migration channels, brackish water rearing habitat with an invertebrate food source. Splittail populations benefit from wet-year flows that result in greater floodplain inundation.

Delta smelt are generally regarded as pelagic fish that typically occupy open water habitat (Moyle 2002). Their use of tidal wetlands is likely limited to consumption of productivity exports, although some direct, opportunistic utilization of shallow water habitat likely occurs. Connectivity of tidal wetlands to the tidal aquatic environment is the key process linking delta smelt with tidal marsh productivity. Delta smelt have been documented in the rivers and sloughs of the east Delta, although their abundance is low compared to most other areas of the Delta (Merz et al. 2011). Since the 1980s, delta smelt have rarely been encountered during sampling in the northeastern Delta.

3.6 Birds

Historically, the shallow water of the Delta tidal marshes and sloughs provided habitat for an abundance of migratory birds. The restoration of tidal emergent wetland habitat in MWT is expected to provide habitat for marsh bird species such as common yellowthroat (*Geothlypis trichas*), black rail, marsh wren (*Cistothorus palustris*) and song sparrow. The return of MWT to a flooded island offers significant potential to study the recolonization of native species in a habitat that currently exists only as scattered remnant in channel islands in the Delta. However, converting fallow farmland to tidal wetlands is not expected to provide foraging habitat for those species that utilize agricultural lands, such as Swainson’s hawks and sandhill cranes.

Similarly, the establishment of additional riparian habitat as a result of the Project is expected to create beneficial nesting and foraging habitat for a broad array of passerine and raptor species. The types of bird species that riparian vegetation support range from Swainson’s hawks that nest in tall riparian trees to house wrens (*Troglodytes aedon*) that forage on the floor of the riparian forest and inside debris piles (Griggs 2009). Other bird species commonly associated with riparian habitat include Least bell’s vireo (*Vireo bellii pusillus*), yellow-billed cuckoo (*Coccyzus americanus occidentalis*), yellow-breasted chat (*Icteria virens*), yellow warbler (*Dendroica petechia*), and song sparrow.

Early successional riparian habitats and openings in mature forest that will be maintained by regular fluvial disturbance benefit many bird species, including lazuli bunting (*Passerina amoena*), song sparrow, common yellowthroat, blue grosbeak (*Passerina caerulea*), and others (Wood et al. 2006; Dybala et al. 2018). Additionally, riparian bird diversity is often higher in riparian forests with lower stand densities with openings in the tree canopy (Dybala et al. 2018).

3.7 Climate Change

Climate change projections for the Sacramento-San Joaquin Delta include more variable rainfall and runoff, particularly in the rain-fed and dam-free Cosumnes River and Dry Creek watersheds (Booth et al. 2006), with more extreme floods and droughts; warmer air temperatures; and sea-level rise. These changes are likely to be accompanied by earlier seasonal runoff, higher water temperatures and Delta salinity intrusion.

The MWT site is ideally situated on the Delta's landscape with a transition zone that can accommodate expected sea level rise (SFEI-ASC 2016). The site's topography, unregulated sediment source, and inundation regime is a key determinant of the viability and sustainability of its vegetation communities. The site will be vegetated with native plant species that are adapted to the Central Valley and Delta's historic pattern of hydrologic variability, including drought, to which naturally recruited riparian vegetation is particularly resilient. The marsh and riparian vegetation will facilitate ground surface accretion, by depositing plant biomass and capturing inorganic sediment. This accretion will enable vegetated habitats to build vertically in response to sea-level rise. The site's gentle slope from tidal to lowland terrestrial/floodplain elevations allows for lateral translation of restored habitats in response to sea-level rise. Having room for habitats to move laterally with sea-level rise improves habitat sustainability and is regionally rare.

Along the restored channel network, the restoration includes riparian vegetation, which will provide shade for fish and wildlife to help offset increases in water temperature. Because of the site's location on the east side of the Delta, its vulnerability to projected salinity intrusion into the west Delta will be limited.

Chapter 4. Project Summary

4.1 Restoration Plan Overview

The MWT site is ideally suited for process-based habitat restoration to floodplain and tidal marsh habitat due to its location at the tidal-fluvial interface of the northeast Delta and higher existing site topography relative to most Delta islands. The MWT Project will restore tidal wetland, riparian, and floodplain habitats by reintroducing fluvial and tidal flows to the site and establishing native vegetation. Multiple levee degrades proposed on MWT exterior levees will reduce flood risk to surrounding areas by eliminating the flood pulse during large flood events, open the tract to regular inundation and tidal exchange, and restore natural hydrologic and ecological processes. The primary MWT Project restoration design elements are listed below. Each of these design elements is described in further detail in the sections that follow, along with information on the scientific basis, constraining factors, and rationale behind the Project restoration design and approach.

The levee degrade locations, widths, and degrade invert elevations were based on detailed hydrologic and hydraulic modeling and sensitivity analyses to optimize the design for regional flood management relief, water quality, and habitat restoration objectives. Major design elements for the MWT Project are illustrated in **Figures 11 and 12** and include the following:

- Constructing a flood weir on the east levee
- Construction a low-flow weir on the Mokelumne River levee
- Completely degrading a portion of the southwest levee to subtidal elevation
- Resloping portions of east and southwest levee sections that were not resloped during Phase A
- Excavating high order tidal channels
- Selectively grading portions of the tract interior for habitat enhancement
- Promoting establishment of native vegetation through natural recruitment and focused planting

4.2 Restoration Design Elements

A portion of the east levee of MWT will be lowered and hardened to function as a weir to convey flood flows onto the tract. Constructing the MWT East Weir would restore fluvial hydrology, sediment deposition processes, and regular riverine floodplain inundation to the interior of the MWT. The weir will be 900 feet wide at the invert or bottom width at 11.1 feet elevation NAVD88, with 12:1 (horizonal:vertical [H:V]) slopes up to the existing levee elevations between 18.0 and 20.0 feet. The design elevation for the crest of the weir is at or slightly higher than the lowest point on the access road leading to the MWT, which will permit equivalent access to the transmission tower as currently exists. The top of the weir would thus also function as part of the access road to the transmission tower when river levels are not high. The East Weir will be protected against erosion and scour with rock slope protection (RSP) placed along the entire degraded segment, including the waterside and landside of the levee.

The Mokelumne River levee breach will also restore fluvial hydrology, sediment deposition processes, and regular riverine floodplain inundation to the interior of the MWT and will convey fluvial flows significantly more frequently to the tract than the East Weir, with an invert elevation just over a foot higher than MHHW elevation. The Mokelumne River breach is designed with an elevation just above the interior tract ground surface to function as a very low weir, allowing very frequent overtopping and regular hydrologic connection between the tidally inundated MWT and the Mokelumne River. The weir elevation and design allow for the road along the levee crest to be maintained for access to the southern MWT for maintenance activities, the only route available to the southeastern portion of MWT. The Mokelumne River breach site is located where the Mokelumne River levee breached during the 2017 flood event and where the levee was repaired to a lowered elevation of 12 to 13 feet NAVD88 with rock. The degrade will be approximately 270 feet wide at its invert, with a bottom elevation of 7.0 feet. The Mokelumne River breach will be armored with RSP to minimize erosion.

Degrading the MWT southwest levee at Dead Horse Cut will allow flood flows to pass out of the tract without causing a surge effect and will promote tidal exchange on the tract. The southwest levee degrade will be degraded to interior tract elevations (approximately 0.0 feet NAVD88) for a width of approximately 1,000 feet, as shown in Figure 14. The levee degrade would have 7H:1V slopes up to the adjacent levee crest at the north and south ends. To ensure that the degrade doesn't erode and widen over time, RSP will be placed on the lower side slopes of the levee degrade up to approximately 8 feet elevation. Because there are no concerns with entrapment of debris or constraining flows at this wider levee degrade location, willow pole cuttings may be planted into voids within the RSP on the degraded side slopes where practical.

The grading design plans for the MWT Project propose more extensive interior landform grading than had been conceptually proposed during earlier Project planning phases. This is due to consideration of tidal gage data incorporating sea level rise that has occurred over the last decades, updated site elevation data, and detailed modeling to more accurately Project expected tidal inundation elevations on the MWT site. These updated analyses revealed that a significantly larger percentage of the site acreage would become permanently inundated subtidal open water habitat following site breaching without any earthwork incorporated, and significantly reduced intertidal marsh acreages would be achieved compared to previous expectations. The interior grading plan for MWT thus incorporates more earthwork to bring up some site elevations to support more extensive intertidal marshplain, riparian berm, and riparian floodplain habitat. The grading plan is a balanced design, generating the necessary borrow material for the work onsite primarily via slightly deepening the southern shallow subtidal portion of the tract, coupled with the excavation of a tidal channel network.

The landform grading designs overall achieve multiple critical habitat restoration objectives. Bringing more site acreages up to intertidal and supratidal elevations will increase resiliency to expected sea level rise, as densely vegetated tidal marsh and riparian areas are expected to accrue sediment at rates that may keep pace with sea level rise via increased sediment entrapment and bioaccretion of organic matter. Adding more tidal marsh and riparian habitat acreage in lieu of shallow subtidal open water and creating habitat complexity within those features additionally is expected to improve native fish habitat and terrestrial-aquatic foodweb connections and improves habitat for a diverse suite of native terrestrial wildlife species. Deepening subtidal areas may also slow or reduce colonization by rooted invasive aquatic vegetation.

The restored tidal and fluvial hydrology to the tract is expected to result in increased topographic variability (scour and deposition) within the interior of MWT and to facilitate conditions for natural recruitment of native tidal marsh and riparian vegetation. Habitats that become established on the MWT after levee breaching will be driven primarily by restored site hydrology, post-grading site elevations, and availability of native plant propagules from extant vegetation in the vicinity of the Project. Tidal flows will dominate site hydrology during the dry season; intertidal land elevations (between MLLW and MHHW) are expected to develop into tidal marsh habitat, while land surfaces lying below MLLW are expected to become primarily shallow subtidal open water habitat, and riparian and seasonal wetland habitats would develop in the supratidal zone (above MHHW).

To facilitate establishment of native vegetation, a process-based assisted natural recruitment approach is proposed; this approach is well-supported by ecological restoration literature and evidence from many regional reference sites, as described in the project Restoration Plan (GEI 2022). Assisted natural recruitment, supplemented with focal planting and seeding, and targeted invasive plant management, is expected to achieve habitat restoration performance standards within 10 years of site breaching. In the short- and mid-term vegetation establishment phases following site breaching, if the Project site is not meeting expectations of measurable and progressive increases in native vegetation cover and habitat quality over time, supplemental planting and/or seeding would occur through adaptive management.

Figure 11. Project Design Components Overview

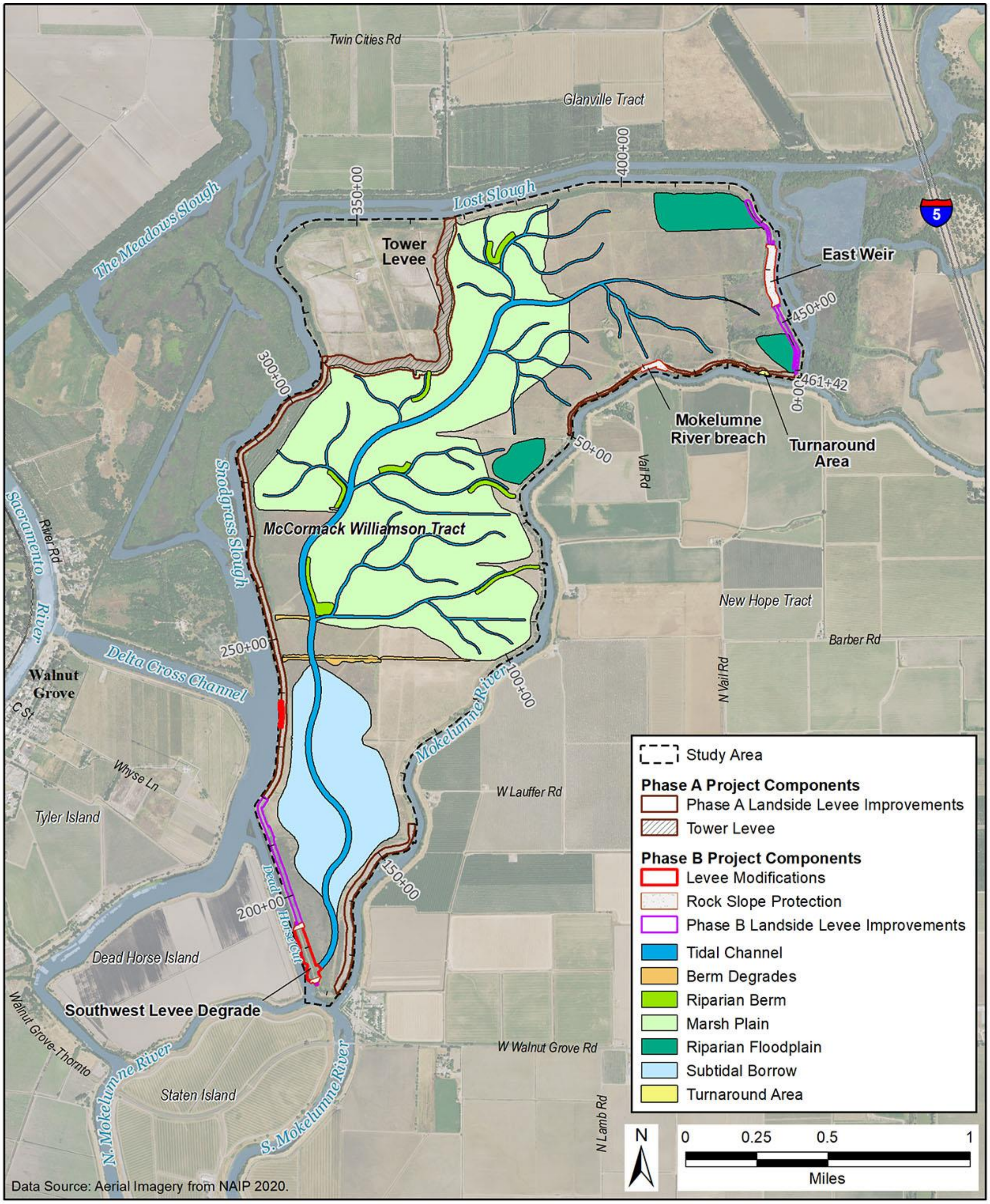

Figure Source: GEI Consultants, Inc. 2022.

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Figure 12. Expected Habitat Evolution on McCormack-Williamson Tract

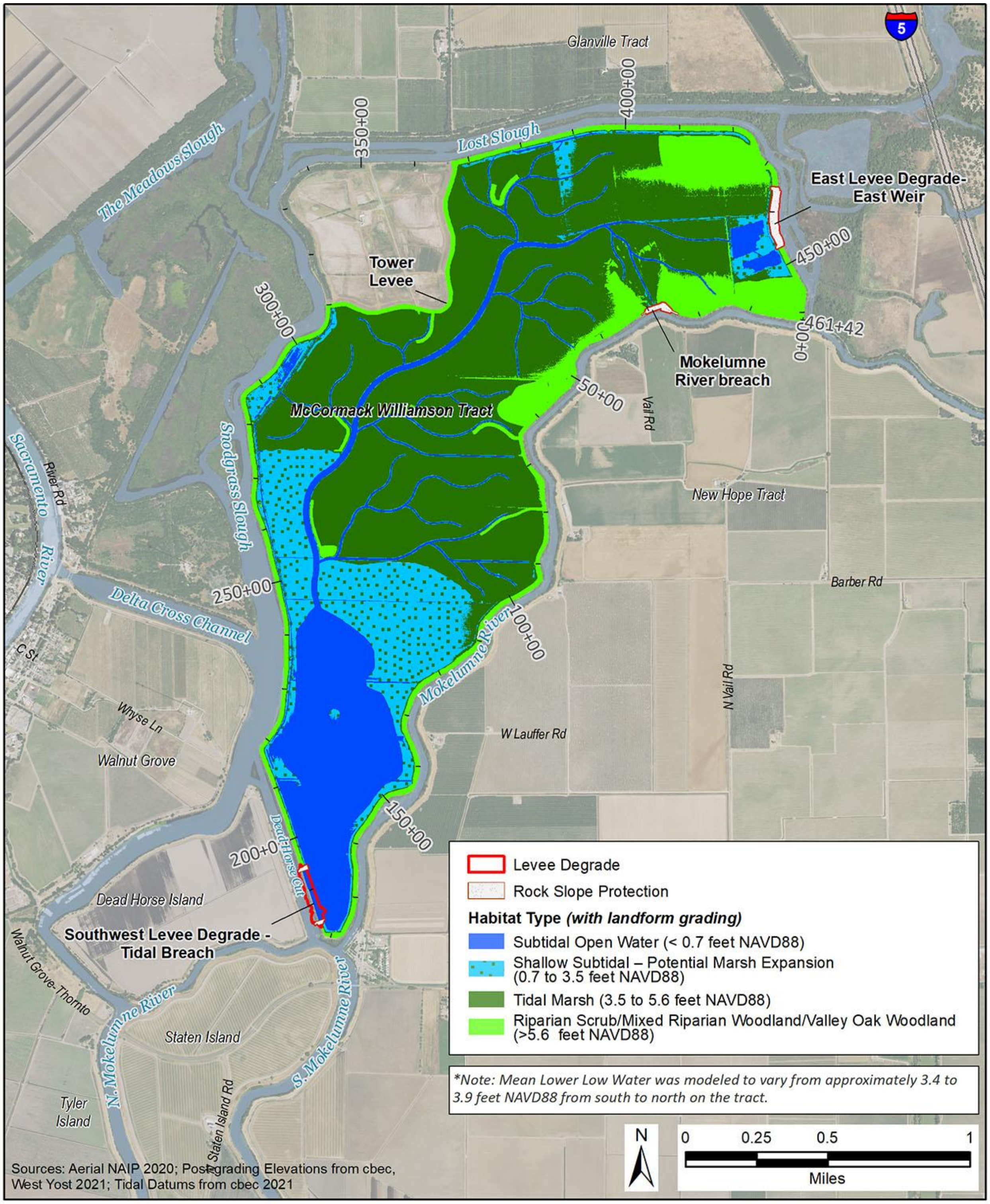

Figure Source: GEI Consultants, Inc. 2022.

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4.3 Uncertainties and Risks

As with most restoration projects, there are uncertainties about Project actions and expected outcomes.

Uncertainties and risks include:

- How will existing sedimentation processes enhance ecosystem restoration?
- Can MWT support dendritic tidal channels?
- Will MWT support native fish species directly (physical habitat use) and/or indirectly (aquatic foodweb production)?
- How will opening MWT to increased flood conveyance affect upstream and downstream areas?
- How might increasing the flood frequency on MWT affect exotic species?
- How will the restoration project affect water quality variables including dissolved organic carbon (DOC) and affect the rate of methylation of mercury?
- What is minimum threshold for floods (e.g., magnitude, timing, duration, etc.) necessary to achieve desired ecosystem objectives?
- Will natural flooding and scour processes create any potential fish stranding issues over time?
- Will the Project design be effective to minimize potential risk of mosquito production?

The Project has been designed to minimize risks and resultant long-term management costs. The area of lowered levee will be reinforced with rock and the new levee to protect the large communications transmissions tower is designed to withstand failure should flood flows reach the levee crest. Internal channels have been designed to maintain tidal flows and positive site drainage year-round to avoid potential for fish stranding. The design facilitates recruitment of native emergent marsh and riparian woody vegetation. Focal plantings of native plants will be maintained for the first few years after construction, and management of target invasive weed populations will be implemented to improve revegetation success. The conceptual design for the Project benefited from input from the North Delta Science Advisory Committee (DWR 2010) and the design was further refined with expert input from another focused MWT Technical Advisory Committee and detailed iterative modeling of expected on-site hydrology under updated designs.

Chapter 5. Measures, Metrics and Monitoring

Measures and metrics are important to demonstrate a project's effectiveness in meeting stated objectives (performance measures), to detect the potential need for corrective management actions (triggers), and to reduce uncertainty and improve the understanding of ecosystem function and restoration practices (special studies). This section focuses on performance measures and management triggers that will be applied following completion of the MWT Project. The MWT site will also be available to researchers for additional special studies, but such topics are only briefly referenced in this draft adaptive management plan.

The source and amount of funding that is eventually secured for post-construction monitoring for the MWT Project will dictate the breadth, duration, and sampling frequency of the monitoring program. As such, the final monitoring approach for the MWT Project is expected to be modified relative to what is presented in this draft plan. Nonetheless, this draft plan represents a good faith effort by DWR to present a realistic vision of what the monitoring for the MWT Project will entail based on existing goals and objectives and understanding of the Project site. DWR is working with the Natural Resources Agency to secure funds for monitoring and management of the Project site once the construction work is complete, particularly with regards to elements of the monitoring program meant to address scientific uncertainties. Sources recently secured include grant funds for near term monitoring (Proposition 1) and general funds allocated for long term management.

It should be noted that performance measures described here are separate from those that are expected to be included in regulatory agency permits obtained for the projects and that were included in the mitigation and monitoring program (MMRP) for the Project resulting from certification of the supplemental EIR (DWR September 2022). Any measures contained in those permits and the MMRP are not optional or funding dependent and need to be implemented in full. Where applicable, data collected during those monitoring efforts may also serve to inform the measures and metrics in this draft plan.

5.1 Performance Measures

Performance measures presented here are derived from MWT Project goals and objectives, as outlined above, and help quantify progress towards achieving these goals and objectives. Performance measures are intended to capture important trends and to address whether specific actions are producing expected results. The monitoring approach is designed so that information collected can support performance measure analysis and reporting. Potential performance measures and associated metrics to assess project success are summarized in **Table 4**.

5.2 Management Triggers

Monitoring to inform post-construction management response will use a targeted approach to detect thresholds or triggers. A trigger is the level or value of a metric that warrants a management response to address an undesired outcome. Triggers can include exceeding thresholds for site stressors, such as abundance of target invasive plants, or related to critical ecological or hydrologic processes (e.g., loss of hydrologic connectivity leading to fish stranding).

Table 4. MWT Project Objectives, Performance Measures, and Metrics

MWT Objectives	Performance Measures	Metrics
Goal: Flood Management		
1a. Convey flood flows to the San Joaquin River without substantial increases in river stage	Maintain or reduce stage height upstream and downstream of the Project during flood events, compared to pre-project baseline.	Water Surface Elevation (WSE) observed at upstream and downstream gages during peak flood flows
1b. Reduce the risk of catastrophic levee failures	MWT levees and downstream tract levees intact after flood events of magnitude that caused levee failures prior to project implementation	Integrity of MWT and downstream site levees
1b. Reduce the risk of catastrophic levee failures	Levee seepage not increased on neighboring tracts following MWT restoration	WSE against/on adjacent tracts Depth to groundwater on adjacent tracts
1c. Design MWT floodplain to minimize "surge" effect	No "surge" effect downstream of MWT when large flood flows exit MWT southwest levee degrade	Observations of surge effect presence/absence/magnitude downstream of MWT
Goal: Ecosystem Restoration		
2a. Restore ecologic, hydrologic, geomorphic, and biologic processes and self-sustaining habitats, including riparian, freshwater tidal marsh, and seasonal floodplain habitats	East levee and Mokelumne River levee degrades (width and depth) remain within 25% of designed width and depth, suitable to provide seasonal fluvial flooding at designed flood frequency	Integrity of levee degrade cross sections
2a. Restore ecologic, hydrologic, geomorphic, and biologic processes and self-sustaining habitats, including riparian, freshwater tidal marsh, and seasonal floodplain habitats	Increased frequency and duration of natural fluvial inundation of MWT during December through May, and draining by summer, relative to existing conditions	Extent, timing, duration, and frequency of floodplain inundation Floodplain and channel water depth (WSE)
2a. Restore ecologic, hydrologic, geomorphic, and biologic processes and self-sustaining habitats, including riparian, freshwater tidal marsh, and seasonal floodplain habitats	Increased water supply and exchange (tidal and seasonal flooding) to tract interior	Extent of inundation under tidal and fluvial flows
2a. Restore ecologic, hydrologic, geomorphic, and biologic processes and self-sustaining habitats, including riparian, freshwater tidal marsh, and seasonal floodplain habitats	Self-sustaining native vegetation communities restored	Tidal marsh vegetation acreage and composition Riparian and seasonal wetland vegetation acreage and composition Subtidal habitat acreage Vegetation cover, composition, structure, function, and recruitment patterns in tidal, seasonal wetland, and riparian habitats
2b. Support native and special-status species	Special-status and other native fish and wildlife species, or suitable habitats, occurring on site	Fish species presence/abundance, condition Bird species presence/abundance Giant garter snake presence/abundance Other terrestrial wildlife presence/abundance
2b. Support native and special-status species	Water quality not degraded by Project	Basic water quality metrics (temperature, EC, turbidity, pH, DO, DOC) and methylmercury at entrance, in interior and downstream of tract.
2b. Support native and special-status species	Minimal potential stranding risk to native fishes	Presence of any isolated ponded areas without tidal connection
2c. Manage invasive species and prevent/limit their establishment	Target invasive terrestrial species cover below trigger thresholds (<20% cover by target invasives)	Extent, composition, and abundance of target invasive terrestrial species
2c. Manage invasive species and prevent/limit their establishment	Submerged aquatic vegetation/ floating aquatic vegetation (SAV/FAV) below trigger thresholds (similar to or lower than observed in other local Delta wetland sites)	Extent and abundance of SAV/FAV

MWT Objectives	Performance Measures	Metrics
2d. Promote food web productivity	Project benefits aquatic foodweb	Fish abundance, composition, health condition Phytoplankton, zooplankton, detrital biomass, and macroinvertebrate abundance Fish growth rates
2d. Promote food web productivity	Project benefits aquatic foodweb	Duration of seasonal floodplain inundation
2e. Promote natural flooding processes and tidal action	East levee and Mokelumne River levee degrades (width and depth) remain within 25% of designed width and depth, suitable to provide seasonal fluvial flooding at designed flood frequency	Integrity of levee degrade cross sections
2e. Promote natural flooding processes and tidal action	Functional tidal flows reestablished	Extent of tidal inundation Water velocities in tidal channels
2e. Promote natural flooding processes and tidal action	Fluvial flows reestablished	Extent of site flooding during high river stages
2e. Promote natural flooding processes and tidal action	Sediment deposition and scour processes increase floodplain heterogeneity over time	Surface elevations of site Sediment accretion at the fluvial-tidal interface
2f. Promote processes to increase land surface elevations in areas of subsidence	Surface elevations of intertidal wetlands maintained or increased over time via sediment deposition and bioaccretion	Surface elevations of tidal wetlands Tidal flows (WSE) Sediment accretion and biomass accretion in the intertidal zone
2f. Promote processes to increase land surface elevations in areas of subsidence	Average surface elevations in subtidal habitats will not decline	Bathymetry of subtidal areas Sediment accretion in the subtidal zone

Source: Updated from 2018 Adaptive Management Framework for North Delta Project (ESA 2018)
Note: Performance measures that were added since the 2018 Draft Adaptive Management Framework was prepared, and corresponding objectives and metrics, are shown in highlighted text.

5.3 Monitoring Metrics and Methods

Metrics and potential monitoring methods proposed are related to project goals, objectives, and performance measures (**Tables 3 and 4**). These will be revisited and refined once the Project design and permitting are complete. Multiple potential methods are described to allow flexibility in implementation and may additionally evolve with rapid technological advances occurring in the field of restoration site monitoring. Potential monitoring metrics that will be used to evaluate performance targets are organized under broad categories in **Table 5**:

- ***Hydrology and Physical Processes*** *– topography, accretion rates, frequency and duration of inundation, flood risk reduction*
- ***Vegetation*** *– community composition and cover, self-sustaining habitats restored, composition and abundance of target invasive species*
- ***Fishes and Aquatic Foodweb*** *– Use of habitats by native fishes, fish stranding risk if scour/deposition cause loss of connectivity, foodweb productivity*
- ***Terrestrial Wildlife*** *– Use of habitats by birds, special-status species, and other target wildlife*
- ***Water Quality –*** *Basic metrics (temperature, dissolved oxygen, pH, turbidity, electrical conductivity); methylmercury consistent with the Regional Water Quality Control Board requirements*

5.4 Monitoring Schedule

An estimate of the potential frequency of monitoring (season and number of years) is outlined in **Table 5**. The source and extent of funding that is eventually secured for post- construction monitoring, as well as funding for optional special studies, will dictate the scale and sampling frequency of monitoring.

The monitoring schedule is approximate and would likely be adjusted each year to account for changing environmental conditions (e.g., floods, drought) and current status of performance standards. In the long-term, monitoring may be downscaled based on future results and recommendations, but certain monitoring metrics are expected to continue on a regular basis to ensure the Project continues to perform as expected. Monitoring and management will be incorporated into ongoing long-term management and monitoring programs by the CRP and DWR.

5.5 Special Studies

Opportunities exist for special studies that require more in-depth investigation than basic monitoring can provide. DWR is open to discussions for studies proposed by prospective researchers. Design and implementation of special studies, however, are outside the scope of this plan and would depend on availability of funding and partners. These studies would ideally be developed with guidance from DWR and the CRP managers and be designed to address unique opportunities provided by the Project site or identified knowledge gaps related to restoration assumptions, questions, hypotheses, or outcomes. Robinson et al. (2018) provides a detailed assessment of knowledge gaps and scientific questions that could be addressed using the MWT as a study site and outlines potential approaches for special studies that may be pursued at this site.

5.6 Data Management

The monitoring program will include a plan for collecting, storing, documenting, and assuring quality in data management. This data management plan will be developed concurrent with the design of the monitoring program. The data management plan will follow standards of DWR and other regional programs where appropriate, such as guidelines and templates for data management prepared by the Interagency Ecological Program Tidal Wetland Monitoring Project Work Team (IEP 2017) and SFEI guidance for data documentation and accessibility (Robinson et al. 2018). The data management plan will address data handling from collection, processing, analysis, maintenance and sharing. Descriptions will include project history, detailed monitoring protocols and standard operating procedures (SOPs) for all field sampling and data entry activities, metadata, quality assurance/quality control process, SOPs for analyses, and data storage (including backup and security). Whenever possible, SOPs used will be comparable to those of long-term regional monitoring programs to maximize data comparability. Metadata will be documented at all stages of data collection and processing and stored in standard formats along with the data.

Data will be placed in a data repository and sharing platform. Data will be made available to other interested researchers as soon as reasonably possible after collection (e.g., within a year after collection). The data, analyses, and interpretation will be made available periodically at such venues as the IEP Annual Workshop. Regular monitoring reports will also be prepared (*see* Section 6.3).

Table 5. Metrics, potential methods, and sampling intervals

Metrics	Potential Methods	Time of Year, Frequency	Pre-Levee Degrade[1]	Post-Levee Degrade[2] 1 yr	Post-Levee Degrade[2] 2 yr	Post-Levee Degrade[2] 3 yr	Post-Levee Degrade[2] 4 yr	Post-Levee Degrade[2] 5 yr	Post-Levee Degrade[2] 5-10 yr	Sites and Samples
Hydrology and Physical Processes										
Water Surface Elevation (WSE) observed at upstream and downstream gages during peak flood flows	Semi-quantitative comparison of WSEs compared to previous similar flood events. Modeling to compare measured WSE to baseline and project models based on boundary conditions	Following large flood events or when deemed necessary by DWR and adjacent landowners	X	D	D	D	D	D	D	Upstream and downstream of MWT, when deemed appropriate by DWR and adjacent landowners
Integrity of MWT and downstream site levees	Qualitative assessments and reports on levee integrity after flood events	Following large flood events and annual inspections	X	X	X	X	X	X	X	MWT levees, east weir, Mokelumne River weir, and southwest levee degrade; downstream tract levees
Water surface elevation (measured elevation relative to a vertical datum) and depth to groundwater (measured vertical distance below ground surface) on adjacent tracts	Observation well transects, piezometers with data loggers	Year round	X	X	X	X	D	D	D	Seepage monitoring network adjacent and downstream of MWT to be established by DWR per Phase B SEIR, with data collected for 1 to 2 years before site breaching, and a minimum of 2 years after MWT breached (longer if any effects evident). Data would be compared to larger groundwater baseline dataset collected by DWR from 1993 to 2015.
Observations of surge effect presence/absence/magnitude	Regional observations during large flood events WSE at gages downstream of MWT	During large flood events	X	X	X	X	X	X	X	Downstream of MWT
Integrity of levee degrade cross sections	Inspection of levee degrade cross sections RTK-GPS survey methods if changes evident	During routine levee inspections and after large (10+ year recurrence) flood events	X	X	D	X	D	X	X	MWT east weir, Mokelumne River weir, and southwest levee degrade. Routine visual inspection sufficient unless cross sections appear to be unstable, then topographic cross section data to be collected. Visual inspection for debris impedance after flood flows.
Extent, timing, duration, and frequency of floodplain inundation Floodplain and channel water depth (WSE) Surface elevations of the site and fluvial-tidal interface Sediment accretion in the fluvial-tidal interface	Observations during site inspections of extent of recent inundation Review satellite aerial imagery and remote sensing of inundation December - May Water level loggers Ground-based elevation surveys Sediment plates or marker horizons	December-May		X	D	X	D	X	D	Supratidal portions of project site
Tidal flows (WSE) and extent of tidal inundation	Water level loggers (pressure transducers)	Year round		X	X	X	X	X	D	Tidal channels and marshplain
Water velocities in tidal channels	Acoustic doppler current profilers to measure velocity	Year round		D	D	D	D	D	D	Tidal channels
Surface elevations of tidal wetlands Sediment accretion and biomass accretion	SfM photogrammetry (UAV) Ground-based elevation surveys Sediment pins or plates or marker horizons	Every 3-5 years in dry season, and *potential special study*, tbd	X	X	D	D	X	D	X	Marshplains throughout project site

Metrics	Potential Methods	Time of Year, Frequency	Pre-Levee Degrade[1]	Post-Levee Degrade[2] 1 yr	Post-Levee Degrade[2] 2 yr	Post-Levee Degrade[2] 3 yr	Post-Levee Degrade[2] 4 yr	Post-Levee Degrade[2] 5 yr	Post-Levee Degrade[2] 5-10 yr	Sites and Samples
Bathymetry of subtidal areas	Pre-levee degrade: ground-based elevation surveys for as-built documentation Post-levee degrade: bathymetric surveys (sonar or sounding rod measurements) Sediment plates or marker horizons	Summer	X	D	D	D	D	X	X	Subtidal open water areas throughout project site
Vegetation										
Tidal marsh vegetation acreage and composition Riparian and seasonal wetland vegetation acreage and composition Subtidal habitat acreage Vegetation cover, composition, structure, function, and recruitment patterns in tidal, seasonal wetland, and riparian habitats	Habitat mapping on updated aerial photos Vegetation sampling (e.g., transects, releves, CRAM methods) Permanent photopoints SfM photogrammetry or LiDAR for vegetation structure Field monitoring to document native species recruitment	May-September	X	X	X	X	X	X	X	At least 15 permanent representative photopoints to be established throughout site and documented annually in spring/summer. Habitat mapping on updated aerial photographs to determine acreages of habitats restored proposed in Years 5, 8, and 10. Stratified vegetation sampling in tidal marsh and riparian habitats proposed to assess composition and cover in Years 2-5, 8, and 10.
Extent, composition, and abundance of target invasive terrestrial species	Visual survey (aerial imagery and ground surveys)	Spring to Summer	X	X	X	X	X	X	X	Walking survey of entire site to detect and map priority weeds and document new invasions during establishment phase. Annual checks for target invasive weeds would continue long-term during qualitative site surveys. Consistent with Cosumnes Preserve Weed Management Plan.
Extent and abundance of SAV/FAV	Remote sensing, aerial imagery Boat surveys, rake transects	Summer		X	X	X	X	X	D	SAV/FAV abundance and extent determined from aerial imagery or boat surveys. Coordinate with Boating and Waterways Invasive FAV/SAV weed management program.
Fishes and Aquatic Foodweb										
Fish abundance, composition, health condition Phytoplankton, zooplankton, detrital biomass, and macroinvertebrate abundance Fish growth rates	Fish surveys (trawls, seines, fyke nets, e-fishing), eDNA monitoring Phytoplankton, zooplankton, detrital biomass, and/or macroinvertebrate surveys (grab samples, sweep nets, chlorophyll fluorescence etc.) Caged fish growth measurements	*Potential special studies*, tbd	D	D	D	D	D	D	D	*Potential special studies*, tbd
Presence of any isolated ponded areas without tidal connection	Survey for potential fish stranding sites (field survey or UAV)	After flood events causing significant scour/deposition		X	X	X	X	X	X	After significant flood events, visual site inspections will be conducted to determine if ponded sites have become hydrologically disconnected by scour/deposition. And if disconnected, determine whether native fish stranding occurring.
Terrestrial Wildlife										
Bird species presence/abundance	Avian habitat use survey, point counts by species	Quarterly	X	D	D	D	D	X	D	Observations from access roads and trails
Giant garter snake presence/abundance	Trapping	May-October						D	D	*Potential special study*, in coordination with USGS

Metrics	Potential Methods	Time of Year, Frequency	Pre-Levee Degrade[1]	Post-Levee Degrade[2] 1 yr	Post-Levee Degrade[2] 2 yr	Post-Levee Degrade[2] 3 yr	Post-Levee Degrade[2] 4 yr	Post-Levee Degrade[2] 5 yr	Post-Levee Degrade[2] 5-10 yr	Sites and Samples
Other terrestrial wildlife presence/abundance	Wildlife monitoring - field observations tracking system, cover boards for herps, pitfall traps for arthropods, bat acoustical surveys, camera stations Focal surveys for special status species (e.g., Swainson's Hawk, burrowing owl, western pond turtle, California black rail)	Baseline DWR Delta Levees Biomonitoring; *Special studies*, tbd	X	D	D	D	D	D	D	*Potential special studies*, tbd
Water Quality										
Basic water quality metrics (temperature, EC, turbidity, pH, DO, DOC)	Temperature sensors in association with water level loggers Water quality metrics by continuous data sonde or discrete water quality measurements	Year around, if using continuous data sonde, optionally discontinued long-term if no indication of WQ concerns Discrete sampling seasonally triggered as needed (e.g., to monitor ponded areas)	X	X	X	X	D	D	D	Within tidal channels or subtidal habitat (quantity tbd) and as dictated by project permits. Additional discrete sampling if observations indicate potential water quality concerns at a particular location.
Methylmercury measurements	Participate in regional Delta Mercury Total Maximum Daily Load (TMDL) project Analysis of water, sediment, or biological tissue samples	*Potential special studies*, tbd	D	D	D	D	D	D	D	*Potential special studies*, tbd

Source: Updated from 2018 Adaptive Management Framework for North Delta Project (ESA 2018)
NOTES:
[1]. Pre-levee degrade sampling for aquatic measures would occur in Mokelumne River/Dead Horse Cut.
[2]. Years after levee degrade: X = Sampling proposed in this year but may be moved if necessary or appropriate, D = Discretionary sampling, contingent on available resources, partners, and project needs.
Performance measures that were added since the 2018 Draft Adaptive Management Framework was prepared, and corresponding metrics and methods, are shown in highlighted text.

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Chapter 6. Management Actions

6.1 Adaptive Management Actions

If progress toward a target goal is slower or not proceeding as expected, or if a trigger level is reached, then a management response may be warranted. Potential management responses can include further or more intensive monitoring of the situation or the target, implementation of corrective actions (e.g., clear debris in a channel that may be impairing hydrologic connectivity, weed control measures), reevaluation of conceptual models and assumptions about system and project function, and/or adjustment of goals and triggers. Any decisions beyond implementation of established best practices would be coordinated between DWR and the CRP manager. **Table 6** presents a series of potential management triggers and responses as they relate to project objectives and performance measures.

6.2 Land Management and Maintenance Actions

MWT is currently managed under the Cosumnes Preserve's Management Plan (Kleinschmidt 2008) and Partnership Agreement and a specific management agreement between BLM and DWR. The BLM manages this site under the authority of the BLM's Mother Lode Field Office Resources Management Plan, the CRP's 2018 Final Management Plan (in prep.), and the CRP's Integrated Pest Management Program and Fire Management Plan. Reclamation District 2110 is funded by DWR to manage and maintain levees under existing levee easements.

Land management activities include mosquito vector control coordination, fire management, weir and levee assessment and management, and evaluation and response to trespass and vandalism. In addition to its dedicated staff, the CRP manages volunteers who assist with routine maintenance such as weed control and trash pick-up. Access for scientific and educational uses will be granted on a case-by-case basis after evaluation of the purpose, impacts, and need for the access.

This draft plan provides general information about measures and surveys to inform land management and maintenance activities. Long-term stewardship and land management is expected be conducted by the CRP or DWR and will be consistent with the CRP Management Plan.

Potential recreational opportunities at MWT once the site is restored are still in the very early conceptual planning stages. One of the recreational opportunities currently being considered include a short walking trail for birdwatchers on the crest of the exterior levee. Another opportunity potentially under consideration is to partner with the CDFW-run Delta Island Hunting Program. This popular program provides limited-permit late-seasonal waterfowl hunts on certain islands in the Delta. Although public access and recreation at the Project site is a desired outcome, achieving this objective is constrained by the need to ensure public safety – since the site is designed to flood regularly.

A Long-Term Management Plan (LTMP) will be developed specifically for the MWT and will identify long-term management needs and other activities necessary to maintain the net enhancement of functions and values of restored habitats, and flood control elements of the MWT. The LTMP will guide site management once the Project has met required performance standards in accordance with regulatory permits. Land management activities that would be described in the LTMP will cover general inspections and monitoring, signage, fencing maintenance, vegetation management, managing trespass, trash removal, fire hazard reduction, erosion control, and reporting. Annual costs required to implement the long-term management and maintenance will be estimated and documented in the LTMP. Long-term land management activities that are expected to occur on the MWT would include:

- General inspections and monitoring
- Mosquito abatement district and California Department of Boating and Waterways (CDBW) coordination
- Levee degrade assessments
- Fencing and signage maintenance
- Vegetation management including invasive plant control
- Fire hazard reduction
- Evaluation and response to trespass and/or vandalism
- Trash and debris removal
- Erosion control/repair
- Management of scientific and educational use access
- Reporting

6.3 Reporting and Communications

It is anticipated that monitoring reports will be the primary mechanism by which to convey information on the current status of target resources within the MWT Project site. Such reports are expected to include a summary of work completed to date, milestones, current status, constraints, and relative accrued benefits of the Project, along with potential remedial actions or management responses. Monitoring reports are anticipated to be prepared years 1, 2, 3, 4, 5, 8 and 10 following site breaching, assuming the project is meeting or is demonstrably on track to meet project objectives. Long-term maintenance and monitoring reports would be prepared by the RD every 5 years thereafter. Discretional special studies may continue more intensively over longer periods where research funding is available.

Table 6. Representative Matrix of Adaptive Management Triggers and Potential Responses

MWT Objectives	Performance Measures	Metrics	Trigger Level	Potential Management Response
Goal: Flood Management				
1a. Convey flood flows to the San Joaquin River without substantial increases in river stage	Maintain or reduce stage height upstream and downstream of the Project during flood events, compared to pre-project baseline.	Water Surface Elevation (WSE) observed at upstream and downstream gages during peak flood flows	MWT project resulting in apparent upstream or downstream stage increases of >0.5 ft over baseline in ≥10-year flood event.	Revisit modeling and potential levee degrade width or revetment modifications. Refine hydrologic modelling and evaluate potential drivers causing discrepancy between expected and realized outcomes. Evaluate with DWR and Preserve managers and adjacent landowners if appropriate, determine if modifications to levee degrade configurations may be necessary to meet target.
1b. Reduce the risk of catastrophic levee failures	MWT levees and downstream tract levees intact after flood events of magnitude that caused levee failures prior to project implementation	Integrity of MWT and downstream site levees	Substantial MWT levee erosion or breach widening, or unexpected levee erosion and/or catastrophic levee failures on adjacent tracts, after a flood event.	Revisit modeling and potential levee degrade width or revetment modifications. Refine hydrologic modelling and evaluate potential drivers causing discrepancy between expected and realized outcomes. Evaluate with DWR and Preserve managers and adjacent landowners if appropriate, determine if modifications to levee degrade configurations may be necessary to meet target. Implement levee repairs.
1b. Reduce the risk of catastrophic levee failures	Levee seepage not increased on neighboring tracts following MWT restoration	WSE against/on adjacent tracts Depth to groundwater on adjacent tracts	DWR seepage monitoring network established on adjacent tracts prior to and following MWT levee breaching indicates project has substantially affected seepage rates. (Defined as a substantial increase beyond what has been observed in historical trends from 1993 to 2015, and other data sources, before inundation of MWT by the project).	DWR financial contributions, land acquisition, and/or direct implementation of seepage control measures (such as enhanced internal drainage, seepage berms, cutoff walls, passive relief wells, and active pumping wells) will be applied adaptively to protect the lands adjacent to MWT if there is a substantial increase in seepage due to project inundation, as described in the MWT Phase B SEIR.
1c. Design MWT floodplain to minimize "surge" effect	No "surge" effect downstream of MWT when large flood flows exit MWT southwest levee degrade	Observations of surge effect presence/absence/magnitude	Surge effect observed downstream of MWT with greater than expected magnitude during significant flood event.	Revisit modeling and potential levee degrade width modifications.
Goal: Ecosystem Restoration				
2a. Restore ecologic, hydrologic, geomorphic, and biologic processes and self-sustaining habitats, including riparian, freshwater tidal marsh, and seasonal floodplain habitats	East levee and Mokelumne River levee degrades (width and depth) remain within 25% of designed width and depth, suitable to provide seasonal fluvial flooding at designed flood frequency	Integrity of levee degrade cross sections	Any levee degrades exceeding 25% change from designed width or depth or experiencing significant erosion scour or depositional blockages.	Repair levee degrades; investigate to determine cause of degrade instability; possibly improve revetment approaches to meet site conditions.
2a. Restore ecologic, hydrologic, geomorphic, and biologic processes and self-sustaining habitats, including riparian, freshwater tidal marsh, and seasonal floodplain habitats	Increased water supply and exchange (tidal and seasonal flooding) to tract interior	Extent of tidal and fluvial inundation	Southwest levee degrade or primary tidal channels filling in and blocking tidal connectivity, or tidal flows on-site otherwise differ substantively from what was modelled for project. Supratidal habitats clearly not experiencing fluvial inundation as expected (compared to previous modeling of on-site inundation during similar magnitude flood events).	Assess extent of inundation and compare with modelling. Evaluate extent and condition of floodplain and wetland vegetation recruitment and survival, to determine if tidal and fluvial inundation is appropriate to sustain tidal and riparian habitats. Evaluate with Preserve managers, determine if modifications to levee breaches or tidal channels may be appropriate to increase hydrologic exchange from adjacent waterways.
2a. Restore ecologic, hydrologic, geomorphic, and biologic processes and self-sustaining habitats, including riparian, freshwater tidal marsh, and seasonal floodplain habitats	Self-sustaining native vegetation communities restored	Tidal marsh vegetation acreage and composition Riparian and seasonal wetland vegetation acreage and composition Subtidal habitat acreage Vegetation cover, composition, structure, function, and recruitment patterns in tidal, seasonal wetland, and riparian habitats	During vegetation establishment phase following levee degrades, areas of Project site remain which have failed to recruit desirable native vegetation, or rate of cover increase of non-native invasive species is higher than that of native species for two years in a row.	Increase chemical or physical control of non-native invasive species, consistent with Preserve Weed Management Plan. Plant native species in areas where desirable native plants have not established in first years following levee degrades.

MWT Objectives	Performance Measures	Metrics	Trigger Level	Potential Management Response
2b. Support native and special-status species	Special-status and other native fish and wildlife species, or suitable habitats, occurring on site	Fish, birds, GGS, and other terrestrial wildlife species presence/abundance, condition	Special studies indicate lower than expected use of habitat by fish and wildlife.	Expand special studies to compare MWT site to reference sites and other similar restoration projects to determine possible causal factors. Apply lessons learned to site improvements or to future restoration projects.
2b. Support native and special-status species	Water quality not degraded by Project	Basic water quality metrics (temperature, EC, turbidity, pH, DO, DOC)	Water quality trigger thresholds (defined by project permits) exceeded, or evidence of fish mortality observed in isolated backwater portions of site.	Assess if water quality thresholds exceeded due to poor hydrologic connectivity or other factors. Potentially excavate new or widen channels to increase hydrologic connectivity to backwater areas exhibiting poor water quality.
2b. Support native and special-status species	Minimal potential stranding risk to native fishes	Presence of any isolated ponded areas without tidal connection	Isolated ponded areas without tidal connection found, and monitoring during salmon outmigration season indicates native fish stranding is occurring.	Reconnect (or fill in) isolated pools to create habitat connectivity to tidal habitats. Implement fish rescues in spring if necessary to rescue out-migrating Chinook salmon juveniles or other native fish of concern.
2c. Manage invasive species and prevent/limit their establishment	Target invasive terrestrial species cover below trigger thresholds (<20% cover by target invasives)	Extent, abundance, and composition of target invasive terrestrial species	Target invasive plants exceeding trigger threshold of 20% cover, or rate of cover increase of nonnative invasive species is higher than that of native species for two years in a row.	Increase intensity of monitoring and chemical or physical control of target invasive species, consistent with Preserve Weed Management Plan.
2c. Manage invasive species and prevent/limit their establishment	SAV/FAV below trigger thresholds (similar to or lower than observed in other local Delta wetland sites)	Extent and abundance of SAV/FAV	Invasive SAV/FAV abundance greater than other similar wetland and subtidal open water sites in the Delta based on remote sensing data.	Work with CDBW to potentially intensify SAV/FAV management on site, potentially conduct research to determine if other measures or site modifications appropriate.
2d. Promote food web productivity	Project benefits aquatic foodweb	Fish abundance, composition, health condition Phytoplankton, zooplankton, detrital biomass, and macroinvertebrate abundance Fish growth rates Duration of seasonal floodplain inundation	Special studies indicate minimal aquatic foodweb benefits from project site, or poor health or low growth rates of fish on site.	Expand special studies to compare MWT site to reference sites and other similar wetland restoration projects to determine possible causal factors. Determine whether floodplain inundation is providing adequate residence time for foodweb enhancement. Apply lessons learned to site improvements or to future restoration projects.
2d. Promote food web productivity	Functional tidal flows reestablished	Extent of tidal inundation	Southwest levee degrade or primary tidal channels filling in and blocking tidal connectivity, or tidal flows on-site otherwise differ substantively from what was modelled for project.	Assess hydrological regime and compare with modelling, and whether off-site projects may be affecting local tidal prism. Evaluate recruitment patterns and tidal marsh vegetation health in intertidal zone. Evaluate to determine if modifications to levee breaches or tidal channels would reduce muting of tidal flows, if applicable.
2d. Promote food web productivity	Fluvial flows reestablished	Extent of site flooding during high river stages	Supratidal habitats clearly not experiencing fluvial inundation as expected (compared to previous modeling of on-site inundation during similar magnitude flood events).	Assess extent of inundation and compare with modelling. Evaluate extent and condition of floodplain and wetland vegetation recruitment and survival, to determine if seasonal inundation is appropriate to sustain riparian community succession. Evaluate with Preserve managers, determine if modifications to the East weir or Mokelumne levee breach may be appropriate to better restore floodplain habitat.
2f. Promote processes to increase land surface elevations in areas of subsidence	Surface elevations of intertidal wetlands maintained or increased over time via sediment deposition and bioaccretion	Surface elevations of tidal wetlands	Surface elevations of tidal wetlands not increasing at expected rates.	Implement adaptive measures to increase sediment capture and deposition (e.g., to reduce wave energy, increase vegetation density, or increase sediment supply).

Source: Updated from 2018 Adaptive Management Framework for North Delta Project (ESA 2018)
Note: Performance measures that were added since the 2018 Draft Adaptive Management Framework was prepared, and corresponding objectives and metrics, are shown in highlighted text.

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