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# Bacon Island Management Plan for Revegetation and Habitat Enhancement



## PREPARED FOR

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(Bacon Island)  
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Cover photos, clockwise from top right: Levee slope to be native grassland habitat, Habitat Enhancement Area 1 with existing willow; Habitat Enhancement Area 3 with existing Riparian Forest and Himalayan blackberry; Habitat Enhancement Area 3 with existing Riparian Forest.

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# 1 INTRODUCTION

## 1.1 Background and Objectives

As part of the Bacon Island Levee Rehabilitation Project (Project), Reclamation District No. 2028 (District) plans to rehabilitate the west side of Bacon Island's levee system, 4.7 miles (mi) in length, to achieve a sustainable Hazard Mitigation Plan (HMP) cross-section<sup>1</sup>. Bacon Island's levee is substandard due to settlement of the levee from consolidation of the underlying peat foundation. The repairs will compensate for future settlement of the peat foundation as well as sea level rise, and ensure a sustainable HMP cross-section standard by incorporating the recommended design cross section, which includes a toe berm and a wider levee crown.

After levee rehabilitation is complete, native grasses will be planted on 4.7 mi of the rehabilitated landside slope for erosion protection as well as to provide habitat for wildlife and pollinators. Additionally, the District has identified four levee-compatible Habitat Enhancement Areas (HEAs) adjacent to the landside of the levee, totaling 4.3 acres (ac), where Riparian Forest<sup>2</sup> and Scrub-shrub<sup>3</sup> habitats will be created or enhanced using nursery plants, cuttings, or seed. These areas are outside the levee prism and therefore can be utilized for habitat enhancement without conflicting with levee maintenance or operations; the adjacent toe ditch provides a natural barrier preventing encroachment of farming activities. These HEAs will help the Project comply with funding requirements to integrate levee improvement with habitat enhancement; in this case, landside levee vegetation features that provide habitat for native plants and wildlife in support of a healthy ecosystem. The HEA's will be maintained in accordance with a future management agreement; the District will enter into a management agreement with the landowner as part of implementation.

This Management Plan for Revegetation and Habitat Enhancement ("Plan") has been developed to outline the planting design for the rehabilitated landside slope and four HEAs and provides maintenance and monitoring recommendations for consideration. Soil preparation, seeding, and monitoring and maintenance recommendations are in accordance with the *Delta Levees Habitat Program Guide to Planting Native Grassland Habitat on a Reconstructed Landside Levee Slope* (CDFW and DWR, unpublished memo; Appendix A), the *Delta Levees Grass Seed Trial Options 2015* (DWR, unpublished memo; Appendix B), and other similar methods approved by CDFW. The Plan uses existing vegetation, soil, and topographic conditions to build communities that can provide habitat for a range of native wildlife species, in addition to erosion protection.

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<sup>1</sup> The HMP compliant cross-section design includes 3:1 landside slopes with a 21-foot crown width, a toe berm extending 120 feet landward of the new landside hinge, and a levee crown elevation of 1 foot above the 100-year flood elevation. An additional 1 foot of vertical overbuild will be included in the Project to account for future settlement.

<sup>2</sup> Assembly Bill (AB) 360 Definition for Riparian Forest habitat includes woody vegetation (including isolated trees or shrubs) greater than 20 ft in height that may or may not overhang the water's edge. Often there is a dense, shrubby understory. The most common trees in the Delta include cottonwood, sycamore, alder, Oregon ash, willows, box elder, black walnut and various oaks.

<sup>3</sup> The AB 360 Definition for Scrub-shrub habitat includes stands of woody vegetation predominantly less than 20 ft in height. The various tree and shrub species that make up Scrub-shrub are generally the same as for Riparian Forest, although in most instances alders and or willows are the dominant plants.

## 1.2 Project Location

Bacon Island is located in the central Sacramento-San Joaquin River Delta, approximately halfway between the city of Antioch to the west and Stockton to the east, in San Joaquin County, California (Figure 1-1). The total size of the island is 5,625 ac. It is situated south of Mandeville Island, west of Mildred Island and Lower Jones Tract, north of Woodward Island, and east of Holland Tract (Figure 1-2). Waterways surrounding the island include Connection Slough to the north, Middle River to the east, Woodward Island Canal to the south, and Old River to the west, which runs along the Project. The island is accessible from Bacon Island Road on Lower Jones Tract. Bacon Island Road runs along the levee of Bacon Island and provides the only road access to Mandeville Island, via a bridge to the north. The island is predominantly used for agricultural crop production, specifically corn, rice, wheat, sunflower, and alfalfa (ICF International 2010, RD2028 2016). Vegetation on the crown and slopes of levees on Bacon Island is regularly controlled by mechanical mowing, herbicides, and/or sheep grazing.

## 1.3 Project Area and Current Conditions

The Project Area includes the landside levee slope from stations 300+00 to 550+00 and four HEAs on the interior of the island, adjacent to the levee (Figure 1-2). The current vegetation on the landside of the levee slope in the Project Area is generally upland ruderal herbaceous consisting of a mosaic of predominantly non-native grasses and forbs with very sparse cover of trees and shrubs. Conditions in the four HEAs are each distinct from one another. HEA1 has wet to mesic soils and is dominated by non-native herbaceous species with low cover of several native woody trees and shrubs, including Goodding's black willow (*Salix gooddingii*), arroyo willow (*Salix lasiolepis*), and American dogwood (*Cornus sericea*). HEA2 has mesic soils and is dominated by non-native herbaceous species with a dense patch of American dogwood near an irrigation ditch on the levee side. HEA3 contains two distinct habitat types: native riparian forest in the northwest quadrant and dense Himalayan blackberry (*Rubus armeniacus*) covering the remainder of the area. HEA4 has dry to mesic soils and is almost entirely dominated by non-native herbaceous species with a single arroyo willow sapling (Stillwater Sciences 2017).

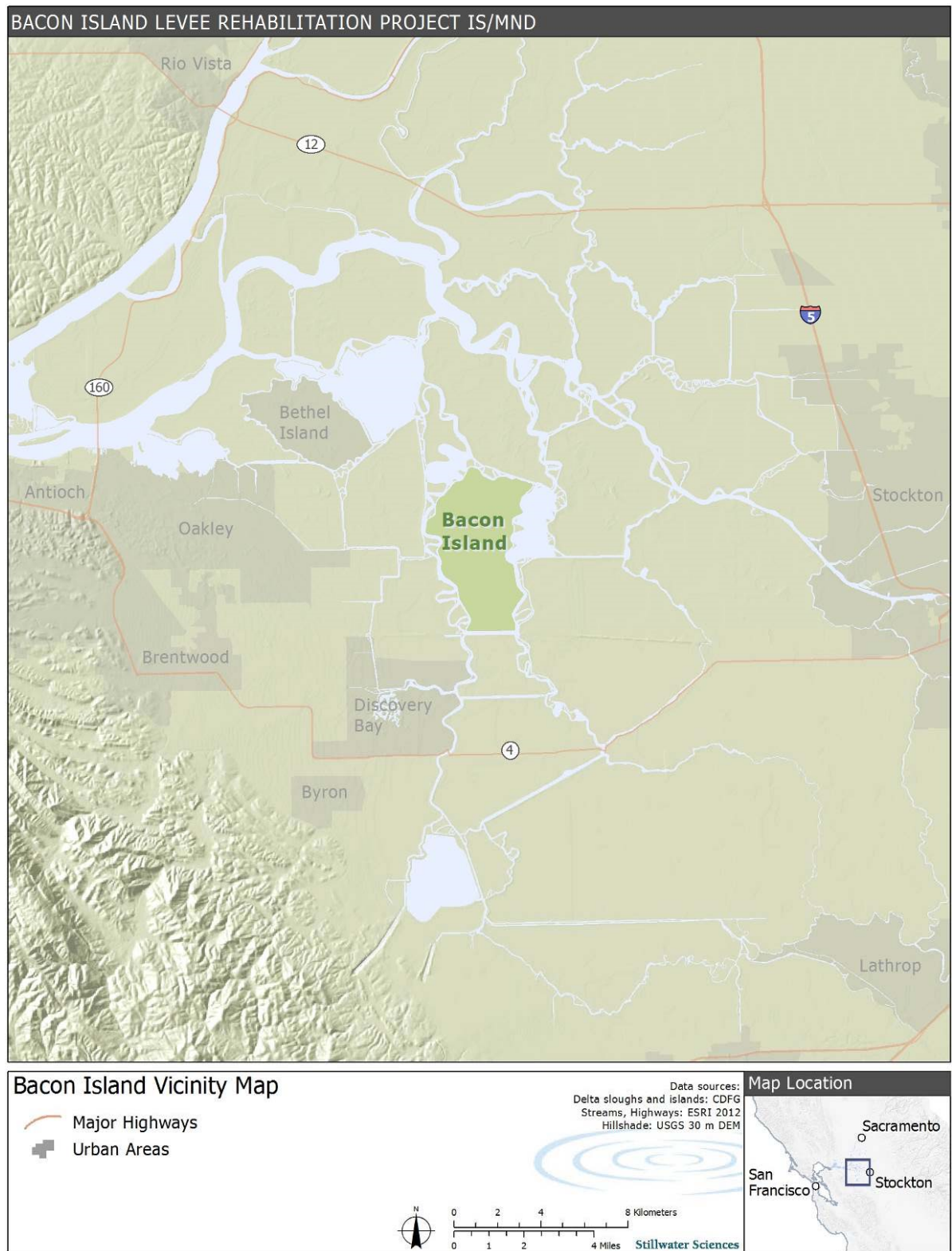


Figure 1-1. Bacon Island location.

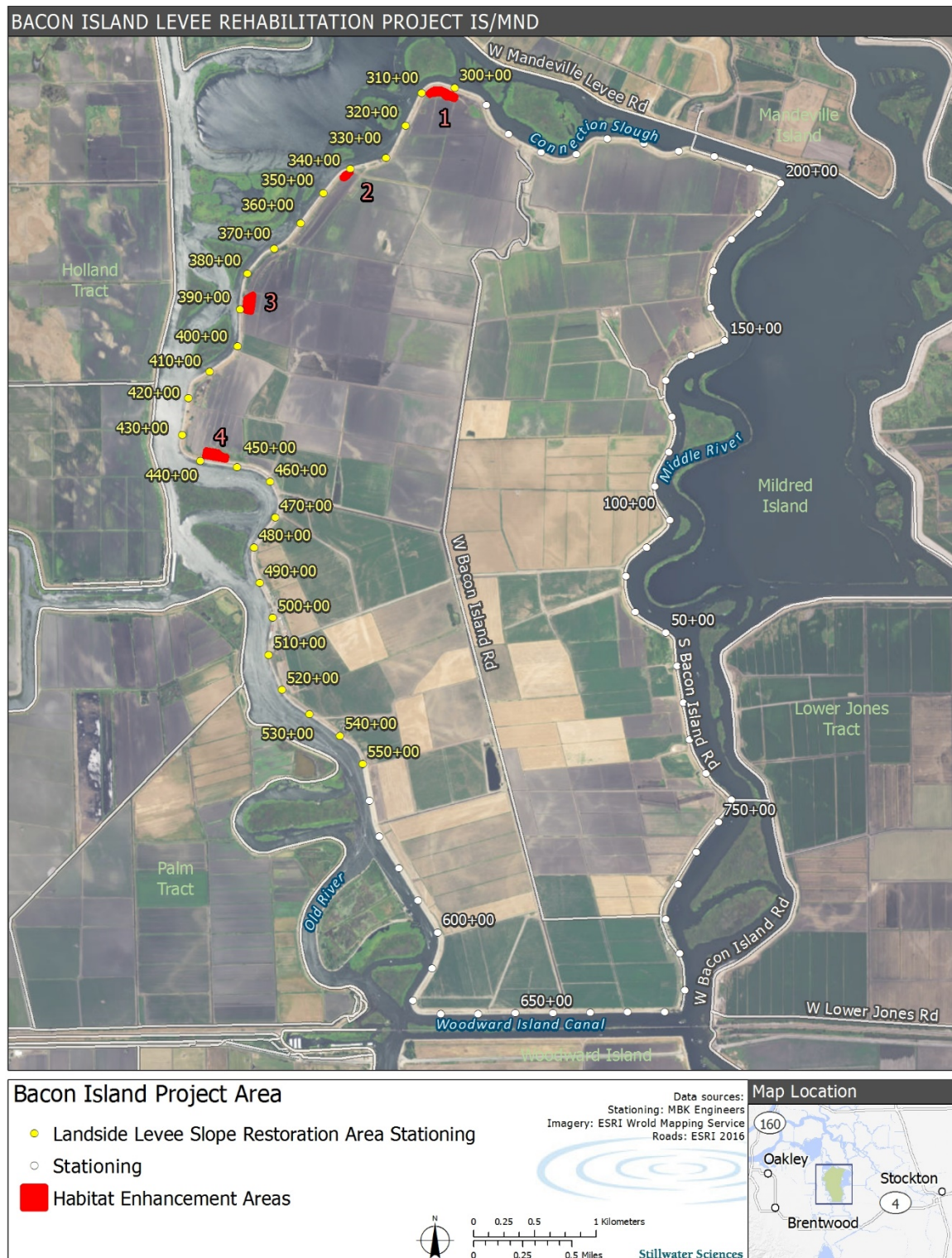


Figure 1-2. Bacon Island Levee Rehabilitation Project area.

## 2 RESTORATION PLANNING AND IMPLEMENTATION

### 2.1 Planting Design

The Project Area will be planted in accordance with detailed planting plans presented in Appendix C. Table 1 summarizes the vegetation types to be planted, with dominant and associated species specified for planting. These vegetation types include species that are native to the Sacramento-San Joaquin River Delta, many of which are already documented on Bacon Island (Stillwater Sciences 2017), and are known to be commercially available. As such, these plants are anticipated to provide habitat for native species and/or be sustainable in the long-term.

Table 1. Proposed planting plan per restoration area.

Vegetation Types		Scientific Name	Common Name	Planting Type <sup>1</sup>
Levee Grassland	Graminoids	<i>Elymus glaucus</i>	blue wild-rye	seed
		<i>Elymus triticoides</i>	beardless wild rye	seed
		<i>Poa secunda</i> subsp. <i>secunda</i>	one-sided blue grass	seed
		<i>Stipa pulchra</i>	purple needle grass	seed
		<i>Bromus carinatus</i>	California brome	seed
	Forbs (after year 3)	<i>Achillea millefolium</i>	yarrow	seed
		<i>Eschscholzia californica</i>	California poppy	seed
		<i>Lupinus bicolor</i>	miniature lupine	seed
Riparian Forest	Woody Species	<i>Acer negundo</i>	box elder	treeband
		<i>Fraxinus latifolia</i>	Oregon ash	deepot 16
		<i>Populus fremontii</i> subsp. <i>fremontii</i>	Fremont cottonwood	cutting
		<i>Salix gooddingii</i>	Goodding's black willow	cutting
		<i>Salix lasiolepis</i>	arroyo willow	cutting
		<i>Rosa californica</i>	California rose	treeband 9
		<i>Vitis californica</i>	California wild grape	treeband 9
Scrub-shrub	Woody Species	<i>Salix exigua</i>	narrowleaf willow	cutting
		<i>Salix laevigata</i>	red willow	cutting
		<i>Salix lasiolepis</i>	arroyo willow	cutting
		<i>Rosa californica</i>	California rose	treeband9
		<i>Baccharis salicifolia</i> subsp. <i>salicifolia</i>	mule fat	treepot 4 or treeband
		<i>Cephalanthus occidentalis</i>	California button willow	treeband
		<i>Cornus sericea</i> subsp. <i>sericea</i>	American dogwood	deepot 16

<sup>1</sup>Planting type indicates commercial nursery terminology for container size.

### 2.1.1 Landside Levee Slope

Designated areas of the landside levee slopes (Appendix C) will be established with a native grass seed mix created specifically for Bacon Island levee slopes, composed of species recommended by the *Delta Levees Habitat Program Guide to Planting Native Grassland Habitat on a Reconstructed Landside Levee Slope* (CDFW and DWR, unpublished memo; Appendix A), species that have performed well in other Delta restoration projects, and/or species documented on Bacon Island (Stillwater Sciences 2017). Subject to available funding, a seed mix of native forbs is recommended beginning three years post-restoration, after broadleaved target invasive plants have been repeatedly maintained with herbicide.

### 2.1.2 Habitat Enhancement Areas

The HEAs will be planted with woody species according to the specifications for Riparian Forest and Scrub-shrub (Appendix C), followed by sowing of an understory seed mix in all areas to establish a native herbaceous layer. Based on current vegetation, HEA1 will support Riparian Forest on the eastern half and Scrub-shrub on the western half. Mature individuals of existing native woody species (Goodding's black willow, arroyo willow, and American dogwood) will be retained and supplemented according to the planting schedule. Scrub-shrub habitat will be extended at HEA2 by retaining a clump of existing American dogwood and amending the remainder of the area with the other species in the Scrub-shrub planting schedule. Existing Riparian Forest in a portion of HEA3 is of significant extent, health, and maturity such that it was removed from the planting design (Appendix C), reducing the planting implementation area from 1.4 to 1.1 ac (although target invasive plant maintenance actions may be beneficial in the understory, so it remains within the Project Area). The remainder of the area will be planted as Riparian Forest. Scrub-shrub habitat will be planted in HEA4, and an existing arroyo willow plant will be retained.

## 2.2 Implementation

### 2.2.1 Landside Levee Slope

#### 2.2.1.1 Site Preparation and Weed Removal

Soil preparation on the landside levee slopes will increase the likelihood of successful germination and establishment of native grasses. Guidelines established in the *Delta Levees Habitat Program Guide to Planting Native Grassland Habitat on a Reconstructed Landside Levee Slope* (CDFW and DWR unpublished memo; Appendix A) recommend utilizing a shallow chisel to a depth of 1–2.5 feet, followed by discing the surface. Construction entails placement of fill on the levee slope; therefore, the top twelve inches of soil will not be compacted and shallow discing may be implemented as needed.

Before planting on levee slopes, several grow/kill cycles may be used to deplete the nonnative seed bank and reduce the potential for target invasive plants to outcompete plantings in the future. Grow/kill cycles consist of irrigating planting areas to initiate weed seed germination and then spraying with an appropriate herbicide to kill the young weeds (when less herbicide is necessary to effectively kill plants), and may be repeated as time allows.

#### 2.2.1.2 Seeding Methods Trial

Two different methods of seeding will be implemented to test the success of establishing native grassland per the *Delta Levees Grass Seed Trial Options 2015* (DWR, unpublished memo; Appendix B) if feasible. To best test and compare the two treatments, both methods should

experience similar conditions. Method A will be utilized between Stations 300+00 to 370+00 and 450+00 to 500+00 and Method B will be utilized between Stations 370+00 to 450+00 and 500+00 to 550+00. This distribution ensures both methods are implemented along levee slopes that generally face two different directions (northeast- and southeast-facing). Fertilizer is not recommended for either method.

Method A involves distributing seed on the prepared ground and incorporating into the soil by dragging a harrow or other tool. Native grass straw will be blown at a rate of 40 bales per acre for approximately 90% coverage and a depth of two inches and followed with hydro-blown mulch and sticker to cover the seeded area.

Method B involves borrowing Sacramento Area Flood Control Agency's (SAFCA) custom-built ridge roller seeder (RRS) if feasible; the District would need to coordinate with SAFCA prior to the planting contract. The RRS textures the soil and applies native grass seed on 3:1 levee slopes while being pulled parallel to the levee road by a tractor via a pin hitch and hydraulic hose connection. To cover the deposited seed, a light-duty ring roller or a chain harrow is attached to the rear of the roller frame and dragged behind.

#### 2.2.1.3 Timing

Seed will be applied to the levee grassland planting areas after fall rains have begun (late October through November) to allow the seeds to germinate and establish prior to dry periods. After three years of grass establishment and weed control, during the subsequent fall rainy season, the levee forb seed mix may be applied into the entire area or to areas where bare ground patches are apparent.

### 2.2.2 Habitat Enhancement Areas

#### 2.2.2.1 Site Preparation and Weed Removal

The first step in site preparation at the HEAs will be flagging of native trees and shrubs that will be retained at each site as follows:

- HEA1: mature individuals of existing native woody species (Goodding's black willow, arroyo willow, and American dogwood);
- HEA2: a clump of existing American dogwood;
- HEA3: the mature Riparian Forest as designated in the planting design; and
- HEA4: an arroyo willow plant.

The HEAs will require clearing of target invasive plants by a combination of herbicide and mechanical removal, or as necessary for removing everything from herbaceous target invasive plants to dense Himalayan blackberry, while not damaging the native woody vegetation. Although the patch of existing Riparian Forest in HEA3 is not specified for receiving plantings, it is part of the Project Area and any understory target invasive plants should be cleared. After clearing, grow/kill cycles may also be used prior to planting and seeding to aid in the success of small woody plantings.

#### 2.2.2.2 Installation

Container stock, plugs, and herbaceous seed mixes will be acquired from contracted plant nurseries and installed by a qualified contractor. As much as possible, local plant stock collected

from the Sacramento-San Joaquin River Delta and grown under similar ecological conditions (e.g., soils, depth to groundwater) will be used. Cuttings of Fremont cottonwood (*Populus fremontii*) and willows (*Salix* spp.) may be taken from existing plants within any of the HEAs.

For potted material, a hole will be prepared that is 1.5 times the depth and 3 times the diameter of the original planting container, the plant will be placed so the root crown is at the soil surface, and the hole will be backfilled with the original soil that was removed. Cuttings of Fremont cottonwood and willows do not require digging; they may be pressed or pounded into the soil to a depth of 1 to 1.5 ft. Immediately after installation, all plantings and cuttings will be thoroughly irrigated. If root crowns become exposed, additional soil will be placed throughout the planting hole to raise the soil to the correct level.

#### 2.2.2.3 Timing

Container stock and plugs will be planted at the beginning or middle of the rainy season to help maximize success of establishment and seed germination.

### 3 MAINTENANCE RECOMMENDATIONS

To ensure the permanency of the seeding and plantings, regular maintenance—primarily weed maintenance—will be implemented. The District will work with DWR to secure funding for vegetation management to include monitoring to ensure germination success, supplemental watering if dry periods develop, mowing<sup>4</sup> with a minimum blade height of eight inches off the ground, and, if appropriate, selectively using herbicides at the appropriate time for best weed control of the targeted weed species. The District will maintain and monitor the plantings for the duration of the funding agreement. The following sections provide procedural details for these potential measures.

#### 3.1 Weed Removal

Controlling invasive, non-native plant species will be key to successful restoration at the sites. Removal efforts will focus on control of target invasive plants; target invasive plants may include those listed in Table 2 which were documented in the Project Area and have a California Invasive Plant Council (Cal-IPC) rating of high or medium (Stillwater Sciences 2017), and may include additional target species if any are found to be detrimental to the successful establishment of seed mixes and plantings in the levee grassland or HEAs.

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<sup>4</sup> The District has a routine maintenance agreement with CDFW, which has jurisdiction over the waterside of the levee; to avoid impacts on ground nesting birds, CDFW recommends all mowing activities should be completed between July 1 and February 14, outside of the nesting season.

Table 2. Target invasive plants.

Species	Common Name	Cal-IPC Rating <sup>1</sup>
<i>Arundo donax</i>	giant reed	High
<i>Avena fatua</i>	wild oat	Moderate
<i>Brassica nigra</i>	black mustard	Moderate
<i>Bromus diandrus</i>	ripgut grass	Moderate
<i>Carduus pycnocephalus</i> subsp. <i>pycnocephalus</i>	Italian thistle	Moderate
<i>Cirsium vulgare</i>	bull thistle	Moderate
<i>Conium maculatum</i>	poison hemlock	Moderate
<i>Cynodon dactylon</i>	Bermuda grass	Moderate
<i>Eichhornia crassipes</i>	common water hyacinth	High
<i>Eucalyptus globulus</i>	blue gum	Moderate
<i>Festuca myuros</i>	rattail sixweeks grass	Moderate
<i>Festuca perennis</i>	rye grass	Moderate
<i>Ficus carica</i>	edible fig	Moderate
<i>Foeniculum vulgare</i>	fennel	High
<i>Hirschfeldia incana</i>	shortpod mustard	Moderate
<i>Hordeum murinum</i>	wall barley	Moderate
<i>Lepidium latifolium</i>	broadleaved pepperweed	High
<i>Ludwigia hexapetala</i>	Uruguayan primrose-willow	High
<i>Rubus armeniacus</i>	Himalayan blackberry	High
<i>Sisymbrium irio</i>	London rocket	Moderate

<sup>1</sup> Cal-IPC:

High—Species having severe ecological impacts on physical processes, plant and animal communities, and vegetation structure.

Moderate—Species having substantial and apparent—but generally not severe—ecological impacts on physical processes, plant and animal communities, and vegetation structure.

Target invasive plant maintenance may include a combination of mechanical (e.g., mowing, pruning or hand removal) and chemical (i.e., herbicide application) methods. If utilized, herbicide will be applied by a licensed applicator, following the products specifications and/or other Project permits. To reduce potential impacts to non-target organisms, herbicides will be considered that are registered for use around wetlands and waterbodies, such as AquaMaster® (Monsanto) and Rodeo® (Dow Chemical), both of which are mixtures of glyphosate and water, with the surfactant Agri-Dex®. These formulations have been shown to be relatively non-toxic to fish and amphibians, but still completely effective at killing both broadleaf plants and grasses.

### 3.2 Irrigation

If feasible, it is recommended that all plantings and seeded areas receive irrigation during the first year of growth including during the dry summer season. At a minimum, irrigation will be necessary if there is an unexpectedly dry fall and/or winter season. An irrigation system appropriate for the landside levee slopes may include truck broadcast irrigation or sprinkler irrigation, whichever will allow for water infiltration without causing runoff. The HEA's generally have relatively high soil moisture, therefore it is not anticipated that irrigation in these areas will be necessary after initial planting.

### 3.3 Mowing

Mowing on the landside levee slopes is recommended multiple times in the first year throughout the spring and summer to reduce the likelihood of target invasive grasses producing viable seed. The first mowing may be early April (informed by visiting the site in March), and thereafter as needed to prevent target invasive grass seed development. In years two and three, if native grasses are dominant and likely to seed, avoid mowing during seed maturation (typically late May to early June), to encourage native seed production.

In the HEAs, weed whacking is recommended over mowing, to more specifically focus on target invasive plants prior to seed development while not causing damage to native herbaceous plants or woody plantings.

### 3.4 Remedial Actions

Actions to help attain dominant native cover may be recommended for plantings along the landside levee slope or in the HEAs. In the landside levee slope areas, the seed mix may be reseeded as late as January, if necessary, to improve establishment and provide competitive cover and thatch to suppress target invasive plant cover. After the forb seed mix has been added in the third year, any remaining open patches can be seeded with either the grass or forb mix, or both.

Monitoring of the planted species in the HEAs is recommended so if poor survival is documented, additional plantings can be installed. Information gathered during monitoring can inform what actions may need to be taken, such as addressing irrigation problems, replacing failed plantings, choosing a different size of container plant, modifying the species list if it is found certain species are categorically unsuccessful at the site, or, in the case of herbivory, installing fencing.

## 4 REFERENCES

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