Habitat Restoration of the Bogg's Bend Unit on the Sacramento River National Wildlife Refuge

Draft Environmental Assessment

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Chapter 1. Purpose of and Need for Action

Introduction

This environmental assessment (EA) evaluates the environmental effects of three alternatives for managing the Bogg's Bend Unit of the Sacramento River National Wildlife Refuge (Refuge). This EA is tiered from the 2005 Comprehensive Conservation Plan and Environmental Assessment (CCP/EA). The following documents are incorporated by reference: (a) 2005 CCP/EA for the Sacramento River National Wildlife Refuge; and (b) 2007 Sacramento River National Wildlife Refuge Environmental Assessment Cumulative Impacts Analysis *(Hunting*) (USFWS 2007). The U.S. Fish and Wildlife Service (Service) will use this EA to solicit public involvement and to determine whether the implementation of the alternatives would have a significant effect on the quality of the human environment. This is part of the Service's decision-making process in accordance with the National Environmental Policy Act (NEPA), amended and its' implementing regulations. This EA addresses habitat enhancement and public use activities specific to the Bogg's Bend Unit. Detailed explanations of related issues of concern and management activities are addressed in the Sacramento River National Wildlife Refuge Final Comprehensive Conservation Plan (CCP) (USFWS 2005). This document serves as amendment to the 2005 CCP (SRNWR CCP Bogg's Bend Amendment, Appendix D).

Purpose of and Need for the Proposed Action

The purpose and need for the proposed action is to restore riparian and associated habitats within the Bogg's Bend Unit in a flood neutral manner to help fulfill the Service's congressional mandate to preserve, restore, and enhance riparian habitat for threatened and endangered species, songbirds, waterfowl, other migratory birds, anadromous fish, resident riparian wildlife, and plants while maintaining public safety associated with the U.S. Army Corps of Engineers flood control system and resource protection. In addition, the Service would continue to work cooperatively with CDFW to insure compatible public use opportunities on the Bogg's Bend Unit as described in the CCP for the SRNWR (USFWS, 2005). Historically, 500,000 acres of riparian forests occupied the Sacramento River floodplain, with valley oak woodland covering the higher river terraces. Since the late 1800s, logging, urbanization, and agricultural conversion have been the primary factors in eliminating riparian habitat. Riparian vegetation along the

Sacramento River has been reduced by approximately 90 percent over that time.

Proposed Action: The Service proposes to implement Alternative B, as described in this EA. This alternative plans to restore riparian habitat including mixed riparian forest, cottonwood riparian forest, rose-baccharis scrub/ valley wildrye grassland on 81.4 acres of the Bogg's Bend Unit that was formerly used for walnut production. This alternative also opens the Bogg's Bend Unit to the six compatible public uses that include hunting, fishing, wildlife observation, photography, interpretation, and environmental education. The proposed action is consistent with the management direction described in the CCP/EA. The proposed action is consistent with Goal 1 in the CCP/EA – *Contribute to the recovery of endangered and threatened species and provide a natural diversity and abundance of migratory birds and anadromous fish through the restoration and management of riparian habitats along the Sacramento River using the principles of landscape ecology*; as well as Goal 2 – *Encourage visitors of all ages and abilities to enjoy wildlife-dependent recreational and educational opportunities and experience, appreciate, and understand the Refuge history, riparian ecosystem, fish, and wildlife*.

Project Area

The Sacramento River National Wildlife Refuge (NWR) (Figure 1) Bogg's Bend Unit is located along the western bank of the Sacramento River at river mile 160.9 – 161.3 (Figure 2). The Unit is in Colusa County south of Afton between Colusa and Princeton, access from the levee on River Road ¼ mile south of E. Glenn Road. The site is located in the Colusa subreach (RM 164-143) south of the Drumheller Slough Unit of the Sacramento River Refuge and adjoins to the Sacramento River Wildlife Area Princeton Southeast Unit managed by the CDFW.

The Bogg's Bend Unit is one of the 30 units of the Sacramento River National Wildlife Refuge (Refuge), which is one of the five National Wildlife Refuges which comprise the Sacramento National Wildlife Refuge Complex (Complex) and is located in the Sacramento Valley of north-central California (Figure 1). The Valley is bordered by the Sierra Nevada Range to the east and the Coast Range to the west. The Refuge was established in 1989 and is currently composed of 30 units along an 81-mile stretch of the Sacramento River between the cities of Red Bluff and Colusa, 90 miles north of the metropolitan area of Sacramento.

Figure 1. Sacramento National Wildlife Refuge Complex Map

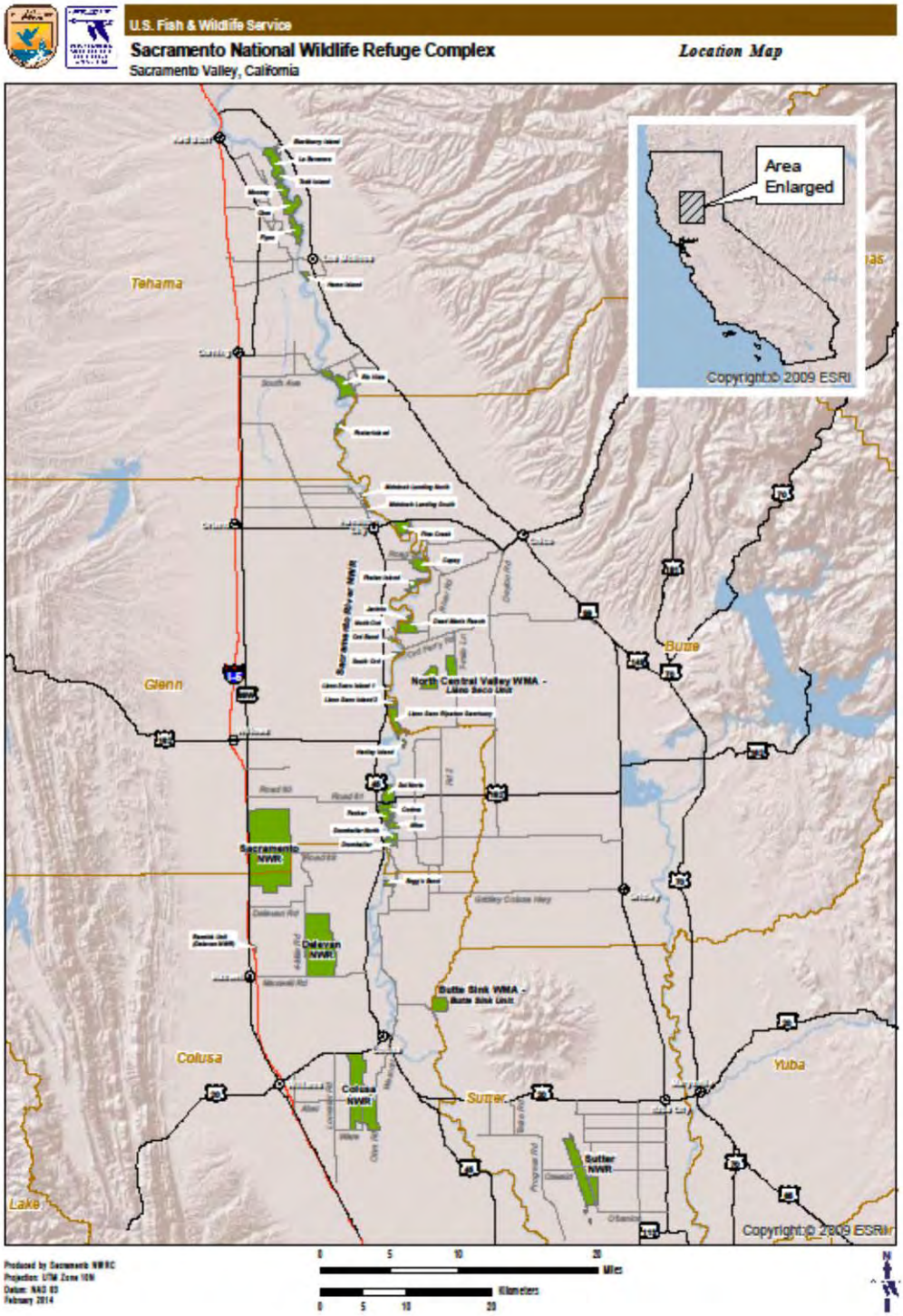
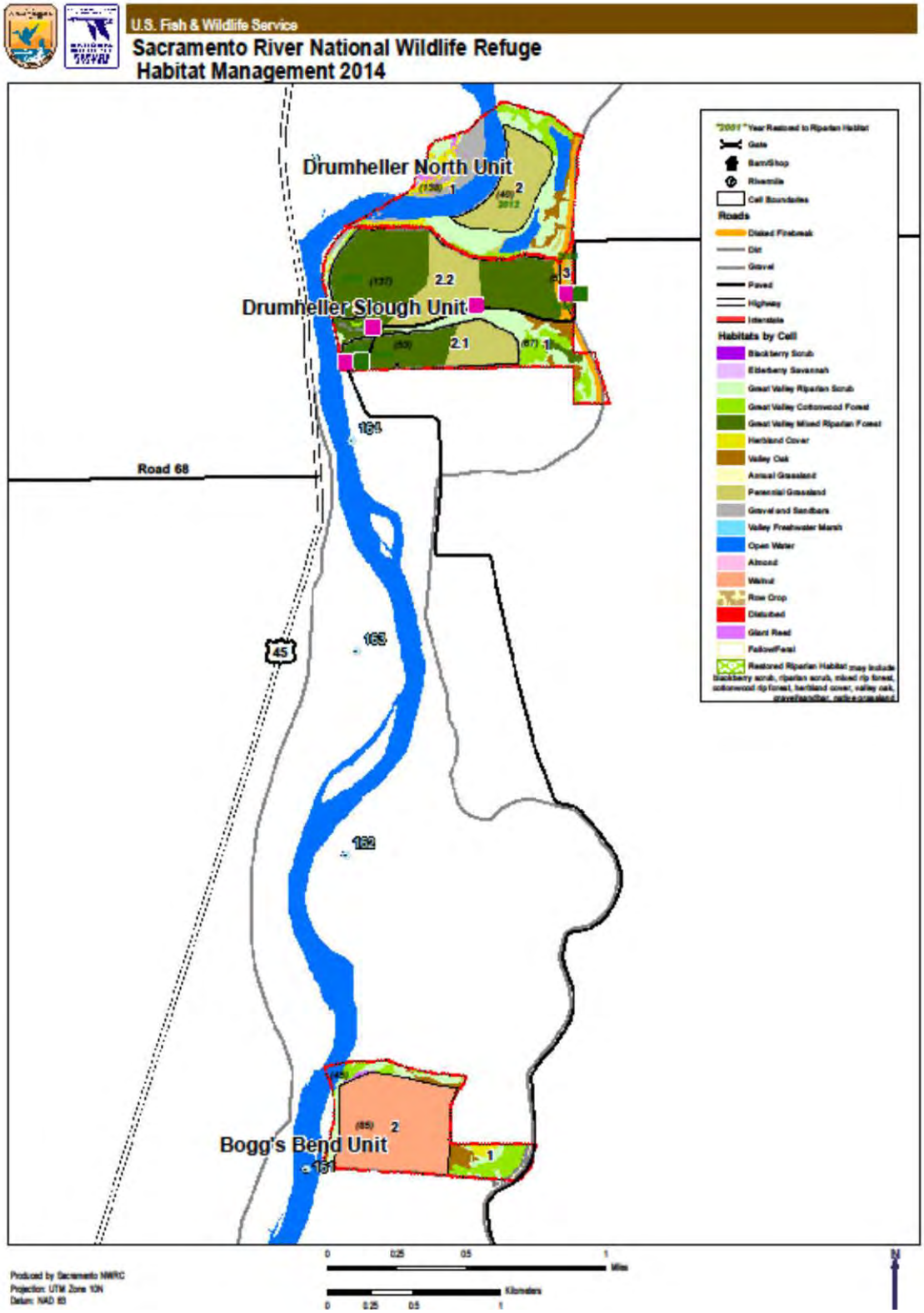


Figure 2. Bogg's Bend Unit of the Sacramento River National Wildlife Refuge Map



Decisions to be Made

Based on the analysis documented in this EA, the Service must determine the type and extent of management on the Bogg's Bend Unit of the Sacramento River Refuge and whether the selected management alternative would have a significant effect on the quality of the human environment.

Public Involvement

The Draft EA will be available for public review and comment for a 30-day period from April 17, 2015 through May 17, 2015. Interested stakeholders, State and local agencies, local landowners, and others were sent notification letters of where they could obtain or review the Draft EA. An electronic copy of the Draft EA is also posted on the Refuge's website (www.fws.gov/refuge/Sacramento/news2.html) and the Sacramento River Conservation Area Forum (SRCAF) website (www.sacramentoriver.org/SRCAF/index.php). In addition, notification of the availability of the document was sent out to over 400 people on the SRCAF mailing list.

U.S. Fish and Wildlife Service and National Wildlife Refuge System

The mission of the Service is working with others to conserve, protect, and enhance the nation's fish and wildlife and their habitats for the continuing benefit of the American people. The Service is the primary Federal agency responsible for migratory birds, endangered plants and animals, certain marine mammals, and anadromous fish. This responsibility to conserve our nation's fish and wildlife resources is shared with other Federal agencies and State and Tribal governments.

As part of this responsibility, the Service manages the National Wildlife Refuge System (Refuge System). The Refuge System is the only nationwide system of Federal lands managed and protected for wildlife and their habitats. The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

The Sacramento River Refuge is managed as part of the Refuge System in accordance with the National Wildlife Refuge System Administration Act of 1966 as amended by the Improvement Act, and other relevant legislation, executive orders, regulations, and policies.

Refuge Purposes
The Refuge purposes are:

“...to conserve (A) fish or wildlife which are listed as endangered species or threatened species....or (B) plants...” 16 U.S.C. Sec. 1534 (Endangered Species Act of 1973).

"…the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions..."16 U.S.C. 3901(b) (Emergency Wetlands Resources Act of 1986).

“...for the development, advancement, management, conservation, and protection of fish and wildlife resources...” 16 U.S.C. 742f (a) (4) “...for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude...” 16 U.S.C. Sec. 742f (b) (1) (Fish and Wildlife Act of 1956).

Chapter 2. Alternatives, Including the Proposed Action

Introduction

This chapter describes three alternatives for managing the Bogg's Bend Unit of Sacramento River Refuge. Alternative A, No Action), Alternative B, Mixed Riparian Forest, Cottonwood Riparian Forest, Rose-Baccharis Scrub/ Valley Wildrye Grassland Restoration and public use (Proposed Action), and Alternative C, Full Mixed Riparian Habitat Restoration and public use.

All alternatives considered in this EA were developed with the mission of the Refuge System and the purposes of the Refuge as guiding principles. Under the No Action alternative, the Service would continue managing the Bogg's Bend Unit as it is currently managed. Two of the three alternatives presented in this chapter are "action alternatives" that would involve a change in the current management of the Refuge. The Service's proposed action is Alternative B. There are no known sensitive natural or cultural resources within the Bogg's Bend Unit that would preclude public use or require special closures (Westwood and White 2005). As such, Alternatives B and C include implementation of the six compatible public uses –hunting, fishing, wildlife observation, photography, interpretation, and environmental education– consistent with the SRNWR CCP (USFWS, 2005) and the Colusa Subreach Plan (TNC 2008), following a determination of compatibility.

The California Department of Fish and Wildlife (CDFW), Region 2 has reviewed the Colusa Subreach Wildlife Habitat Restoration Project as a project under the California Environmental Quality Act (CEQA) to determine whether it could have a significant effect on the environment. Under CEQA, "significant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by a project (CEQA Guidelines Section 15382). CDFW has issued a mitigated negative declaration for the Colusa Subreach Wildlife Habitat Restoration Project including the Bogg's Bend Unit formerly known as the Jensen Tract (North State Resources 2008).
CDFW manages 14 Units of the State's Sacramento River Wildlife Area in Tehama, Butte, Glenn and Colusa counties (https://www.wildlife.ca.gov/Lands/Places-to-Visit/Sacramento-River-WA. Six of these units lie within the Colusa Subreach, with their Princeton Southeast Unit adjoining the north and east

borders of the Bogg's Bend Unit. While distinct from policies and management from the Sacramento River NWR, CDFW management includes habitat restoration and public use, which has been identified during various phases of planning for the Colusa Subreach (Ayres Associates 2008; EDAW 2002, 2006; TNC 2008). Planning and coordination between the Refuge and CDFW is done to facilitate wildlife and habitat management and public use opportunities and law enforcement (MOU 2005). This optimizes habitat restoration results and provides for appropriate and seamless public use activities across the agencies common borders.

Alternative A: No Action, Natural Recruitment

Under this alternative, the Service would continue to manage the Sacramento River Refuge as it has in the recent past, in accordance with the CCP. The Bogg's Bend Unit consists of a former 81.4-acre walnut orchard that is surrounded by 44 acres of existing remnant riparian floodplain habitats, including open river channel water, off-channel oxbow wetlands, herbland cover, Great Valley riparian scrub, Great Valley cottonwood riparian forest, Valley oak, and giant reed (Figure 2). The orchard was no longer productive and was removed to prevent walnut pests from infesting an abandoned orchard thereby preventing the spread to neighboring orchards. No weed control has been conducted since the removal of the walnut orchard and would not be conducted in the future under this alternative. Active riparian restoration activities would not occur on the Bogg' Bend Unit under Alternative A. Currently, non-native species established on the Refuge threaten its biological integrity as well as the biological integrity of downstream Refuge and non-Refuge lands.

Under this alternative, no planting of native riparian floodplain trees, shrubs, grasses and other herbaceous species would occur, therefore only plants that would become established at the site would be through natural recruitment. Natural recruitment would be expected to modify the vegetation patterns on the Bogg's Bend Unit over time and would include both native and undesirable non-native species. Due to the fragmented nature of remnant vegetation, riparian restoration could take decades under this alternative.

No public use would occur under this alternative at the Bogg's Bend Unit because public use was closed for orchard operations and management programs and activities for this new unit of the Refuge needed to be amended to the Sacramento River NWR CCP.

Alternative B: Habitat Restoration; Mixed Riparian Forest, Cottonwood Riparian Forest, Rose-Baccharis Scrub/ Valley Wildrye Grassland *(Proposed Action)*

Under this alternative, the Refuge would restore 55.9 acres of mixed riparian forest, 1.5 acres of cottonwood riparian forest, and 24 acres of rose-baccharis scrub/ valley wildrye grassland on the Bogg's Bend Unit (Figure 3). A Riparian Habitat Restoration Plan was developed by The Nature Conservancy (TNC) (2013, Appendix A). The plan describes a specific restoration design based on the environmental conditions and ecological goals on the Bogg's Bend Unit. Ecological goals include establishing riparian floodplain habitats for endangered and threatened species, migratory water birds and landbirds, and anadromous fish. A variety of plant communities (vegetation type) are used because various trees, shrubs, vines, and herbaceous plants are adapted to the different physical site conditions. Important site conditions include, soil texture and chemistry, depth to the water table, depth the refusal (i.e., gravel) where root penetration is not possible due to lack of water, and flood frequency. Planting appropriate species according to these ecological conditions results in sites within the restoration of various species composition, various frequencies of the selected plant species, and various planting densities: all of these variables combine to define the type of vegetation, or plant community. In addition to ecological goals, social or cultural goals are implemented which results in the use of specific plant communities. For example, maintaining conveyance for flood waters sometimes necessitates the use of flexible shrub/vine/herbaceous and savanna vegetation. The procedures site preparation, planting/seeding, maintenance, and monitoring are also described in this plan (Appendix A). This restoration plan is consistent with the evaluation of environmental effects associated with riparian floodplain habitat restoration along the Colusa subreach (North State Resources, 2008), the Environmental Assessment for Proposed Restoration Activities on the Sacramento River National Wildlife Refuge (USFWS 2002), the Final Comprehensive Conservation Plan for the Sacramento River National Wildlife Refuge (USFWS 2005), and the results of the Colusa Subreach hydraulic modeling report (Ayers Associates 2008, Appendix B; RiverSmith Engineering Memorandum 2015, Appendix C). The communities planned for habitat restoration are based on site assessments of the soil profile, topography, flood frequency and hydraulic modeling, depth to groundwater at base flows, weed community, and existing riparian community.

Objectives for this alternative include:

- To establish early and late successional stage riparian

communities which have been severely reduced in extent along the Sacramento River since 1850.

- Provide habitat for endangered and threatened species.
- To provide habitat for neo-tropical migrant land birds.
- Improve water quality for aquatic resources including anadromous fish by decreasing sediment and pesticide runoff into Bogg’s Bend slough channel and the Sacramento River.
- Provide high quality public use opportunities.
- Reduce potential impacts to the flood control system and neighboring landowners.

The Bogg’s Bend Unit is in the active floodplain, so this alternative was developed taking into consideration the Sacramento River flood control features, which includes the functional operation of the levees, and Moulton and Colusa weirs. According to the California Department of Water Resources, the Bogg’s Bend Unit floods every 1 to 5 years with the 81.4-acre restoration area in the 4-year estimated flood frequency interval. The 24 acres of rose-baccharis scrub/ valley wildrye grassland habitat will serve as an essential flood corridor due to its low tree density.

An iterative design approach was used in a joint effort of TNC ecologists and Ayers Associates engineers. The appropriate land covers were designed based on the existing vegetation, soil types and availability of groundwater so that no higher hydraulic friction would naturally occur. The proposed 24-acre rose-baccharis scrub/ valley wildrye grassland in would decrease Manning’s Roughness Coefficient from 0.075 for orchard to 0.070 for light riparian/ riparian scrub and 0.032 for grass (Ayers Associates 2008).

The restoration design incorporates scrub/ grassland cover to reduce locations of increased water surface elevation and the computed results show water surface elevations either slightly decreasing or slightly increasing (Ayers Associates 2008) . Analysis of the model shows that a slight increase of 0.05 ft. is isolated and limited to a small area near the eastern edge of the Unit and does not extend to the levee, so no changes will occur to the existing freeboard at the levee (RiverSmith Engineering Memorandum 2015).

The proposed restoration will have no effect on the seepage potential either through or under the levees both on the

proposed restoration site and adjacent sites (Ayers Associates 2008).

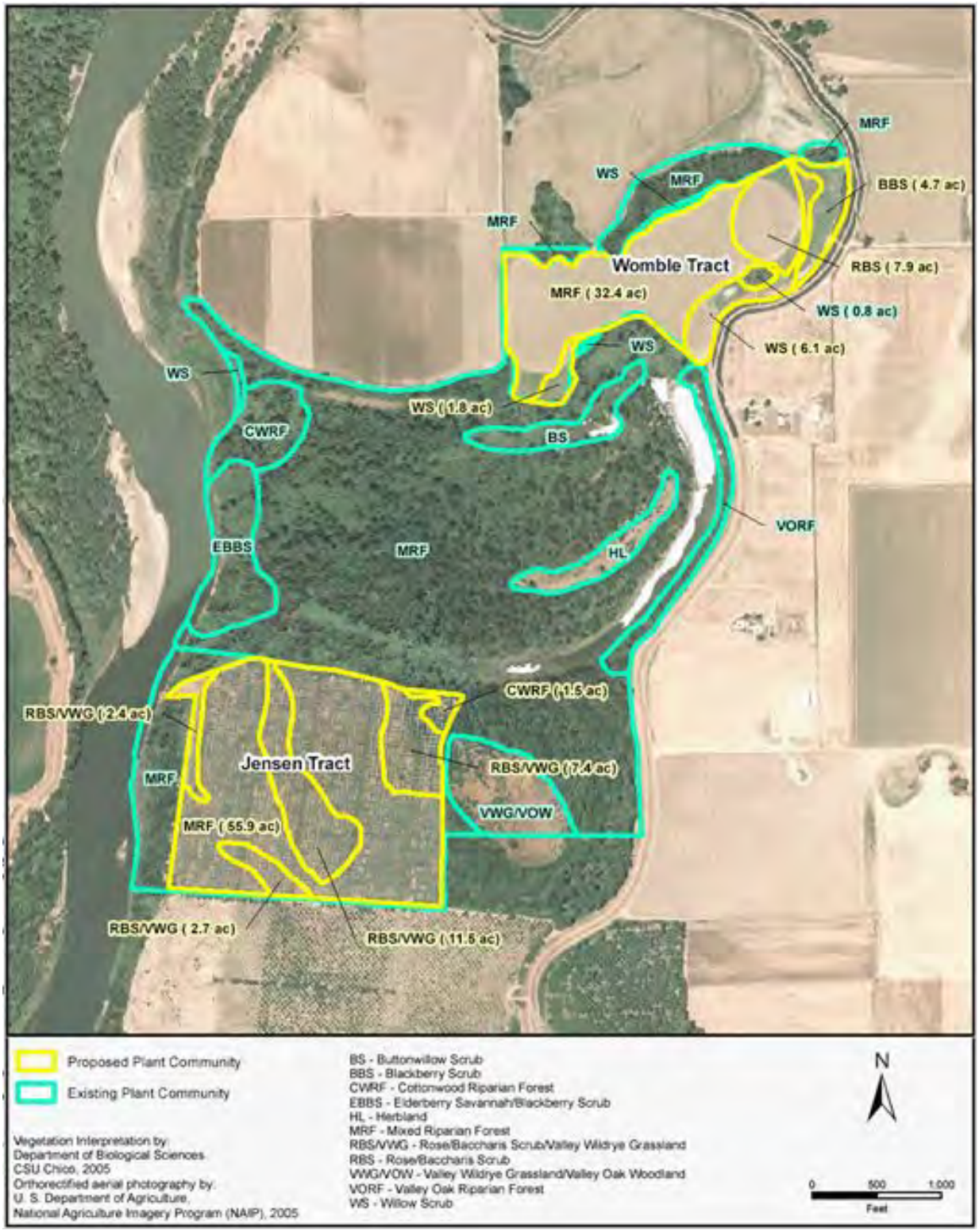
The proposed restoration design is planted at various densities with plants communities of various roughness, which effects velocities and design flow and patterns of overbank erosion and deposition. The model shows velocity decreases of up to 0.5 feet per second (fps) at the restoration site for mixed riparian forest and at the property to the east; and, slight increases in velocity at the restoration site for shrub/ grass and to the west of the site up to 1.0 fps, and smaller increases of 0.10 to 0.30 fps at the downstream property (Ayers Associates 2008). Since these increases are less than 2 fps, no induced erosion on these properties is expected (Ayers Associates 2008 Furthermore, the velocities patterns are highest in the native grass planting, but these velocities are non-erosional for native grass cover (RiverSmith Engineering Memorandum 2015).

The 81.4-acre Bogg’s Bend Unit restoration will improve the ecological health and long-term viability of at-risk species and riparian communities along the Sacramento River by restoring riparian habitat and improving water quality through active restoration. Restoration on this site facilitates the establishment of native riparian habitat that without active cultivated restoration would return to native vegetation at a very slow rate or not return at all. Restoring riparian habitat in the area will improve habitat for fish and wildlife by creating a large continuous block of habitat. Fish benefit from riparian areas that become flooded at high flows, where floodwaters are relatively slower and warmer than the main channel and provide refugia for young and juvenile fish. Additionally, large woody debris, a result of increased riparian habitat, provides food and cover for critical life stages of anadromous fish. Additionally, restored riparian forests will buffer and filter toxic and organic matter that originate further away from the river, thereby further enhancing water and sediment quality.

The restoration site will provide habitat for the Valley elderberry longhorn beetle (VELB) in 24 acres of rose/ baccharis scrub (TNC 2013). Plant communities with low woody species densities (i.e., savannas) and/ or low canopy height containing blue elderberry (*Sambucus mexicana*) bushes provide long-term high quality VELB habitat because the bushes thrive in open canopy vegetation. Existing riparian habitat at the restoration site may provide source VELB populations for restoration site colonization.

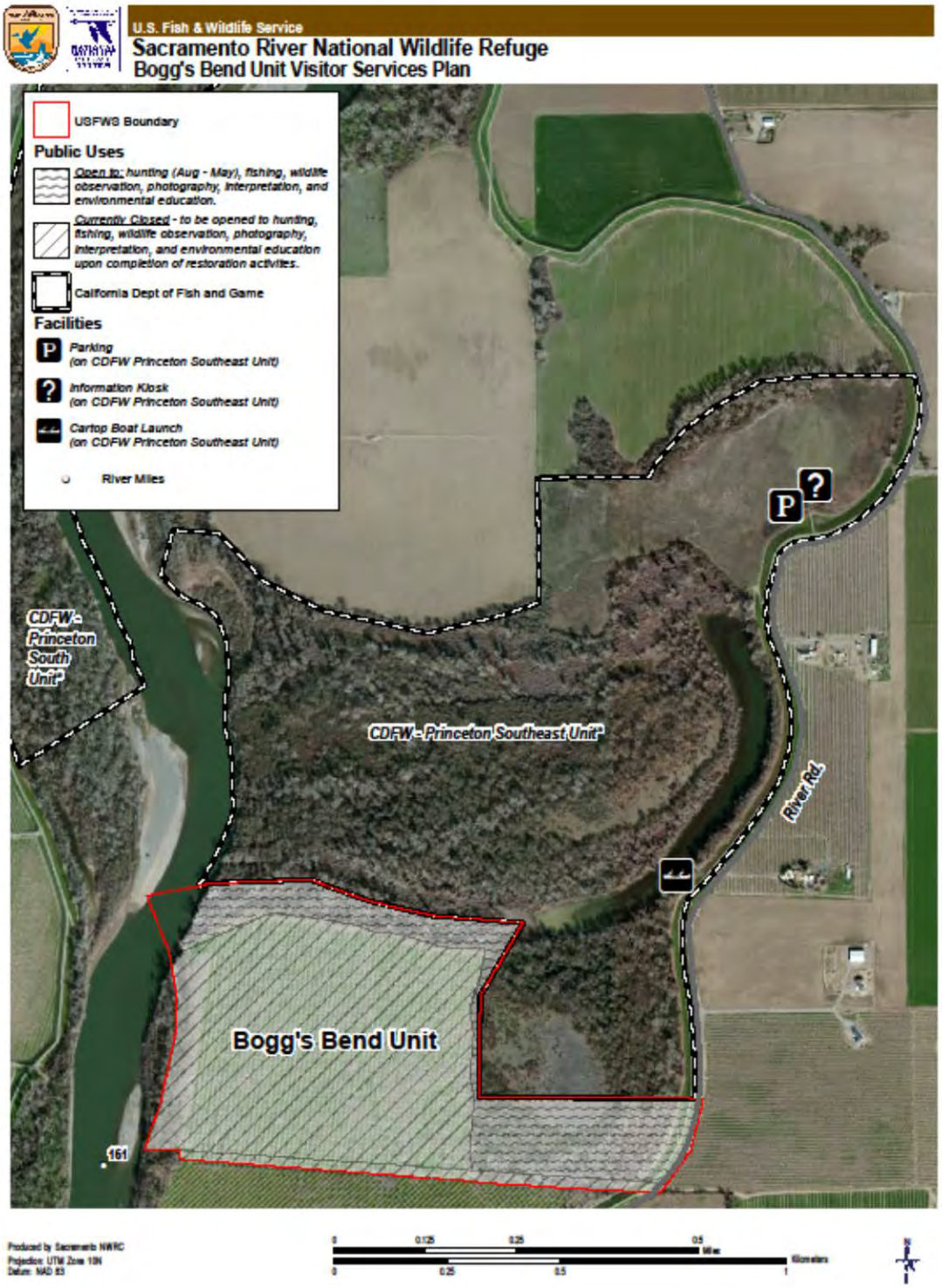
The Refuge in partnership with conservation groups and other government agencies has planted about 118,000 elderberry shrubs in restoration projects along the Refuge over the past 20 years. Recent research investigations have documented successful VELB colonization at these restoration sites (Gilbart 2009; River Partners 2004). The CCP for the Sacramento River Refuge (USFWS 2005) identifies the need to work with Federal, State, county, levee and irrigation districts to investigate best management practices for habitat, water diversion, and flood management projects through technical studies and agency coordination. Accordingly, the Refuge has implemented a self-imposed, 100-foot valley elderberry shrub-free zone (Appendix A, Environmental Assessment, Mitigation Measures) intended to buffer the boundaries between Refuge restoration sites and private orchards, levees, and roadways so that agricultural pesticide drift from those neighboring private orchards and facility and levee maintenance operations will not affect VELB habitat in restoration sites or adjacent landowner operations. The Refuge has coordinated and worked with the local levee districts to maintain 20-30 foot vegetation free areas where appropriate along the borders with private lands and adjacent to the U.S. Army Corps of Engineer (ACOE) levees. No restoration plantings will occur within 900 feet of the ACOE levee. Construction and maintenance of vegetation firebreaks on all Refuge property bordering ACOE is incorporated as “high” priority projects described in the Annual Habitat Management Plans for the Sacramento River Refuge.

Figure 3. Bogg's Bend Unit Restoration Map



Management of the Bogg’s Bend Unit will be consistent with the Sacramento River National Wildlife Refuge Final CCP (June 2005) and SRNWR CCP Bogg’s Bend Amendment (Appendix D). Accordingly, the Bogg’s Bend Unit will eventually be open to six priority uses –hunting, fishing, wildlife observation, photography, interpretation, and environmental education– (Figure 4). However, these six priority uses will be deferred on a portion of the Unit until habitat restoration has been completed. Two information kiosks will be developed, parking area improvements will be implemented, public use signs will be installed, and interpretive brochures will be provided. The Service is coordinating/ partnering with the CDFW to develop a plan to improve existing facilities and cooperatively manage the visitor services facilities on the CDFW’s Sacramento River Wildlife Area Princeton Southeast Unit to provide access to the Service’s Bogg’s Bend Unit of the Sacramento River National Wildlife Refuge (MOU 2005). No new facilities will be developed as recommended in the 2008 Colusa Subreach Planning Report. Access to the Service’s newly opened Bogg’s Bend Unit will be limited to the CDFW access points and a closed area will remain in place along the private property adjoining the Refuge on the southern boundary to reduce impacts to adjacent landowners (Figure 4).

Figure 4. Visitor Service Opportunities on the Bogg's Bend Unit



Alternative C: Habitat Restoration; Full Mixed Riparian Forest
Under this alternative, the Refuge would restore 81.4 acres of mixed riparian forest on the Bogg's Bend Unit. Unlike Alternative B, valley oak savanna, cottonwood riparian forest, and grassland would not be included in the restoration. This alternative is consistent with the Final Comprehensive Conservation Plan for the Sacramento River National Wildlife Refuge (USFWS 2005).

Ecological objectives for this alternative include:

- To establish early and late successional stage riparian communities which have been severely reduced in extent along the Sacramento River.
- Provide habitat for endangered and threatened species.
- To provide habitat for neo-tropical migrant land birds.
- Improve water quality for aquatic resources including anadromous fish by decreasing sediment and pesticide runoff into Bogg's Bend slough channel and the Sacramento River.
- Provide high quality public use opportunities.

Mixed riparian forest typically occurs in association with watercourses within the Great Central Valley of California and is a California Natural Diversity Database listed sensitive plant community (CDFG 2003). Common tree and shrub species include Oregon ash, Fremont's cottonwood, valley oak, Himalayan blackberry, arroyo willow, blue elderberry, poison-oak, California rose, and California wild grape. Herbaceous plant species include Santa Barbara sedge and mugwort.

Riparian forests provide food, water, migration and dispersal corridors, and escape, nesting, and thermal cover for a diversity of wildlife species. According to Mayer and Laudenslayer (1988), at least 50 amphibian and reptile species are known to occur in lowland riparian systems, and approximately 55 species of mammals are known to use Central Valley riparian communities. Due to the dense canopy and understory of the riparian forest habitat type, a large variety of neo-tropical migrant bird species use this habitat, including western yellow-billed cuckoo, Audubon's warbler, black-headed grosbeak, black-chinned hummingbird, Anna's hummingbird, downy woodpecker, Nuttall's woodpecker, and spotted towhee (USFWS 2005).

This alternative is consistent with the Refuge's wildlife and habitat restoration and management goals, as well as the intent of Congress in authorizing development of an 18,000-acre Refuge

along the Sacramento River. In addition to meeting the project purpose, this alternative supports the purposes for which the Sacramento River NWR was established: to conserve endangered and threatened fish, wildlife and plants and their habitats (Endangered Species Act of 1973); conserve wetlands to maintain public benefits and fulfill international migratory bird treaty obligations (Emergency Wetlands Resources Act of 1986)); and, to develop, advance, manage, conserve and protect fish and wildlife resources (Fish and Wildlife Conservation Act of 1956)(USFWS 2005). This option would have the highest benefit for wildlife and fisheries resources.

Although this alternative is consistent with the Refuge's restoration goals, it is not supported by the hydraulic modeling conducted for the Colusa Bend reach of the Sacramento River. A hydraulic model was designed to represent a maximum vegetation conservation and restoration configuration that would not exceed maximum freeboard requirements (Ayers Associates 2008). This model incorporated more riparian forest, while maintaining some scrub/ grassland habitat. The water surface elevations increased in several areas as a result of the model. These increases forest were not acceptable by the Central Valley Flood Protection Board guidelines, which mandated that the project be flood neutral (no increase in water surface over existing conditions, regardless of freeboard). In addition, scrub/ grassland restoration design includes elderberry shrubs, needed habitat for the federal-listed VELB.

Long-term management activities and public use would be similar to Alternative B.

Chapter 3. Affected Environment

A completed description of the Refuge environment can be found in the 2005 CCP/EA. This chapter primarily addresses the existing condition and resources at the Boggs Bend Unit.

Physical Environment

Geology, Hydrology, and Soils

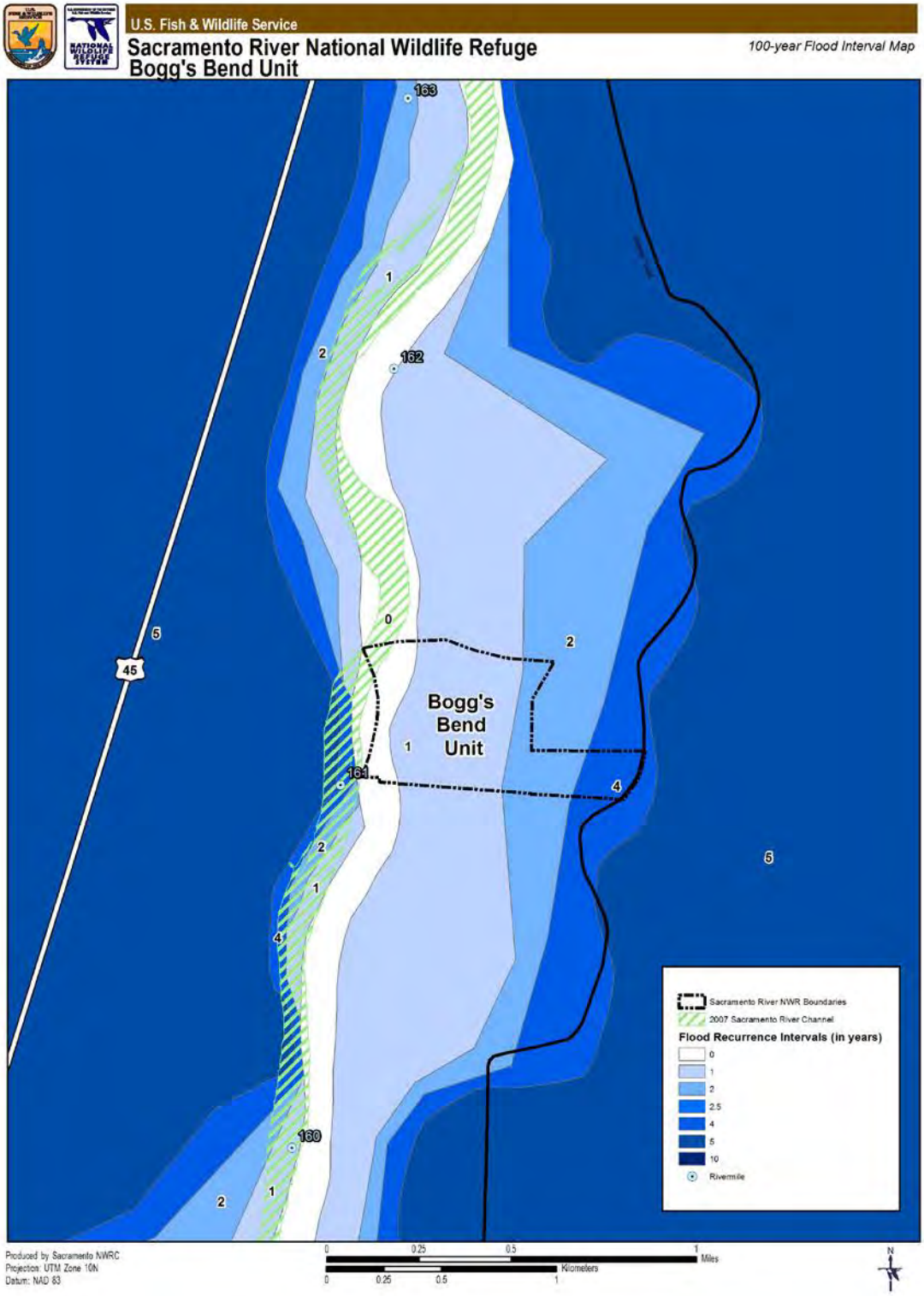
The area of the Refuge between Chico Landing and Colusa is underlain by sedimentary and volcanic deposits associated with the Tehama, Tuscan, and Red Bluff formations (Harwood and Helley 1982; Helley and Harwood 1985). On top of these formations lie terrace deposits, such as Riverbank and Modesto formations, as well as paleochannel deposits, alluvial fans, meanderbelt deposits, and basin and marsh deposits (Department of Water Resources 1994; Robertson 1987). The Modesto and Riverbank deposits flank the river in steps away from the channel and tend to erode at lower rates than other young deposits. These areas tend to form higher, more consolidated banks, and have a high proportion of Class I agricultural soils, including the Columbia and Vina loams. The Bogg’s Bend Unit consists of Vina loam, 0 to 2 percent slopes, frequently flooded (NRCS websoilsurvey Custom Soil Resource Report). In that region the water table is greater than 80 inches (typically even with the Sacramento River) and the soils well drained (NRCS websoilsurvey Custom Soil Resource Report).

There are many tributaries that enter the Sacramento River through Refuge properties located north of Chico, including Coyote Creek, Oat Creek, Elder Creek and Hoag Slough. Although this area has a large number of tributaries, the overall hydrology has been greatly changed due to the presence of Shasta Dam. Bank erosion rates have declined, likely due to reduction in frequency of overbank flows and increased bank protection. From Red Bluff to Colusa, the Sacramento River is characterized by three general levels of bank protection; however, the U.S. Army Corps of Engineers (ACOE) and California Department of Water Resources rip-rap isolated stretches throughout this area. First, from Red Bluff to Ord Bend, bank protection consists of small private levees discontinuously protecting individual private properties. The ACOE Sacramento River Bank Protection Program levee system begins at the left bank at Ord Bend and at the right bank about seven miles below. Second, from this point downstream, the ACOE project levees are continuous. In the leveed portion of the Beehive Bend subreach, there are no

significant tributaries entering the Sacramento River. Third, in the Colusa subreach, the levees constrict just below Princeton, greatly reducing the formation of point bars and floodplain, which in turn affect the regeneration of cottonwood and willow forests.

The Bogg’s Bend Unit has a flood frequency of 1 to 4 years with the majority of the property the in the 1-year estimated flood frequency interval (Figure 5; California Department of Water Resources at http://www.sacramentoriver.org/srcaf/index.php?fus_id=16).

Figure 5. Estimated Flood Recurrence Intervals



Contaminants and Water Quality

The Refuge lies within the jurisdiction of the Central Valley Regional Water Quality Control Board, which established beneficial uses and water quality objectives for surface water and groundwater in the Water Quality Control Plan (Basin Plan) for the region. Because the Sacramento River originates as snowmelt, it is of excellent water quality; therefore, it supports all existing beneficial uses of the Basin Plan, including domestic, agricultural, and industrial water supply; recreation; wildlife habitat; cold and warm freshwater fish habitat; and migration and spawning for salmonid fisheries. The water is considered soft, moderately alkaline, and low in dissolved solids, with high turbidity during peak runoff periods. The Sacramento River is listed as impaired on the U.S. Environmental Protection Agency's (EPA) Section 303 (d) list of water bodies for the pesticide diazinon, and trace metals (including mercury, cadmium, copper, and zinc).

A Level I Contaminants survey was conducted by the Service and found no contaminants on the Bogg's Bend Unit. However, the walnut orchard on the Bogg's Bend Unit may have had problems with surface drainage of fertilizers and pesticides into the River. This may include Manex, a heavy metal and carcinogen, Copper Hydroxide, Confirm, Intrepid, GF-120, Apollo, and Glyphosate. The effects of both Manex and Copper Hydroxide are of concern to fish, especially sub lethal behavioral modifications. Converting the Bogg's Bend Unit from a walnut production orchard to native riparian habitat will reduce or eliminate any further introduction of these chemicals in the future.

Air Quality

The Bogg's Bend Unit lies within the Sacramento Valley Air Basin (SVAB) and is under the jurisdiction of the Colusa County Air Pollution Control District (CCAPCD). The SVAB is bounded on the north and west by the Coastal Mountain Range and on the east by the southern portion of the Cascade Mountain Range and the northern portion of the Sierra Nevada Mountains. These mountain ranges provide a substantial physical barrier to locally created pollution, as well as that transported northward on prevailing winds from the Sacramento Metropolitan area. The valley is often subjected to inversion layers that, coupled with geographic barriers and high summer temperatures, create a high potential for air pollution problems.

The state is divided into Air Pollution Control Districts and Air Quality Management Districts. These agencies are county or

regional governing authorities that have primary responsibility for controlling air pollution from stationary sources. The CCAPCD establishes policies, regulations, and permit procedures and monitors air quality parameters within Colusa County.

Biological Environment

Vegetation
The Sacramento River Refuge currently consists of 11,644 acres of primarily riparian floodplain habitats. Agricultural areas consists of walnut orchards and row crops; currently, accounting for 5 percent of Refuge lands. Riparian habitats include open river channel water, off-channel oxbow wetlands, herbland cover, Great Valley riparian scrub, Great Valley cottonwood riparian forest, Valley oak, and giant reed. Appendix G of the CCP (USFWS 2005) contains a complete list of plant species that occur and potentially occur on the Refuge.

Currently, fallow agricultural lands dominate the Bogg's Bend Unit (Figure 2). The unit contains an 81.4 acre of former walnut orchard that is surrounded by 44 acres of existing remnant habitat. Walnut orchards in the project area are a monoculture of English walnut. The remnant habitat is primarily mixed riparian forest in composition.

Wildlife Resources
Riparian and floodplain habitats at the Refuge provide water, food, cover and shelter to a variety of wildlife, which breed and/or winter here. These include migratory gulls and terns, herons and egrets, ducks and geese, shorebirds, hawks, eagles and turkey vultures, and variety of songbirds and other landbirds such as swallows and woodpeckers, California quail and wild turkey. The Refuge also provides habitat for various bats, rabbits/hares, squirrels, raccoon, ringtail cat, skunk, river otter, black-tailed deer, coyote, bobcat, mountain lion, lizards, skink, western pond turtle, snakes, frogs and various aquatic and terrestrial insects, including beetles, bees, flies, butterflies, moths, dragon and damsel flies, and spiders. Appendix G of the CCP (USFWS 2005) contains a complete list of wildlife species that occur and potentially occur on the Sacramento River Refuge.

The food, water, and shade that agricultural crops offer attract a limited amount of wildlife species. Mourning dove, western bluebird, scrub-jay, red shafted-flicker, lazuli bunting, European starling, and house finch are known to nest in orchards. Black-tailed hare, California vole, and pocket gopher

are also present in orchards. Deer and rabbits browse on trees; squirrels and various birds feed on nuts. Species that have been reported to feed on nut crops include northern flicker, scrub jay, American crow, plain titmouse, Brewer's blackbird, house finch, and California ground squirrel (Mayer and Laudenslayer 1988)

Fisheries Resources
The Sacramento River provides important habitat for a diverse assemblage of fishes, including both anadromous and resident species. Anadromous fish include Chinook salmon (four runs), steelhead, striped bass, American shad, green and white sturgeon, and pacific lamprey. Resident fish can be separated into warmwater game fish (such as largemouth bass, white and black crappie, channel catfish, white catfish, brown bullhead, bluegill, and green sunfish), coldwater game fish (including rainbow trout and brown trout), and nongame fish (such as Sacramento squawfish, Sacramento splittail, Sacramento sucker, and golden shiner). Appendix G of the CCP (USFWS 2005) contains a complete list of fish species that occur and potentially occur on the Sacramento River Refuge.

Sensitive Species
The Sacramento River Refuge provides breeding, rearing, migratory staging, and wintering habitats for Federal and State special status species. These species include: Green Sturgeon Southern DPS (Federal threatened); Sacramento River Winter-run Chinook Salmon ESU (Federal and State endangered); Central Valley Spring-run Chinook Salmon ESU (Federal and State threatened); Chinook salmon fall- and late-fall run ESU (Federal species of concern); Central Valley Steelhead ESU (Federal threatened); Valley Elderberry Longhorn Beetle (Federal threatened); Yellow-billed Cuckoo Western DPS (Federal threatened and State endangered); Bald Eagle (State endangered); Swainson's Hawk (State threatened); Bank Swallow (State threatened); and Willow Flycatcher (State endangered). Appendix G of the CCP (USFWS 2005) contains a List of sensitive species that occur and potentially occur on the Sacramento River Refuge.

VELB spends its entire life cycle on blue elderberry, which provides reproductive habitat and food for the species. As such, elderberry shrubs are legally protected because they are the host plant for VELB. Elderberry shrubs occur in mixed riparian forests, savannas and scrubs. Elderberry shrubs are present in riparian areas near the restoration sites but are not common in agricultural or orchard habitats where routine

agricultural practices prevent the germination or growth of seedlings.

The existing riparian vegetation and proposed areas of restored riparian vegetation do and will support several species of migratory birds. Some of these species, including yellow-billed cuckoo, require mature riparian vegetation composed of willow and cottonwood. This habitat type will support other special-status species (such as willow flycatcher, a State-listed endangered species) during migration and will provide nesting habitat for many other bird species.

Bald eagle nest along the Sacramento River from below Red Bluff to Butte City and are observed down the river through Colusa. They nest in tall trees, such as cottonwood and oak, near the river where they prey on fish and carrion. Bald eagle were once rare in the summer along the Sacramento River, but under conservation provided by the Endangered Species Act of 1973, their populations recovered and breeding pairs and eaglets are observed in nests, and adults are observed fishing, from the river channel. Riparian restoration provides potential nesting habitat (i.e., cottonwood, sycamore and oak trees) for bald eagle on the Sacramento River. The USFWS determined the bald eagle fully recovered in 2007 and delisted. Along with the golden eagle, is fully protected under the Bald and Golden Eagle Protection Act of 1940 and the Migratory Bird Treaty Act of 1918.

In the Central Valley, Swainson’s hawk nest sites are strongly associated with riparian forest and savanna vegetation near open agriculture such as cereal grains and irrigated pasture; the primary habitat requisite provided by riparian systems is nesting substrate, typically large trees (Riparian Habitat Joint Venture 2004). In Central California, about 85 percent of Swainson’s hawk nests are within riparian forest or remnant riparian trees, with nearby treeless agricultural lands used for foraging (RHJV 2004). Swainson’s hawks have been observed perched in valley oak trees and flying in broad circles along the Sacramento River between Red Bluff to Colusa. While they are not known to nest in the project area, they are known to nest in the vicinity along the Sacramento River floodplain.

Periodic erosion of mid and high floodplain elevation banks is necessary for Bank Swallow (BANS) colony establishment. The largest BANS populations in California occur along the middle Sacramento River, from Red Bluff to Colusa, and survey results have shown the importance of the Sacramento River Refuge to the

BANS, a State-threatened species. Portions of the western boundary of the Bogg's Bend Unit and the Princeton Southeast Unit provided habitat for BANS colonies in 2014.

Social and Economic Environment

Employment

California ranks as the largest state economy in the nation and the fifth largest economy in the world. In 2014, approximately 355,000 jobs were created in the non-farm sector. The unemployment rate is currently 7.3 percent and is forecasted to decrease to 6.0 percent by 2016 (California Department of Transportation 2014). The per capita income in California is $49,134 and the average salary per worker is $69,341.

Agriculture is the dominant industry in Colusa County where rice growing is among the most productive in the nation (New Valley Connexions 2001). Rice and almonds account for 60 percent of the total agricultural output. Real farm crop value for 2013 was 747.2 million (California Department of Transportation 2014). In November 2014, total nonfarm employment was 6,590 jobs and farm employment was 2.350 jobs (California Department of Finance 2015). The 2014-2040 County-Level Economic Forecast reported that Colusa County had 9,000 wage and salary jobs in 2013, increasing 2.4 percent (210 jobs) from the previous year: farm employment increased by 4.8 percent and the nonfarm employment grew by 1.6 percent (California Department of Transportation 2014).The largest increases were in agriculture (110 jobs), retail trade (70 jobs), transportation/ utilities (50 jobs), and manufacturing (40 jobs). The per capita income in Colusa County was $47,184 and the average salary per worker was $44,777 (California Department of Transportation 2014).Unemployment in 2013 was 18.5 percent, declining from 20.3 the previous year. Employment growth is expected to increase to 2019 with agriculture and government accounting for 72 percent of net job creation.

Agriculture is a critical part of the economy in Glenn County accounting for 26 percent of total wage and salary employment with total real farm crop valued at $731.9 million in 2013 (California Department of Transportation 2014). Almonds, rice and walnuts account for more than half of this total. In November 2014, total nonfarm employment was 9,120 jobs and farm employment was 2,710 jobs (California Department of Finance 2015). The 2014-2040 County-Level Economic Forecast reported that Glenn County had 8,350 wage and salary jobs in 2013,

increasing 1.5 percent (120 jobs) from the previous year: the agricultural sector increased by 2.3 percent and the nonfarm sector grew by 1.3 percent (California Department of Transportation 2014). The per capita income was $39,633 and the average salary per worker was $42,931 (California Department of Transportation 2014). Unemployment in 2013 was 12.2 percent, declining from 14.4 the previous year. Employment growth is expected to increase over the next several years, as a result of growth in the non-farm sector.

Butte County's agriculture industry is a vital factor in the county's economic success. The County has ideal conditions for agricultural production supporting a variety of crops including rice, almonds, walnuts, prunes, peaches, and kiwi fruit. Real farm crop value for 2013 was 737 million (California Department of Transportation 2014). In November 2014, total nonfarm employment was 77,300 jobs and farm employment was 3,200 jobs (California Department of Finance 2015). The 2014-2040 County-Level Economic Forecast reported that Butte County had 77,000 wage and salary jobs in 2013, increasing 4.6 percent (3,400 jobs) from the previous year, one of the highest rates in California (California Department of Transportation 2015). The largest gains were in education and healthcare. The per capita income was $37,640 and the average salary per worker was $45,541 (California Department of Transportation 2014). Unemployment in 2013 was 10.0 percent, declining from 12.0 the previous year. Employment growth is expected to increase by an average of 1.4 percent per year to 2019.

Tehama County is a large recreational and agricultural region that includes vast areas of open space for cattle, ranches, orchards, row crops, and both large and small farms. (Real farm crop value for 2013 was 309.7 million (California Department of Transportation 2014). In November 2014, total nonfarm employment was 15,960 jobs and farm employment was 2,020 jobs (California Department of Finance 2015). The 2014-2040 County-Level Economic Forecast reported that Tehama County had 16,000 wage and salary jobs in 2013, increasing 2.5 percent (400 jobs) from the previous year: the agricultural sector increased 3.1 percent and the non-farm sector increased by 2.4 percent (California Department of Transportation 2015). The largest gains were in transportation/ utilities (240 jobs), education and healthcare (240 jobs), and construction (100 jobs), while the largest losses were in professional and business services (210 jobs) and government (130 jobs). The per capita income was $31,087 and the average salary per worker was $44,568 (California Department of Transportation 2014). Unemployment in 2013 was 13.7 percent,

declining only from 13.8 the previous year. The largest increases in employment growth (accounting for 84 percent of jobs created forecasted out to 2019) are for manufacturing, transportation and utilities, wholesale and retail trade, professional and business services, education and health services, and government

The Bogg's Bend Unit, located in Colusa County, was acquired in 2014. The unit's 81.4 acres of walnut acres were managed under a Cooperative Land Management Agreement (CLMA) with TNC and leased to a tenant farmer. However, no trees have been replanted in the last fifteen years, and the orchard had lost productivity. Due to lack of productivity, this orchard was removed from production following the 2014 growing season.

Local Economy

Agriculture is the dominant economic enterprise in the northern Sacramento Valley. The diversity of crops grown in the Sacramento Valley reflects the diversity of soils, climate, cultural and economic factors. Butte County's major crops include rice, almonds, prunes, and walnuts; Glenn County's include rice, almonds, prunes, alfalfa, and corn; Tehama County's include prunes, walnuts, olives, and pasture; and Colusa County's include rice, tomatoes, and almonds. Areas in proximity to the river mainly support tree crops. Countywide agricultural production values for 2013 are: $747.2million for Colusa; $731.9 million for Glenn; $737.0 million for Butte; and, $309.7 million for Tehama (California Department of Transportation 2014).

The 2014-2040 County-Level Economic Forecast (California Department of Transportation 2014) reported that the following for 2013: Colusa County's per capita income was $47,184 and the average salary per worker was $44,777; Glenn County's per capita income was $39,633 and the average salary per worker was $42,931; Butte County's per capita income was $37,640 and the average salary per worker was $45,541; and Tehama County's per capita income was $31,087 and the average salary per worker was $44,568. Employment growth is forecasted for each county (California Department of Transportation 2014).

Although the lands included within the Refuge are federally owned and therefore provide no property taxes, several factors help to mitigate this loss of revenue to local governments. First, Refuge lands and waters demand little in the way of expensive infrastructure or services. Second, when the Service acquires private land in fee, Congress allocates payments to

counties under the Refuge Revenue Sharing Act to partially compensate for the loss of property taxes. In addition, the designation of this property as a Refuge and the resources protected within the Refuge contribute to the local economy by drawing visitors from outside the county to the area for wildlife viewing, hunting, environmental interpretation, and other ecotourism related activities. While visiting the Refuge, visitors contribute by purchasing goods and services from local businesses. In addition, they contribute additional sales taxes to local governments, as well as transit occupancy taxes that are used by local governments to fund a variety of services.

The report “Banking on Nature 2006: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation” (USFWS 2007b) detailed the findings from 80 national wildlife refuges, including Sacramento Refuge. The Banking on Nature 2006 study included money spent for food and refreshments, lodging at motels, cabins, lodges or campgrounds, and transportation when it calculated the total economic activity related to refuge recreational use.

Sacramento Refuge had over 137,430 visits in 2006. Refuge visitors enjoyed a variety of activities, including wildlife viewing, hiking, and migratory bird hunting. Non-residents accounted for about 127,408 or 93 percent of recreation visits and almost all of the visits were for non-consumptive recreations (129,257). Sacramento Refuge generated an estimated $2.4 million in total economic activity related to refuge recreational use with associated employment of 25 jobs, $773,500 in employment income and $391,100 in total tax revenue. Total expenditures were $1.8 million with non-residents accounting for 1.7 million or 96 percent of total expenditures. Expenditures on hunting accounted for 57 percent of all expenditures, and non-consumptive activities accounted for 43 percent. Sacramento Refuge generated $2.78 of recreation-related benefits for every $1 of budget expenditure during 2006.

The Bogg’s Bend Unit’s 81.4 acres walnut orchard consisted of Ashley variety walnuts, managed by TNC and leased to a tenant farmer. The orchard had lost general vigor and produced alternately between 210,000 and 290,000 in-shell pounds per acre. The Ashley variety was difficult and more expensive to farm because it is more susceptible to walnut blight, codling moth, walnut husk fly, and the structural defects of the shell. In some years, after all the other pests and diseases had taken their toll, 30 to 40 percent of the walnuts were lost or damaged at harvest from breaking the weakened shell. This orchard was 38

years old, while walnut trees typically have about a 35 year economic life, and was missing about 15 percent of its trees. This property was estimated to have 82 percent producing acreage in 2011. The average yield of property and crop based upon three years history was poor compared to yields of similar crops and properties. The irrigation required the hand moving of aluminum pipe and this added to production costs. This property did not command an average rent due to tree variety, age, and irrigation system.

There were several other management problems with the former Bogg’s Bend orchard. Surface drainage of fertilizers and pesticides into the river was also an issue. Weed, disease, insect, and rodent populations were relatively high, while farming pesticide restrictions by TNC and the USFWS made control methods more challenging than more typical methods at nearby orchards. The property is located within the levee system and is subjected to frequent flooding. During flood events, silt and some debris can also be deposited, but the Sacramento River Wildlife Area Princeton Southeast Unit north of the Bogg’s Bend Unit helps to trap some of this material.

Land Use and Zoning

The Refuge is bordered by private lands, as well as Federal and State owned public lands. Private lands are mostly agricultural land (orchards, row crops, rice), with some private duck-hunting clubs, farmsteads, businesses, trailer parks, and isolated homes.

Each of the four counties in which the Refuge acquisition boundary is located has its own General Plan that outlines land use policies. The Colusa County Draft General Plan (De Novo Planning Group. 2011) contains several sections that regulate local land uses. Those that apply to the proposed action are identified in: Section 2 of the Draft Agriculture Element; Section 5 of the Draft Conservation Element; Section 8 of the Draft Land Use Element; and, Section 10 of the Draft Open Space and Recreation Element.

2. Agriculture Element (Draft)

Farming and related agricultural industries define Colusa County’s character, economy, and lifestyle. Protection and expansion of agriculture is identified as some of the most critical issues in the Colusa County 2030 General Plan. This element contains goals, objectives, policies and action items to protect and expand agricultural, and reduce conflicts between agriculture and other land uses.

Policy AG-1-2. Lands designated for agricultural uses shall remain designated for agriculture and not be rezoned or redesignated to an urban use unless certain criteria are met, such as: (e.) *No feasible alternative location (e.g., non-agricultural lands or less productive agricultural lands) exist*.

Policy AG-1-14. Resource conservation activities such as habitat creation and active habitat or species management on lands designated for agricultural uses shall require a General Plan Amendment to Resource Conservation unless certain conditions are met, such as: (b.) *The resource conservation activities are compatible with agricultural activites on the site and existing or potential agricultural activities in the vicinity*.

5. Conservation Element (Draft)

Colusa County has a great diversity of natural resources, waterways, wildlife habitats, and historical resources. State law mandates this element to address conservation, development and utilization of natural resources, including forests, soils, rivers and other waters, fisheries, wildlife, minerals, water, hydrology, energy conservation, air quality, and cultural and historical resources preservation. Conservation Goal 1 (Goal CON-1) is to conserve and protect Colusa County's ecosystem and provides objects to: protect, enhance, and manage the County's ecosystems and habitats; protect endangered, threatened and special-status plant and animal species, and their habitats, and other sensitive habitats; protect and enhance local fisheries and riparian and aquatic habitat; protect surface water quality in the County's lakes, creeks and rivers; ensure a sustainable and long-term supply of safe and reliable water to support the needs of County residents, businesses, and agricultural operations; and effectively conserve and manage the County's forests and timber resources. Specific policies are identified to successfully implement these goals and many of these relate to the proposed project:

Policy CON 1-1: *Maintain ample areas of land designated Resource Conservation (RC)*.

Policy CON 1-5: *Attempt to resolve conflicts between resource conservation areas and adjoining agricultural or recreation lands on a case by case basis in a manner which recognizes the public interests in both resource protection and the sound management of agricultural recreational resources*.

Policy CON 1-6: *Focus conservation efforts on high priority conservation areas that contain suitable habitat for endangered, threatened, migratory or special-status species and that can be managed with minimal interference with nearby agricultural activities*.

Policy CON 1-7: *Preserve and enhance those biological communities that contribute to the County's rich biodiversity including, but not limited to, blue oak woodlands, annual grasslands, mixed chaparral, pine woodlands, wetlands, riparian areas, aquatic habiat, and agricultural lands*.

Policy CON 1-11: *Protect wetlands and riparian habitat areas from encroachment by development to the greatest extent feasible*.

Policy CON 1-12: *Require new development to include maintained and managed setbacks and buffers along riparian corridors and adjacent to sensitive habitat*.

Policy CON 1-13: *Sensitive habitats include blue oak woodlands, wetlands, vernal pools, riparian areas, wildlife and fish migration corridors, native plant nursery sites, waters of the U.S., and other habitats designated by state and federal agencies and laws*.

Policy CON 1-20. *Protect, restore and enhance habitat for protected fish species in a manner that does not result in the conversion of agricultural lands or result in the loss of agricultural water supplies*.

Policy CON 1-21: *Protect riparian habitat along the Sacramento River in order to maintain suitable habitat for anadromous fish species, including salmon and steelhead trout, and native sport fishing species*.

Policy CON 1-25: *Balance the needs of aquatic and riparian ecosystem enhancement efforts with flood management objectives*.

8. Land Use Element (Draft)

This element provides for development and resource conservation land use patterns that preserves the advances the rural and agricultural character of Colusa County while providing the potential for economic development. State law requires the Land Use Element to address certain issues: *the proposed general distribution and general location and extent of land uses of the land for housing, business industry, open space, including agriculture, natural resources, recreation, and enjoyment of scenic beauty, education, public buildings and grounds, solid and liquid waste, disposal facilities, and other categories of public and private uses of the land; population density and building intensity; and, areas subject to flooding*.

<u>Open Space and Resource Conservation Policies</u>:

Policy LU 3-36: *Protect public lands in the National Forest and Wildlife Refuges from encroachment by activities on adjacent lands that could damage environmental quality Agriculture, in kind, should be protected from encroachment by activities on adjacent National Forest and Wildlife Refuge lands*.

Policy LU 3-38: Low intensity development that supports management and conservation of Resource Conservation lands is allowed, such as: 4) when the development would not detract from the area's value for habitat, open space, or research.

> *"Action LU 3-H: Revise the Zoning Ordinance to create a Resource Conservation or Habitat Management zoning district that accommodates active habitat conservation and management and incorporates standards established by Policy OSR 1-4."*

10. Open Space and Recreation Element (Draft)

The rural atmosphere, open space, wildlife refuges, working landscapes, lakes, rivers and scenic vistas of Colusa County are astounding and represent some of the County's greatest assets. Representing over 75 percent of the land base, agriculture vastly contributes to the County's open space character. Vast resources provide for a variety of outdoor recreational activities and tourism while also providing a natural resource base for agriculture, forestry, wildlife habitat, watershed storage, water quality, and a high quality of live for Colusa County residence. Goals, objectives, policies and implementation programs of this element are intended to be consistent with those of other General Plan Elements (e.g., Agriculture, Conservation, Land Use) to fulfill the County's growth and community development vision for over the next 20 years. Several objectives and policies are relevant to the proposed project

"Objective OSR 1-A: Provide a Diverse and Accessible Range of Open Space Lands"

Policy OSR 1-2: Support regional and local natural resource preservation plans of public agencies that retain and protect open space within the County, …

Policy OSR 1-3: Support the preservation of open space consistent with this General Plan, via acquisition of fee title or easements by land trusts, government agencies, and conservancies from willing landowners, subject to the standards identified in Policy OSR 1-4.

Policy OSR 1-4: Habitat and/or wildlife easements proposed in Colusa County for the loss of
open space or habitat in other jurisdictions will not be recognized and are not acceptable unless the easement meets all of the following criteria:
• Prior notification to Colusa County;
• Consistency with the goals and policies of the Colusa County General Plan, particularly as
related to planned growth, infrastructure, and agricultural preservation;
• Compensation to Colusa County for all lost direct and indirect revenue;
• Compatible with neighboring land uses;
• Located outside of urban and urban reserve areas;
• Secured water rights and infrastructure to economically maintain the proposed mitigation
use;
• Requirements that existing agricultural operations continue to be farmed for commercial
gain;
• Requirements that habitat management practices do not adversely impact adjacent
Agricultural operations;
• Prioritize purchase of mitigation credits by local developers; and
• Accommodation of recreational uses or public access, where appropriate.

Policy OSR 1-5: Open space that is actively managed or placed under conservation easement for habitat, wetlands, or species preservation or conservation shall be restricted to lands designated Resource Conservation (RC).

Policy OSR 1-6: The National Wildlife Refuges in the County should remain in their present use and any significant expansion or alterations shall be subject to the same criteria listed in Policy OSR 1-4.

Policy OSR 2-3: Encourage the expansion of public access and recreation facilities along the Sacramento River, …

Policy OSR 2-12: Enhance parking and public facilities at the Sacramento River, …

Policy OSR 2-13: Encourage recreational uses that emphasize use of the waterways in locations directly on the Sacramento River, …

Demographics

In the first 150 years of statehood, California grew from fewer than 100,000 citizens in 1850 to almost 34 million in 2000 (California Department of Finance 2002). Between 1950 and 2000 alone, California's population increased by 200 percent (California Department of Finance 2002). By 2010, the total population of California reached 37,253,956 (California Department of Finance 2012). At this rate, the 50-million mark will be passed sometime between 2030 and 2040 (California Department of Finance 2002).

The Central Valley has been one of the fastest growing areas in California during the last few decades. All four counties within the Sacramento River NWR planning area experienced positive population growth from the 2000 to 2010 census (U.S. Census Bureau 2015) and continued growth is projected for each (California Department of Finance (2012). In 2010, Butte County's population was 220,000 (134 persons per square mile), an 8% increase from 2000, and is projected to increase by 46% from 2010 to 2030 (California Department of Finance 2012). The racial makeup of the county was 87.0 percent white, 15.1 percent Hispanic, 4.4 percent Asian, 2.4 percent Native American, 1.8 percent African American, with the remaining percentage from other races (Percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, US Census Bureau 2015).

In 2010, Glenn County's population was 28,122 (21 persons per square mile), a 6% increase from 2000, and is projected to increase by 46% from 2010 to 2030 (California Department of

Finance 2012). The racial makeup of the county was 90.1 percent white, 39.5 percent Hispanic, 2.9percent Asian, 3.0 percent Native American, 1.1 percent African American, with the remaining percentage from other races (Percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, US Census Bureau 2015).

In 2010, Colusa County's population was 21,419 (19 persons per square mile), a 14% increase from 2000, and is projected to increase by 45% from 2010 to 2030 (California Department of Finance 2012). The racial makeup of the county was 91.6 percent white, 57.5 percent Hispanic, 2.7 percent Native American, 1.8 percent Asian, 1.2 percent African American, with the remaining percentage from other races (Percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, US Census Bureau 2015).

In 2010, Tehama County's population was 63,463 (22 persons per square mile), a 13% increase from 2000, and is projected to increase by 43% from 2010 to 2013 (California Department of Finance 2012). The racial makeup of the county was 90.9 percent white, 23.5 percent Hispanic, 3.3 percent Native American, 1.3 percent Asian, 0.9 percent African American, with the remaining percentage from other races (Percentage total can be greater than 100 percent because Hispanics can be counted in multiple races, US Census Bureau 2015).

In January 2002, TNC facilitated The Sacramento River Public Recreation Access Study (EDAW 2002). The primary purpose of the study was to "…assess existing and potential public recreation uses, access, needs, and opportunities along the Sacramento River between Red Bluff and Colusa." The goals of the study were to 1) identify and characterize existing public access opportunities and needs associated with public recreation facilities and infrastructure… 2) and to identify and make recommendations for future public recreation access opportunities and management programs…" The study areas were developed so that data would be meaningful and useful to the partners that are developing management plans (TNC 2008).

Two study areas are portrayed (EDAW 2002): 1) the local study area comprising Tehama, Butte, Glenn, and Colusa counties and 2) the regional study area encompassing 20 adjacent counties where there is reasonable likelihood of recreational visitation.

EDAW (2002) depicts a profile of the potential local Refuge visitor as predominately Caucasian, 31-50 years of age, some

college education/trade school education with a household income under $20,000 to $40,000 (median income $31-35,000). The current population in the local four counties is expected to grow by 55 percent, in contrast to the adjacent 20 counties, which are expected to grow by 25 percent (EDAW 2003). There is a significant Hispanic population, including one-half of the residents of Colusa County, and about one-third of the residents of Glenn County. The local area residents tended to have lower household income brackets than their regional counterparts.

Cultural Resources

Information from Service cultural resources division staff and the Northeast Information Center of the California Historical Information System at California State University (CSU) Chico verified that the areas bordering the Sacramento River are considered sensitive for both prehistoric and historic cultural resources. Additionally, these areas may be used as traditional cultural properties.

The CSU Chico Research Foundation Archaeological Research Program (ARP) conducted an archeological study of the middle Sacramento River floodplain in 2002, leading to the comprehensive Cultural Resource Overview and Management Plan – Sacramento River Conservation Area (White et al. 2003). The study completed an archaeological survey, assisting the Service in meeting cultural resource inventory mandates as specified in Sections 106 and 110 of the National Historic Preservation Act. The final overview, assessment, and management plan provides a summary of the status of known cultural resources, a sensitivity study for resources yet- to-be identified, and general plans for future scientific investigations, public interpretation of archaeological and paleo-environmental findings, and administration and coordination for future actions which may affect cultural resources.

The CSU Chico Research Foundation Archaeological Research Program (ARP) conducted an archeological study of the middle Sacramento River floodplain in the Colusa Subreach, leading to the Cultural Resource Investigation for the Colusa Subreach Planning Report, Glen and Colusa Counties, California (Westwood and White 2005).

The Bogg’s Bend Unit, which had been in orchard operation, was included in this second study which determined that no culturally significant resources were known to be located on the site. Accordingly, the Refuge completed a Request for Cultural Resource Compliance Review to comply with the National Historic

Preservation Action, Section 106. The Service's Cultural Resources Office (Region 1) has reviewed the proposed project and determined that no impacts to cultural resources are anticipated, therefore, no further cultural resource identification is necessary (USFWS Memo 2014a).

Public Use

The Bogg's Bend Unit is a newly acquired unit of the Refuge and therefore is currently not open to public use.

Chapter 4. Environmental Consequences

This chapter analyzes the environmental impacts expected to occur from the implementation of the alternatives described in Chapter 2. Impact evaluation has been conducted for each aspect of the environments described in Chapter 3, including physical, biological, and social and economic resources. Direct, indirect, and cumulative impacts are described where applicable for each alternative. Alternative A (No Action) is a continuation of management practices that are in place today and serves as a baseline against which Alternatives B and C are compared.

The National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) 1502.16 regulations require a discussion of mitigation measures when adverse impacts to habitats, wildlife, or the human environment are identified. All potential impacts were considered and mitigation measures were identified for Alternatives B and C.

In describing the significance of impacts, the Service defers to NEPA Implementing Regulations at 40 CFR 1508.27.

> "Significantly" as used in NEPA requires considerations of both context and intensity:
>
> (a) Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.
>
> (b) Intensity. This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. "

Significance of impacts to the human environment determines whether preparation of an EIS is warranted. Thus, an EA provides a discussion of the magnitude of the impacts within the context of the situation for each impact topic.

Effects on the Physical Environment

Geology and Soils
Alternative A (No Action) could result in an increase in erosion and sedimentation rates, since there would be no replanting of native riparian vegetation after orchard removal. Natural recruitment of native vegetation would take some time, leaving the soil more vulnerable to erosion and sedimentation than if the area was restored to native habitat.

Alternative B and C: Several site preparation activities would be conducted as part of Alternatives B and C to prepare the Refuge units for restoration planting. Some of these activities, such disking, floating, and trenching (to install irrigation), would involve some soil disturbance and may temporarily increase erosion and sedimentation rates in the project area. However, any temporary increase in erosion and sedimentation rate would be offset by the substantial long-term reduction in erosion and sedimentation rates that would result from taking the Refuge units out of agricultural production and restoring them to native riparian habitat.

Mitigation Measures to Address Erosion Risks:

- The restoration area will be disked and planed prior to restoration planting. The planting will tighten the soil and reduce the chance of erosion. Ground cover vegetation (native grasses and wildflowers) would be allowed to become established further stabilizing the soil.

Hydrology
No Action: Under the no action alternative with no replanting of vegetation, there would potentially be an increase in flood flow velocities across the unit leading to potential bank destabilization and increase erosion and sedimentation rates.

Alternative B: Under Alternative B, riparian and floodplain restoration on the Sacramento River at Bogg’s Bend, RM 160.6-161.3 indicates that the 81.4-acre restoration area may support the proposed riparian vegetation while retaining flood neutrality within the Colusa Subreach between River Miles 165 and 143 (Ayers Associates 2008; RiverSmith Engineering Memorandum 2015). According to the hydraulic analysis, planting the unit with 55.9 acres of mixed riparian forest, 1.5 acres of cottonwood riparian forest, and 24 acres of rose-baccharis scrub/ valley wildrye grassland will not result in increases of flood water surface levels at the downstream edge of the Colusa

Subreach of the Sacramento River Flood Control Levee System.

Alternative C: Alternative C would not maintain flood neutrality within the Beehive Bend Subreach.

Water Quality/Contaminants
Alternatives No Action, B and C: Floodplain habitat restoration includes one-time ground disturbance to prepare the site for re-vegetation. These include disking, floating, ridging and minor limited shallow trenching to establish drip irrigation. While these activities are common in establishing production orchards in the area, sediments associated with ground disturbance, fluids associated with the equipment (e.g., oil, grease), and pesticides used for weed control are contaminants, which could become introduced into the River. Contaminants may be toxic to fish or adversely affect their respiration and feeding. Even the no action alternative includes disking and floating. All the alternatives would include a reduction in ground water extraction and protection by abandoning the production well within 3 years. With the implementation of the following mitigation measures, no adverse effects on fish would occur under Alternatives A, B or C.

<u>Mitigation Measures to Address Impacts on Water Quality:</u>

- A variety of sediment control measures such as buffers or set backs from the River, silt fences, straw or rice bale barriers, brush or rock filters, sediment traps, fiber rolls, or other similar linear barriers can be placed at the edge of the project area to prevent sediment from flowing off site.
- The contractor will establish a spill-prevention and countermeasure plan before project construction begins; this plan will include on-site handling criteria to avoid input of contaminants to the waterway. A staging, washing, and storage area will be provides at least 100 feet away from the waterway for equipment, construction materials, fuels, lubricants, solvents, and other possible contaminants.
- No ground disturbing work will occur within the active channel of the Sacramento River.
- Exclusionary fencing will be used to mark boundaries of all waters to be avoided.
- Only herbicides identified in the Sacramento NWR Complex Integrated Pest Management Plan and are processed through the annual Pesticide Use Proposal review will be used on the restoration site.

- Herbicide applications will be prescribed by a state-licensed PCA (pest control advisor) and applied by state licensed applicators.
- Following the restoration phase (three years), the ground water production well will be abandoned per county code thereby reducing the amount of ground water extraction in the area and protecting ground water resources from potential contamination from floodwaters.

Alternatives B and C: In the long-term, restored vegetation on the Bogg's Bend Unit under both action alternatives would have some filtering effect on overland flow by removing floating debris, minimizing erosion, and capturing sediment. Replacing flood-prone agriculture with restored riparian habitat will decrease pesticide and herbicide applications on land adjacent to the river, thereby increasing water and sediment quality. Restored riparian forests also buffer and filter toxic and organic matter that originate further away from the river, further enhancing water and sediment quality.

During restoration activities, TNC will follow all Colusa County and Department of Pesticide Regulation and Service Policy for Pesticide Use Permits requirements concerning the application of herbicides for weed control in the Bogg's Bend restoration area. Herbicide use will be reported to Colusa County as required by State and County law. Due to problematic weeds that could inhibit native plant growth if unchecked, weed control will be conducted year round on an as needed basis according to weather conditions.

Air Quality

No Action: Under the no action alternative there would be no change in air quality except for temporary increases in dust and tailpipe emissions from eventual orchard removal.

Alternatives B and C: Under Alternatives B and C, short-term increases in dust and tailpipe emissions due to orchard removal and restoration projects, which disturb the soil and/or require the use of heavy equipment work, will occur. However, Alternatives B and C would have an overall positive effect on air quality with the implementation of restoration over time. With the implementation of the following mitigation measures during the active restoration phase, no adverse effects to air quality would occur.

<u>Mitigation Measures to Address Impacts on Air Quality</u>:

- Land disturbing operations will be suspended when winds exceed 20 mph to limit fugitive dust and particulate matter.
- Dust control measures (i.e. water trucks) will be utilized as necessary to manage dust on the project site.

Effects on the Biological Environment

Vegetation
No Action: Under this alternative, only one-time disking and floating would occur to prepare the ground to reduce safety hazards. Without active cultivated restoration this site would return to native vegetation at a very slow rate or not return at all. Exotic weeds inhibit seedling establishment of native riparian vegetation and a diminished flood disturbance regime limit natural establishment of floodplain riparian communities.

While this alternative is technically feasible, it is inconsistent with the intent of Congress in authorizing development of an 18,000-acre Refuge along the Sacramento River. It would result in substantially fewer benefits to wildlife along the river than Alternatives B and C. This alternative would provide no short-term and little long-term benefit to wildlife and fishery resources, and recruitment would likely promote colonization by non-native invasive plant species that have lower value for target wildlife species. This option could also have negative impacts on adjacent riparian habitat because without restoration, the site would serve as a source of invasive weeds which would potentially spread to the adjacent remnant native habitats. Although the No Action Alternative would not meet the project purpose or need, and would not conform to the Service’s congressional mandate to preserve, restore, and enhance natural habitats for threatened and endangered species, songbirds, waterfowl, other migratory birds, anadromous fish, resident wildlife, and plants on the Refuge System, it is included in the analysis as a benchmark comparison to the action alternatives.

Alternatives B and C: No adverse effects on special-status plants or sensitive natural communities would occur from implementation of proposed habitat restoration with Alternatives B or C. Disturbance from restoration activities would be less intense than the former walnut orchard operations. Restoration activities are implemented over three years and are relatively short-term when compared to the previous commercial orchard land

use. Over the long-term, native indigenous (local ecotypes) plants and sensitive natural communities would benefit from implementation of the proposed habitat restoration, which would increase the acreage of forest, savannah, and grassland communities throughout the Sacramento River Refuge. Beneficial effects include management to promote greater species diversity, protection from adjacent land uses, and an increase of natural communities. The existing riparian forest community would be protected and its habitat area expanded.

Under Alternatives B and C, riparian restoration would have long-term beneficial impacts on the Refuge through the implementation of the various wildlife and habitat strategies associated with the Sacramento River Refuge CCP (USFWS 2005). Habitat restoration fulfills the Refuge purposes to conserve, manage and protect riparian habitat for endangered and threatened species, and wetlands (including riparian floodplains) for migratory birds, anadromous fish, and other fish and resident riparian wildlife and plants. Overall natural diversity would increase through restoration of native riparian floodplain vegetation (e.g., forests, savannas, grasslands, herblands) using local ecotypes of indigenous plant species.

Wildlife Resources

No Action: Under the no action alternative there would be little change in wildlife resources, since the former orchard lands would not undergo replanting of native riparian vegetation. Over time, the area would become revegetated, but with a high proportion of non-native invasive plant species that do not support wildlife diversity, therefore, no habitat benefits and population increases would be expected for endangered and threatened species, migratory birds and anadromous fish.

Alternatives B and C: Alternatives B and C would result in short-term and long-term benefits and potentially some adverse impacts on wildlife initially. Short-term benefits include an elimination of pesticide and fertilizer applications to the area, as well as increased habitat complexity in the new restoration compared to the orchard. Herbicide use will be limited to the initial stages of restoration. The restoration of 81.4 acres of riparian habitat could temporarily disturb wildlife (i.e. from construction noise, displace species using the orchard land). However, the temporary disturbance and displacement of wildlife is considered a minor effect because disturbance would cease following active restoration. Walnut orchards do not provide high quality wildlife habitat and do not

support high populations of native wildlife species. Once restoration is completed there would be a long-term benefit to wildlife because the restored native forest and savannah cover types will provide food and cover for a variety of riparian dependent wildlife species, compared to the existing orchard.

With riparian habitat restoration under Alternatives B and C, riverine fish fauna will benefit from the maintenance of sediment deposition, habitat diversity, restored shaded riverine aquatic habitat, overhanging vegetation, and seasonally available spawning and rearing habitats. However, project implementation could result in temporary impacts on fish species in the project vicinity during construction. Restoration site preparation (disking/floating/ridging) and irrigation system installation would loosen the soil and could result in minor and temporary increases in sediment load to the river during a flood event. Increased input of sediment has the potential to increase turbidity, possibly reducing the feeding efficiency of juvenile and adult fish. Because the Sacramento River is typically a turbid system, additional sediment input resulting from project activity would be comparatively minimal. There would be no noticeable effect relative to the overall condition of the river, and sediment runoff from the restoration sites would only occur during storm or flooding events. Furthermore, this would be a short-term impact, occurring only during the first year of active restoration, the three-year period necessary to establish native vegetation that, in the long-term, would prevent sediment runoff.

As structural complexity of restoration sites are established, species richness will increase. Research has indicated that riparian restoration sites provide habitat for a diverse community of landbirds (Golet et al. 2008). This project is also expected to provide important breeding, spring staging, and winter habitats for migratory songbirds. As riparian restoration matures, habitat becomes suitable for an increasing number of other species. Furthermore, mature riparian forests support a much higher faunal diversity than orchards. For example, bat activity has shown to be higher in riparian forests than in orchards (Stillwater Sciences et al. 2003). Although the restoration proposed under Alternative C would provide greater benefits to wildlife using riparian forest habitats, Alternative B would provide a mosaic of riparian habitat types that could promote higher faunal diversity.

Under Alternatives B and C this Unit would be opened to wildlife observation and photography, environmental education and

interpretation, fishing, and hunting. Due to the nature of this Refuge, fishing is conducted primarily by boat on the Sacramento River. Both hunting and fishing would be conducted in accordance with the Hunting and Fishing plans contained in the 2005 CCP/EA. All public uses would be conducted in accordance with the amended compatibility determinations which are included in Appendix D. The primary impacts to wildlife resources from opening the Refuge to wildlife observation and photography are related to disturbance. These types of effects were previously considered in the 2005 CCP/EA and found to be minimal. Opening this Unit to wildlife observation and photography, environmental education and interpretation, fishing, and hunting following site restoration would have similar effects as those considered in the 2005 CCP/EA. Similarly, effects to wildlife from hunting were considered and evaluated in the supplemental EA for cumulative impacts analysis for hunting (USFWS 2007). Impacts to wildlife from opening this Unit to hunting would be similar to those presented in that EA.

Previous restoration projects along the Sacramento River have been highly successful in providing habitats for special status species such as VELB (Gilbart 2009) and Yellow-billed Cuckoo (Hammond 2011), and have also been effective in providing habitats for top predators (Derugin 2013). Monitoring surveys and research investigations have demonstrated that riparian floodplain restoration on the Sacramento River is revitalizing the larger native riparian community, though restoring physical river process is yet needed to sustain this alluvial ecosystem (Golet et al. 2008, 2013). Because the Bogg’s Bend Unit is bordered on three sides by existing riparian habitat and/or the Sacramento River, the proposed restoration will decrease habitat fragmentation and increase the level of connectivity across the larger riparian landscape.

Special Status Species

Under the no action alternative there would be no change in special status species. The habitat restoration proposed in Alternatives B and C will result in short-term and long-term benefits for special-status wildlife species. Immediate elimination of pesticide and fertilizer use, as well as the elimination of herbicide application after several years, will increase habitat suitability for special status species. Many of these species have declined due to loss of riparian forest and savanna habitats; therefore, restoration of these habitats will benefit these species. Restoration will facilitate the establishment of native riparian habitat that without active cultivated restoration would return to native vegetation at very

slow rate and with significant amounts of invasive weeds, or not return at all. Special status species expected to benefit from the Bogg's Bend restoration include the VELB (Federal threatened species), the Yellow-billed Cuckoo, Western Distinct Population Segment (or YBCU, Federal threatened and State endangered species), Swainson's hawk (State threatened species), and Bank Swallow (or BANS, State threatened species). VELB habitat and populations would likely increase only under Alternative B, which provides scrub habitat that is associated with the VELB host plant, blue elderberry. Nesting and foraging habitats would increase for the YBCU through the restoration of cotton wood trees (nesting habitat— Alternatives B and C) adjacent to scrub and herbaceous vegetation (foraging habitats— Alternative B only). Restoring riparian forest vegetation which includes cottonwood, sycamore and oak (Alternatives B and C) would provide tall trees suitable for nesting by bald eagle. These trees, when mature and near the active channel, are currently used by eagles from Red Bluff to Butte City. Restoring mixed riparian forest and valley oak savanna would increase nesting and roosting habitat (Alternatives B and C) for Swainson's hawk, while grassland restoration would provide foraging habitat (Alternative B only). Native grassland restoration under Alternative B would benefit local Bank Swallow (BANS) colonies through increases in insects, which are ideal prey for this species (Moffatt et al. 2005). Willow flycatcher use natural and restored forest and scrub habitats during spring migration on the Sacramento River and the proposed restoration would increase these habitats, while increasing local habitat patch size associated with the adjacent natural habitats. Migration stop-over habitat for the willow flycatcher would increase under both Alternatives B and C, however only Alternative B provides the scrub habitat component.

Indirect adverse effects on BANS are not likely to result from the conversion of agricultural habitats to riparian forest, although some biologists believe that an eroding bank without roots makes bank swallow nests less accessible to predators because predators cannot cling to roots while depredating swallow nests. Restoration activities are not likely to increase the amount of roots in eroding banks because restored areas would be converted from orchards to riparian habitat, substituting one type of root for another. Furthermore, root density would be decreased along the majority of the bank as orchards are converted to savanna habitat under Alternative B.

By providing important floodplain rearing habitat and reducing agricultural inputs into the Sacramento River system, it is

expected that winter-run Chinook salmon, spring-run Chinook salmon, steelhead, green sturgeon, and Sacramento splittail (State species of concern) will also benefit from this project. Special status anadromous fishes would benefit from the restored forests and scrub/ grassland providing shaded riverine aquatic habitat and future sources of large woody debris.

The levee district has expressed concerns that planting elderberry shrubs near levees could lead to the spread of VELB, with resulting special-status species issues. Landowners have also voiced concern that the presence of elderberry shrubs on adjacent Refuge land would restrict current farming practices, especially spraying of agricultural chemicals. The Refuge has implemented a self-imposed, 100-foot valley elderberry shrub-free zone intended to buffer the boundaries between private orchards, levees, roadways and that of Refuge restoration sites so that agricultural pesticide drift from neighboring private orchards and facility and levee maintenance operations will not affect VELB habitat in restoration sites or adjacent landowner operations. No elderberry shrubs would be planted in this corridor, thereby reducing the likelihood that VELB would spread onto levees as a result of the restoration program. The proposed restoration areas in the Bogg's Bend Unit are also bordered on all sides by existing habitat already managed by the Refuge where the levee and a 20 to 30 foot buffer from the toe to habitat is managed as vegetation-free. No restoration plantings will occur within 900 feet of the ACOE levee. Construction and maintenance of vegetation firebreaks on all Refuge property bordering ACOE is incorporated as "high" priority projects described in the Annual Habitat Management Plans for the Sacramento River Refuge.

<u>Mitigation Measures to Address Impacts on Special Status Species:</u>

- Refuge wildlife surveys will be conducted prior to site preparation to make sure that nesting wildlife (i.e. BANS) will not be directly impacted or so that impacts can be minimized.
- If an active nest(s) is located within 500 feet of construction activities, it shall be mapped, and a qualified biologist will determine the extent of a construction-free buffer zone to be established around the nest until young have fledged.

Effects on the Social and Economic Environment

Employment
Under the no action alternative, the orchard was losing productivity and was removed from the farming program following the 2014 growing season; therefore the availability of employment will continue to decline. The displacement of agricultural production due to orchard removal on the Bogg's Bend Unit under all the alternatives would not represent a substantial loss of employment opportunities in Colusa County. Employment growth is expected to increase over the next several years, as a result of growth in the non-farm sector. As a result, any reduction in employment from taking the Bogg's Bend Unit out of agricultural production would be offset by this growth.

Local Economy
The displacement of agricultural production due to orchard removal on the Bogg's Bend Unit would not represent a substantial loss of crop production value to Colusa County. Although implementation of the proposed action would eliminate agricultural production on 81.4 acres of land along the Sacramento River, this land contained an orchard that was no longer productive or profitable. Furthermore, it is the only orchard the Refuge owns in Colusa County. The Refuge supports full payment to the county under the Refuge Revenue Sharing Program. That percentage is determined annually by Congress. However, these revenue sharing payments were instituted to mitigate the effects of property acquisition, not restoration. Implementation of the three year restoration project will support short-term new employment opportunities in form of contracts with orchard removal, irrigation system, site preparation, plant propagation, labor, and materials. In Long-term, the additional recreational opportunities will provide some increases in local business sales. Between 2010 and 2015, visitation to the Sacramento River NWR has increased from approximately 20,000 in 2010 to over 60,000 visitors in 2014.

There are a few potential effects on neighboring agricultural properties, such as loss occurring in the form of crop depredation from birds, rodents or mammals inhabiting newly planted riparian habitat. However, the proposed restoration areas within the Bogg's Bend Unit are already bordered on three sides by existing habitat already in habitat or State Wildlife Area ownership, so any effects on surrounding properties would be minimal.

Mitigation Measures to Address Impacts on the Economy:

- Local vendors will be used for restoration activities and materials whenever possible.
- Visitor service opportunities associated with the restoration will offset local economic impacts.

Land Use

The proposed action is compatible with Colusa County land use policies. Restoring the Bogg's Bend Unit to riparian habitat will preserve valuable open space, provide recreational opportunities, improve water quality, and improve the quality of wildlife habitat. The restoration will protect water quality and quantity by providing a buffer strip between agricultural activities and the Sacramento River, and ground water wells will also be removed following restoration. By preserving this land as wildlife habitat and open space, further protection against urban encroachment will be secured.

From a land use perspective, the acreage to be converted has already been acquired by the Service. The prospective change in land use was approved previously and has remained as agriculture with the understanding that it would eventually be restored to native habitats. No additional changes are proposed as part of the restoration program. The Bogg's Bend orchard was no longer productive, since phasing out of the orchard began 6 years ago under previous ownership. Along with a general policy regarding the protection of agricultural land, Colusa County also promotes protection and improvement of natural areas for the benefit of wildlife and calls for early consultation with wildlife agencies on all projects. The proposed action is consistent with these land use policies relating to natural habitat protection.

Demographics

All alternatives are expected to have no significant impacts to demographics of Glenn County and the surrounding region.

Cultural Resources

Minor impacts to cultural resources are minimized through cultural resource reviews and surveys. Under Federal ownership, archaeological and historical resources within a Refuge receive protection under Federal laws mandating the management of cultural resources, including, but not limited to, the Archaeological Resources Protection Act; Archaeological and Historic Preservation Act; Native American Graves Protection and Repatriation Act, and National Historic Preservation Act. Under

all alternatives, if any additional cultural resources were discovered on the Refuge, the Service would take all necessary steps to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

Compliance with Section 106 of the National Historic Preservation Act has been completed for the Bogg's Bend Unit restoration. The Service's Regional Archeologist has evaluated the potential impact of the proposed restoration on cultural resources on the Bogg's Bend Unit, and no impacts to cultural resources are anticipated from the project (USFWS Memo 2014a). The restoration activities would only take place in former agricultural lands where no impacts to cultural resources are anticipated. Since the site was cleared of native habitats between the late 19th and early 20th centuries and has been used as an orchard for many years, any cultural resources in the top several feet of the soil have most likely already been disturbed. No further cultural resource identification is necessary for the project. However, if cultural resources are discovered during project implementation, any ground disturbing activity will be halted, and the Regional Archaeologist will be notified.

Public Use
Under Alternatives B and C this Unit of the Refuge would be opened to hunting, fishing, wildlife observation, photography, environmental education, and interpretation. Opening this Unit to the public these priority uses provide additional recreational opportunities for the public. Environmental impacts from expanded public use are addressed under Wildlife Resources.

Environmental Justice
On February 11, 1994, the President issued Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations") requiring that all Federal agencies achieve environmental justice by "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Environmental justice is defined as the "fair treatment for peoples of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies.

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish and wildlife

and their habitats for the continuing benefit of the American people. The developing environmental justice strategy of the Service extends this mission by seeking to ensure that all segments of the human population have equal access to America's fish and wildlife resources, as well as equal access to information that will enable them to participate meaningfully in activities and policy shaping. Restoration of the Cordora Unit would not disproportionately affect any minority or low-income populations.

Unavoidable Adverse Impacts

None of the proposed alternatives would have unavoidable adverse impacts on the environment.

Irreversible and Irretrievable Commitments of Resources

None of the proposed alternatives would result in an unavoidable or irretrievable commitment of resources.

Short-term Uses versus Long-term Productivity

The habitat protection and management program proposed as part of the Refuge System is permanent and exclusively dedicated to maintaining the long-term productivity of the Refuge habitats and recreational opportunities. The local short-term uses of the environment would include increased management of wildlife habitats and development of public use opportunities. The resulting long-term productivity would include increased protection and survival of endangered species as well as a myriad of plant and animal species.

Cumulative Impacts

Cumulative effects (or impacts) are those effects on the environment resulting from incremental consequences of the Service's proposed actions when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes these actions. Cumulative effects can be the result of individually minor impacts, which can become significant when added over a period of time. Accurately summarizing cumulative effects is difficult in that while one action increases or improves a resource in an area, other unrelated actions may decrease or degrade that resource in another area.

Both action alternatives would have long-term benefits for native wildlife species and habitats within the Bogg's Bend Unit, as well as the neighboring Sacramento River Wildlife Area Princeton Southeast Unit. The development and protection of wildlife habitats within the Refuge would represent a benefit to the long-term conservation of threatened and endangered species

and other native wildlife species. Alternatives B and C would provide greater benefits due to the increased amount of habitat restoration that would take place. The restoration proposed under Alternative B would provide a mosaic of riparian habitat types that could promote higher faunal diversity. Alternative C would provide greater benefits to wildlife using riparian forest habitats, as the density of riparian vegetation in the restoration would be increased.

The hydraulic model used to evaluate the effects of the proposed project models the Colusa Subreach of the Sacramento River between River Mile 165 to 143 taking into account all known past and projected restoration projects planned along the 22-mile stretch. Agricultural land use changes were also updated as part of the modeling exercise taking into consideration the cumulative effects of land use changes throughout the Colusa Subreach (North State Resources 2008; Ayers Associates 2008; RiverSmith Engineering Memorandum 2015). The modeling results of the Proposed Action by Ayers (2008) meet all evaluation criteria (water surface elevation, freeboard). By converting areas of orchard to scrub/ grassland habitat, water surfaces will be reduced which will compensate for converting other areas to riparian vegetation. The proposed restoration configuration takes into account areas where water surface elevations are especially sensitive to additional riparian plantings, including the flood control project levee east of the Refuge. The Proposed Action results in minimal change to water surface elevation and freeboard over existing conditions; therefore, the flood neutrality of the system will be maintained within the project area

There are many projects that benefit wildlife and habitats on the Sacramento River. The establishment of the Refuge and restoration that will be accomplished under this Restoration EA both provide beneficial effects. The Refuge is also, just one of the many partners along the river that is restoring habitat for wildlife along the Sacramento River. However, despite these restoration efforts, there are ongoing activities such as water diversion, habitat destruction, and bank protection that continue to reduce native habitat along the Sacramento River. The proposed action will provide relatively modest increases in environmental benefits when compared to the historic and ongoing loss of native cover types. The Refuge encompasses only a small portion of the 382-mile long Sacramento River.

The greatest past, present, and foreseeable future impact in the vicinity of the Refuge is development. There is a clear trend in

California of increasing development and associated habitat loss. Additional residential and commercial development may be planned throughout the local area. The Refuge does not have control over the cumulative negative impacts to native habitats from local development. However, the Refuge helps to mitigate impacts to native habitats by working with partners to protect important habitats from development and by restoring native habitats within the Refuge.

None of the alternatives are expected to have adverse cumulative impacts on the economy. Adherence to the policies and regulations pertaining to the protection of cultural resources would avoid any cumulative effects as a result of implementing any of the action alternatives.

The CDFW, Region 2 has reviewed the Colusa Subreach Wildlife Habitat Restoration Project which included the Bogg’s Bend Unit (formerly known as the Jensen Tract) as a project under the California Environmental Quality Act (CEQA) to determine whether it could have a significant effect on the environment. Under CEQA, “significant effect on the environment” means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by a project (CEQA Guidelines Section 15382). CDFW has issued a mitigated negative declaration for the Colusa Subreach Wildlife Habitat Restoration Project (North State Resources 2008).

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Appendix A

Riparian Habitat Restoration Workplan for the Bogg's Bend Unit, Sacramento River (RM 160.9 – 161.3)

Riparian Habitat Restoration Workplan

for the Boggs Bend Unit of the Sacramento River National Wildlife Refuge

Sacramento River (RM 161L)

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July 2008
Revised March 2015

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EXECUTIVE SUMMARY

The Riparian Restoration Plan for the Boggs Bend Unit of the Sacramento River National Wildlife Refuge (formerly known as the Boggs Bend Unit) was prepared by TNC's Sacramento River Project team based on TNC's previous experience implementing restoration projects along the Sacramento River. It draws from information that was derived from the Colusa Subreach Planning process led by TNC between 2004 and 2008.

This restoration plan describes a specific restoration design based on the environmental conditions and ecological goals at the Boggs Bend Unit, and the procedures for implementation of site preparation, planting/seeding, maintenance, and monitoring.

RESTORATION PLAN SUMMARY

LOCATION	**Unit Name**	Boggs Bend
	Street address	River road
	Nearest city	Colusa
	County	Colusa
	APNs	012-120-019-000
	River mile	161L
RESTORATION SUMMARY	**Restoration Unit area**	81.4 acres
	Plant communities: acres	Mixed Riparian Forest (MRF): 55.9 acres Cottonwood Riparian Forest (CWRF): 1.5 acres Rose-Baccharis Scrub/Valley Wildrye Grassland (BRS/VWG): 24 acres
	Planting density (plant x row spacing): emitters/acre	Mixed Riparian Forest: (11ft x 30ft): 132 Cottonwood Riparian Forest (11ft x 30ft): 132 Rose-*Baccharis* Scrub/ Valley Wildrye Grassland (11ft x 30ft): 132

INTRODUCTION

A. Location

The Boggs Bend Unit is an approximate 98-acre site located about 2 miles south of Princeton on the east side of the river. Figure 3 depicts the site on a 2006 aerial photo. About 81 acres of the Unit was a walnut orchard (until October 2014) and 17 acres are in riparian vegetation. The Boggs BendUnit adjoins the river on the west, and riparian portions of the California Department of Fish & Wildlife Sacramento River Wildlife Area Princeton SE Unit on the north and along the north half of the east boundary. Access to the site is across a private easement from River Road.

The orchard area of Boggs Bend is proposed to be restored to riparian habitat. The orchard area abuts onsite riparian area to the west. It abuts a walnut orchard, with a single owner on the south. The orchard area is leveled and irrigation is supplied from an onsite well.

The Boggs BendUnit, including the proposed restoration area, is adjacent to agricultural land to the south and riparian habitat to the north, east, and west. The private land to the south is a mature walnut orchard with about 2,100 feet adjoining the proposed restoration area on the Boggs Bend Unit.

B. Unit History

The Boggs Bend Unit was purchased by TNC in 2000. TNC then transferred the property to the US Fish and Wildlife Service in November 2013. It was farmed as a walnut orchard until October 2014.

C. Significance of Restoration

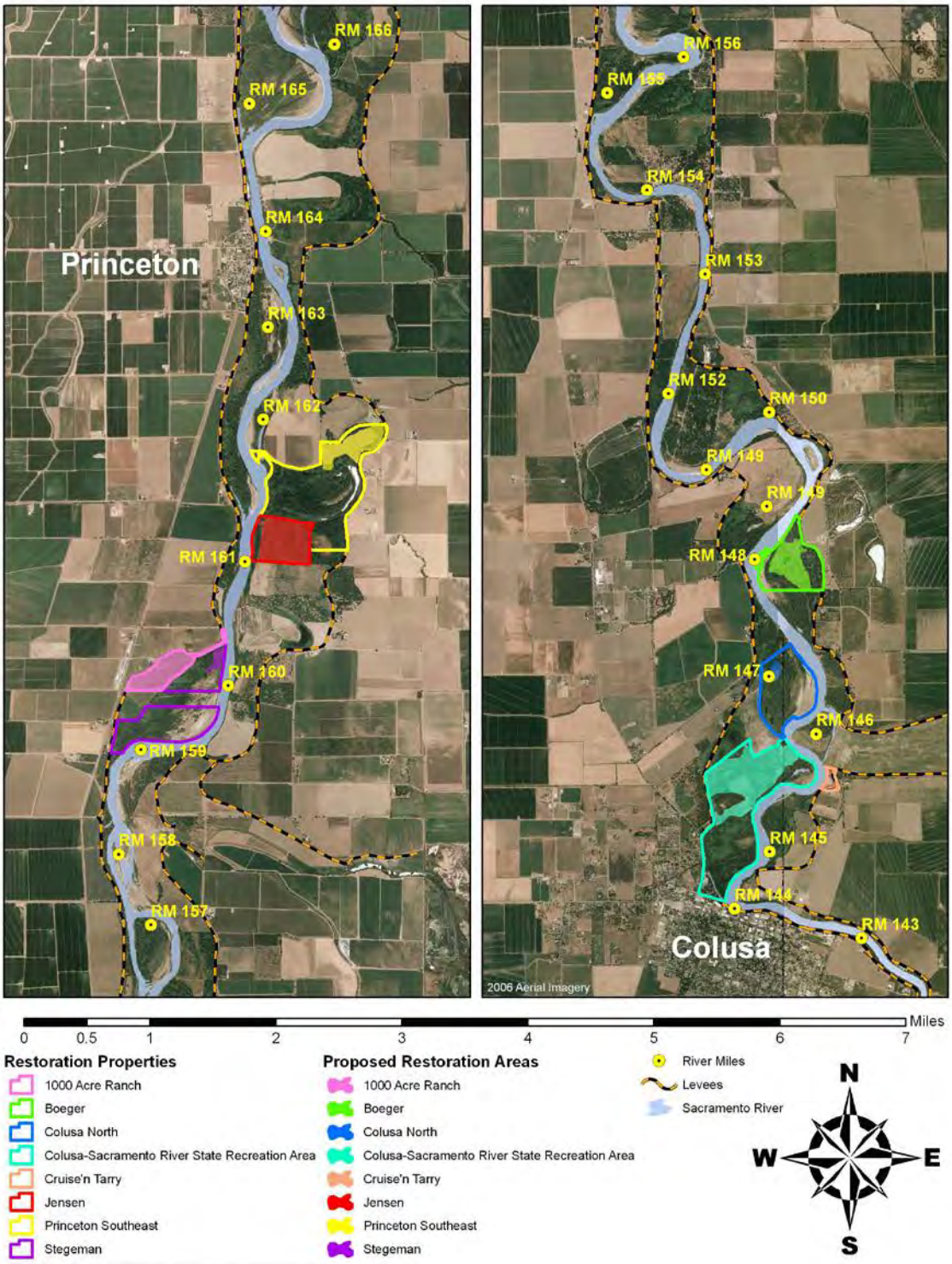
The Sacramento River is a fundamental state water source that drains 24,000 square miles of the northern Central Valley and supplies 80% of freshwater flowing into the Bay-Delta (CA State Lands Commission 1993). Historically, the river was lined by approximately 800,000 acres of riparian forest (Katibah 1984). Over 95% of this habitat has been lost, to selective logging, agriculture, urban development, and flood control and power generation projects. Cumulatively, these changes have greatly stressed the Sacramento River and associated species. The loss and degradation of riparian habitat has greatly diminished the river's ability to support viable wildlife populations and encouraged the invasion and proliferation of non-native invasive species. Two-thirds of the linear extent of the river's banks have been modified and confined by levees and riprap. Channelization, bank protection, and the construction of the Shasta Dam degraded riparian habitat along the Sacramento River by restricting the dynamic hydrologic forces that promote natural habitat succession and regeneration.

Healthy riparian habitats contain a great number of flora and fauna due to the range of community types, overall structural diversity, availability of water and soil moisture, potential as corridors for migration, and critical breeding grounds (California State Lands Commission 1993, California Resources Agency 2000). Additionally, riparian corridors provide two primary functions essential to maintaining water quality: 1) moderating stream temperature and 2) reducing sediments and nutrients emanating from upland agriculture (Castelle *et al*. 1994). The loss of high-quality habitat and the decrease in water quality along the Sacramento River has caused many native species populations to become critically endangered. Important at-risk species include the Sacramento splittail, green sturgeon, chinook salmon, steelhead trout, western yellow-billed cuckoo, Swainson's hawk, least Bell's vireo, bank swallow, and Valley elderberry longhorn beetle (VELB) (CALFED Multi-Species Conservation Strategy 2000).

Although severely degraded, the Sacramento River is still the most diverse and extensive river ecosystem in California (California State Lands Commission 1993). In an effort to improve ecosystem health in the region, federal, state, and local governments, as well as non-government organizations, have begun to implement a series of ecosystem restoration programs along the river. In 1986, the California State Legislature passed Senate Bill 1086, which mandated the development of a management plan for the Sacramento River and its tributaries to protect, restore, and enhance fisheries and riparian habitat (California Resources Agency 2000). The Sacramento River Conservation Area Forum (SRCAF) non-profit organization formed and set as its primary goal the preservation of remaining riparian habitat and reestablishment of a continuous riparian corridor along the Sacramento River from Red Bluff to Colusa. Studies have shown that restoration has been successful in aiding the recovery of a wide diversity of fauna to the Sacramento River ecosystem (Golet et al. 2008).

Figure 1. Location of the Colusa Subreach along the Sacramento River within California's Great Central Valley.

Figure 2. Location of the eight potential restoration sites within the Colusa Subreach, Glenn and Colusa Counties, CA. The Boggs Bend Unit is located on the right side of the river on the left panel. Shaded areas are proposed for restoration. Line polygons demarcate Unit boundaries.



D. Agreements

Under a grant agreement between DFG and TNC (agreement # ERP-02-P27), TNC developed a restoration plan for the Boggs BendUnit. This document fulfills this obligation.

E. Objectives

1. Short-term objective

The short-term goal for the Project is to plant a diverse mosaic of riparian communities on 81 acres in spring Project Year 1. Exotic weeds that inhibit seedling establishment of native riparian vegetation and a diminished flood disturbance regime limit natural establishment of floodplain riparian communities, therefore it is necessary to conduct active horticultural restoration (Hubbell et al. 2005). Restoration on this site facilitates the rapid establishment of native riparian habitat that without active cultivated restoration would return to native vegetation at a very slow rate or not return at all.

2. Long-term ecological objectives

The long-term goal of the habitat restoration is to improve the ecological health and long-term viability of at-risk species and riparian communities along the Sacramento River by restoring riparian habitat and improving water quality through active horticultural restoration.

Based on the ecological conditions found in naturally occurring riparian forests along the Sacramento River from Red Bluff to Colusa, TNC's ecological objectives for this site are:

a. To establish early-successional stage and late-successional-stage riparian communities which have been severely reduced in extent along the Sacramento River since 1850.

The Project will add riparian habitat to an ecologically important floodplain vital to the health and survival of riparian obligate species. Restoring complex riparian habitat in the area will improve habitat for fish and wildlife. Fish benefit from complex riparian areas that become flooded at high flows, slow floodwaters down and provide refugia for young and juvenile fish. Additionally, large woody debris, a result of increased riparian habitat, provides food and cover for critical life stages of anadromous fish (Bryant 1983).

b. To provide habitat for neo-tropical migrant land birds.

Both aquatic and terrestrial at-risk riparian species, as well as common riparian species, will benefit from protection and restoration of large expanses of habitat along the mainstem and at the confluences of tributaries to the Sacramento River.

c. To improve water quality by decreasing sediment and pesticide runoff into the Sacramento River.

Replacing flood-prone agriculture with restored riparian habitat will decrease pesticide and herbicide applications on land adjacent to the river, thereby increasing water and sediment quality. Additionally, restored riparian forests will

buffer and filter toxic and organic matter that originate further away from the river, thereby further enhancing water and sediment quality.

3. Management Objectives

The management objectives, which are implementation standards for achieving the ecological objectives, are outlined as follows:

a. Meet, or exceed, a survival of at least 80% plants three years after planting (December of Project Year 3).

b. Meet, or exceed, herbaceous frequency of 80% or greater by December of Project Year 3.

c. Ensure that the restoration site has a woody plant species diversity comparable to nearby remnant mixed riparian forest.

F. Permits and Environmental Documentation

1. CEQA/NEPA

CEQA was completed in August 2008 when the Department of Fish and Wildlife signed the Notice of Determination (SCH # 20080529098). The USFWS will complete any required National Environmental Policy Act (NEPA) analyses prior to project implementation.

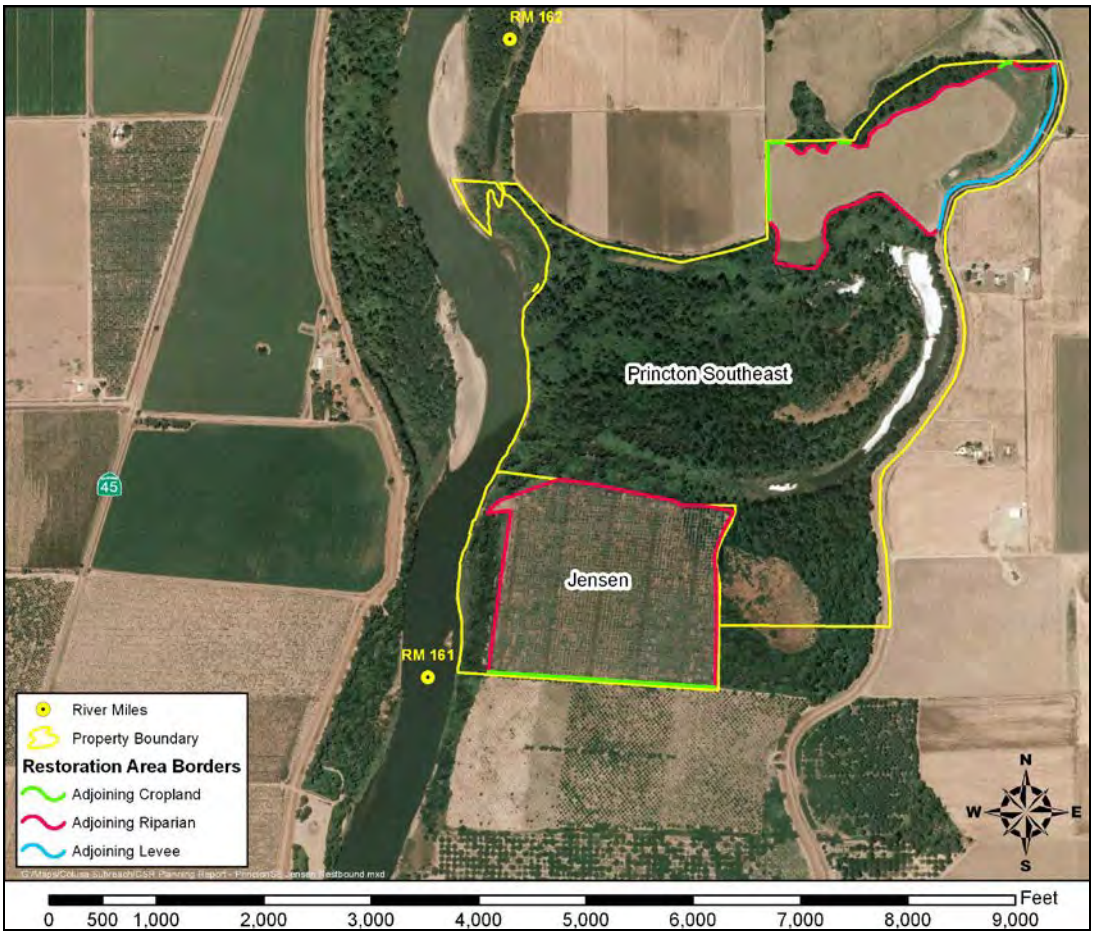
2. Floodplain Encroachment Permit

A floodplain encroachment is not necessary since the Boggs BendUnit is in USFWS ownership. However, the USFWS with consult with the Central Valley Flood Protection Board to address any concerns raised during the NEPA review.

3. Pesticide Use Permits

When restoration of the site is initiated, the restoration manager will need to follow all Colusa County and State of California pesticide use laws and USFWS guidelines for pesticide use requirements concerning the application of herbicides for weed control during implementation of the Project when applying herbicides for weed control in the restoration area.

Figure 3. Aerial photograph of the Boggs Bend Unit from 1999. The green polygon identifies the Unit boundary, the red polygon identifies the proposed restoration area, and the dashed blue line current access road along the levee. The nearby Princeton SE Unit (Princeton Southeast) Unit is also shown.



II. SCHEDULE OF ACTIVITIES

The timing of the annual activities is outlined below.

	Project Year 1				Project Year 2				Project Year 3			
	W	SP	SU	F	W	SP	SU	F	W	SP	SU	F
PLANNING												
Restoration plan*												
Env. Compliance*												
PROPOGATION												
Seed collection*												
Nursery propagation*												
Cutting collection*												
FIELDWORK												
Field preparation												
Layout												
Overstory planting												
Understory planting												
Understory seeding												
MAINTENANCE												
Weed control												
Irrigation												
MONITORING and												
Post-planting												
Regular check-in												
End of Season												
REPORTING												
Annual												
Completion**												

* to be completed prior to on the ground implementation
** to be completed in January 2017

III. PLANNING

A. Site Assessment

A site assessment for the Unit was conducted by personnel at the Department of Biological Sciences, California State University, Chico (Hubbell et al. 2006). The information collected in the site assessment is summarized below.

Information collected for the preparation of the restoration plan includes seven parameters: vegetation on and nearby the Unit, native fish and wildlife usage, soil profile, regional hydrology, depth to water table, historic geomorphic condition, and topography.

The information from the site assessment is used to determine the flooding regime, drainage, riparian restoration communities, and plant species appropriate for planting the Unit. The structure, or appearance of a riparian forest is dictated by these factors. Some influences can be seen immediately on a restoration site and others may not be seen for many years or even decades. For example, gravel inclusions in the soil profile cause immediate mortality of planted

trees due to lack of water, whereas the effects of hydrology on reproduction/recruitment of specific species in a planting is not apparent for many years.

1. Soil Profile and Water Table Analyses

A detailed analysis of the soils profile can be found in the Boggs Bend Unit Baseline Assessment (Hubbell et al. 2006).

2. Adjacent Native Vegetation Surveys

Unit-specific qualitative descriptions of dominant tree, shrub, and native understory species in adjacent riparian areas give valuable insight as to what species are appropriate for restoring a site. A vegetation assessment was conducted in May and June 2005 on remnant habitats located in the adjoining Princeton SW Unit and on the periphery of the Boggs Bend Unit. The following habitat types were located and mapped: mixed riparian forest, herbland, willow scrub, elderberry blackberry scrub, buttonbush scrub, blackberry scrub, valley oak riparian forest, valley wildrye grassland, and valley oak woodland (see Figure 5 in Hubbell et al. 2006). These remnant riparian habitats serve as models for the species composition and relative species frequencies for the riparian communities that have the potential to be established on the on the Boggs Bend Unit. In addition to the remnant vegetation surveys, TNC relies on habitat composition descriptions from Holland (1986) and Vaghti (2003) and edaphic condtions (depth to refusal, depth to water table) to inform the composition of these restoration communities.

3. Hydrology and Geomorphology

The history of channel meander across the site is detailed in Hubbell et al. (2006). The majority of the property is within the 1- to 4-year flood recurrence interval period. The property floods regularly in the winter which dictates a spring planting schedule. It has been demonstrated that floodplains of the Sacramento River are less prone to erosion and more stable when riparian habitat is present as opposed to agricultural land cover (Micheli et al. 2004).

4. Native Fish and Wildlife Usage

In June 2005, a query was made of the California Natural Diversity Database (CA DFG 2005). Four special-status species were found to occur within 1.0 miles of the project area, these species are: Swainson's hawk (state threatened), bank swallow (state threatened), valley elderberry longhorn beetle (federal threatened), and western yellow-billed cuckoo (federal threatened, state endangered), and osprey (state species of special concern).

Other special status-species with the potential to benefit from the restoration include: Sacramento splittail, hardhead, western spadefoot toad, western pond turtle, giant garter snake, American white pelican, double-crested cormorant, white-aced ibis, osprey, bald eagle northern harrier, sharp-shinned hawk, Cooper's hawk, ferruginous hawk, golden eagle, peregrine falcon, prairie falcon, California gull, burrowing owl, short-eared owl, long-eared owl, greater sandhill crane, long-billed curlew, willow flycatcher, loggerhead shrike, purple martin, yellow warbler, yellow-breasted chat, California horned lark, tricolored blackbird, Townsend's big-eared bat, pallid bat, western mastiff bat.

5. Cultural Resources

Archaeological sites, with their historic, cultural, and educational value, should be protected from land management activities that can lead to their degradation. Because rivers and floodplains are typically rich in natural resources (e.g., fish and game), they often harbor significant archaeological sites. It is understandable therefore that significant legal mandates exist to ensure that care is taken when planning management activities (including restoration) on floodplain lands (King 1998; King 2000).

The 83-acre Boggs Bend Unit analysis area was surveyed on December 5, 2004. This project area consists of an active walnut orchard, recently mowed, and containing several smoldering burn piles and irrigation piping. Ground surface visibility was approximately 35 percent. Twenty-meter transect intervals were used during the survey of the Boggs Bend Unit. No cultural resources were observed during the survey.

6. Consultations with Neighbors

Several meetings with neighbors to the restoration Unit have already been held. The focus of these meetings was to discuss plans for the proposed restoration, and to review the results of the hydraulic analysis study and other studies that addressed potential positive and negative impacts of restoration on neighboring landowners. If the Unit is to be planted, then additional meeting(s) will be held prior to restoration implementation to review the planting schedule and specific implementation activities. The entity that plants and maintains the Unit should establish a contact person for all neighboring landowners. TNC will provide to the entities that are involved with the future restoration of these sites all records of past neighbor contact. These records include the names, titles, and contact information of the persons that were consulted with, as well as a list of the materials that were shared.

B. Stakeholder Issues

River restoration projects have the potential to influence many of the societal functions (e.g., flood control, recreation opportunities) that rivers provide, yet most projects fail to consider this in a comprehensive manner. We conducted a set of coordinated studies to evaluate societal impacts of Sacramento River restoration projects over a large geographic area. Our studies were designed to help maximize benefits of these projects to both society and the ecosystem and to meet the information needs of agency planning teams focusing on the area. We worked with the Colusa Subreach Planning Advisory Workgroup to design and implement the studies which assessed the effects of proposed restoration actions (including restoration of the Boggs Bend Unit) on a suite of issues, including: flooding, public access and recreation, socioeconomics, agricultural pests, and regulatory constraints. Impacts of these types are important to consider, as they influence the extent to which natural riverine processes and habitats may be restored while maintaining the important societal benefits that river systems provide to local communities (Golet et al. 2006). Below we briefly present the rationale for, and major findings of, these studies. Then we report how the information was applied to restoration planning at the Ward Unit, and more generally across the Colusa Subreach.

1. Flood Impact Assessment

Landowners in the Colusa area, many of whom are farmers, expressed concern that habitat restoration activities on neighboring conservation lands might exacerbate problems of flooding on their properties. These concerns were shared by public agencies responsible for maintaining travel corridors and associated infrastructure (e.g., roads and bridges), as well as important Sacramento River Flood Control Project (FCP) features such as levees and weirs (US Army Corps of Engineers 2002, 2003).

To address these questions, TNC conUnited with Ayres Associates to calibrate and run a two-dimensional hydraulic model (RMA-2V; US Army Corps of Engineers 1997) for an areas slightly larger than the Colusa Subreach area (river mile 142.5–164.5). The model quantified the effects that proposed land-use changes (replacement of agricultural lands with native vegetation plantings) would have on floodwater surface elevation, velocity, and flow patterns. Because different types of riparian vegetation (e.g., forest, grassland) impede the passage of floodwaters to varying degrees (Mount 1995), TNC needed to supply the hydraulic modelers with a map depicting future land-cover patterns at the restoration area. To generate the map, TNC worked with Chico State scientists and applied a simple model that relates plant community types to physical site characteristics such as soil stratigraphy and depth to groundwater (The Nature Conservancy 2003).

The study determined that at the Boggs Bend Unit the velocity increases and decreases will not affect erosional or depositional patterns.

The computed water surface elevations (WSE) for the proposed restoration is below the 1957 design profile by 0.8-1.0 ft depending upon the specific location. Thus, no WSE impacts are expected from the project. Nor are there any expected effects on seepage. Overall the study concluded that impacts on adjacent lands are expected to be less than significant. For further information on the Flood Impact Assessment see Ayres Associates (2007).

2. Public Access and Recreation Analysis

Recreational opportunities are consistently identified as one of the most important parameters in defining quality of life for Americans (Cordell and others 1999). Natural river habitats offer great potential for recreation opportunities, yet concern has arisen that conservation entities, such as TNC, have been purchasing private agricultural land (often with public funds) and keeping it closed to the public (Ellena 2000). At the same time, other stakeholders are opposed to opening more land to public access, largely due to concerns that this will lead to increased instances of trespass onto adjoining private lands. To better understand these issues in the context of additional transfers of lands to public agencies (e.g., State Parks, Department of Fish and Game, USFWS) we contracted with a consulting firm to conduct a study to characterize current public access and recreation use patterns along the river and to identify opportunities for improvements. Information was gathered from available demographic data, previous recreation and access studies (e.g., EDAW 2003), site visits,

interviews with land and facility managers, selected interest group representatives, and public scoping meetings.

Results indicate considerable interest in Sacramento River Restoration opportunities. As awareness of the Sacramento River corridor has grown, the river has become an increasingly popular recreation destination. Continued conservation and restoration along the river will likely draw even more people to this area, as Californians indicate that natural areas are highly sought after as recreational settings (California Department of Parks and Recreation 1998). Regional trends indicate a continued interest in the traditional recreational activities of boating, fishing and hunting, and suggest that non-consumptive recreational pursuits such as bird watching, nature observation, and hiking will increase by 65% over the next 40 years (California Department of Water Resources 1982; California Department of Parks and Recreation 1998; Cordell and others 1999). Moreover, as the population in the region grows, demand for public recreational opportunities are expected to increase (Cordell and others 1999).

Continuing with and building upon efforts to increase compatible public recreation opportunities along the Sacramento River is important to achieve successful, community-supported restoration of the dynamic river ecosystem as well as benefiting the region's economic and social well-being. Increases in recreational activities such as wildlife viewing, hunting, and fishing often translate to increases in support for conservation actions (Theodori and others 1998).

However, not all stakeholders are interested in seeing more public access sites along the river. There is widespread concern that there are insufficient resources to provide adequate patrolling of publically accessible public lands, and existing public agency management resources are not currently adequate to accommodate additional uses and land access sites. Accordingly the continuation of water-only access at most sites in the Colusa Subreach was supported by most attendees at public meetings (EDAW 2007a). Without adequate surveillance and enforcement, illegal activities such as dumping and vandalism are likely to take place at these sites and also, potentially, on adjoining private lands. Related to this, some members of the public expressed concern that certain "Landowner Assurances" are needed to help safeguard the property rights of landowners whose property adjoins public lands. Specific provisions of the "Good Neighbor Policy," which has been adopted by the Sacramento River Conservation Area Forum (SRCAF) should help provide this, as they establish procedures for effective communication between entities proposing new public ownership or habitat restoration and the neighboring landowners. TNC and the public agencies that manage land in the Colusa Subreach and are implementing these provisions. Among the eight Colusa Subreach Planning potential restoration sites, only the Ward Unit, an annexation to the Colusa-Sacramento River State Recreation Area (SRA), was determined to be currently appropriate for large-scale enhancement of recreation and access. This was recognized early on the Colusa Subreach Planning process, which led the advisory workgroup to call for a separate, but complementary, planning effort to be undertaken which focused on this one Unit. The Colusa Sacramento River State Recreation Area Master plan (EDAW 2007b) was the product of this effort.

3. Fiscal and Economic Impact Analysis

Changes in land-use patterns associated with habitat protection and restoration have the potential to affect local and regional economies in complex ways (Sutherland 2002), but these concerns are rarely considered quantitatively. In reaction to TNC and its partners efforts to restore agricultural lands along the Sacramento River, agricultural advocacy groups worried that there would be losses of revenues to the local taxing agencies and the local economy with the conversion of land from agriculture to habitat (Sutton 2001; Hacking 2003). To address these concerns, we initiated a fiscal and economic impact analysis to quantify potential third-party impacts (both positive and negative) to counties, landowners, and the general public that might result from acquiring and transferring and restoring lands in the Project area. The analysis evaluated impacts on the two counties (Colusa and Glenn) that border the Colusa subreach. It built upon two previous studies of similar focus that were limited to Butte County (Adams and Gallo 1999, 2001), and another that focused on a larger four county area (Jones & Stokes 2003). Prior to conducting the technical analyses, a future condition scenario was defined based on habitat restoration potential at the 8 proposed restoration sites.

The analysis estimated changes in regional economic activity and fiscal conditions and changes in resource costs and benefits. These effects were estimated by analyzing changes in spending for agriculture, recreation, and habitat restoration using IMPLAN, a regional economic software model that describes flows from producers to intermediate and final consumers using a series of economic multipliers (Rickman and Schwer 1993; Miller and Blair 1985). The fiscal study modeled how restoration would change revenue flows to the counties, estimating changes in property tax revenues, federal revenue sharing payments, state in-lieu payments, and Williamson Act subvention payments.

Overall, the socioeconomic assessment suggested that adverse impacts of the modeled acquisition and restoration program would be relatively minor and localized. It should be possible to partially offset these impacts through state and federal in-lieu payments and by further developing sustainable recreational opportunities. For further information on the Socioeconomic Assessment see EPS (2006).

4. Agricultural Pest Analysis

This study aims to provide objective scientific information regarding pest damage potentially affecting crops and agricultural operations in the Colusa Subreach. This study focused on several pest effect issues, including identification and prioritization of pest species, characterization of potential changes with restoration of riparian habitat, and identification and prioritization of solutions to address potential pest damage. A total of 26 priority pests identified by an Advisory Workgroup were analyzed in this study. Potential increases in pest populations and/or damage presented in this study are based on expert information and the best available science. Riparian habitat restoration proposed in the Colusa Subreach is likely to provide both benefits and some minimal risks in pest effect changes to agricultural operations compared to existing conditions. However, with 55% of the Subreach in existing riparian habitat and only 7% of the Subreach proposed for riparian habitat restoration, the anticipated change in pest populations and pest effects is unlikely to be substantial. Overall, there may be a decrease in pest effects. This is because riparian habitat does not support most

agricultural pests evaluated in this study, as discussed in Section 4.2. Pest effects that do occur, however, could shift to new farmlands in a few of the restoration sites. All of those farmlands already are bounded by at least some riparian habitat and in some cases, they are substantially surrounded by riparian habitat. Only 11% of the perimeters of the eight restoration Units are directly adjacent to cropland. Of six cropland properties that adjoin proposed restoration areas, 60% of the perimeter of these cropland areas is directly adjacent to existing riparian habitat. Following restoration, the percentage would increase to 84%. Each of these adjacent cropland areas already is subjected to riparian habitat influences to a substantial degree. As a result, it is expected that the proposed restoration will not introduce completely new influences on the existing cropland.

Of the 25 species identified by the Advisory Workgroup and External Experts Group as high or medium priority pests, four are likely to have some increases in pest effects, eleven are expected to remain the same in pest effects, and ten are likely to yield decreased pest effects in both the short (0-4 years) and long term (more than 5 years) following restoration plantings. Of the species that have potential to increase in population size or crop damage, the overall change is expected to be small. For further information on the Agricultural Pest Analysis see EDAW (2008).

5. Regulatory Constraints Analysis

This study aims to provide objective scientific information regarding environmental regulations potentially affecting agricultural operations in the Colusa Subreach. This study focused on several regulatory issues, including identification and prioritization of regulatory constraints, characterization of potential changes with restoration of riparian habitat, and identification and prioritization of solutions to address potential regulatory constraints. A total of seven federal and eight state laws and regulations identified by an Advisory Workgroup were analyzed in this study.

Of the seven federal and eight California laws and regulations analyzed, only one potentially significant increase in agricultural regulatory constraints is likely to result from the restoration of riparian habitat in the Colusa Subreach: restrictions within 100 feet of elderberry shrubs which is habitat for the valley elderberry longhorn beetle, a species that is federally-listed as threatened. However, because the open canopy types of riparian habitat (e.g., savannah) that are most suitable to the growth of elderberry shrubs constitute only a small percentage of the proposed restoration area and because only a small percentage of the proposed restoration perimeter borders agricultural land, the potential increase in valley elderberry longhorn beetle-related regulatory constraints on adjacent agricultural parcels is expected to be small. Riparian habitat restoration is not expected to increase agricultural regulatory constraints associated with the other 14 regulations, 14 protected species, and 6 protected habitats analyzed in this study.

> To comply with Endangered Species Act (ESA) protections for the valley elderberry longhorn beetle, activities within 100 feet of elderberry shrubs with stem diameters 1.0 inches or greater at ground level could be restricted, and riparian habitat restoration may result in a small increase of such shrubs within 100 feet of farm activities. These practices are not limited, however, adjacent to smaller elderberry shrubs, and such shrubs may be

removed by landowners before they reach the protected 1 inch stem diameter size. For further information on the Regulatory Constraints Analysis see EDAW (2008). Following restoration guidelines set forth in the USFWS's Final Comprehensive Conservation Plan for the Sacramento River National Wildlife Refuge (USFWS 2005), no woody vegetation will be planted within 30 feet and no elderberries will be planted within 100 feet of the adjacent private land boundary or roads. No Elderberries will be planted within 30 feet of Refuge roads.

C. Cultivated Restoration Design

Communities planned for habitat restoration are based on the baseline assessment (including soil profile, topography, flood frequency, depth to groundwater at base flows, weed community, and the existing adjacent riparian community) and hydraulic impacts analysis. Species composition is determined by the ecological objectives, existing native species at and around the Unit, and available native vegetation propagule sources.

Point Reyes Bird Observatory (PRBO) monitors bird usage on habitats of the Sacramento River. PRBO has provided TNC with recommendations for restoring appropriate breeding and foraging habitat for riparian obligate songbirds. PRBO has recommended establishing communities with a divers canopy structure both horizontally and vertically across any given restoration site. This will be accomplished by restoring a mosaic of habitat types across the Unit. In addition, the restoration plantings will include areas where trees are clumped and interspersed with more open areas dominated by lower stature shrubs and forbs. This allows for usage of the site by a diverse array of wildlife species that require different habitat structure and composition types.

1. Restoration Communities

The 81-acre restoration area will be planted with the following plant communities (Holland 1986): Mixed Riparian Forest (MRF), Cottonwood Riparian Forest (CWRF), and Rose-*Baccharis* Scrub/Valley Wildrye Grassland (RBS/VWG).

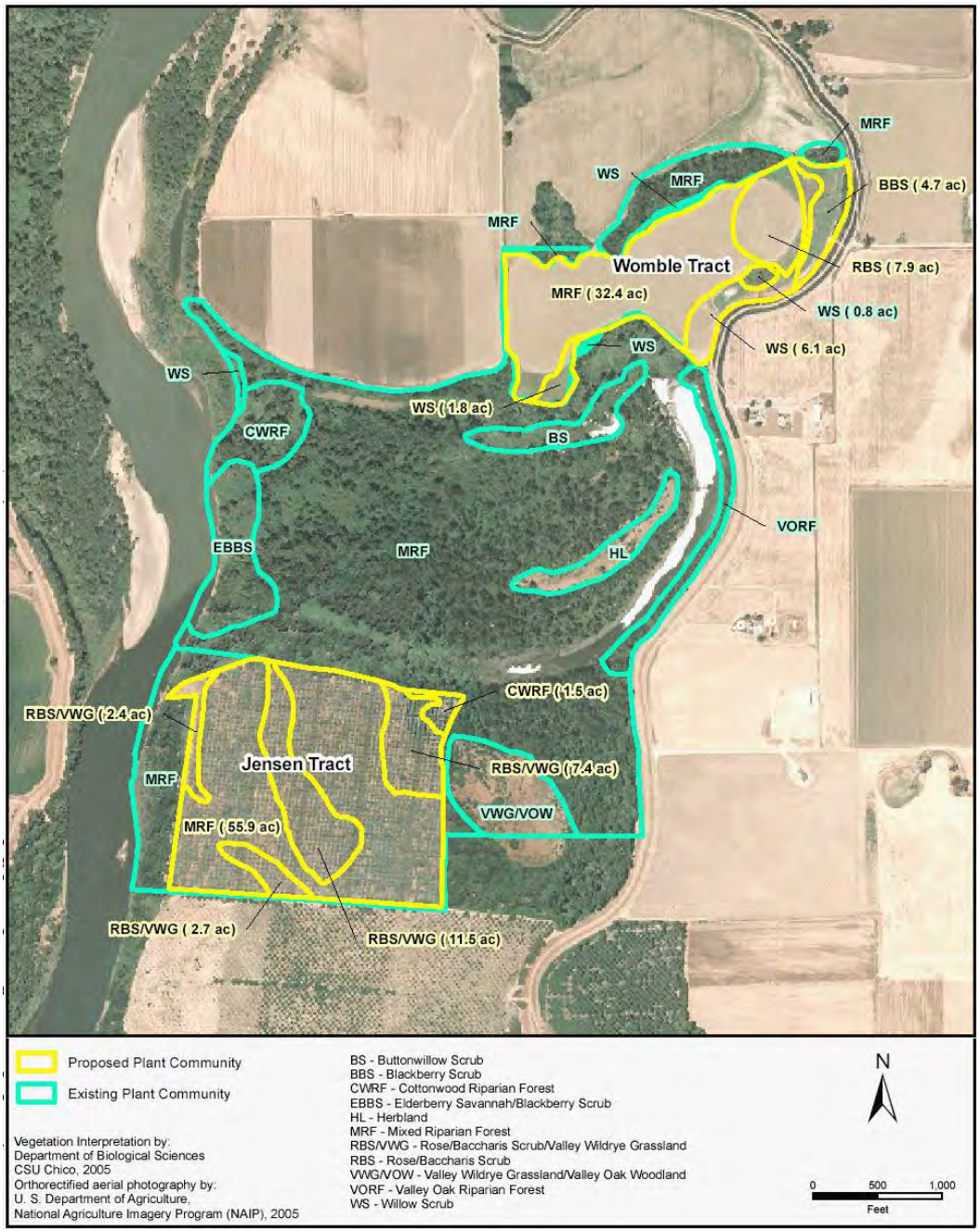
See Figure 4 for a detailed restoration community layout plan. The species composition for these communities is listed in Appendix 1.

2. Planting Design

The arrangement of plants across the site in any given 10 row by 10 planting area will be arranged to maximize structural and compositional diversity both vertically and horizontally across the field. At each location, spaced 11 feet along the planting strips, one or two plants will be planted according to the community-specific planting composition. The planting strips will be aligned with the contour of the river flow. Planting strips in the Mixed Riparian Forest (MRF) and Cottonwood Riparian Forest (CWRF) restoration communities will be spaced 30 feet apart while the Rose-*Baccharis*/Valley Wildrye Grassland (RBS/VWG) rows will be planted 40 feet apart. Where appropriate, an understory plant (shrub, forb, grass, or vine) will be planted either next to an overstory plant or clustered with other understory plants. Note that the

understory forb/grass plantings do not equal 100% frequency in the mixed riparian or cottonwood riparian forest, this is a result of not planting an understory forb or grass adjacent to willow trees due to competition. This planting scheme allows for the development of both vertical and horizontal structural diversity. Appendix 1 details the planting composition of each community.

Figure 4. Native vegetation community distribution proposed for the Boggs Bend Unit restoration. This figure also shows the proposed vegetation community distribution for the nearby Princeton SE Unit.



3. Plant Propagation

Container plants are raised from seeds or cuttings collected from the Sacramento River floodplain and should be propagated by local nurseries (e.g., CSU Chico, Floral Native Nursery, and Hedgerow Farms) for planting as seedlings at the Unit. Willow and cottonwood cuttings refer to branches about 1" in diameter and 24" long cut from mature cottonwood and willow trees and planted directly into the field. Cuttings should be collected January Project Year 2 and placed in cold storage until needed for planting; cuttings are to be soaked for 24 hours before being planted. Phase 1 overstory and understory plants will be hand planted in spring of Project Year 2 while the Phase 2 understory grass seed will be directly seeded with a rangeland drill in December of Project Year 2.

The restoration conUnitor is responsible for the plant propagation for all of the riparian plants. Planting crews are hired and supervised by the restoration conUnitor.

IV. RESTORATION IMPLEMENTATION

Active restoration is proposed to restore native vegetation on an 81-acre orchard area based upon information contained in *Baseline Assessment for Riparian Restoration at the Jensen Restoration Area* (Hubbell et al. 2006). The proposed vegetation communities within the restoration area along with remnant riparian habitat in the general vicinity of the Boggs Bend Unit are shown on Figure 4. The existing mixed riparian habitat adjacent to the northern portion of the restoration area has required more than 50 years to attain their current size. This suggests that the development of high-quality habitat would occur very slowly. In addition, the higher elevation of the proposed restoration site would likely preclude it from flooding to the degree required for natural process restoration to be successful. The higher floodplain also contributes to an increased risk of infestation by non-native invasive species such as yellow-starthistle, Johnson grass, and Bermuda grass.

After removal of the existing walnut orchard, most of the site would be converted to mixed riparian forest, which would expand the existing mixed riparian forest north and west of the site. The restoration area is appropriate for riparian forest habitat because of its clay loam soils, the fact that its elevation is similar to that of the remnant vegetation, and its location within the 1- to 2-year floodplain.

The mid-section and portions of the site along the western, southern, and northeast boundaries would be restored to rose/baccharis scrub and valley wildrye grassland. The combination of these two vegetative habitat types would reflect both the composition of the valley wildrye grassland/valley oak woodland found in nearby remnant vegetation as well as the physical factors of the proposed restoration area. Planting of rose/baccharis scrub vegetation would provide structural and habitat diversity to the site.

A small area of cottonwood riparian forest would be planted in the northeast corner of the proposed restoration site. Restoration of this portion of the site to cottonwood riparian forest would expand the cottonwood forest near the oxbow lake located to the northeast and increase habitat diversity. The higher water table in this portion of the restoration area, the fact that its elevation is similar to that of the adjacent remnant vegetation, and its location in the 2-year floodplain make it conducive to supporting cottonwood riparian forest.

A. Field Preparations

The field will be prepared prior to planting including removing the orchard, clearing orchard debris, disking, and landplaning. Correct field preparation will set the site up for efficient and effective weed control and native grass seeding later in the Project schedule.

Site layout is the preliminary stage of planting and occurs after field preparations have been completed. Site layout organizes the field according to the details outlined in the plant design. Boundaries between planned restoration communities will be delineated using GPS. Exact locations of each native plant to be planted will be marked using different colored flags.

B. Irrigation Design and Installation

A microdrip, hard-hose irrigation system will be installed in spring of Project Year 1 immediately after the walnut orchard is removed and prior to planting the native plants. Irrigation/planting rows will be installed following the same contour as the levee to enhance flood water conveyance.

C. Planting

1. **Phase 1**

   The first phase of the planting will be implemented as soon as the threat of flooding is over in spring Project Year 1, the restoration contractor will plant all nursery grown potted stock plants as well as all cottonwood and willow cuttings. Phase 1 planting for the site is scheduled for spring of Project Year 1 (see Appendix 1).

2. **Phase 2**

   This is the understory component of the restoration program; the herbaceous layer will be directly seeded in December of Project Year 2 or 3 depending on weather, the effectiveness of weed control, and growth rates of the trees and shrubs that may limit access to the planting alleyways by machinery used for direct seeding.

Protective milk cartons are to be placed around nursery grown plants and cuttings. The cartons protect the plants from herbicide drift during weed control. Two small bamboo stakes are used to anchor the cartons.

V. MAINTENANCE

Maintenance (irrigation and weed control) is scheduled to follow directly after the Phase 1 planting and continue for 3 years. The Phase 2 understory direct seeding planting will be maintained during the final project year and for years after by the USFWS.

A. Restoration Maintenance (spring Project Year 1 – December Project Year 3)

1. **Irrigation**

   a. **Method**

   Irrigation is the single most important factor in the success of riparian restoration projects in California. Adequate soil moisture allows plants to grow vigorously and compete effectively with weeds. If at anytime it is determined that either

irrigation scheduling or the irrigation system is inadequate and plants are not growing actively, the restoration manager will remedy this problem immediately.

b. Standards

Standards are based on plant growth and survival assessed during weekly assessments by the restoration manager. Adequate soil moisture and weed control must be maintained to ensure vigorous native plant growth. A watering regime will be determined each week according to weather, growing, and site conditions.

2. Weed Control

a. Methods

This site has annual rye grass, Johnson grass, morning glory, chick weed, and other problematic weeds that will inhibit native plant growth if unchecked. Control efforts will concentrate on controlling these noxious weeds through herbicide application, mowing, and discing when and where appropriate. The restoration manager will use adaptive management to determining best management practices for weed control. Aggressive control by mowing, disking, and herbicide application will control these weeds as a serious problem in the restoration site.

Pesticide Use: The State of California and each county regulate the use of all pesticides, only state and locally approved herbicides will be used on the restoration site. Herbicide applications will be prescribed by a state-licensed PCA (pest control advisor) and applied by state-licensed applicators. Herbicide use will be reported to the county agriculture commission as required by state and county law. Weed control will be conducted year round, as needed, and follow USFWS pesticide use proposal policy, which includes the reporting of all applications in an annual report to the Refuge.

b. Standards

The height and vigor of weeds on restoration sites has a direct effect on the growth and survival of the cultivated riparian plants. The restoration manager's objective is to optimize growth of the riparian species past a point where they can compete effectively with these exotic plants, envisioned for December Project Year 5. The larger the riparian species the less they are affected by weeds.

Standards for weed control for this project are as follows:
<u>Project Year 1 growing season:</u> No weed growth within the alleyways. Weed growth in the planting strips is kept to less than 6". Weed stem density within the strips should be less than $3/ft^2$. Alleyways to be direct seeded are kept completely clean, no weed growth. Manually remove all weeds growing inside each milk carton.

<u>Project Year 2 growing season:</u> No weed growth within the alleyways. Direct seeded native grass will dominate the alleyways and compete with the non-native

weeds. Weed growth in the planting strips is kept to less than 6". Weed stem density within the strips should be less than 3/ft^2.

Project Year 3 growing season: No weed growth within the alleyways. Direct seeded native grass will dominate the alleyways and compete with non-native weeds. Weed growth in the planting strips is kept to less than 6". Weed stem density within the strips should be less than 3/ft^2.

VI. MONITORING

A. 30-Day Post-Planting Monitoring

The restoration manager will conduct a post-planting assessments to determine the composition and survival of planted nursery stock and cuttings 30 days after all plants are planted (Project Year 2). This provides baseline information for comparison at the end of each growing season (Project Year 1-3) and for the Completion Report.

B. Weekly Site Conditions Monitoring

Post planting, the restoration manager will check in weekly to ensure the site is being managed according to guidelines set forth in this document.

C. End of Growing Season Monitoring

This monitoring will be completed in November (Project Years 1-3) before plants go dormant for the winter. End of Growing Season Monitoring is an interim assessment of the planting Unit to determine success at the end of each planting season. This information is summarized in the Annual Reports.

D. Annual Reports

Annual reports will be prepared by the restoration manager summarizing restoration activity for that year. The survivorship and height for each planted species are detailed and included in the report in tabular format. In addition, there will be a summary discussion of the previous year's work activities and the results of the survivorship and height data. Annual reports will be submitted by January 31, 2015, 2016, and 2017.

If the Year 1 or Year 2 Annual Report indicate less than 80% overall survival for a community, the restoration manager will replant where necessary to ensure achieving a minimum 80% survival rate for each community by the overstory restoration project completion date (December 31, 2016).

E. Completion Report

A completion report will be prepared at the end of the 3-year maintenance phase (January 31, 2017) to report the final survivorship and height of the restoration planting. Data on survivorship and height of the planted species will be provided in tabular format accompanied by text that will explain all activities during the 3-year maintenance phase and a summary discussion of the survivorship and height data of the restoration planting.

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Appendix 1. Boggs Bend Cultivated Restoration Plant Composition.

Mixed Riparian Forest (MRF)

Phase 1 - Manual Planting

Planting Spacings (plants x row)	11' x 30'
Emitter Density per acre	132
Acres	55.9
Target Planting Date	Spring, 2014
Total Locations	7,379
Total Plants	13,725

Canopy Structure	Species		Frequency	Total
Overstory				
	Populus fremontii	Fremont cottonwood	13%	959
	Quercus lobata	Valley oak	19%	1402
Midstory	*Acer negundo*	Box elder	15%	1,107
	Cephalanthus occidentalis	Button willow	3%	221
	Fraxinus latifolia	Oregon ash	6%	443
	Salix gooddingii	Goodding's willow	7%	517
	Salix laevigata	Red willow	2%	148
	Salix lasiolepis	Arroyo willow	3%	221
	Salix lucida	Shining willow	2%	148
	*Sambucus Mexicana***	Elderberry	4%	295
Understory shrubs	*Rosa californica*	California rose	4%	295
	Rubus ursinus	California blackberry	17%	1,254
	Toxicodendron diversilobum	Poison oak	5%	369
			100%	7,379
Sedges	*Carex barbarae*	Santa Barbara sedge	10%	738
	Caerex praegracillis	Slender sedge	5%	369
Forbs	*Artemisia douglasiana*	Mugwort	20%	1,476
	Euthamia ocidentalis	California goldenrod	20%	1,476
	Lotus purshianus	Lotus	3%	221
	Urtica dioecia	Hoary nettle	6%	443
	Oenothera hookeri	Primrose	5%	369
Vines	*Aristolochia californica*	California pipevine	7%	517
	Clematis ligusticifolia	Clematis	5%	369
	Vitis californica	California grape	5%	369
			86%	6,346

* companion planting frequency is 86%, this accounts for not planting a companion plant next to the willow species.
** Plant on edges or adjacent to low growing plants so they are not shaded out by cottonwoods.

Phase 2 - Direct Understory Seeding

Acres	55.9
Seeding rate (lb/acre)	13
Target Planting Date	December, 2014 or 2015

Grass Species		Ecotype	Seeding Rate
Elymus glaucus	Blue wildrye	Parrott	30%
Hordeum brachyantherum	California meadow barley	Yolo Co.	25%
Leymus triticoides	Creeping wildrye	Yolo Co.	45%

100%

Cottonwood Riparian Forest (CWRF)

Phase 1 - Manual Planting

Planting Spacings (plants x row)	11' x 30'
Emitter Density per acre	132
Acres	1.5
Target Planting Date	Spring, 2014
Total Locations	198
Total Plants	354

Canopy Structure	**Species**		**Frequency**	**Total**
Overstory	*Populus fremontii*	Fremont cottonwood	35%	69
Midstory	*Acer negundo*	Box elder	22%	44
	Cephalanthus occidentalis	Button willow	5%	10
	Fraxinus latifolia	Oregon ash	6%	12
	Salix exigua	Narrow leaved willow	4%	8
	Salix gooddingii	Goodding's willow	4%	8
	Salix laevigata	Red willow	4%	8
	Salix lasiolepis	Arroyo willow	5%	10
	Salix lucida	Shining willow	4%	8
Understory shrubs	*Rubus ursinus*	California blackberry	11%	22
			100%	198
Sedges	*Carex barbarae*	Santa Barbara sedge	13%	26
	Caerex praegracillis	Slender sedge	5%	10
Forbs	*Artemisia douglasiana*	Mugwort	31%	61
	Euthamia ocidentalis	California goldenrod	10%	20
	Urtica dioecia	Hoary nettle	5%	10
	Oenothera hookeri	Primrose	5%	10
Vines	*Vitis californica*	California grape	10%	20
			79%	156

* companion planting frequency is 79%, this accounts for not planting a companion plant next to the willow species.

Phase 2 - Direct Understory Seeding

Acres	1.5
Seeding rate (lb/acre)	13
Target Planting Date	December, 2014 or 2015

Grass Species		**Ecotype**	**Seeding Rate**
Elymus glaucus	Blue wildrye	Parrott	30%
Hordeum brachyantherum	California meadow barley	Yolo Co.	25%
Leymus triticoides	Creeping wildrye	Yolo Co.	45%
			100%

Rose-Baccharis Scrub/Valley Wildrye Grassland (RBS/VWG)

Phase 1 - Manual Planting

Planting Spacings (plants x row)	11' x 40'
Emitter Density per acre	99
Acres	24
Target Planting Date	Spring, 2014
Total Locations	2,376
Total Plants	4,752

Canopy Structure	**Species**		**Frequency**	**Total**
Midstory	*Baccharis pilularis*	Coyote brush	31%	737
	Sambucus mexicana	Elderberry	15%	356
Shrubs	*Rosa californica*	California rose	30%	713
	Rubus ursinus	California blackberry	12%	285
	Toxicodendron diversilobum	Poison oak	12%	285
			100%	2,376
Sedges	*Carex barbarae*	Santa Barbara sedge	20%	475
	Caerex praegracillis	Slender sedge	15%	356
Forbs	*Artemisia douglasiana*	Mugwort	17%	404
	Euthamia ocidentalis	California goldenrod	17%	404
	Urtica dioecia	Hoary nettle	20%	475
	Oenothera hookeri	Primrose	11%	261
			100%	2,376

Phase 2 - Direct Understory Seeding

Acres	24
Seeding rate (lb/acre)	13
Target Planting Date	December, 2014 or 2015

Grass Species		**Ecotype**	**Seeding Rate**
Elymus glaucus	Blue wildrye	Parrott	30%
Leymus triticoides	Creeping wildrye	Yolo Co.	35%
Nassella pulchra	Purple needlegrass	Llano Seco	35%
			100%

Appendix B

Two-dimensional Hydraulic Modeling of Riparian Habitat Restoration from Colusa to Princeton: Sacramento River, RM 142.5 to RM 164.5, Glenn and Colusa Counties, CA. March 28, 2008

TWO-DIMENSIONAL HYDRAULIC MODELING OF RIPARIAN HABITAT RESTORATION FROM COLUSA TO PRINCETON

SACRAMENTO RIVER, RM 142.5 TO RM 164.5
GLENN AND COLUSA COUNTIES, CA

March 28, 2008

Prepared For:

The Nature Conservancy.
Protecting nature. Preserving life.

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AYRES ASSOCIATES

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Ayres Associates Project No. 33.0551.00

EXECUTIVE SUMMARY

This report provides results from a detailed hydraulic analysis of planned riparian restorations on the Sacramento River between Princeton (RM 164.0) and Colusa (River Mile 144.4). The hydraulic modeling tool was RMA-2V, which is a 2-dimensional model. It was calibrated using the1995 high flow runoff, available1997 river topography and the 1995 surveyed high water marks. The calibrated model was then updated to 2006 LIDAR topography and 2006 land use conditions and then re-run for the 1957 Corps of Engineers design flow. This model was then used as a tool for comparison to the previously published 1957 design profiles and the water surface profiles planned restorations.

Eight parcels within the 20 mile reach of river are proposed for conversion from agricultural use to riparian restoration. The sites range from the Womble property near RM 162 to the Ward parcel near RM 146. While many of the sites are not close to each other, one hydraulic model that covers the entire reach was used to determine if there were cumulative effects from one site to the next. Multiple alternative restoration scenarios were tried until acceptable water surface conditions were finally achieved. The limiting criteria was that the proposed restorations would not create a higher water surface than the existing conditions or the 1957 Corps design profile, whichever was the greater.

The report also summarizes findings from the examination of other issues. Historical thalweg comparisons of the river were plotted and compared, however the results proved to be inconclusive as to an overall trend of aggradation or degradation within this reach of the river.

An inventory of the existing large woody debris within this reach was conducted and the hydraulic model re-run for an increased level of wood in the river system. Results showed little impact primarily because the woody debris occupied such a small portion of the overall flood flow cross section. The report also evaluates impacts to adjacent properties and the levees themselves.

Specific results for each of the planned restorations are included in Section 6 of the report with accompanying plots in the Appendix. In general, the computed water surface elevations for proposed restoration sites are at or below either the existing conditions run or the 1957 design profile with the exception of the Jensen site that has a small area at the downstream edge that is 0.05 ft above existing within the restoration site. This is a small increase and the extent is confined within the floodplain therefore no impact on levee freeboard.

Included in the Appendix are responses to comments by others on the report and a detailed analysis of methods, procedures and results by personnel at DWR.

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1.0 INTRODUCTION

1.1 General

This report summarizes the findings of a hydraulic analysis performed to review the existing floodplain capacity and investigate the effects of proposed restoration of riparian habitat within the Sacramento River floodplain. The Nature Conservancy (TNC) is proposing to restore riparian and savannah habitat on multiple properties within the leveed section of the Sacramento River north of Colusa. A two-dimensional (2D) hydraulic model of the Sacramento River from river mile (RM) 142.5 to 164.5 (Colusa to Princeton) was developed to assist in this analysis. The model was calibrated using recorded high water marks from the 1995 storm event and documented flow splits at the overflow weirs. The 1957 USACE design water surface elevations were used as the maximum water surface elevation for comparing any hydraulic impacts. The project location and model limits are shown in **Figure 1**. The restoration areas are shown in **Figures 2** and **3**.

This hydraulic analysis is in support to the Colusa Subreach Planning Program, which is focused on the Sacramento River floodplain between Princeton and Colusa, an area known as the Colusa Subreach. The scope of this analysis was approved by the Colusa Subreach Planning Advisory Workgroup in response to their identification of specific "Landowner Concerns" regarding wildlife habitat conservation within the floodplain. This analysis will provide specific information regarding the capacity of the floodplain and the effects of restoring native wildlife habitat on eight potential sites within the floodplain. As requested by the Advisory Workgroup, the analysis includes modeling of the entire Colusa Subreach so that cumulative effects are considered.

1.2 Background

The reach of the Sacramento River between RM 142.5 and 164.5 is leveed on both sides, and is a meandering channel with two overflow weirs into the Butte Basin. Upstream of RM 144, the levees are generally setback from the main channel with wide overbanks. From about RM 144 to the downstream end of the model (RM 142.4), the levees are tight against the riverbank. The channel upstream of RM 144 has migrated over the years and is continuing to migrate. **Figure 4** shows the river channel in its various alignments since 1896.

Within this reach of the Sacramento River levee system, the two overflow weirs, Moulton and Colusa, convey excess floodwater into the Butte Basin. The location of these weirs is shown in Figure 1. These weirs are unregulated and free flow when the stage hits the weir crest. For the Moulton Weir, the crest stage is 73.95 ft (NGVD-29) and for the Colusa Weir, the stage for flow to begin is 58.91 ft (NGVD-29). In the early 1990's, a pilot channel was built next to the Colusa Weir to prevent the weir from being cutoff due to the river channel migrating westward.

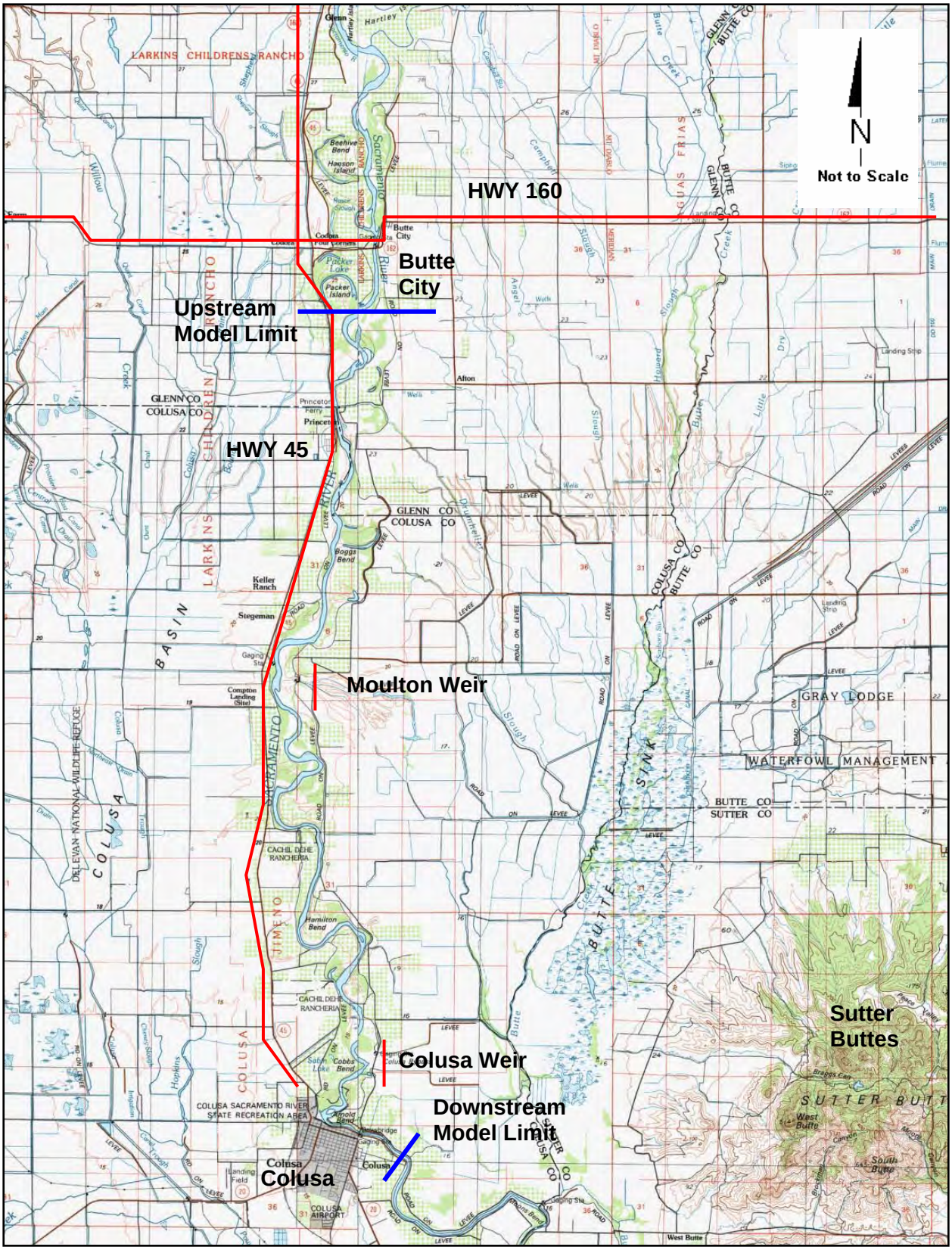


Figure 1. Project Location

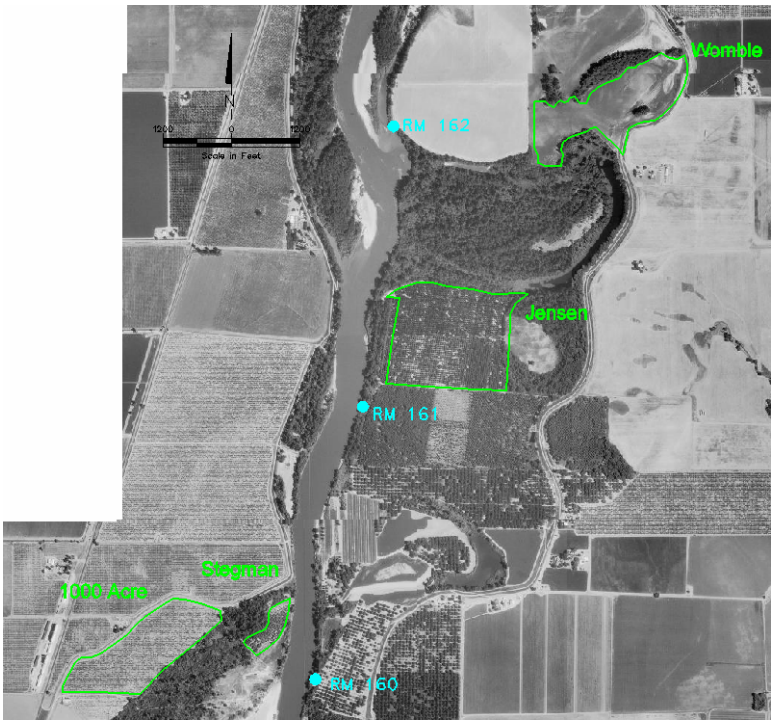


Figure 2. Planned Restoration Sites at the Upstream End of the Model

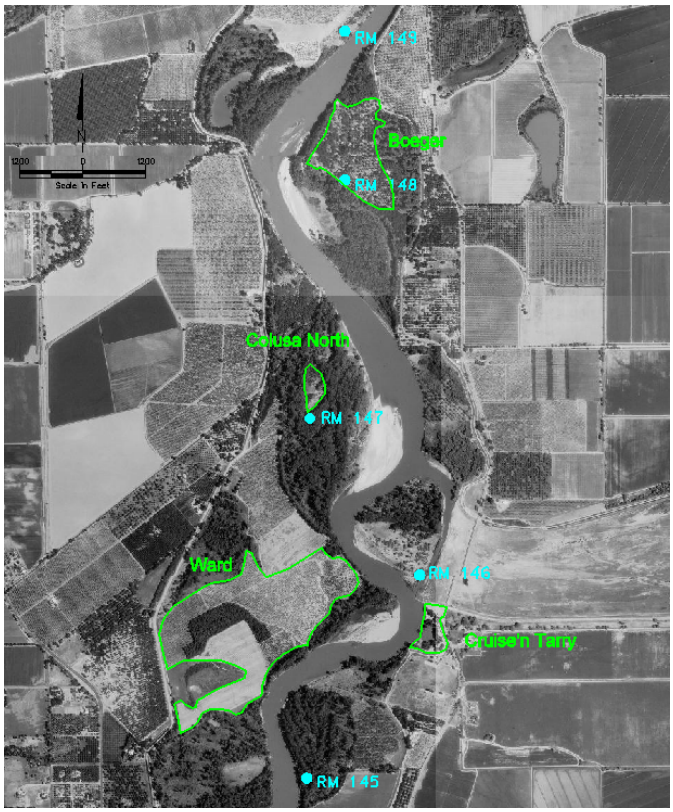


Figure 3. Planned Restoration Sites at the Downstream End of the Model

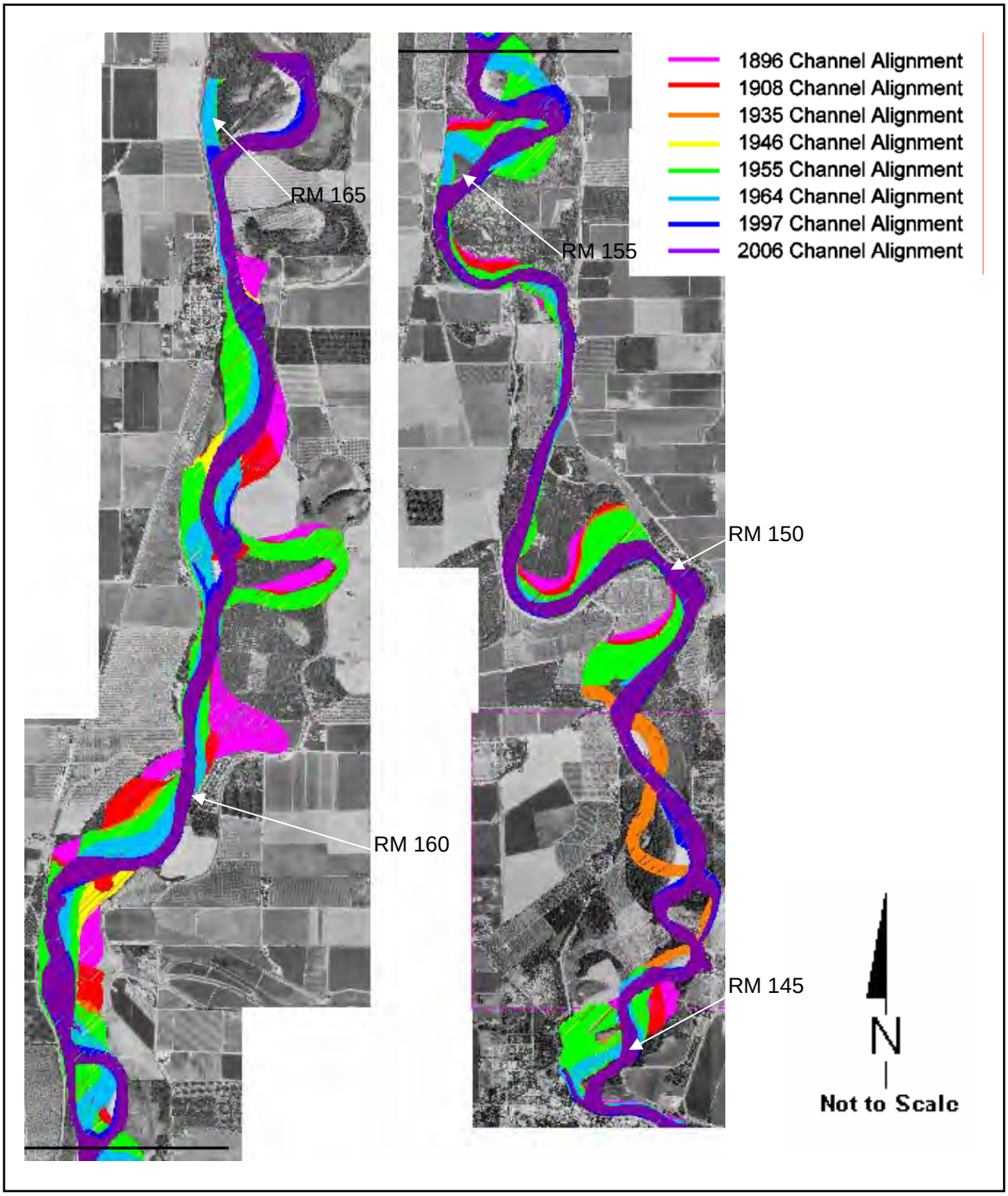


Figure 4. Channel Alignments and Migration Paths

1.3 Purpose and Scope

The purpose of this project is to determine the hydraulic impacts of proposed riparian restorations on the floodplain, the river channel, and levees. To determine these hydraulic impacts, the scope outlines the following tasks:

- Compare channel thalweg profiles from the 1930's, 1957, and 1997.
- Develop an inventory of in-channel, large woody debris.
- Develop and calibrate a base 2D hydraulic model.
- Update model terrain with 2006 LIDAR topography.
- Run an existing conditions hydraulic model using the design flow.
- Re-run the hydraulic model to simulate the effects of large woody debris
- Re-run hydraulic models for the restoration conditions.
- Evaluate the effects of the restoration planting on seepage through the levee.
- Evaluate the hydraulic impacts on the properties adjoining the restoration sites.

1.4 Acknowledgements

This project was scoped by The Nature Conservancy (TNC) and the project manager is Mr. Gregg Werner. The project manager for Ayres Associates is Mr. Thomas W. Smith, PE, GE.

The 1997 river topography was provided by the US Army Corps of Engineers (USACE) and the 2006 LIDAR topography was provided by TNC. Aerial images from 1998 were obtained from Terraserver and images from 2005 were obtained from the Natural Resource Conservation Service.

2.0 CHANNEL THALWEG COMPARISON

The Advisory Workgroup noted that a concern often mentioned by the landowner is that the channel had been aggraded or "silted in" within the Colusa Subreach so that flood-carrying capacity was diminished. To help address this concern, a comparison of available thalweg data was conducted. The thalweg is defined as the deepest part of the river channel bottom. The purpose of the comparison was to determine if the available information would document a general trend in the depth of the channel over time.

Channel thalweg data was collected and recorded in topographic surveys in 1937, 1957, and 1997. The 1937 data came from a survey completed by the USACE, which consisted of measuring a water surface elevation and taking water depths at selected cross sections. The cross sections were taken about every 1/10 of a mile. The 1957 thalweg data came for the USACE design profiles that include the river invert, the method of measurement is not known. The 1997 data was obtained from a detailed bathymetric survey (2-ft contour interval) completed for the USACE and is believed to be the most detailed topography of the 3 surveys.

The channel thalweg profile is shown in **Figure 5**. Upon first glance it appears that the profile shows great variability in the riverbed. Ultimately this profile is inconclusive. Many factors can influence the river thalweg and these factors are not taken into account with a simple profile. The variance in channel width can affect the capacity. Some of the variation in the channel bed

could be due to the rock placement on the banks and levees. The different methods of surveying can also be a factor. It is possible that the more detailed survey of 1997 picked up more of the high and low points in the channel that was missed in the previous surveys. Given the channel migration and variance in width and split flows, as seen in Figure 2, this comparison does not contain adequate detail to correctly interpret the results.

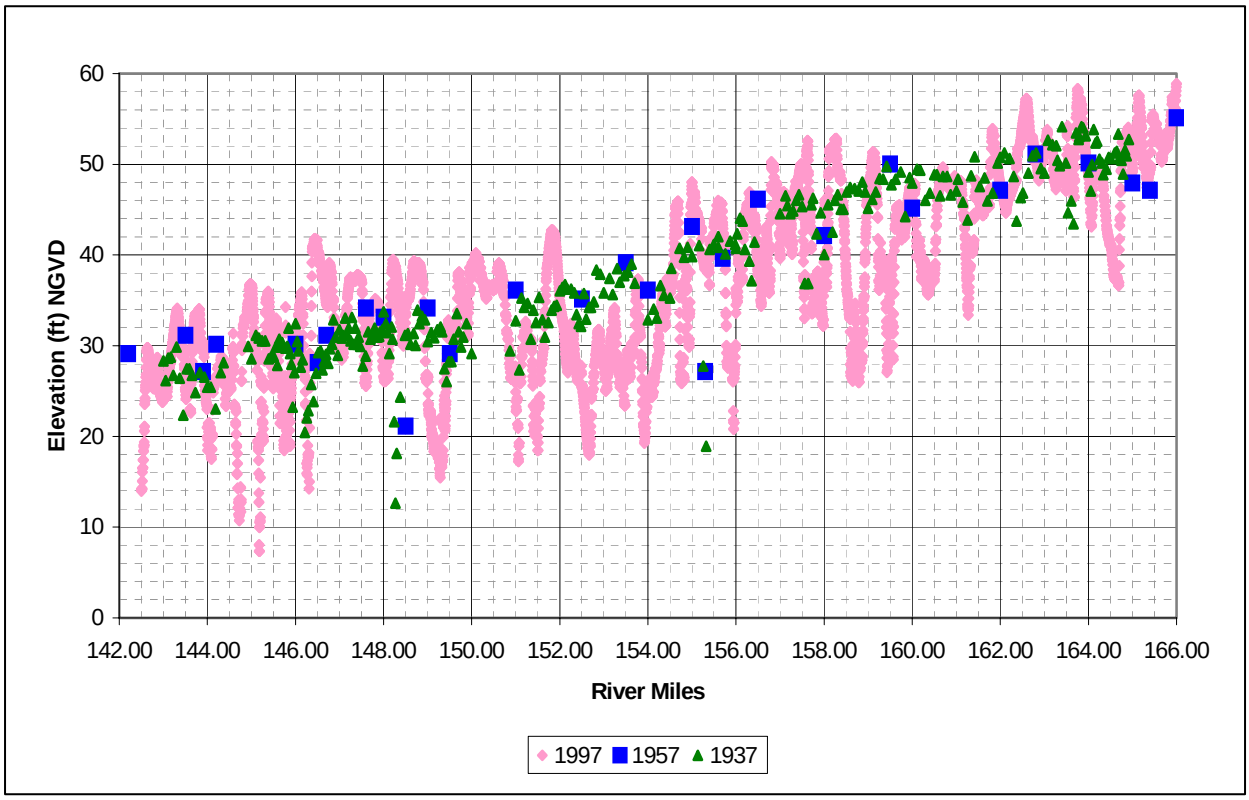


Figure 5. Sacramento River Thalweg, RM 142.5 to 166

3.0 LARGE WOODY DEBRIS INVENTORY

The Advisory Workgroup identified an additional landowner concern that the presence of large woody debris in the channel results in a loss of channel capacity by restricting flow and by increasing the buildup of sediment. To help address this concern, a detailed inventory of large woody debris was conducted for the Colusa Subreach. This inventory was later incorporated into one of the hydraulic model runs to specifically evaluate the effects of this debris on the water surface elevation of this reach of channel. It was reported that in the past, large woody debris was removed from the channel to facilitate commercial navigation but this removal has been discontinued for many years. Reasons for this discontinuance are thought to include lack of commercial navigation, negative impact on fish habitat and lack of funding.

On July 13, 2006, Ayres personnel performed this inventory of in-channel, large woody debris (by boat) through the entire study reach. The flow at the time in the Sacramento River was roughly 10,500 cfs, according to the Butte City gage (BTC). The observed trees were those visible above or just below the water surface on that day. Debris may have moved downstream since then so these numbers can only be assured for that given day. A table showing the

inventory of trees, including estimated river mile, waypoint(s), the respective bank location, number of trees at the specific location, and any pertinent notes, is included in **Appendix A**.

Some stretches of the river were fairly barren of tree debris, while others were heavily laden with debris. The approximate location of each observed tree (marked by a red x) and the waypoints are shown on aerial maps, also located in Appendix A. The area of thickest debris density is between RM 156.5 and RM 157.5, this particular stretch of the river is often referred to as “debris alley.”

The long duration high flows of early 2006 may have affected debris in two ways. It may have recruited more woody debris through bank erosion and channel migration, or it may have relocated much of the existing debris into lower river reaches.

4.0 HYDRAULIC MODEL RUNS

4.1 Calibration Run

The calibration run consists of performing a simulation of the hydraulic model with known variables to ensure the accuracy of our subsequent model runs. For this project, the model was calibrated to a flood that occurred on January 2, 1995. This was a significant flood flow that has good data available, including surveyed high water marks, gage data, and aerial imagery. The topography used for this run was from the 1997 Sacramento River survey. Aerial imagery from 1998 was used to help identify land uses during the time. Gage data from the Butte City gage, upstream of the site, and the Colusa Bridge gage, near the downstream end of the model, were used for flow data. Stage data from the Department of Water Resources (DWR) and the corresponding rating curve along with historic flow split data were used to determine the flow into the weirs.

4.2 Existing Conditions Run

The existing run simulates present (2006) conditions of the river using the USACE design flow. This run is used as a base for comparison to proposed restoration conditions. The topographic data used in this run was the 1997 survey and was updated with LIDAR topographic data (provided by TNC) for overbanks and any changes to channel alignment. Aerial imagery from 2005 (available from the Natural Resources Conservation Service) was used to establish existing land uses.

4.3 Large Woody Debris Run

The large woody debris run utilizes the existing conditions run as a base model and then incorporates simulated increases in roughness for specific areas of documented large woody debris. Based on the inventory developed in the field, the roughness of specific elements, within the model grid, were increased to account for the documented large woody debris of 2006. The roughness increases were based on the guidance in USGS Water Supply Paper 2339. Adjustments ranged from minor (where the sphere of the influence around one obstruction does not extend to another – increases of 0.005 to 0.015) to appreciable (where the space between obstructions is enough to cause the effect to be additive – increases of 0.02 to 0.03). This run should be looked at as only a “snapshot” in time because debris is somewhat

transient in this system. The true purpose of this run was to show how much of an increase large woody debris can make on water surface elevation.

4.4 Restoration Conditions Run

The restoration condition simulates the same flow conditions as the existing conditions model, except the land uses on certain properties were changed to reflect the proposed 8 restoration sites. The sites are referred to as: Womble, Jensen, Stegman, 1000 Acre, Boeger, Colusa North, Cruise'n Tarry, and Ward. The locations of the sites were shown in figures 2 and 3 and the land use plots are shown in **Appendix B** for existing conditions and **Appendix D** for restoration conditions.

The Womble property is situated on the east floodplain near RM 162, in a back-water area. It is approximately 56 acres with a planned conversion from field crops to a scrub and riparian forest.

The Jensen site is just upstream from RM 161 in the east overbank. The property is about 82 acres and the existing land use is orchard. The proposed conversion is to a mix of riparian forest and grassland/shrub mixture.

Stegman is a small restoration site of approximately 7 acres, located adjacent to the river in the west overbank, at RM 160. The current land use is a mixture of scrub and orchard. The restoration is for scrub and riparian forest.

1000 Acres is located just west of Stegman, at RM 160. The 51 acre property is currently orchard, with a planned restoration to riparian forest.

The Boeger property is located in the east floodplain at RM 148. It is about 45 acres and currently field crops. It is proposed to be restored to a combination of riparian forest and scrub.

Colusa North is currently a little orchard (roughly 5 acres) surrounded by riparian habitat. It is in the west overbank at RM 147 with a planned restoration to mixture of savannah, scrub, and riparian forest.

The Cruise'n Tarry property is unique; the upper portion of it is high ground and remains dry for most storm events, while the lower portion remains a reverse current area. It is approximately 8 acres and the planned conversion is from old oxbow/bare earth/some riparian to full riparian.

The Ward property is 142 acres and is located in the west overbank from RM 146 to 145. The current land use is field crops and the proposed restoration is to riparian forest with some savannah and a meadow flow through path. Although the Ward property is being restored by the Department of Water Recourses (DWR), we have included it for cumulative effects and as a courtesy to DWR.

5.0 HYDRAULIC MODELING

5.1 General

The 2-dimensional (2D) hydraulic modeling tool used for this project was the RMA-2V program, version 4.35, maintained and distributed by the USACE and modified by Ayres Associates. The

program has been used extensively for similar projects on the Sacramento River and has proven to be an effective model for representing river flow conditions. The Surface-Water Modeling System (SMS) version 9.0 software was used to develop the model geometry file and to view model results.

5.2 Model Development

The geometric definition of the project reach is given in the form of a finite element network of triangular and quadrilateral elements, known as a mesh, a section of the mesh is shown in **Figure 6**. The elements were sized and oriented to represent hydraulic features, breaklines, structures, and topographic changes. Each element contains corner and mid-side nodes, which represent points in space (X, Y, Z) and define the topography of the project reach.

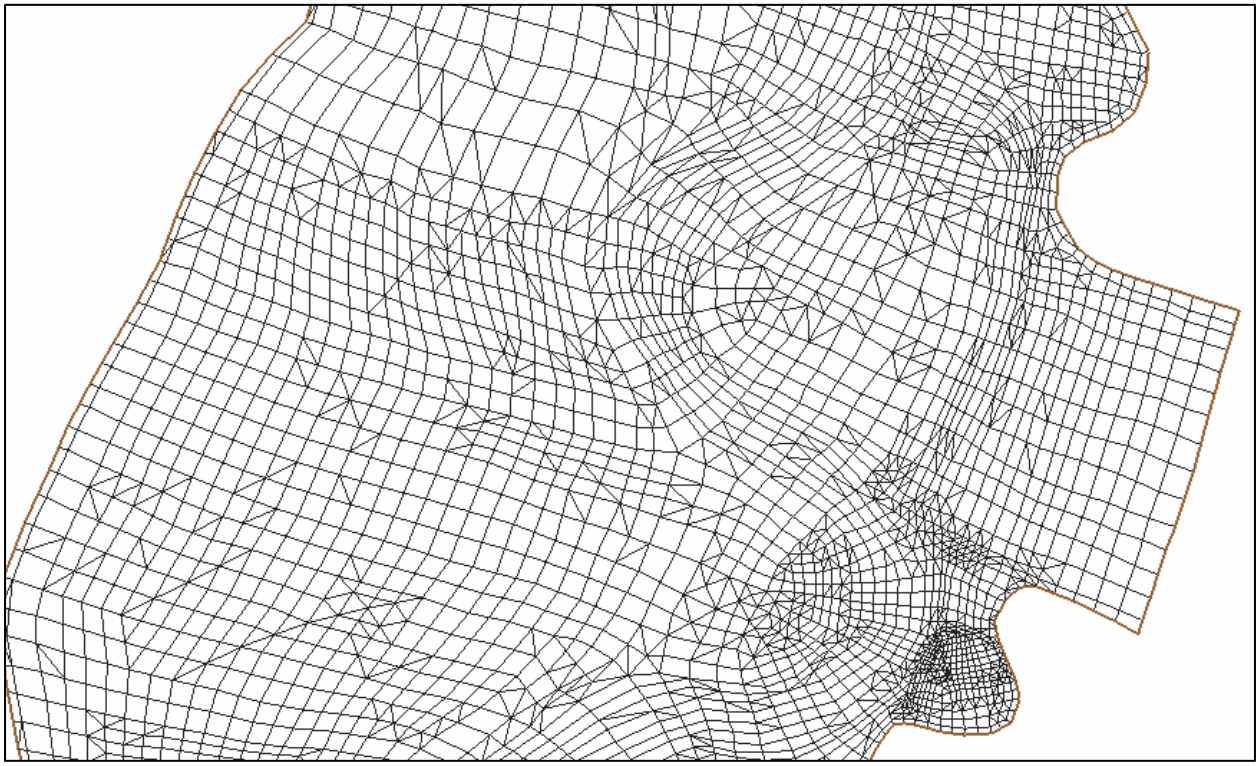


Figure 6. Finite Element Mesh

The topography used to develop the mesh came from a combination of two mapping projects. The initial mesh was developed using the 1997 bathymetric survey completed by Ayres Associates for the USACE. The mesh and channel alignment were updated with the 2006 LIDAR topography provided by TNC. The model mesh coordinates are in NGVD-29, NAD-83, US feet.

5.3 Material Roughness

In the river reach, material types within each element were categorized based on land use and roughness characteristics (dense vegetation, grassland, sandbars, etc.). The material types were assigned to each of the elements in the finite element mesh using aerial photography from the 1998 (USGS) for the calibration model and 2005 aerial imagery developed by the Natural

Resource Conservation Service. A summary of the roughness parameters used for this project is provided below in **Table 2**. The land uses for the existing conditions, debris run, and with-project conditions are shown in **Appendix B, C** and **D**, respectively. These values match closely to a previous hydraulic model performed by Ayres Associates in the early 1990's, adjacent to the Colusa Weir.

Table 2. Material Roughness

Material	Roughness value
Levee	0.03
Scrub	0.04
Orchard	0.075
Sparse Trees	0.06
Light Riparian/Riparian Scrub	0.07
Riparian Forest	0.09
Bare Earth	0.03
Smooth Concrete	0.014
Cobble	0.04
Rock Riprap	0.045
Structure	0.20
Channel	0.028
Grass	0.032
Sandbar	0.02
Oxbow	0.035
Field Crops	0.035
Savannah	0.045
Channel with Minor Debris Effects	0.032 – 0.43
Channel with Appreciable Debris Effects	0.048 – 0.058

5.4 Flow Splits

This reach of the Sacramento River contains two overflow weirs (Moulton and Colusa), which significantly reduce the flow down the main channel by diverting portions of the flow into the Butte Basin. These overflow weirs, shown in Figure 1, start to spill when the flow in the Sacramento River water surface elevation reaches 58.91ft (NGVD) at the Colusa Weir, and 73.95ft (NGVD) at the Moulton Weir.

Our initial model run used the 1957 design capacities for the main river and the weirs. However, after many trials we found that the model would not solve with these flow splits. Upon a further review the historic data for the Sacramento River, Moulton Weir, and the Colusa Weir, some inconsistencies in the flow splits were discovered. The 1957 design capacities of the weirs (25,000 cfs for Moulton and 70,000 cfs for Colusa) are not compatible with recorded historic events (34,000 cfs over Moulton -1970 and 75,300 cfs over Colusa - 1958). The weirs appear to accommodate more overflow than the stated 1957 design flow capacities. Therefore, the historic flow split data was deemed more accurate than the 1957 design flows. Also, we found that the weir rating tables, developed by the Department of Water Resources (DWR), matched very closely to historic stage/flow data and have shown these comparisons in **Figures 7 and 8**.

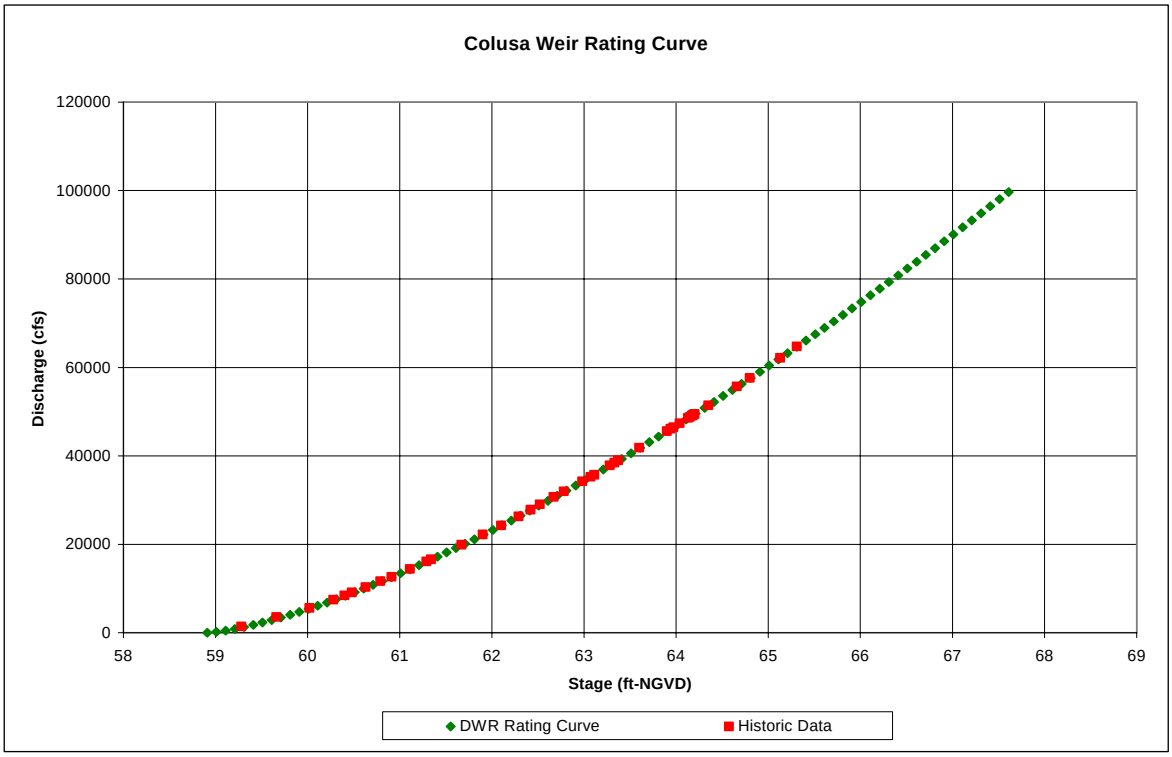


Figure 7. Rating Curve at Colusa Weir

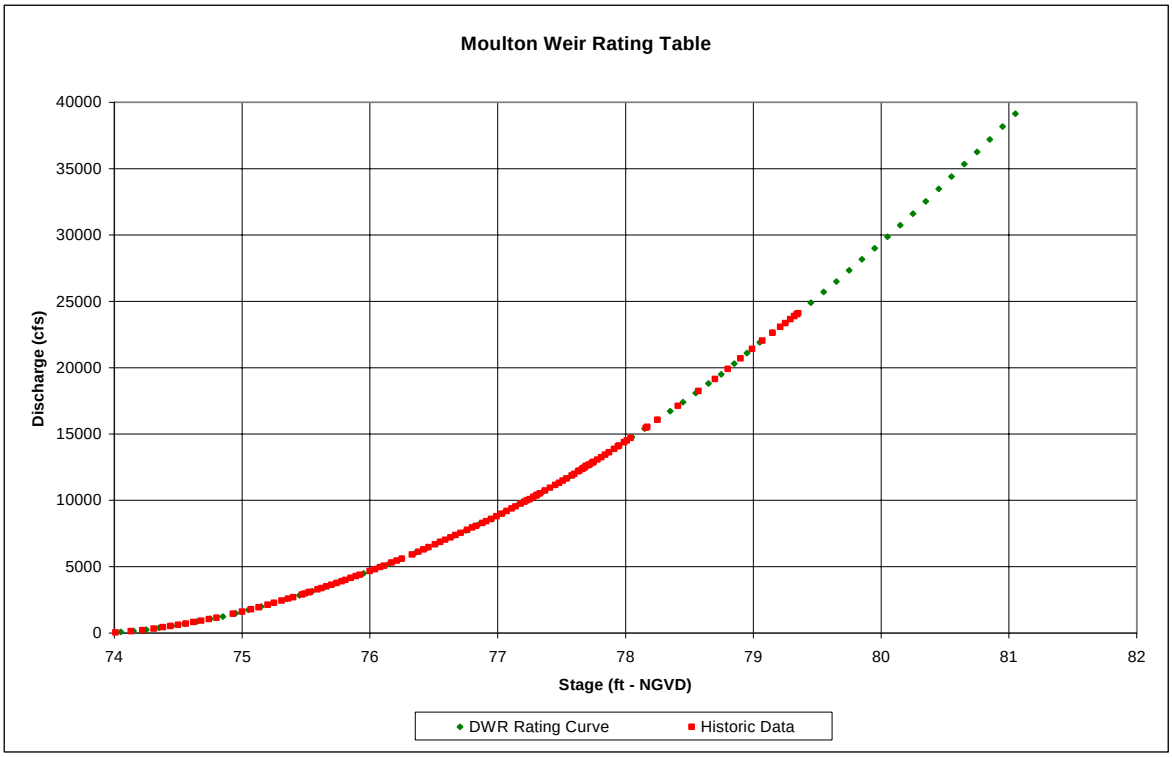


Figure 8. Rating Curve at Moulton Weir

Further, based on the historic data and other available sources, the design capacity in the river, adjacent to the City of Colusa, does not seem correct. The recorded flow at the Colusa bridge gage has never reached the design capacity of 65,000 cfs. The greatest flow of record past the City of Colusa was 51,800 cfs in 1983. In 1958 (one year after the design flows were developed) a flood of 160,000 cfs (design event) passed by Butte City. From this flow only 45,800 cfs passed the City of Colusa. In addition, the DWR rating curve for the Colusa Bridge only extends to 53,000 cfs. A summary of the design and large historic flood events is shown in **Table 3**.

Table 3. Design Flow and Historic Flood Events on the Sacramento River.

Location	USACE Design Flow	1942 Historic Event	1958 Historic Event	1983 Historic Event
Butte City Gage	160,000	170,000	158,000	157,000
Moulton Weir Gage	25,000	N/A	34,700	N/A
Colusa Weir Gage	70,000	N/A	71,200	N/A
Colusa Bridge Gage	65,000	49,000	44,800	51,800

To further document the problems with the design flow capacity numbers, we have provided some graphics. By extending the official Colusa Bridge rating curve (**Figure 9**), the water surface elevation for 65,000 cfs (design flow) would be 71 ft (NGVD). Spot elevations on the east bank are at 71.1, 71.5, and 71.9. There would not be adequate freeboard for a flow of 65,000 cfs. A cross section just upstream of the Colusa Bridge is shown in **Figure 10** with the estimated water surface elevation for 65,000 cfs.

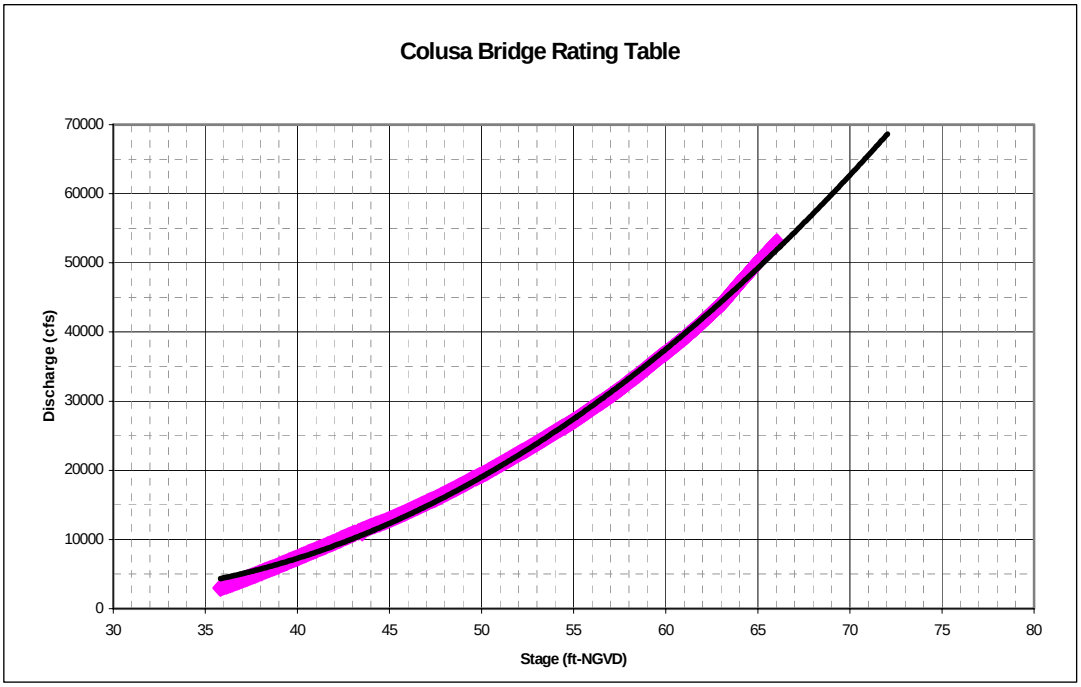


Figure 9. DWR Rating Curve at Colusa Bridge

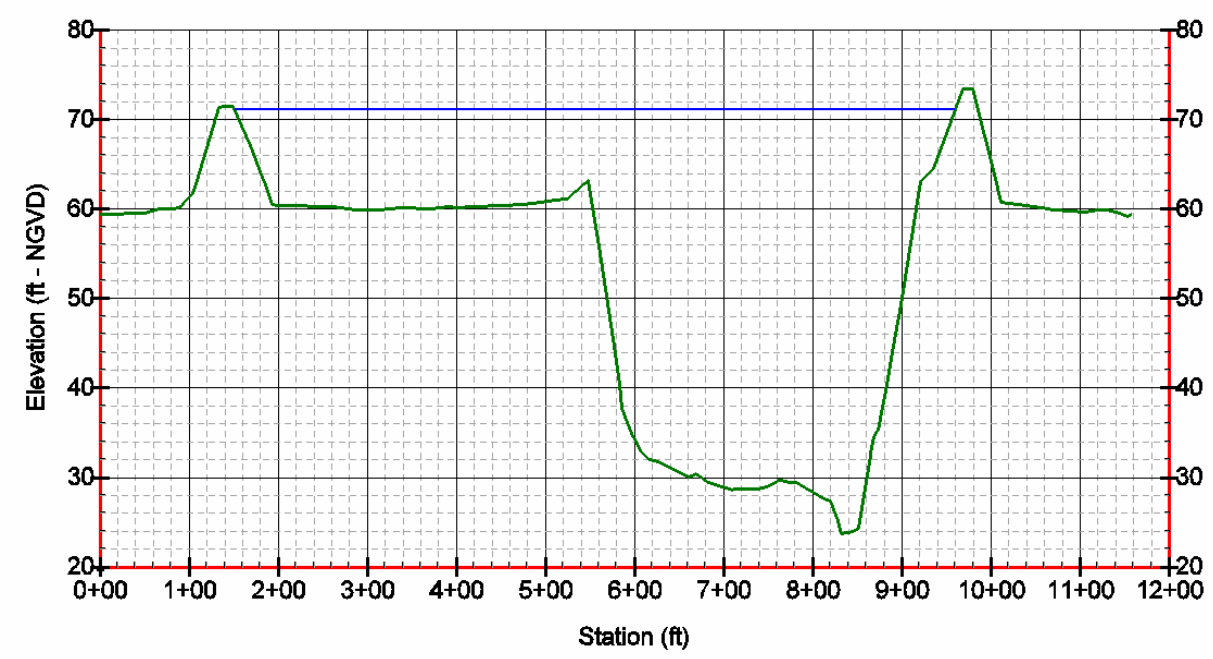


Figure 10. Cross Section of the Sacramento River, just Upstream of Colusa Bridge with Water Surface Elevation Corresponding to a Flow of 65,000 cfs

5.5 Boundary Conditions

The boundary conditions used in the calibration model came from the historic flood event of January 2, 1995. The boundary conditions for the existing conditions model were based on the 1958 historic flow data and slightly increased proportionally to match the upstream flow of 160,000 cfs. The 1958 flow was chosen since it came the closest to the official 1957 USACE design flow (158,000 cfs vs. 160,000 cfs). The boundary conditions for the hydraulic models are summarized in **Table 4**.

Table 4. Boundary Conditions

Boundary	Calibration Model	Existing Conditions/ Developed Models
Upstream Limit (RM 164.5)	143,000 cfs	160,000 cfs
Moulton Weir	24,900 cfs	35,700 cfs
Colusa Weir	69,200 cfs	72,500/73,500 cfs
Downstream Limit (RM 142.5)	48,900 cfs 64 ft (NGVD)	51,800/50,800 cfs 65 ft (NGVD)

5.6 Calibration

Calibration is performed to establish the accuracy of a model, typically by simulating a historic flow with well-established high water marks. This model was calibrated to the January 10, 1995 high flow. Gage data was recorded by USGS at the Colusa gage and Butte City gage. Stage elevations at the Moulton and Colusa weirs were recorded by the DWR's Sutter Maintenance

Yard and rating curves were used to determine the flow. High water marks on the east and west levees were recorded shortly after the flood flow by the DWR's Northern District. Land uses were derived from the 1998 aerial images and altered where known land use changes had occurred after1995.

In our initial run, our model over estimated water surfaces throughout the system. The initial roughness values were overestimated were adjusted accordingly. Further analysis showed specific areas where the water surface was being overestimated. Some investigative work into the land use in these areas was conducted and many areas were found to have different land uses than the 1998 aerial image showed. However, between RM 154 to RM 152, we still had modeled water surfaces of about a foot over the surveyed high water marks. This stretch of the river is narrow and has shown no significant changes throughout the river's recorded history. It is possible that some channel dynamics occurred between 1995 and the survey of 1997 that we cannot account for. Since there are no planned restorations in this stretch of the river, we consider the results in this area to be conservative and adequate for modeling purposes.

A comparison of the surveyed high water marks and the calibrated model water surface is shown in **Table 5**. A profile comparison is shown in **Figure 11** for the East Bank and **Figure 12** for the West Bank.

Based on our professional judgment and experience with previous hydraulic models on the Sacramento River, the overall results show acceptable agreement between the model and the surveyed values. The modeled water surface elevations are all less than 1 foot off from the measured high water marks with only two exceptions. This discrepancy is most likely due to the fact that the river configuration had changed somewhat either during or after the flood event, causing difficulty in recreating the same local topographic and hydraulic conditions. In the locations where the calibration is close to a foot off, there is no restoration planned.

Table 5. Comparison to High Water Marks

River Mile	1995 Surveyed High Water Mark (ft)	Model Elevation (ft)	Difference
East Bank			
165.5	89.4	89.6	0.2
164.7	88.6	89.34	0.74
164.5	87.7	88.62	0.92
164	87.6	88.12	0.52
163.6	86.2	86.48	0.28
162.7	85.3	85.87	0.57
162.5	85	85.39	0.39
162.3	84.8	85.38	0.58
160.5	83.1	83.88	0.78
160.3	83.3	83.86	0.56
160	83.2	82.93	-0.27
159.6	82.6	82.83	0.23
158.3	79.6	79.88	0.28
157.4	79.5	79.14	-0.36
156.1	78.4	77.6	-0.8
150.5	70.9	71.95	1.05
149.5	70	70.17	0.17

River Mile	1995 Surveyed High Water Mark (ft)	Model Elevation (ft)	Difference
East Bank			
147.7	66.8	67.24	0.44
146.8	66	66.76	0.76
145.3	65.8	65.76	-0.04
144.5	64.7	65.15	0.45
143.8	64.5	64.86	0.36
143.1	64.5	64.28	-0.22
West Bank			
164.9	89.4	89.35	-0.05
164.4	87.7	88.13	0.43
163.8	86.5	86.71	0.21
163.3	85.9	86.27	0.37
162.8	85.3	85.88	0.58
161.9	84.9	85.27	0.37
161.6	84.1	84.97	0.87
160.9	83.5	84.06	0.56
160.4	83.1	83.02	-0.08
160.3	82	82.79	0.79
160.2	82.1	82.51	0.41
159.4	81.8	82.25	0.45
158.2	79.9	80.39	0.49
156.9	79.1	79.54	0.44
156.6	79	79.43	0.43
155	77.6	78.29	0.69
154.6	77	78.06	1.06
154.1	76.4	77.58	1.18
153.5	75	76.13	1.13
152.4	74	74.71	0.71
152.1	73.8	73.78	-0.02
151.8	73.2	73.39	0.19
151.4	72.4	72.96	0.56
151	71.8	72.52	0.72
149.2	68.6	68.63	0.03
147.8	67.5	67.62	0.12
147.3	66.8	66.74	-0.06
146	66.1	65.98	-0.12

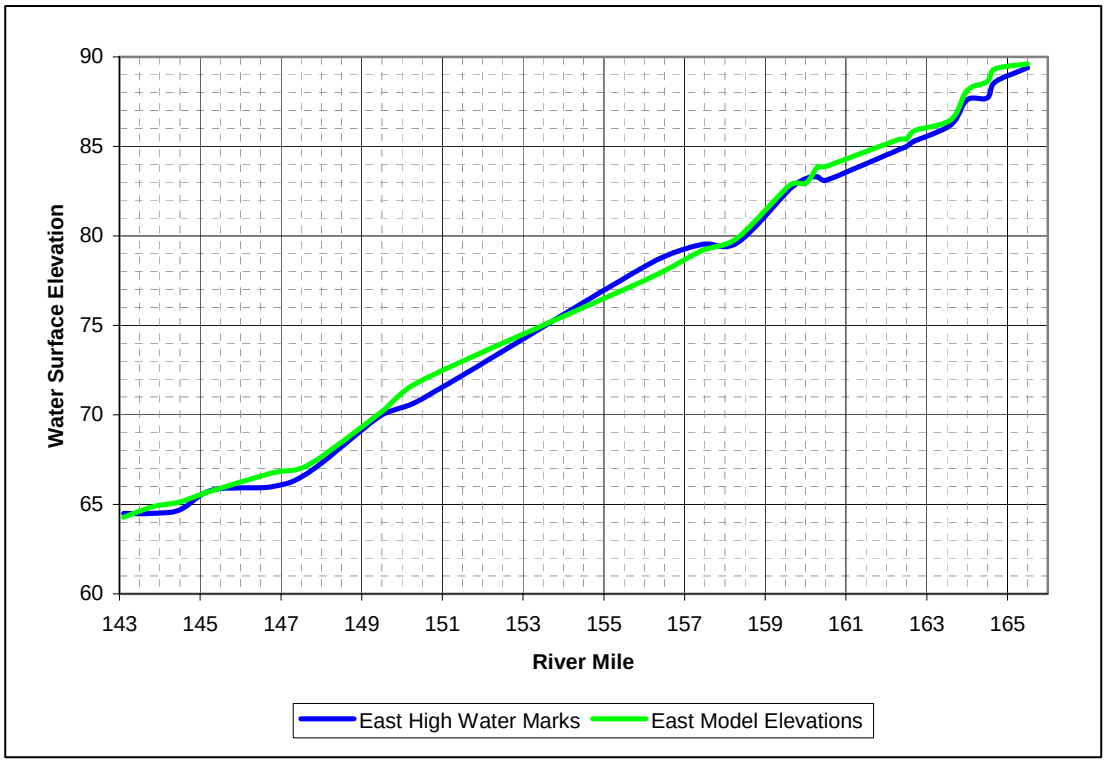


Figure 11. Profile Comparison of High Water Marks on the East Bank

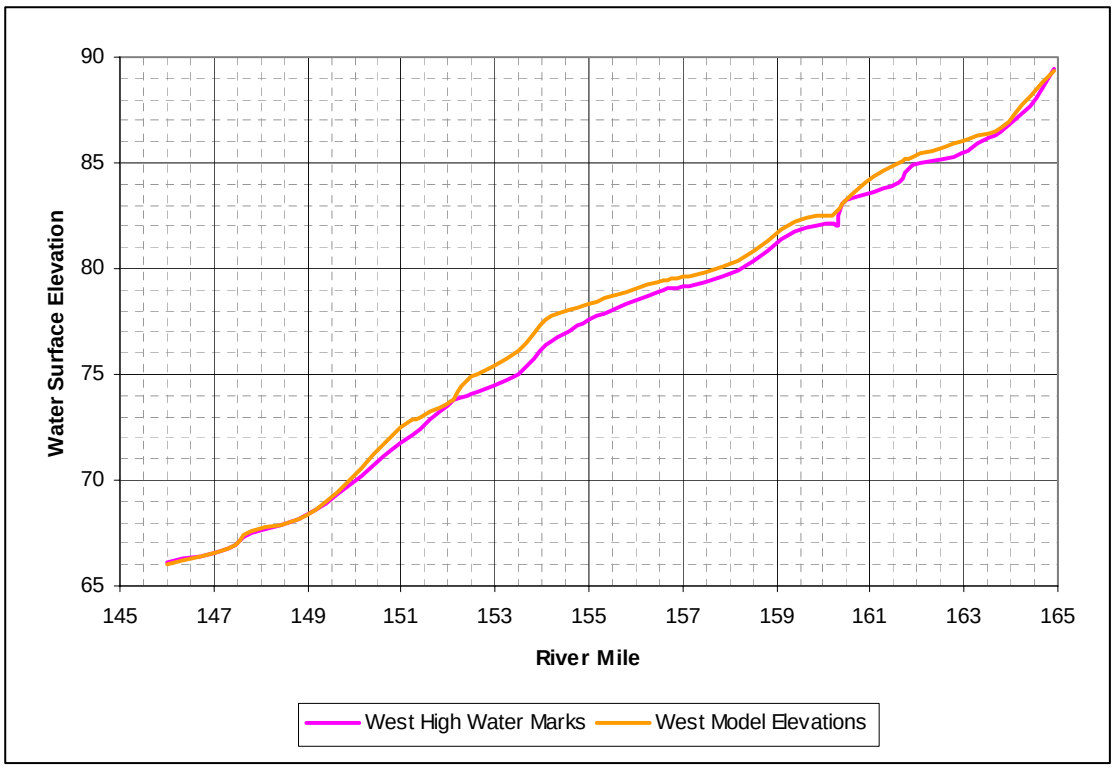


Figure 12. Profile Comparison of High Water Marks on the West Bank

6.0 Results

6.1 Velocity

6.1.1 Existing Conditions Model

The velocity contour plots are overlaid on the 1998 aerial image and are provided in **Appendix E**. The velocity in the channel typically ranges from 3 to 8 fps. Around the sharp bends it gets up to 11 fps. The velocity lowers some after both of the weirs since the weirs are diverting flow. With less flow and roughly the same channel area, the velocity decreases. The overbanks range from less than a foot per second in backwater areas to 3 fps. The velocity in the overbank is greatest in the section where the floodplains are narrowest.

The proposed restoration areas are outlined in white and labeled on the contour plots. The Womble restoration site shows less than 2 fps of velocity, and is essentially a backwater area. The Jensen restoration area shows between 1 and 3 fps and is in the active floodplain. The Stegman restoration has velocities less than 3 fps and is in the active floodplain. The 1000-Acre restoration is less than 2 fps and in a backwater section of the floodplain. The Boeger restoration area is in a narrower section of river and the velocities are between 2 and 3 fps. The Colusa North restoration has velocities below 1 fps and is in a relatively ineffective velocity area. The Cruise'n Tarry restoration area is a backwater section, with a large eddy. The velocities are less than 2 fps. The Ward restoration gets velocities up to 3 fps.

6.1.2 Large Woody Debris Model

The velocity contour plots for the large woody debris run are provided in **Appendix F** and the velocity differential between the debris run and existing conditions is provided in **Appendix G**. The overall velocity and distribution is essentially the same as the existing conditions with some changes within the areas of heavier debris fields. This run does demonstrate that debris fields do have some impact, but it's important to remember that debris is not a static feature of river and the debris fields will change size and locations over time.

None of the impacts shown in this run occur near any of the proposed restoration areas. However, there are two areas that show noticeable changes over the existing conditions model. The cutoff at RM 157, commonly referred to as "debris alley", causes a reduction in velocity of up to 1.0 fps. With a base velocity of 3 to 4 fps, this lowering could potentially create some additional deposition in this area, but that is unlikely in this case because of the increased turbulence created by the heavy debris field. The other area of obvious change is at RM 149 where there is an increase in velocity of up to 1.0 fps in the outer channel that extends partially into the main channel. This increase could cause some erosion on the sandbar island that has formed near the left bank of the channel and the left riverbank.

6.1.3 With-Project Conditions Model

The velocity contour plots for the with-project restoration conditions are provided in **Appendix H** and the velocity differential between the developed conditions and existing conditions is provided in **Appendix I**. The velocity patterns are similar to the existing conditions. The velocity in the channel ranges from 3 to 9 fps, with the velocity in the bends reaching up to 12 fps. The overbank velocities are typically under 4 fps.

On the Womble property, there are velocity decreases of 0.53 fps in the restoration area where the land use roughness increases, which results in up to 0.42 fps of increases adjacent to the property. One of theses increases is adjacent to the levee, where the increase pushes the

velocity up to 2.0 fps, which is not high enough to cause erosion. At the Jensen property, the change in land use from orchard (existing) to forest and shrub/grassland (with-project) results in some increases and decreases. In the sections converted to riparian forest, the velocity decreases up to 0.5 fps. There are increases in the scrub/grassland areas and on the west side of the site next to the river. These increases are up to 1.0 fps. This increase puts the maximum velocity at below 3.0 fps, which is not enough to cause erosion on a vegetation bank.

At the 1000-Acre property, the majority of the with-project area has a reduction in velocity and there are no increases. The existing velocity in this area is under 1.0 fps, so any changes should not have any negative effects on the system. The Stegman restoration site has a velocity increase of up to 1.5 fps adjacent to the main channel. This increase brings the velocity on the channel bank to over 4 fps, therefore depending on the cover, erosion may occur.

The Boeger restoration site creates a velocity increase in the main channel of up to 0.3 fps in an already high velocity area. Since the increase is limited to the center of the channel and does not extent to the banks, it should not have any negative impact on the river system. The Colusa North property has a velocity increase of less than 0.22 fps in spots within the restoration. The Cruise'n Tarry restoration site is located in a purely backwater area and the development of this area has no significant impact on the river system.

The Ward property causes decreases upstream, downstream, and within the restoration site from the conversion of open space to riparian habitat. The result of these decreases is increases along the west levee and in the main channel. Along the west levee, the velocity increases by up to 0.78 fps. This increase however does not bring the velocity against the levee past the 1.0 fps mark; therefore it should not have any negative impacts on that levee. Within the main channel, the velocity increases by a maximum of just over 1.0 fps, bringing the main channel velocity to between 3 and 6 fps. An increase adjacent to the east levee, at the southern tip of the Cruise'n Tarry property, brings the velocity up to 4.2 fps over the existing 4.0 fps. Given that the existing conditions velocity is already above the possible erosion threshold, this slight increase should not change the erodibility factor.

6.2 Water Surface Elevation

The water surface elevations for the 1957 design profile, existing conditions land use, and with project land use are shown with cross sections through each restoration site. The cross section locations are shown in **Appendix J** and the cross sections are shown in **Appendix K**. For comparison purposes, we have also included the water surface differential plots between the existing condition run and the 1957 design profile in **Appendix L**. The water surface elevation differential between the existing conditions and the large woody debris run are shown in **Appendix M**. The water surface elevation differential between the existing conditions and the with-project run are shown in **Appendix N**.

6.2.1 Existing Conditions

The plots in Appendix L show the differential water surface between the existing conditions model run and the 1957 design water surface. Of particular interest is that in some reaches (approximately 1/3 of the modeled reach) the existing conditions water surface elevation is higher than the 1957 design profile and particularly in the downstream reaches the existing conditions water surface is lower than the 1957 design profile. We don't have an explanation

for this, but obvious reasons include changes in land use within the levees and a greater capacity than the design for both weirs.

The cross section plots in Appendix K show that the existing conditions water surface elevation is lower than the design elevation at the Womble restoration, the Stegman restoration, most of the 1000 Acre restoration, the Boeger restoration, Colusa North restoration, Cruise'n Tarry restoration, and Ward restoration properties. The Jensen restoration site and the southern portion of the 1000-Acre restoration show greater water surface elevation (less than 0.15 ft) in parts and about the same elevation as the design in other parts.

6.2.2 Large Woody Debris Run

This run was completed as a demonstration of the effects on water surface based on mapped debris fields. This run takes the base model and superimposes the debris fields observed and mapping by Ayres in the summer of 2006. Technically, the base model, calibrated to the 1995 high flow event, already includes some effects of debris at that time, but we lack any data from that period so were unable to compare how much different the 1995 debris fields were from those in 2006. However, for demonstration purposes, the roughness associated with the debris fields in 2006 was added to the base model and the model rerun to show how much of an increase in water surface could be associated with just the large woody debris as mapped in 2006.

Figure 13 shows a cross section at RM 157 showing debris within the channel. This was done to show how much of the total flood flow path is impacted by debris. The trees shown are of a 3 ft and 1.5 ft diameter.

The results from this run (Appendix M) show negligible effects throughout most of the entire reach with the exception of Stegman and 1000 Acre parcels, where the water surface is roughly 0.10 ft higher due to the heavy debris load in the area between RM 157 and 158. The results can also be interpreted to mean that if all of this debris were to be removed, the water surface would be reduced by that same amount in these same areas.

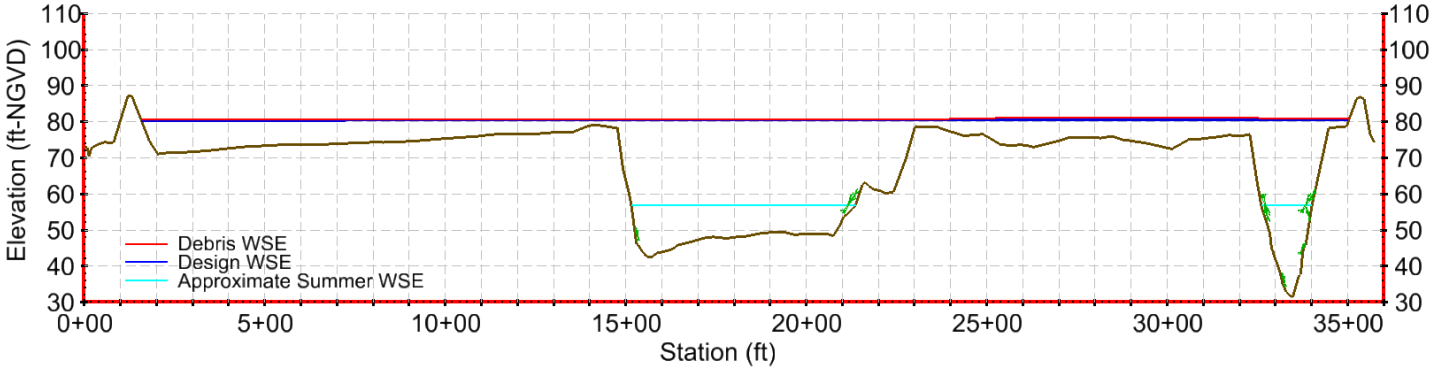


Figure 13. Cross Section at RM 157 Showing Locations of Woody Debris

6.2.3 With-Project Conditions

The with-project conditions water surface elevation is lower than the 1957 design water surface from RM 143 to 154 and from RM 161 to 164. In the remaining areas, the water surface elevation is higher than the 1957 design but at or lower than existing .

At the Womble property, the water surface is more than 0.74 ft below the design elevation and 0.05 ft below the existing conditions at the upstream edge (Figure K-1 in the Appendix) and 0.56 ft below design and 0.11 ft below existing conditions at the downstream edge (Figure K-2 in the Appendix).

On the Jensen property, the with-project condition is slightly less than the existing condition, but greater than the 1957 design by a maximum of 0.36 ft on the upstream edge (Figures K-3 in the Appendix), and on the downstream end it is above the existing and the design conditions elevation by no more than 0.15 ft (Figure K-4), however this increase is confined to the center of the floodplain and does not extend to the levee, so there is no impact on freeboard (Figure N-2 in the Appendix).

On the Stegman property, the with-project water surface is below the 1957 design and 0.1 ft above the existing conditions (Figure K-5 in the Appendix). The upstream end of 1000-Acre is below the 1957 design, however the downstream end is 0.16 ft above it. When compared to the existing conditions, there is a maximum increase of 0.02 ft on the northern portion of the site, which is considered negligible. There is no increase over existing conditions on the southern portion of the 1000 Acre restoration site.

For the Boeger property, the water surface is below the 1957 design and maximum of 0.25 ft above the existing conditions.

On the Colusa North property, the with-project water surface elevation is below the 1957 design and roughly 0.05 ft higher than the existing conditions water surface elevation.

At Cruise'n Tarry the water surface elevation is below the 1957 design and roughly the same as the existing conditions.

For the restoration site on the Ward property, the with-project water surface elevation is below the 1957 design. When compared to the existing conditions water surface elevation, the with-project elevation ranges from the same elevation to 0.1 ft higher.

6.3 Effects of Restorations on Seepage through and under the Levees

Possible effects on seepage though or under the levees is directly related to **1)** increases in water surface which would produce a higher driving force for seepage and **2)** to longer durations of flood events as a result of the restorations. A review of the differential water surface plot information shows that the water surfaces at the proposed restoration sites are all either roughly at or below either existing conditions and below the 1957 design profile.

As for any increase in flood duration, there are no features that will be incorporated that will change the volume of floodplain storage and therefore no change will occur in the runoff hydrograph for this reach of river as a result of the proposed project. For the project to impact flood duration, it would have to include features that store water and released it at a later time during the runoff hydrograph. Since the water surfaces remain virtually unchanged, the volume of existing storage within the river and floodplain remain unchanged for this proposed project.

The other possible cause of increased seepage potential could be in the seepage path was shortened by erosion of the levee surface. A review of changes in velocity as a result of the restorations did not show any areas where levee erosion would increase enough to cause a shortened seepage path.

6.4 Impacts to Properties Adjoining Restoration Sites

Impacts to adjoining properties were analyzed in terms of both higher water surfaces during overbank flow events and velocity. In general the differences in water surface for the model runs performed were very small over the existing conditions model and any associated impact is negligible.

Changes in velocity could be of more significance in that it could affect the patterns of overbank erosion or deposition. The area adjacent to each proposed restoration was reviewed and summarized as follows.

Womble; near RM 162: The water surface plot in Appendix K (K-1 and K-2) shows the with-project condition to be a slightly lower water which will have no impact on adjacent properties. In regards to changes in velocity, the first plot in Appendix I (I-1) shows that most of the change is contained within the Womble property itself and in general is a reduction of 0.1 fps to 0. 5 fps. On the property directly to the west of Womble, there is a small area of velocity increase of maximum 0.43 fps, which brings the with-project velocity up into the range of 1.5 to 2.0 fps. Since 2.0 fps is still below the range where erosion would occur for bare soil, we see no impacts related to new soil erosion. If deposition were occurring now, it would be slightly reduced.

Jensen; near RM 161: The water surface plot in Appendix K (K-3 and K-4) shows the with-project condition for the Jensen plot to be the same as the existing condition which will have no impact on adjacent properties. The velocity plot included in Appendix I (I-2), shows increased velocities for shrub/grass corridors and just west of the site, up to 1.0 fps for a resultant velocity of 4 fps. Increases of a smaller magnitude on the downstream property are in the 0.10 to 0.30 fps range. Since the velocities with-project are still less than 2 fps, no induced erosion on these properties is expected. Correspondingly lower velocities are shown in the restoration site and on the property to the east of Jensen. No impacts are expected on the property to the east of Jensen.

Stegman; near RM 160: The water surface plot in Appendix K (K-5) shows the with-project condition to be very close to the existing condition which will have no impact on adjacent properties. The velocity plot in Appendix I (I-2) shows considerable change at the site and a smaller increase immediately west of the site. The new velocity at this location is now up to 1.5 fps, however still below the potential to induce erosion on bare soil (2 fps). There is also an increase of up to 1.5 fps along the west riverbank. With project velocities at design flow are now in the range of 5 to 7 fps and this will increase the potential for bank erosion in the area downstream of the armored section (the armored section ends at the upstream end of the site).

1000-Acre; near RM 160: The water surface plot in Appendix K (K-5 and K-6) shows the with-project condition to be very close to the existing condition which will result no impact on adjacent properties. The velocity differential plot in Appendix I (I-2) for this site shows a slight decrease in velocity for the property immediately downstream of 1000-Acre, which should not have any impacts on the adjacent property.

Boeger; near RM 148: The water surface plot in Appendix K (K-7 and K-8) shows the with-project condition to be very close to the existing condition (and about 1.5 feet below the 1957 design water surface) which will have no impact on adjacent properties. The velocity differential plot in Appendix I (I-4) shows lower velocities on and immediately adjacent to the Boeger site with some small pockets of increased velocity that are considered to be less than significant. Velocities increase within the river proper by about 0.2 fps. Base velocities are

already high in this area (6 to 9 fps) and sediment transport capacity in the river may increase. The opposite riverbank is currently armored and this armor should adequate handle the 0.20 fps increase in bank velocity.

Colusa North; near RM 147: The water surface plot in Appendix K (K-9) shows the with-project condition to be very close to the existing condition which will have no impact on adjacent properties. The differential velocity plot in Appendix I (I-5) shows only a minor change to adjacent property (immediately east of Colusa North) and is considered to be less than significant. This adjacent property is owned by the Department of Fish and Game, so it should not be an issue.

Cruise'n Tarry; near RM 146: Both the differential velocity (I-5) plot and the water surface plot (K-10) show very little change that can be attributed to the proposed project. This site is very small and any impacts near this small site are overwhelmed by the influence of the Ward site across the river.

Ward; near RM 146: The water surface plot in Appendix K (K-11, K-12, and K-13) shows the with-project condition to be very close to the existing condition which will have no impact on adjacent properties. There are both some increases and decreases in floodplain velocities adjacent to the Ward site as can be seen in Appendix I (I-5). A review of the actual with-project velocities in Appendix H (H-5) shows that all overbank velocities are less than 2 fps and below the threshold for initiating erosion. Some new deposition may be possible in the areas of reduced velocity. The differential velocity plot also shows some velocity increases in the main river channel ranging from 0.10 fps to 1.0 fps. However most of these increases are away from the levee and in general will increase transport capacity in this reach. In the two areas where the river is close to the levee, immediately downstream of Cruise'n Tarry's and at RM 144.6L the increases are less than 0.2 fps. The upstream site was a repaired critical erosion site (set back levee) and the downstream site is armored.

7.0 CONCLUSIONS

Based upon our stated analyses of the Colusa to Princeton Subreach of the Sacramento River, we offer the following conclusions:

1. While the report was scoped to include a comparison of the three historic thalweg surveys (Figure 5) for this reach of the river, the results appear inconclusive in demonstrating overall trends of regional aggradation or degradation as they relate to river capacity. While the 1997 data shows a greater range of high and low points along the entire length of the profile, it is quite possible that this is because the newer data set has closer spaced cross sections and shows more detail over the 1937 values. Also the other element that was not considered in looking at changes in capacity, is the width of the existing channel over what existed in 1937. Overall changes in river and floodplain capacity are better demonstrated by the plots in Appendix L – Water Surface Elevation Differential, Design to Existing Conditions, which show which areas now have more freeboard than in 1957 and which reaches have less.

2. The hydraulic run with large woody debris added to the model is a "snapshot" in time and was performed to demonstrate how much a documented amount of woody debris in the river can affect water surface elevations. The 2006 inventory of large woody debris

was used for this run because it was a real situation and followed a large runoff event that most likely caused higher levels of accumulated debris. This run showed only minimal increases in selected areas (maximum of 0.1 foot) and also goes to show that the opposite would occur (0.1 ft of lowering) if the woody debris was removed.

3. The hydraulic model would not calibrate using the published design flows (1957) at the boundary conditions (Moulton Weir, Colusa Weir and Sacramento River at Colusa). Historic flow records from stream gage data were found to be a more accurate representation of the actual flow splits at the weirs and were used to calibrate the hydraulic model.

4. The computed water surface elevations for proposed restoration sites are at or below either the existing conditions run or the 1957 design profile with the exception of the Jensen site that has a small area at the downstream edge of the site that is 0.05 ft above existing within the restoration site. While 0.05 ft is considered to be insignificant, it is still an increase, however the location of this increase is limited to within the floodplain and does not impact the adjacent levee.

5. The proposed restoration will have no effect on the seepage potential either through or under the levees both on the proposed restoration sites and on any adjacent sites.

6. While the changes in floodplain velocities will have some effect on adjacent properties, in general, they were considered to be less than significant. Some small changes in deposition and erosion patterns may be seen for the design flow event.

Appendix A -
Woody Debris Inventory Locations

Woody Debris Inventory

Approximate River Mile	Waypoint	Upstream Waypoint	Downstream Waypoint	Number of Trees	Location	Notes
164		WD01	WD02	7	right bank	All trees are within 50 ft of the bank and evenly spaced. The downstream most tree is sticking out of the water, and the rest only the tops are sticking out. Picture is taken looking upstream.
164	WD03			1	left bank	Picture taken looking at left bank.
163.7		WD04	WD05	5	right bank	The upstream most tree, the top of the tree is on the bank and the lower portion is submerged. Pictures a,b, and c were taking looking upstream, picture d is looking at the right bank.
163.5	WD06				right center	Tree is located in the center of the main channel, just west of a sandbar. Picture taken looking east.
163.5		WD07	WD08	8	left and right bank of side channel	Trees are located in a small side channel east of a sandbar. Most of the trees are on the left bank with a couple on the right. Pictures a and c are lookingat the left bank, picture b is of the right bank of the side channel and the sandbar, picture d is looking downstream.
163	WD10	WD09	WD11	21	left bank	This reach had multiple trees and snags. 20 of the trees were on the left bank and 1 was in the center of the channel. Pictures are taken looking upstream at left bank.
162.8	WD12			6	left bank	The trees are in a cluster on the left bank. Picture taken looking upstream.
162.5	WD13			1	middle	Top of tree sticking out, causing a major riffle.
162.3	WD14			1	left center	Tree barely visible at that day's flow, riffle was observed.
161.9	WD15			4	right bank	Large percentage of the trees are sticking out above the water line.
161.6	WD16			2	right bank	Two trees with lots of brach debris on the right bank.
161.5		WD17	WD18	9	right bank	Pictures a, b, c, and d are looking at the right bank, pictures e and f are looking upstream.
161.5	WD19			4	right bank	Trees on right bank at upstream end of a sandbar. Picture looking upstream.
161.5	WD20			8	left and center	7 trees on left bank, 1 in center. Picture looking upstream.
161.3	WD21			5	left to middle	Trees spread out from center of channle to the left bank.
161.1	WD22			6	left to center	A cluster of 2 trees in the middle of the river and approximately 4 trees on the left bank. The left bank trees had lots of branches tied up in them.

Woody Debris Inventory

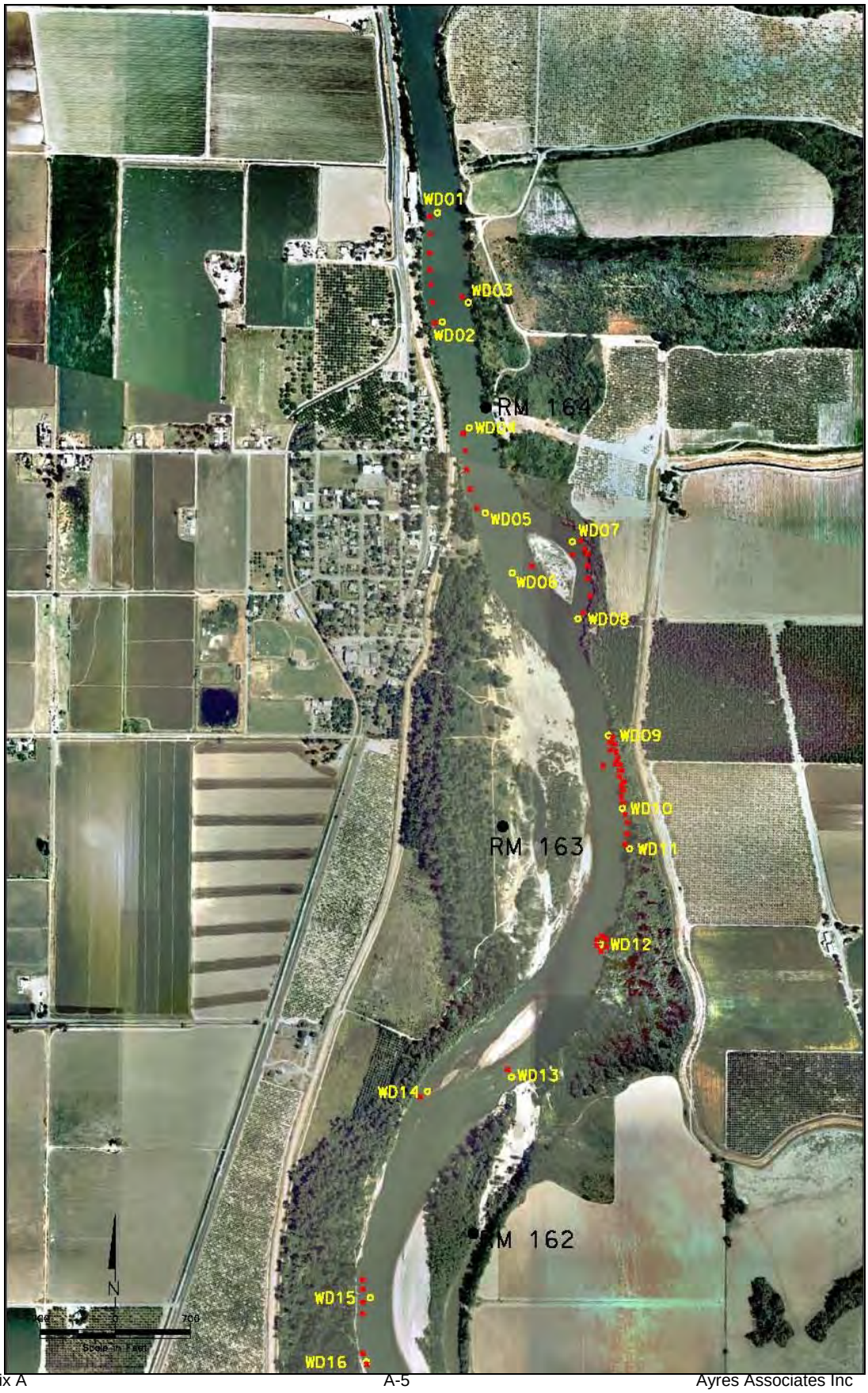
Approximate River Mile	Waypoint	Upstream Waypoint	Downstream Waypoint	Number of Trees	Location	Notes
161	WD23			4	left bank	Approximately 20 to 40 feet from the left bank, 2 barely sticking above the water level.
160.6	WD24			4	left and right	2 trees were on the left bank and 2 on the right bank.
160.2	WD25			3	left and middle	2 trees in the middle of the channel, 1 on the east bank.
159.8	WD26			2	left bank	
159.7	WD27			1	right bank	Tree protrudes out from the bank into the river.
159.4		WD28	WD29	9	middle	Trees are located in the middle of the channel with 8 exposed and 1 just underwater.
158.8	WD30			6	right bank	Cluster of multiple trees, may be more or less trees, water too high to distinguish.
158.6		WD31	WD32	8	right bank	8 trees were observed on the right bank, with the potential for more underwater. Lots of debris on the banks.
158.1	WD33			10	right, middle and left	7 trees on the right bank, 1 in the middle, and 2 on the left bank.
157.7	WD34			6	right bank	Multiple branches still attached to tree trunks.
157.4	WD35			1	left bank	Lone tree adjacent to large sandbar on the left bank.
157.1 - 156.6		WD36	WD37	54	throughout	This stretch of the river is commonly refered to as "debris alley" and is the right channel of the river Trees are located throught the section with some only slightly sticking out above the water. Picture a is taken from the upstream of the section and picture b is about halfway through the river section.
156.4	WD38			2	middle	2 trees in the middle of the river with multiple snags.
156.2		WD39	WD40	30	throughout	The river widens out at this location, trees are observed throught the channel and there is lots of debris is on the right bank.
155.8	WD41			4	right bank	Trees located adjacent to a sandbar. Picture taken looking upstream.
155.5 - 154.8		WD42	WD43	46	throughout	The majority of the trees are on the right bank with some in the middle and on the left. Some are just under the water.
154.5	WD44			3	right bank	Picture taken looking downstream.
154.4	WD45			1	left bank	Large tree with multiple large branches sticking out.
154.2	WD46			1	left bank	
154	WD47			4	left bank	Majority of trees are underwater.

Woody Debris Inventory

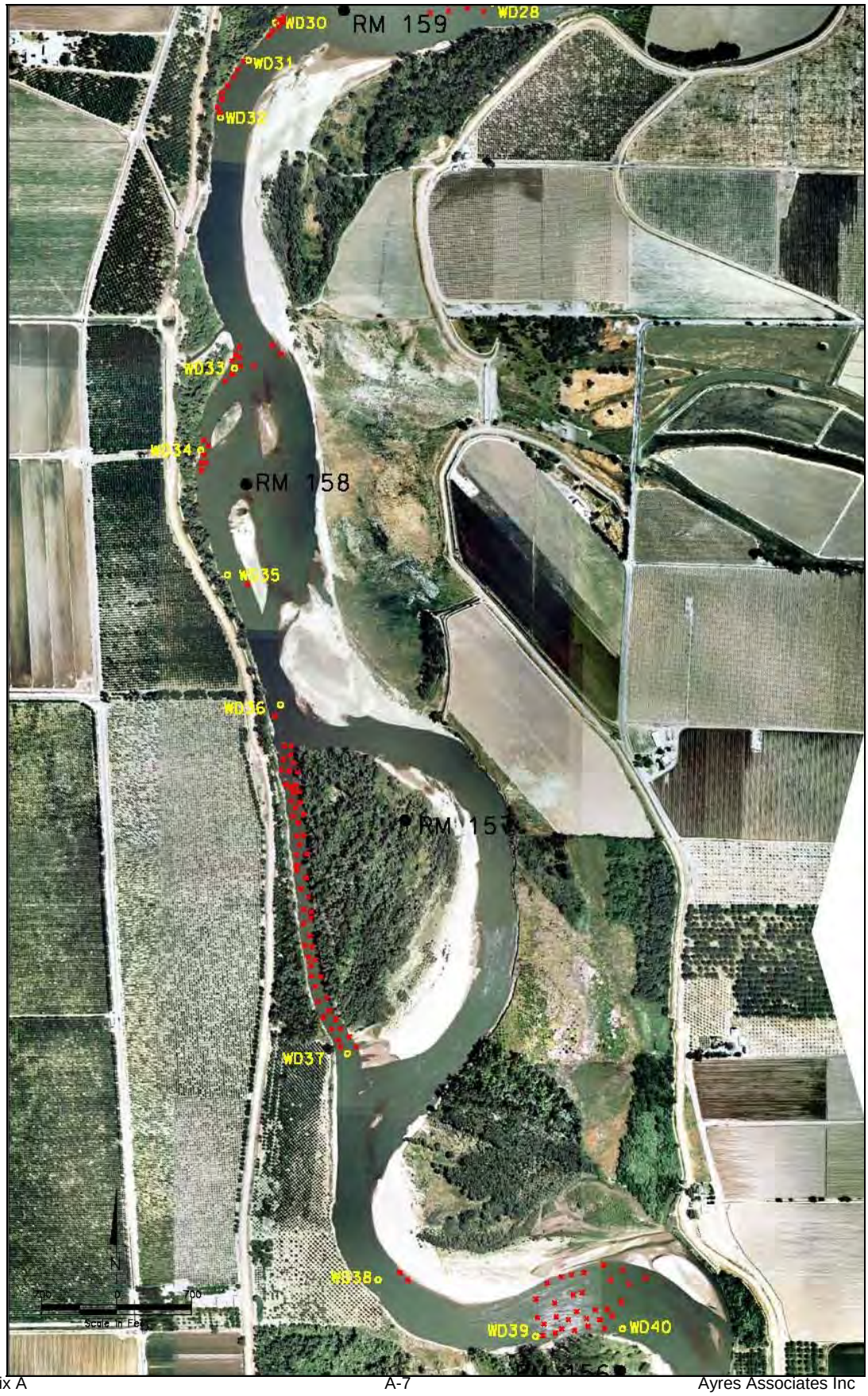
Approximate River Mile	Waypoint	Upstream Waypoint	Downstream Waypoint	Number of Trees	Location	Notes
153.2		WD48	WD49	6	right bank	Picture not great, trees are in the shadows.
152.8		WD50	WD51	14	right bank	Trees have multiple piles of branches and snags caught on them. Some of the trees are half in the water half on the bank.
152.5	WD52			3	right bank	Trees are located very close to the right bank. Pictures taken looking upstream.
152.1	WD53			4	right bank	Trees are clustered, estimated 4 but possible more or less.
152		WD54	WD55	9	right bank	Cluster of trees at the upstream end.
151.4	WD56			1	left bank	On tree close to the left bank.
150.8		WD57	WD58	7	right bank	4 trees are clumped together at the downstream end. Picture a looking downstream, pictures b and c are looking upstream.
149.5	WD59			3	right bank	Trees are caught up on each other and located on the right bank of the right river channel.
149.3	WD60			1	right bank	Lone tree (with 2 branches sticking out) near sandbar on right bank.
149.1		WD61	WD62	4	right bank	The 4 trees are clustered together.
148	WD63			1	middle	About 2 ft of tree sticking out above the water in the center of the channel.
147.6	WD64			1	middle	Single tree in center of river.
147.2	WD65			1	middle	A portion of the tree is visible in the center of the river and causing a noticable riffle.
147.1	WD66			1	left bank	
146.5		WD67	WD68	24	throughout	Trees are scattered throughout the channel. Picture a is at the upstream end looking donstream and picture b is at the downstream end looking upstream.
146	WD69			1	left bank	Picture taken looking downstream.
145.9	WD70			1	middle	Picture taken looking downstream.
145.8	WD71			2	middle	Picture taken looking downstream.
145.7	WD72			1	right center	Picture taken looking downstream.
145.5		WD73	WD74	18	right and center	Picture of upstream most trees on the right bank.
145.2	WD75			2	middle	Picture taken looking downstream.
145	WD76			1	right	Tree close to right bank, with lots of debris on the bank.

Woody Debris Inventory

Approximate River Mile	Waypoint	Upstream Waypoint	Downstream Waypoint	Number of Trees	Location	Notes
144		WD77	WD78	10	left	Picture taken from the upstream end of the river section.
143.4 Colusa Bridge	WD79			6	both piers	On the east pier, 2 trees are stuck above the water line and 2 trees are around the pier at the water line. The west pier has about 2 (maybe more) trees with lots of debris.
143.3 Pump				numerous	Abandoned pump structure	An abandonded pump structure, about 10 ft tall and 5 ft wide is covered in trees, on the top, side, and front. Too numerous to count, over 20.

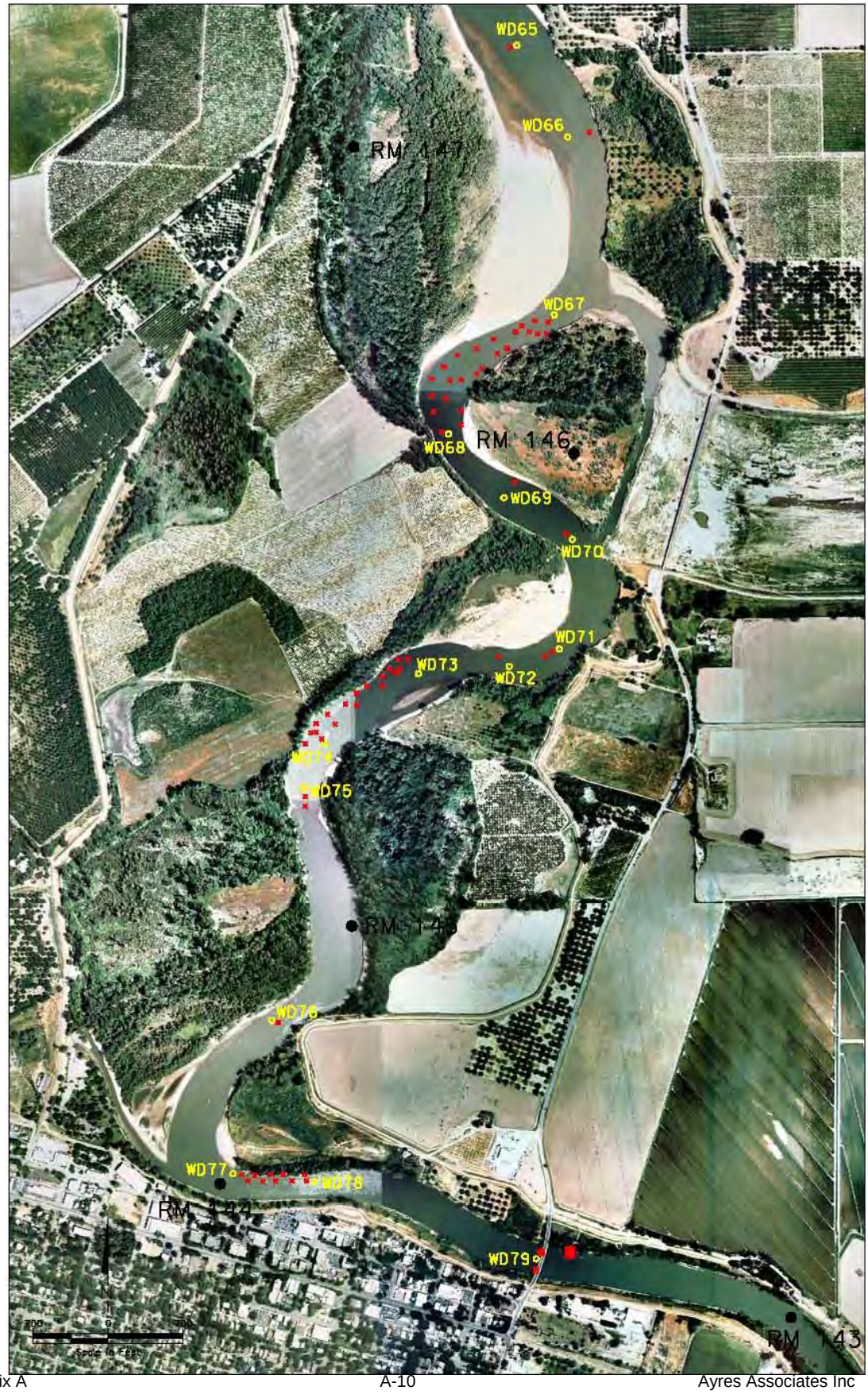

WD01
WD03
WD02
RM 164
WD04
WD05
WD07
WD06
WD08
WD09
WD10
RM 163
WD11
WD12
WD13
WD14
M 162
WD15
WD16
N
Scale in Feet

WD17
WD18
WD19
WD20
N
Scale In Feet
WD21
WD22
RM 161
WD23
WD24
WD25
RM 160
WD26
WD28
WD27
WD28
RM 159

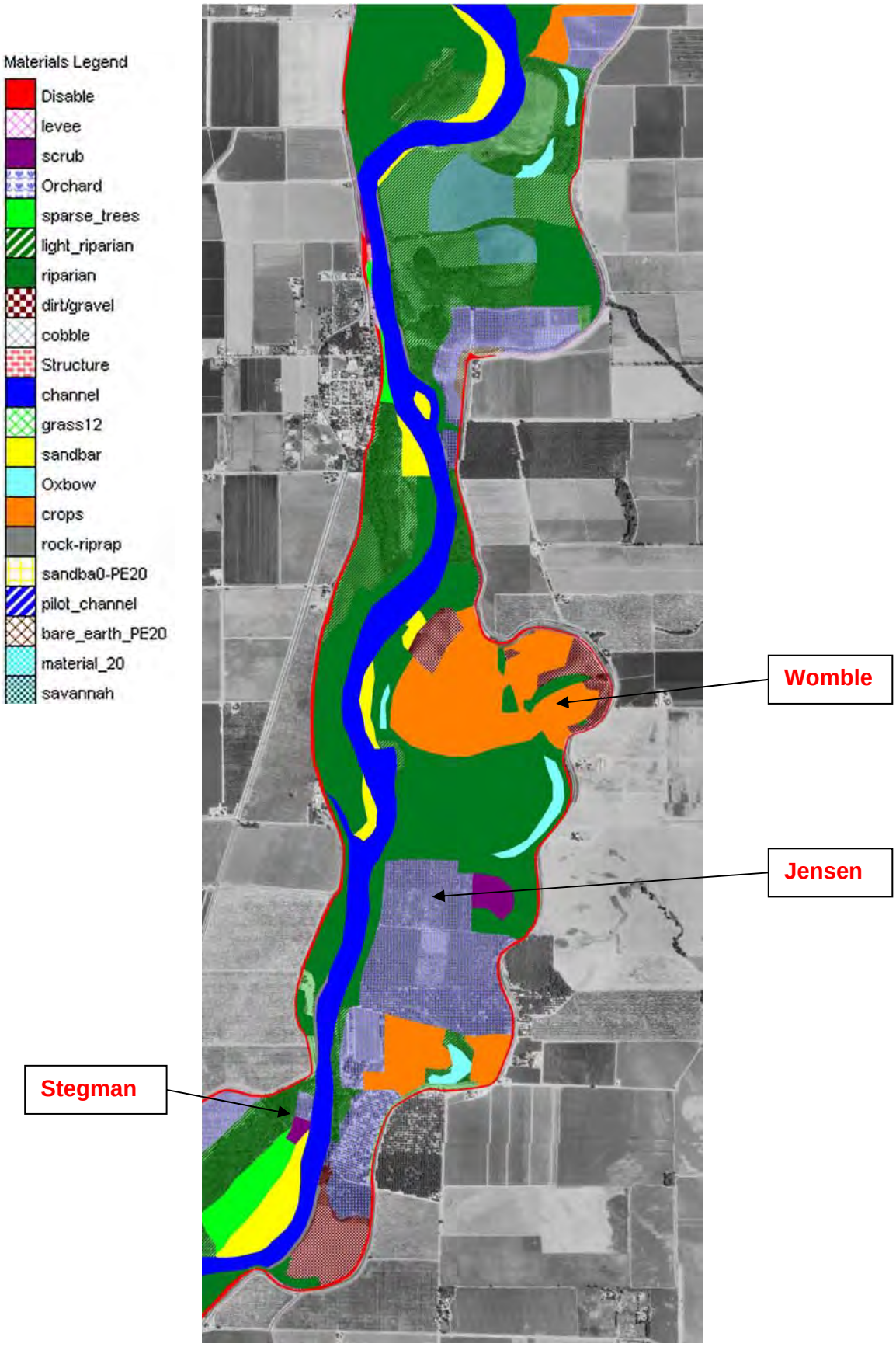

WD28
RM 159
WD30
WD31
WD32
WD33
WD34
RM 158
WD35
WD36
RM 157
WD37
WD38
WD39
WD40
N
Scale in Feet

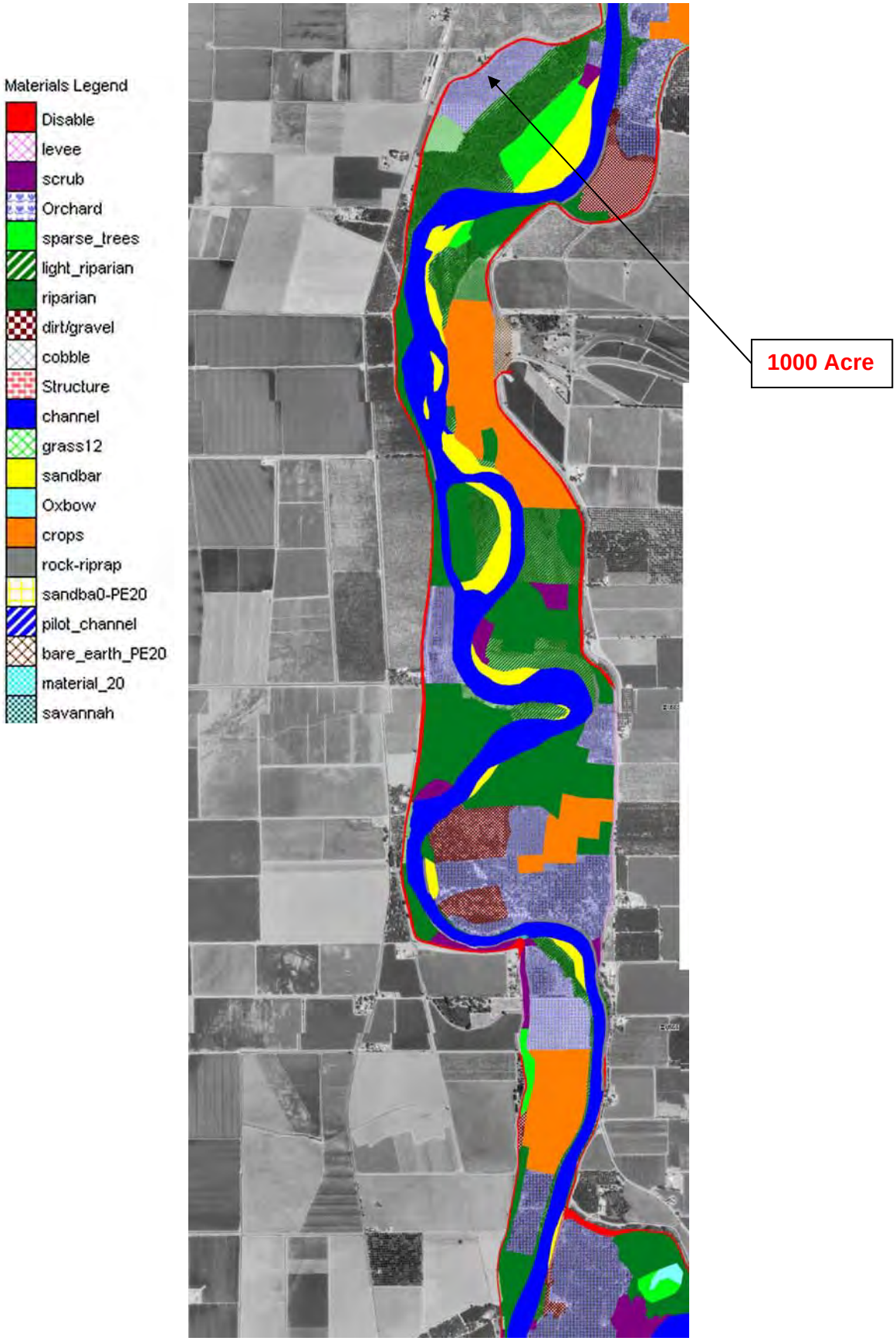
RM 156
WD41
WD42
RM 155
WD43
WD44
WD45
RM 154
WD46
WD47
WD48
WD49
RM 153
WD50
WD51
WD52
N
700
0
700
Scale in Feet

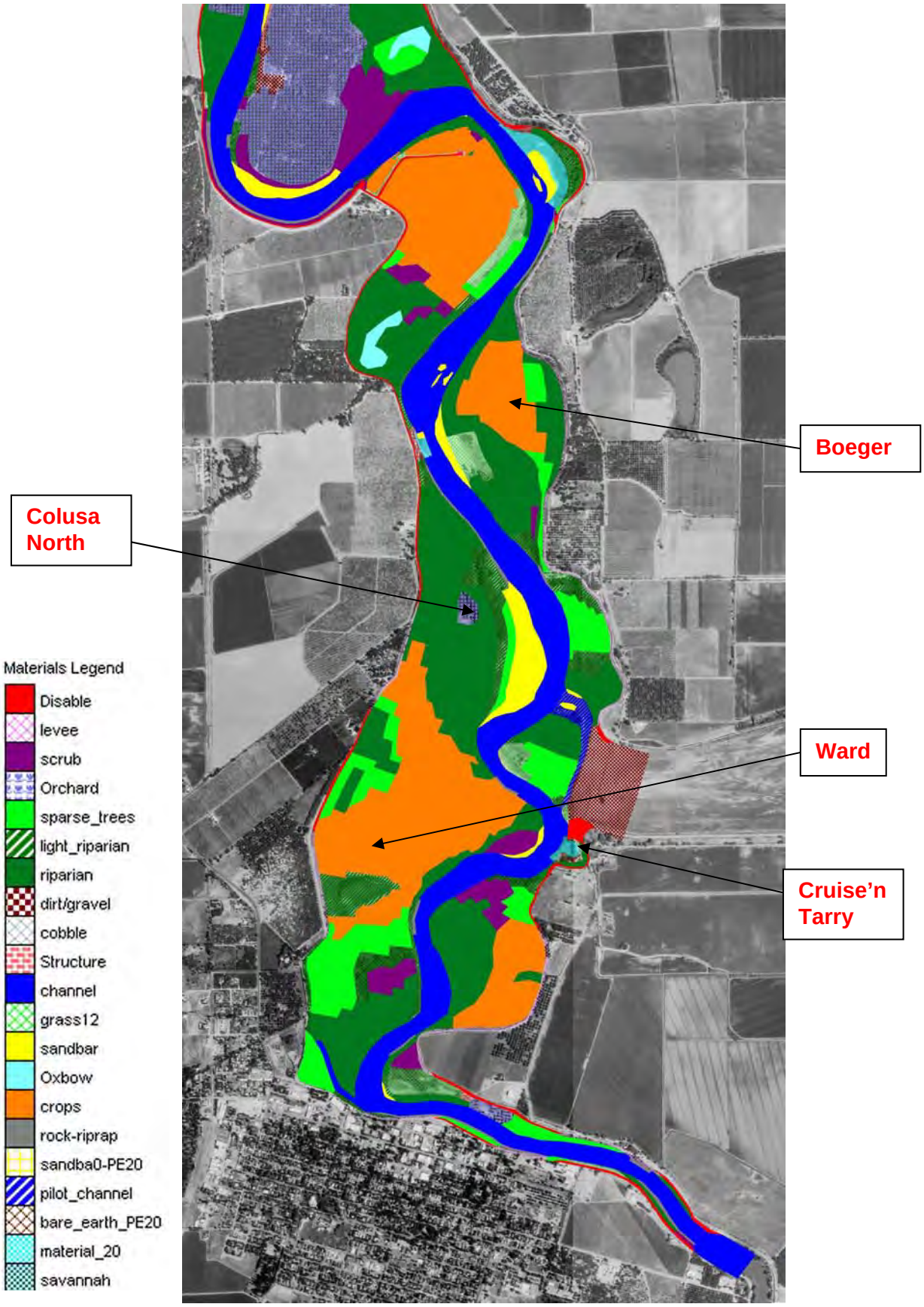
WD52
WD53
RM 152
WD54
RM 150
WD55
WD58
WD56
RM 151
WD57
WD59
WD60
RM 149
WD61
WD62
RM 148
WD63
WD64
N
700
0
700


WD65
WD66
RM 147
WD67
WD68
RM 146
WD69
WD70
WD71
WD73
WD72
WD74
WD75
RM 145
WD76
WD77
WD78
RM 144
WD79
RM 143
N
200
0
200
Scale in Feet

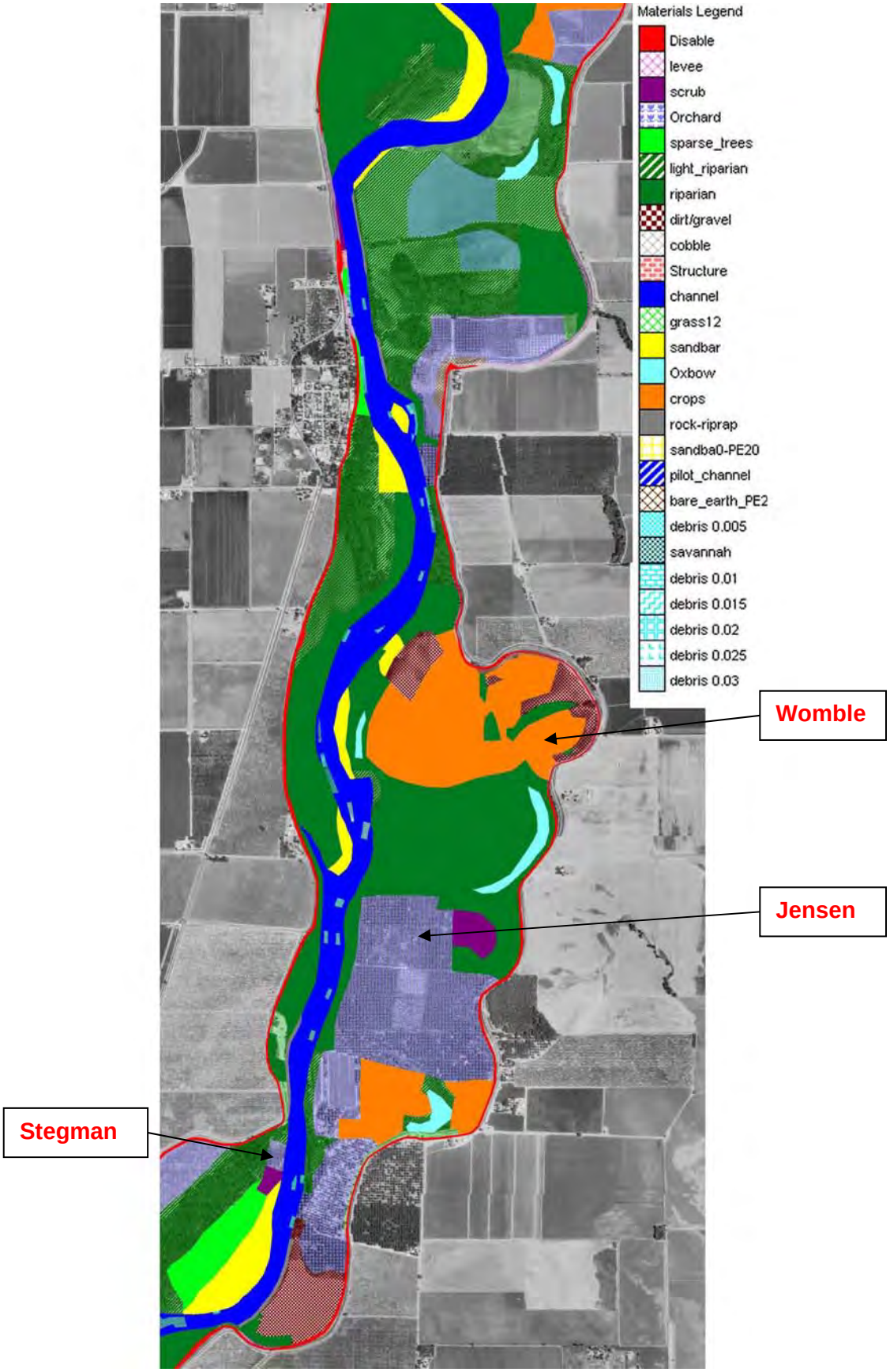
Appendix B – Land Use Figures
Existing Conditions


Materials Legend
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE20
material_20
savannah
Womble
Jensen
Stegman


Materials Legend
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE20
material_20
savannah
1000 Acre


Boeger
Colusa North
Ward
Cruise'n Tarry
Materials Legend
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE20
material_20
savannah

Appendix C – Land Use Figures
Debris Conditions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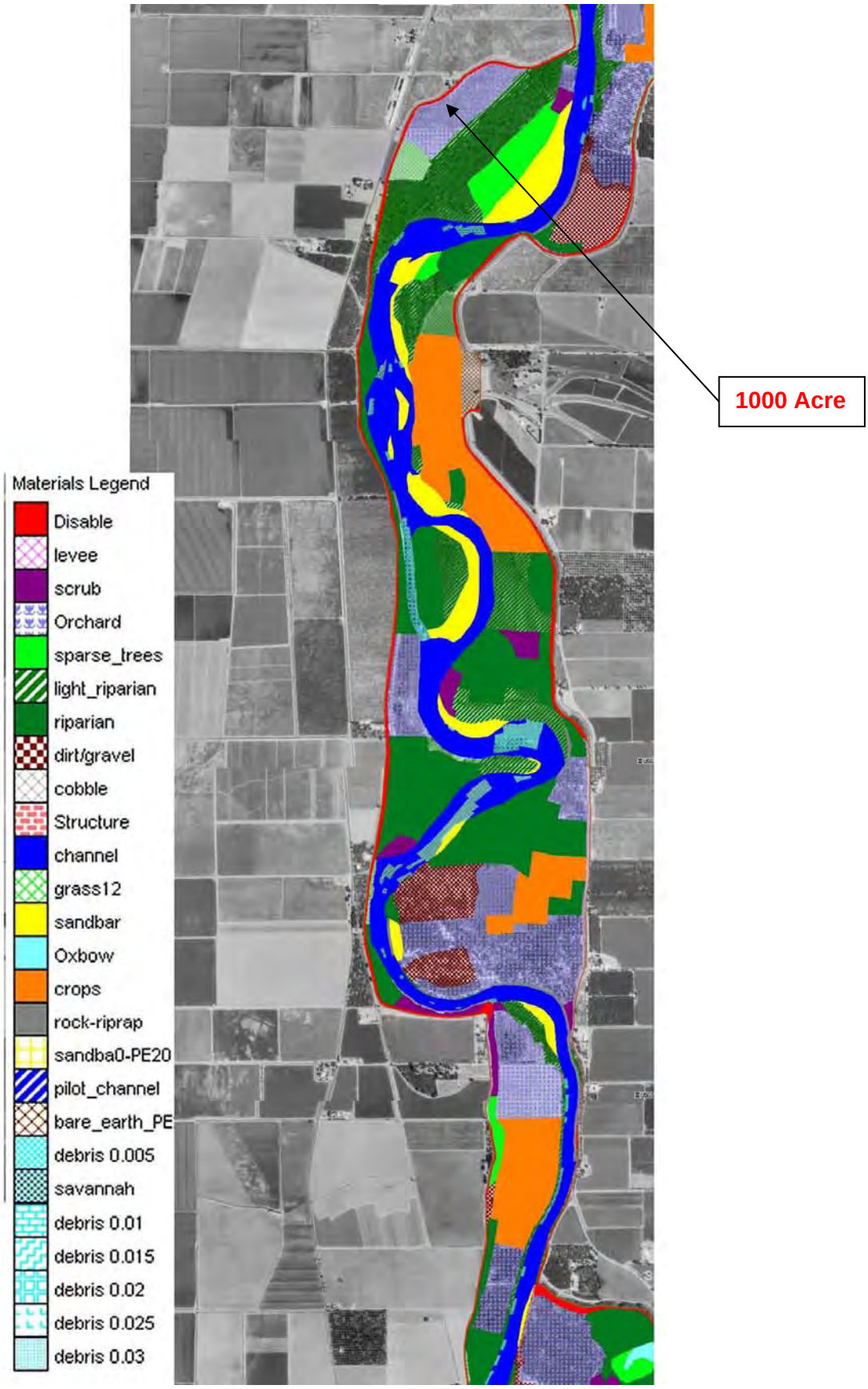
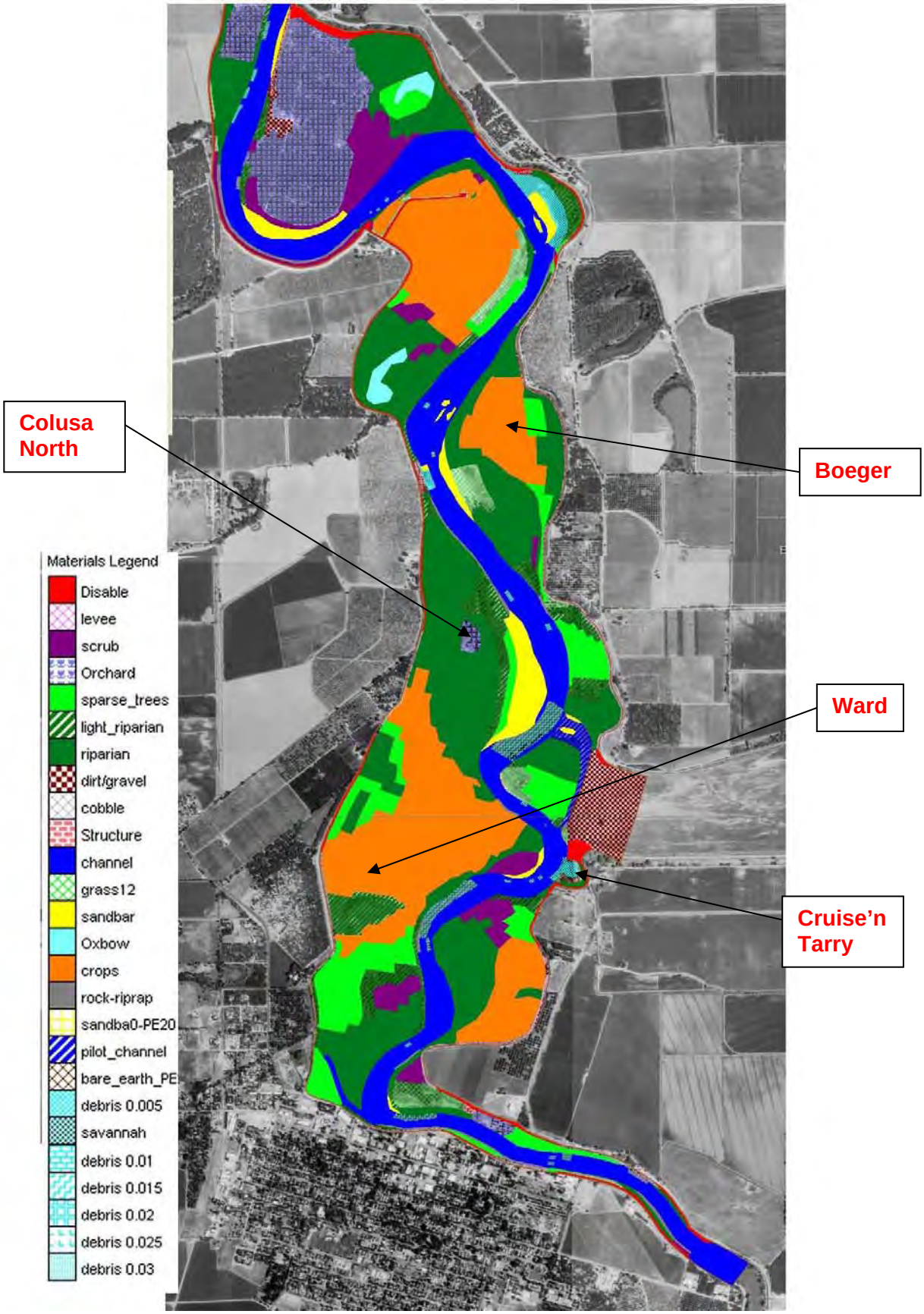
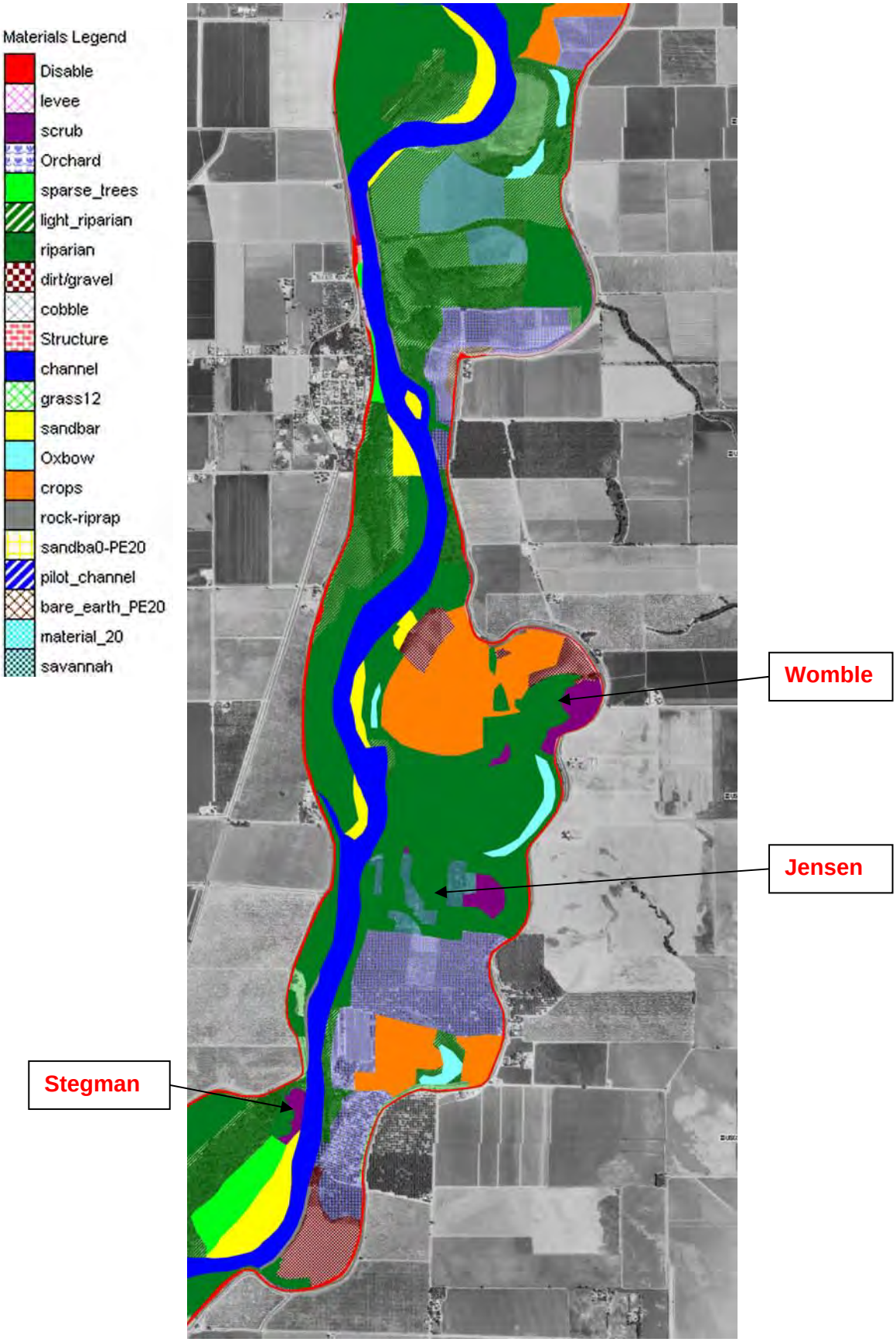
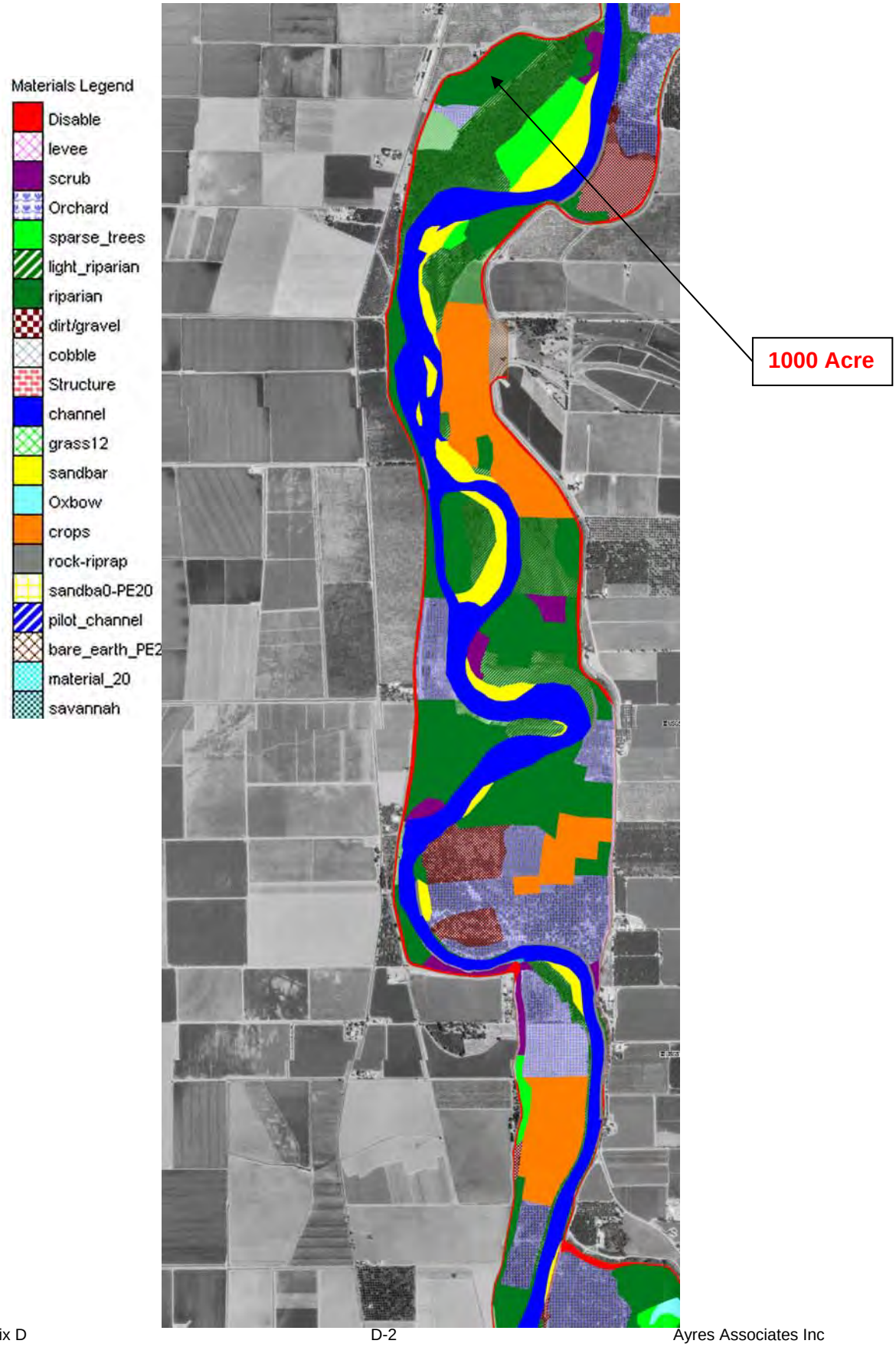
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE2
debris 0.005
savannah
debris 0.01
debris 0.015
debris 0.02
debris 0.025
debris 0.03
Womble
Jensen
Stegman

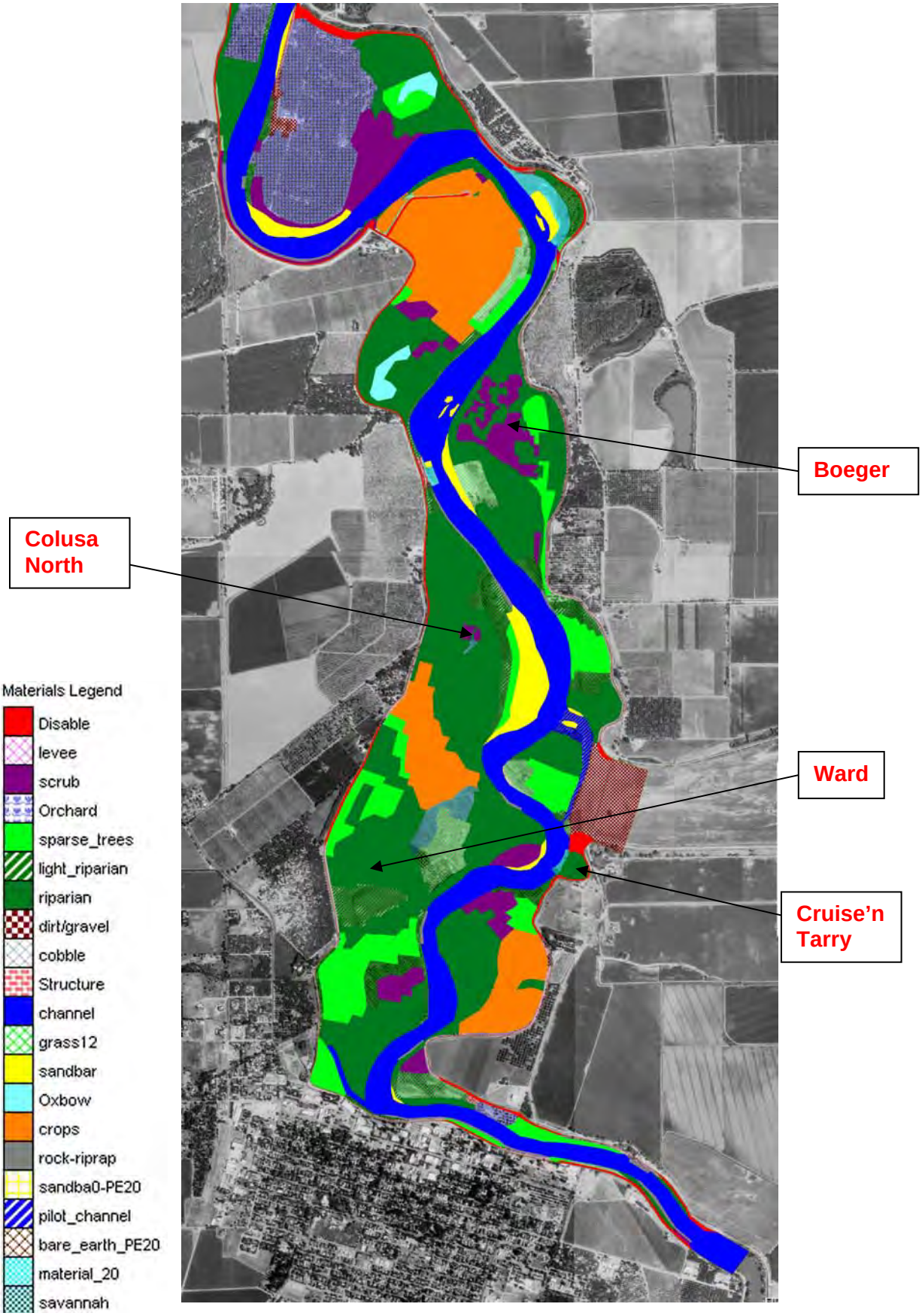

1000 Acre
Materials Legend
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE
debris 0.005
savannah
debris 0.01
debris 0.015
debris 0.02
debris 0.025
debris 0.03


Colusa North
Boeger
Ward
Cruise'n Tarry
Materials Legend
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE
debris 0.005
savannah
debris 0.01
debris 0.015
debris 0.02
debris 0.025
debris 0.03

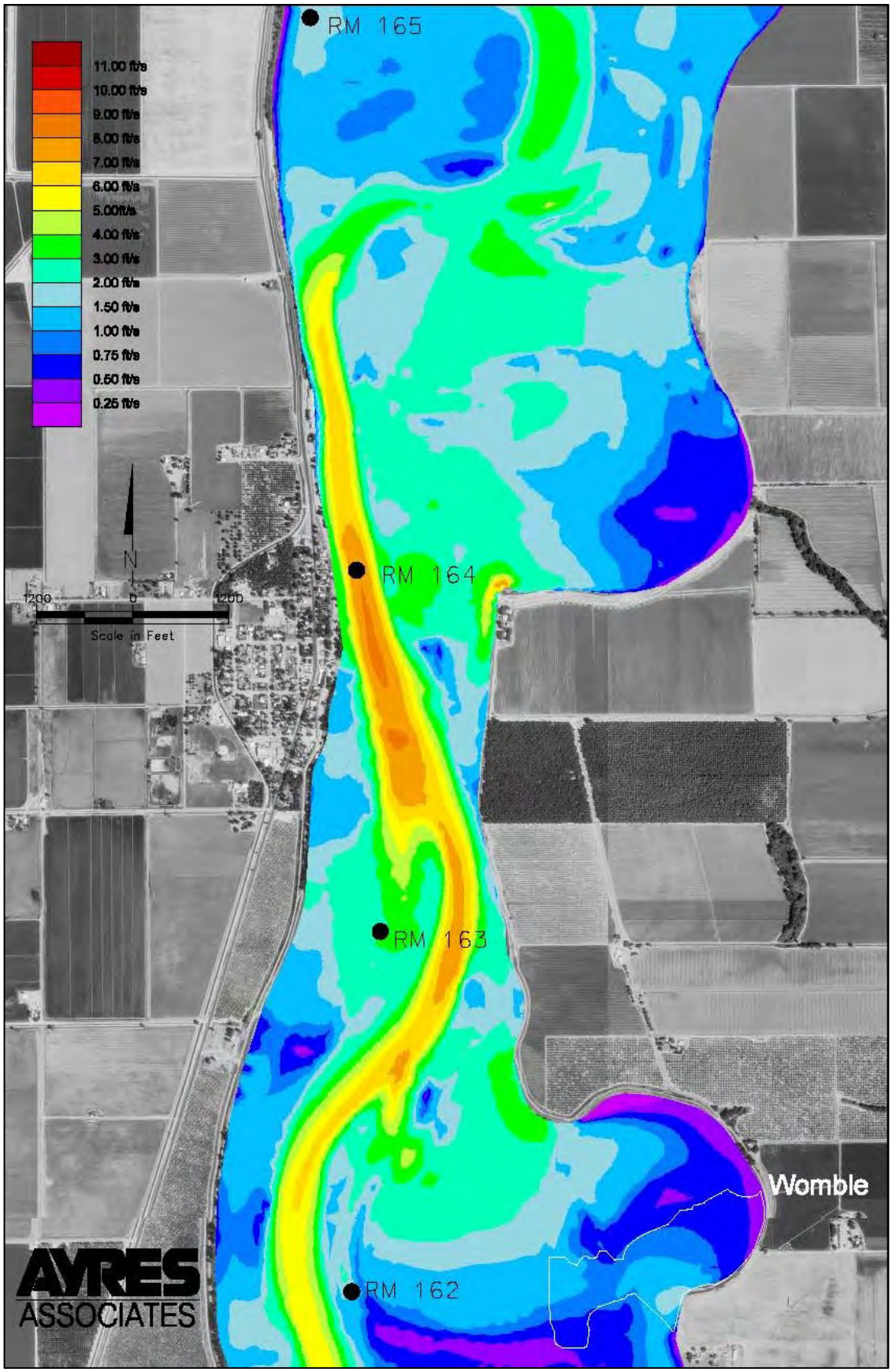
Appendix D – Land Use Figures
Restoration Conditions

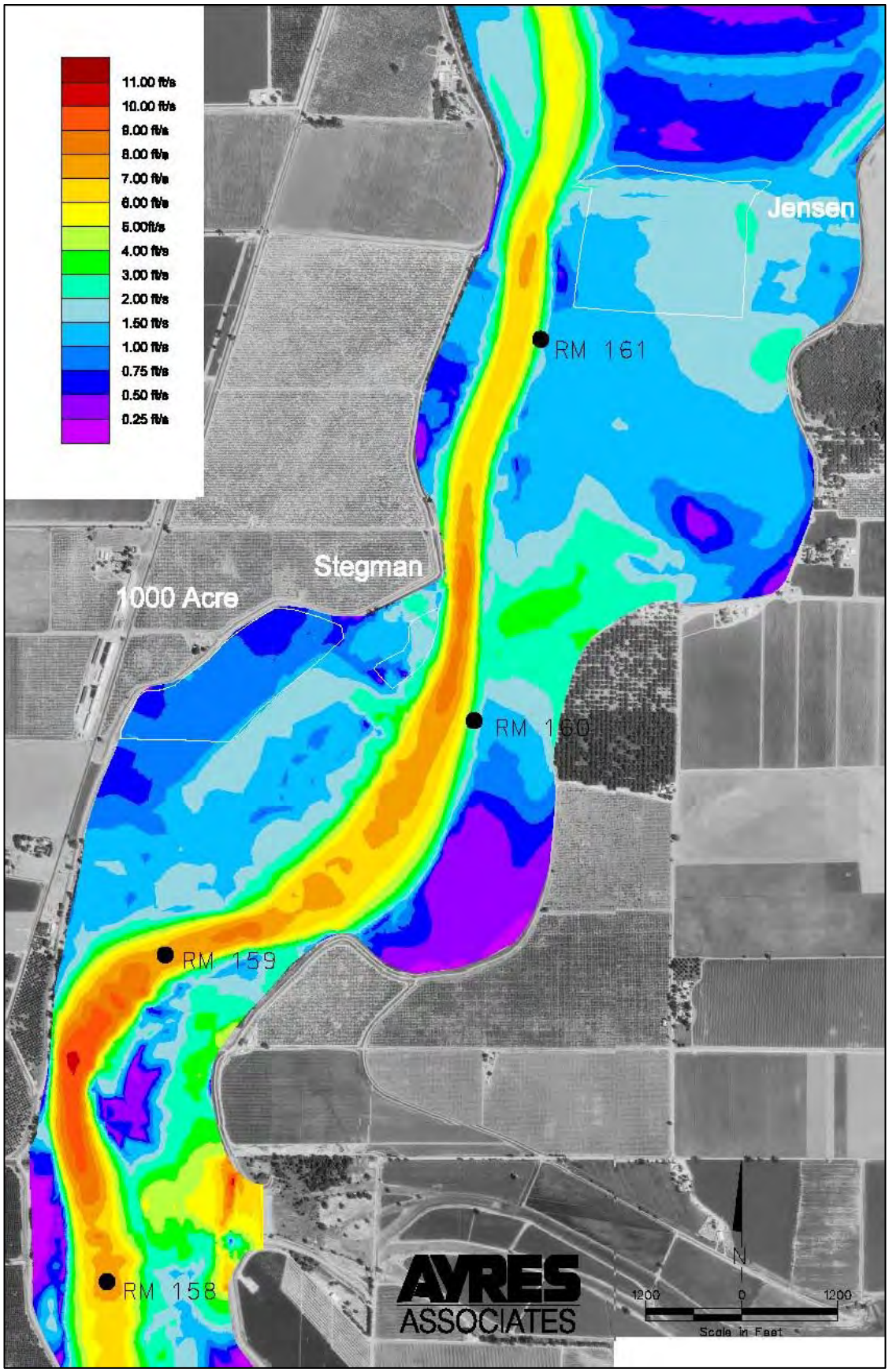

Materials Legend
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE20
material_20
savannah
Womble
Jensen
Stegman

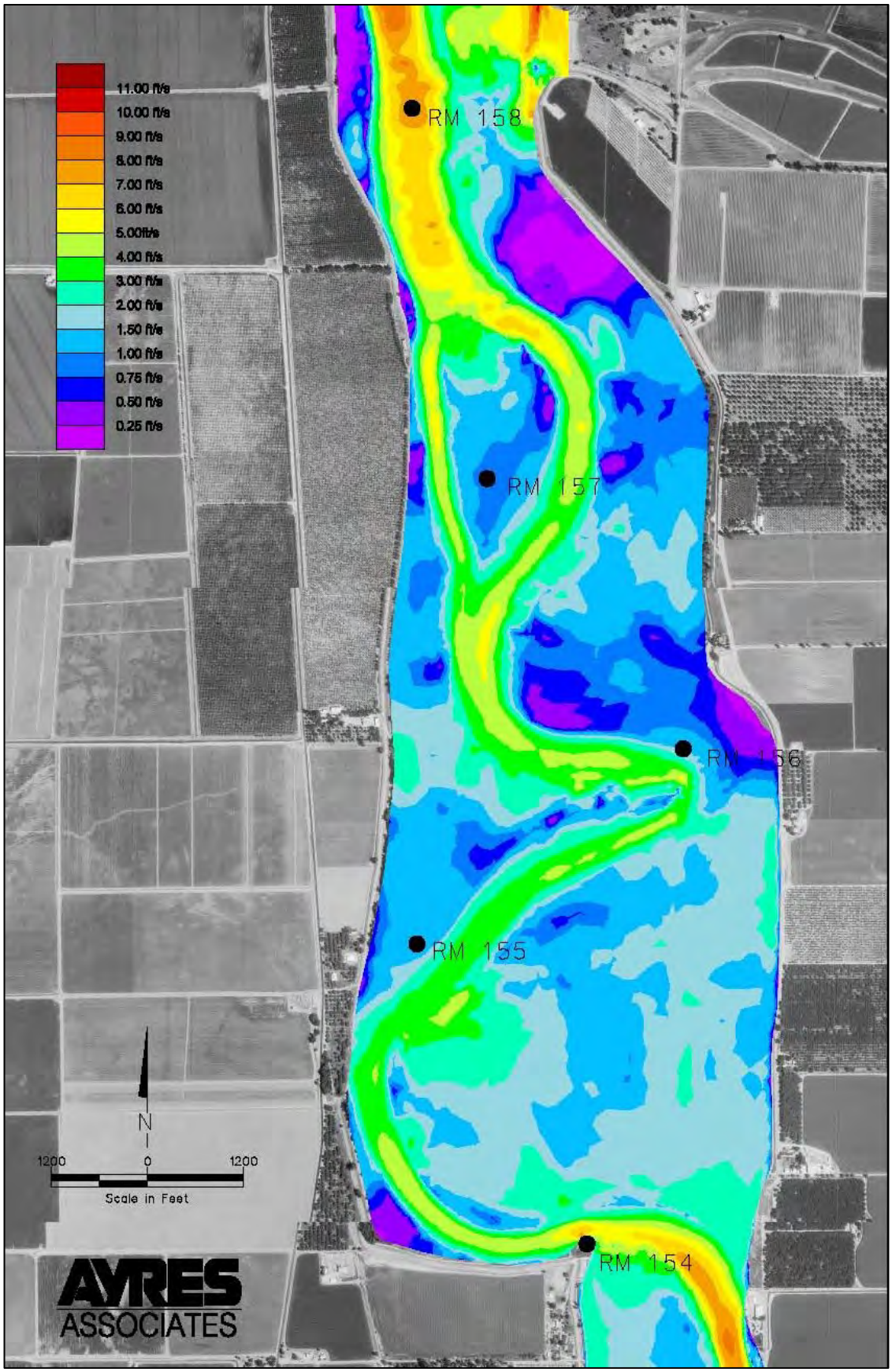

Materials Legend
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE2
material_20
savannah
1000 Acre

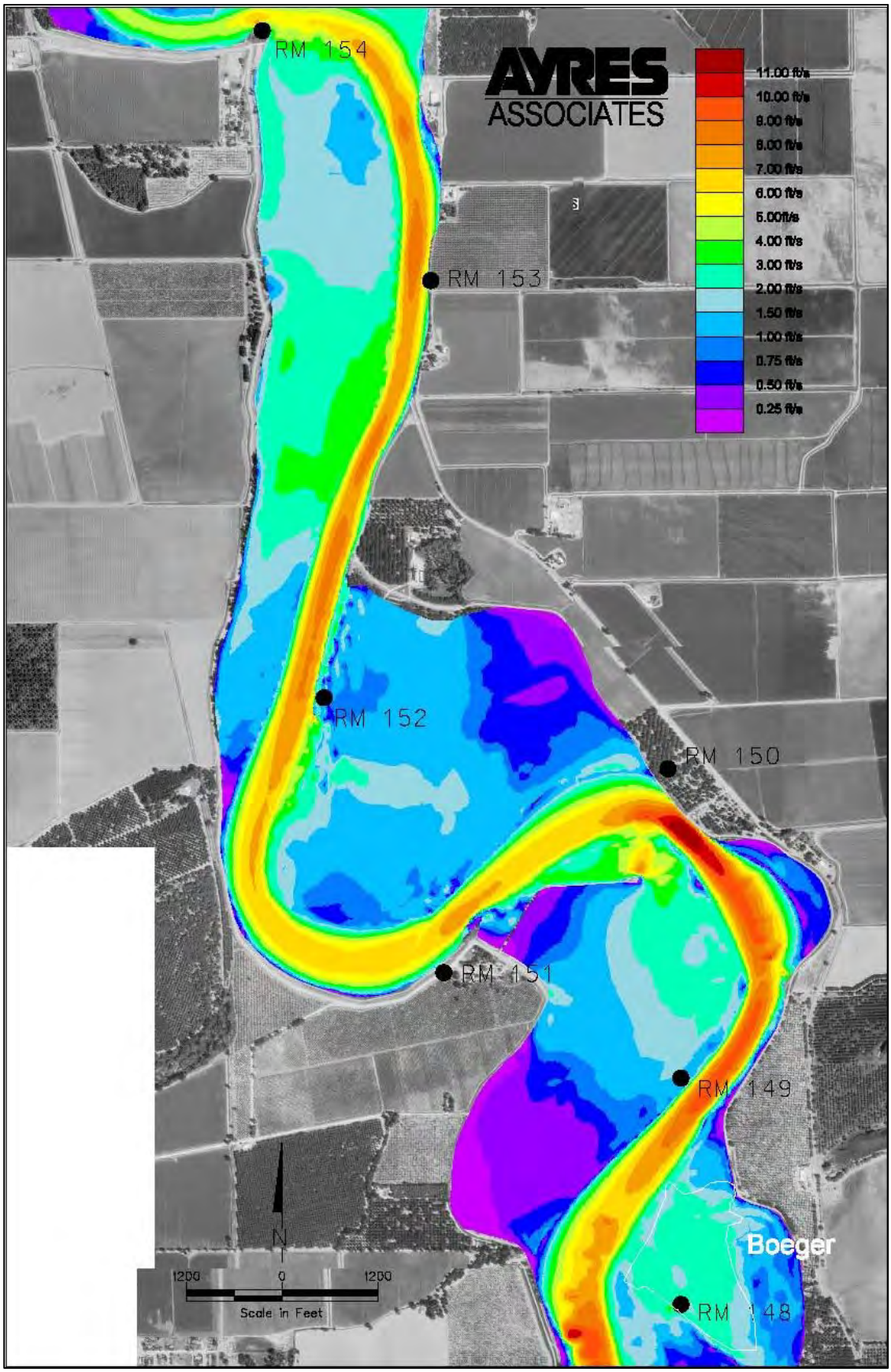

Boeger
Colusa North
Ward
Cruise'n Tarry
Materials Legend
Disable
levee
scrub
Orchard
sparse_trees
light_riparian
riparian
dirt/gravel
cobble
Structure
channel
grass12
sandbar
Oxbow
crops
rock-riprap
sandba0-PE20
pilot_channel
bare_earth_PE20
material_20
savannah

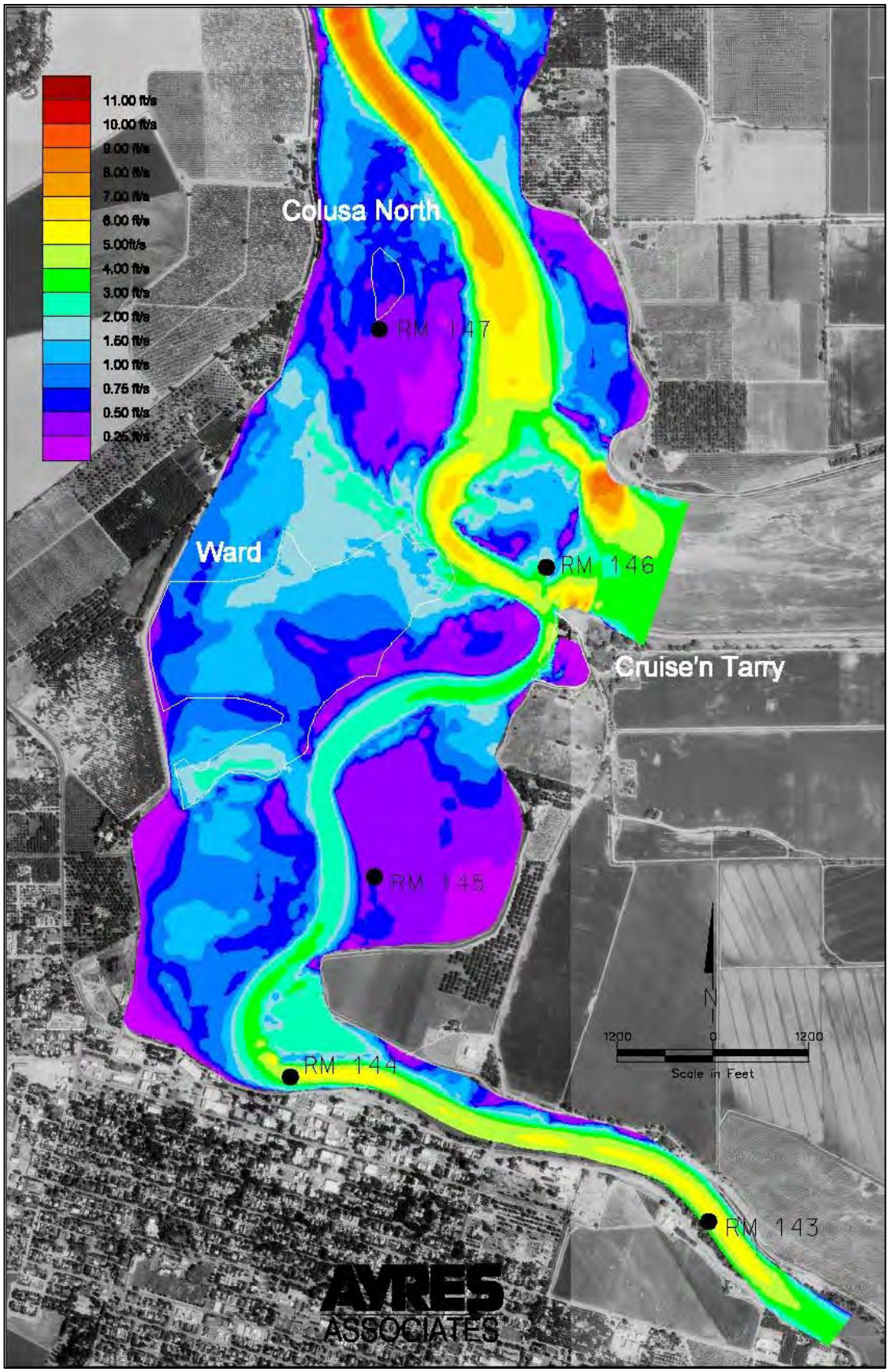
Appendix E – Velocity Plots
Existing Conditions


RM 165
11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
N
1200
0
1200
Scale in Feet
RM 164
RM 163
RM 162
Womble
AYRES
ASSOCIATES

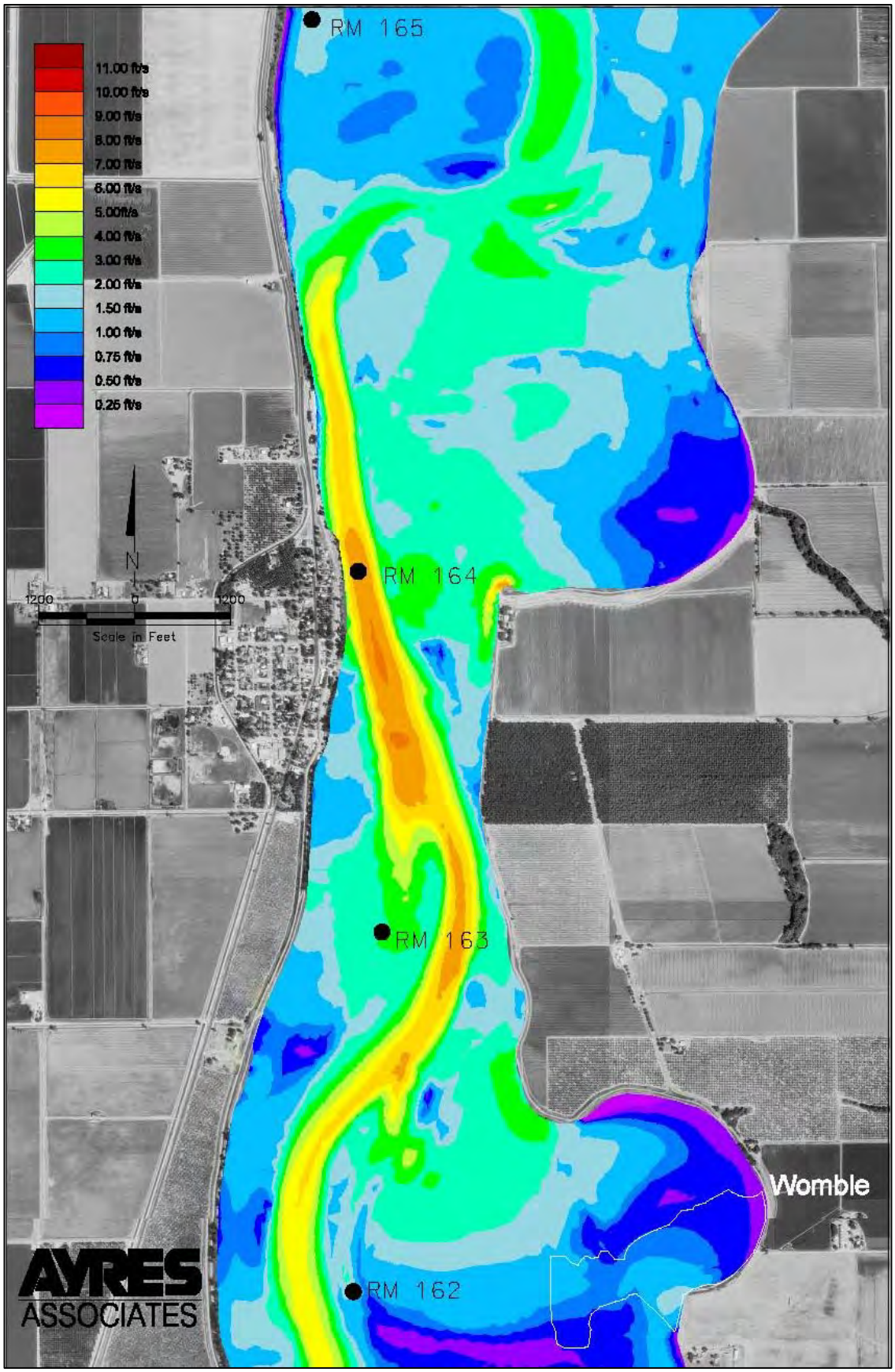

11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
Jensen
RM 161
Stegman
1000 Acre
RM 160
RM 159
RM 158
AYRES
ASSOCIATES
N
1200
0
1200
Scale in Feet

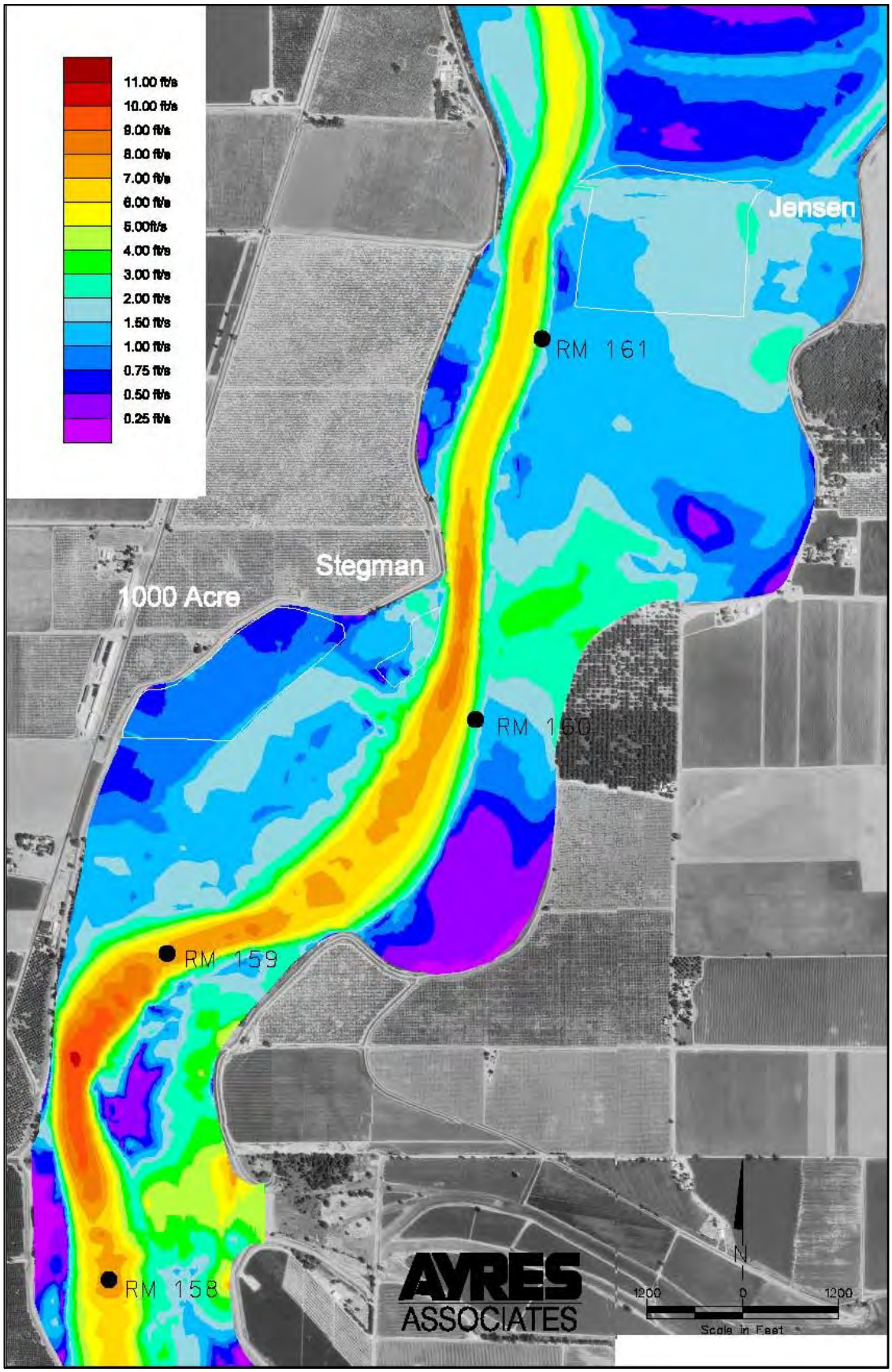

11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
RM 158
RM 157
RM 156
RM 155
RM 154
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES

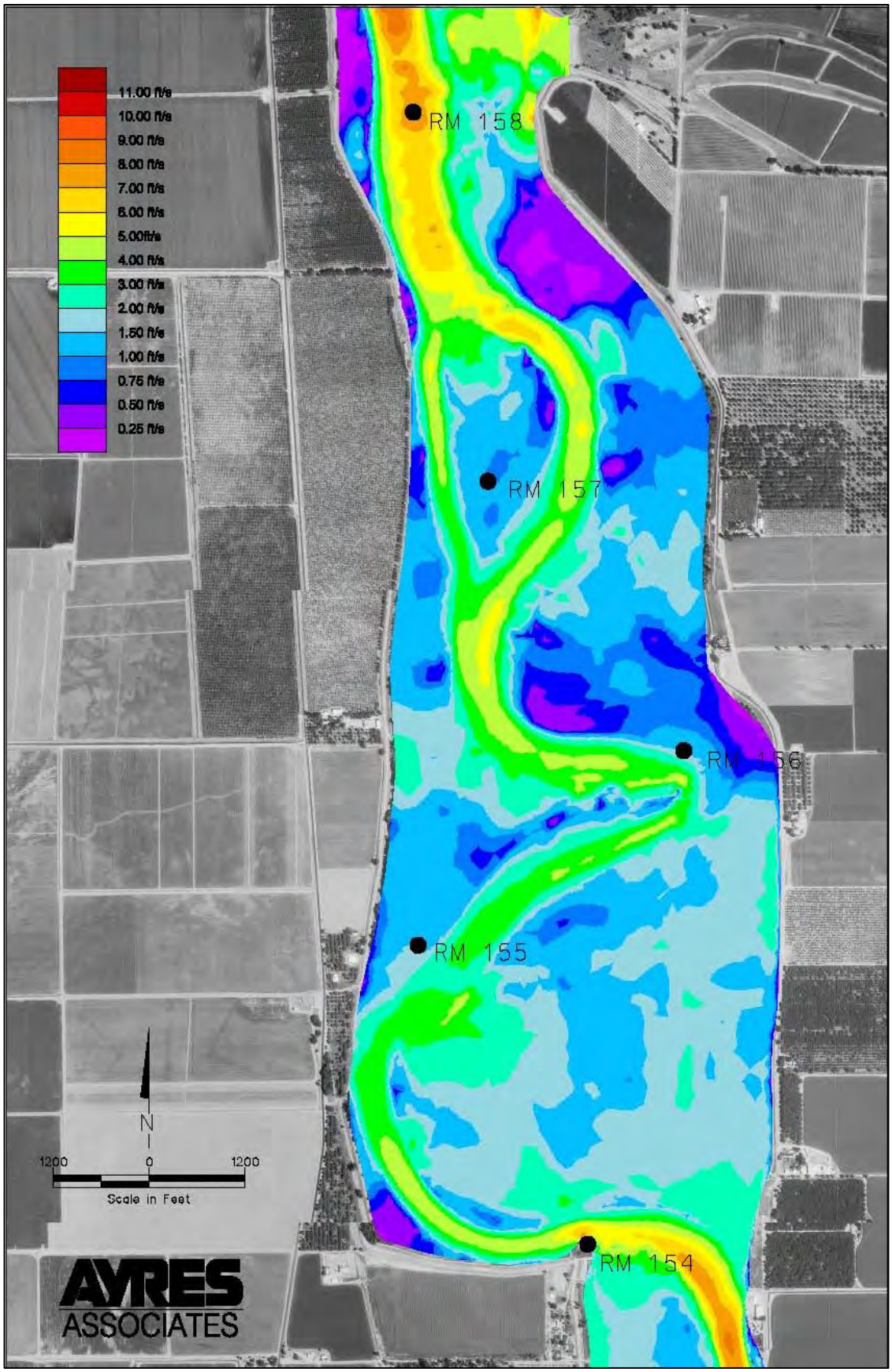

AYRES
ASSOCIATES
11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
RM 154
RM 153
RM 152
RM 150
RM 151
RM 149
RM 148
Boeger
N
1200
0
1200
Scale in Feet

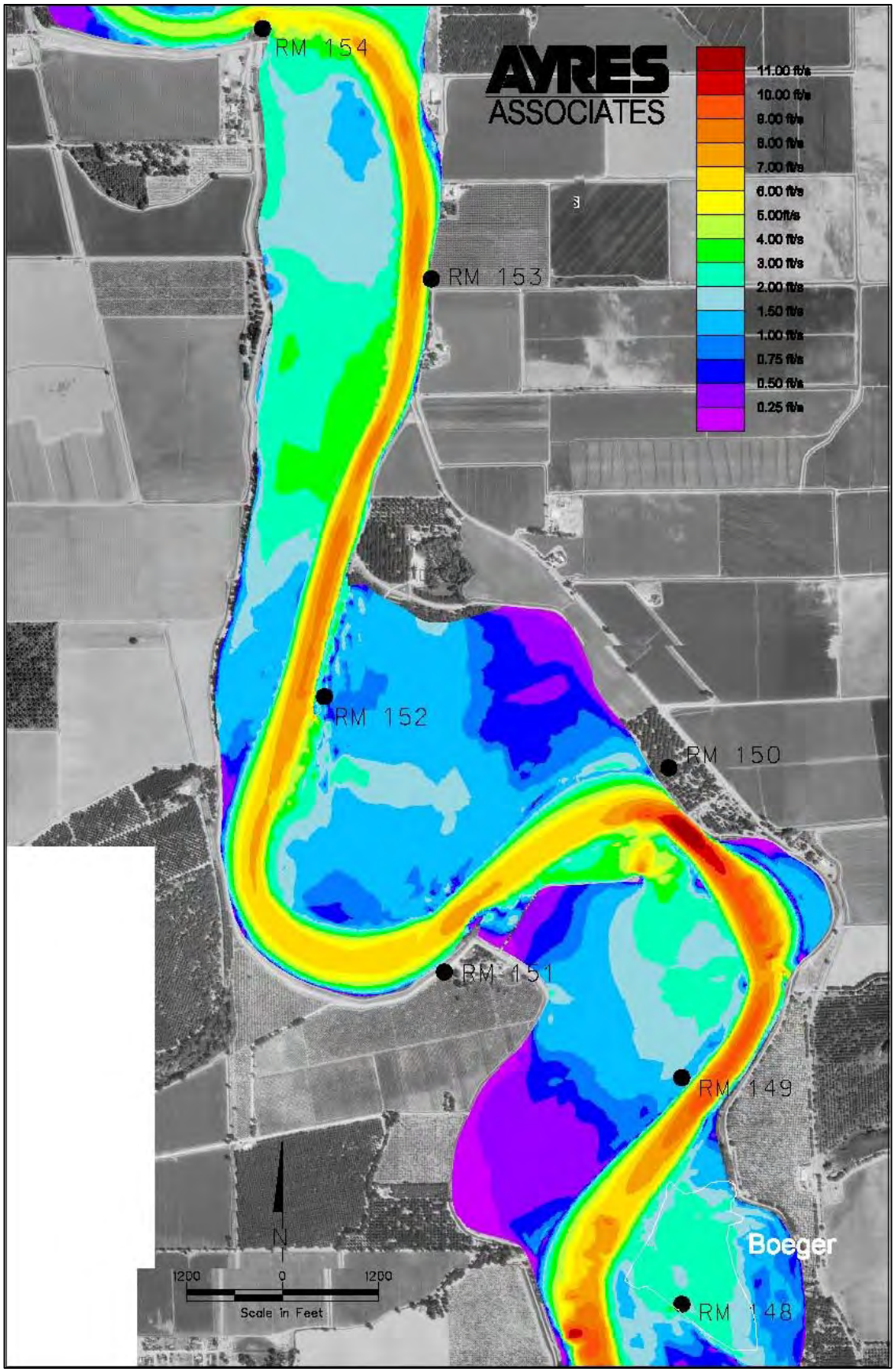

11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
Colusa North
RM 147
Ward
RM 146
Cruise'n Tarry
RM 145
N
1200
0
1200
Scale in Feet
RM 144
RM 143
AYRES
ASSOCIATES

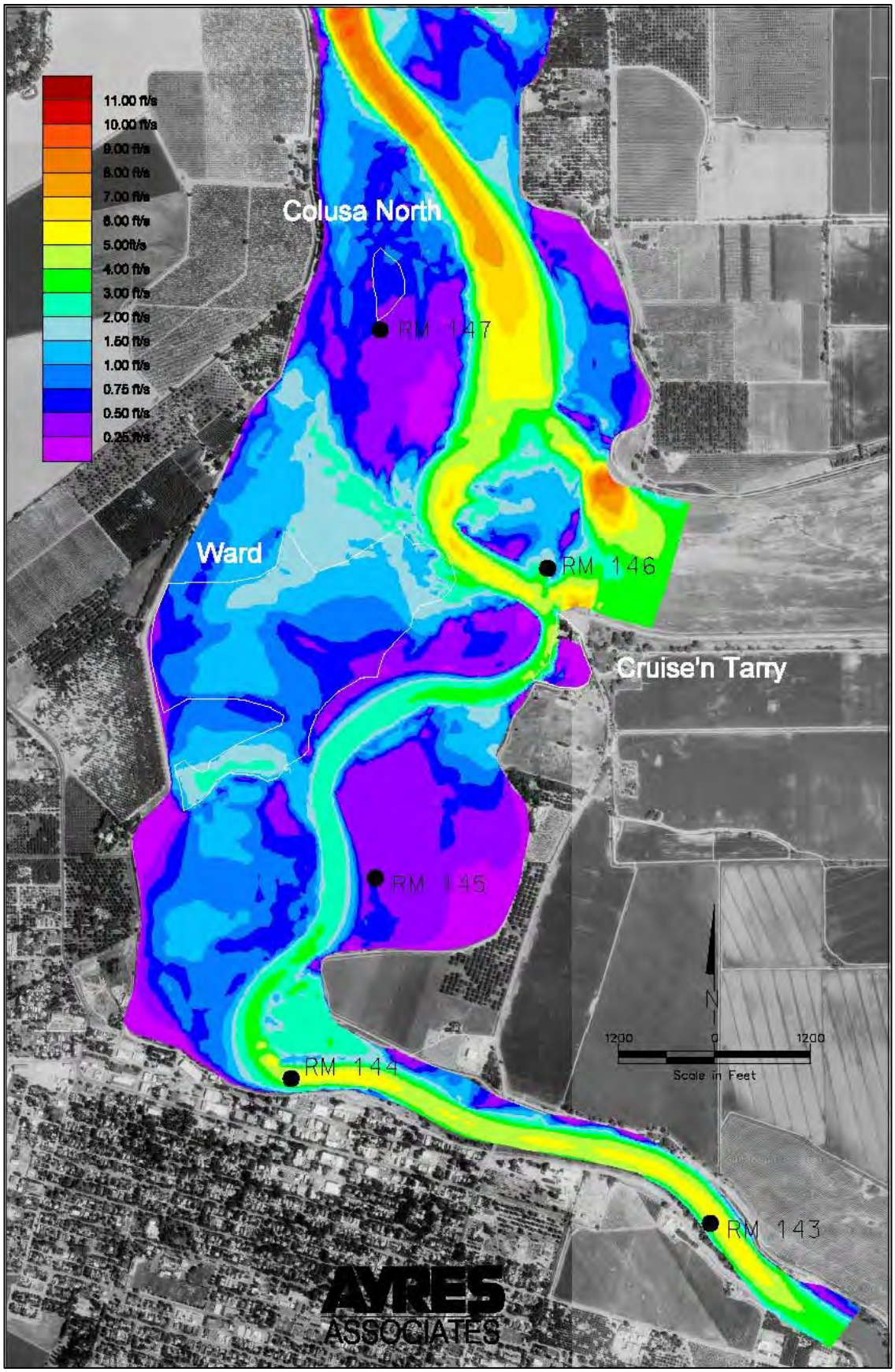
Appendix F – Velocity Plots
Debris Conditions


RM 165
11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
N
1200
0
1200
Scale in Feet
RM 164
RM 163
RM 162
Womble
AYRES
ASSOCIATES

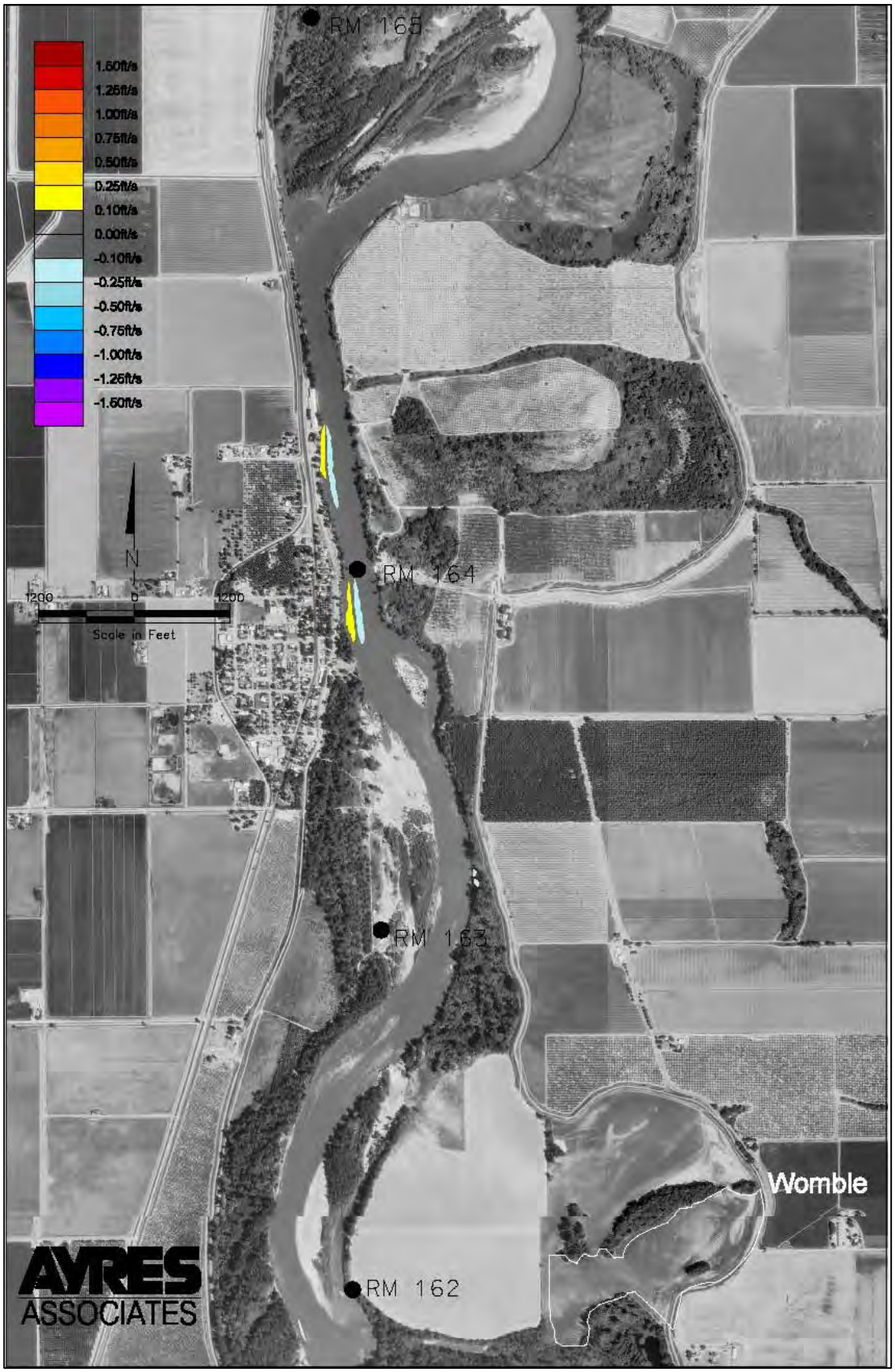

11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
Jensen
RM 161
Stegman
1000 Acre
RM 160
RM 159
RM 158
AYRES
ASSOCIATES
N
1200
0
1200
Scale in Feet

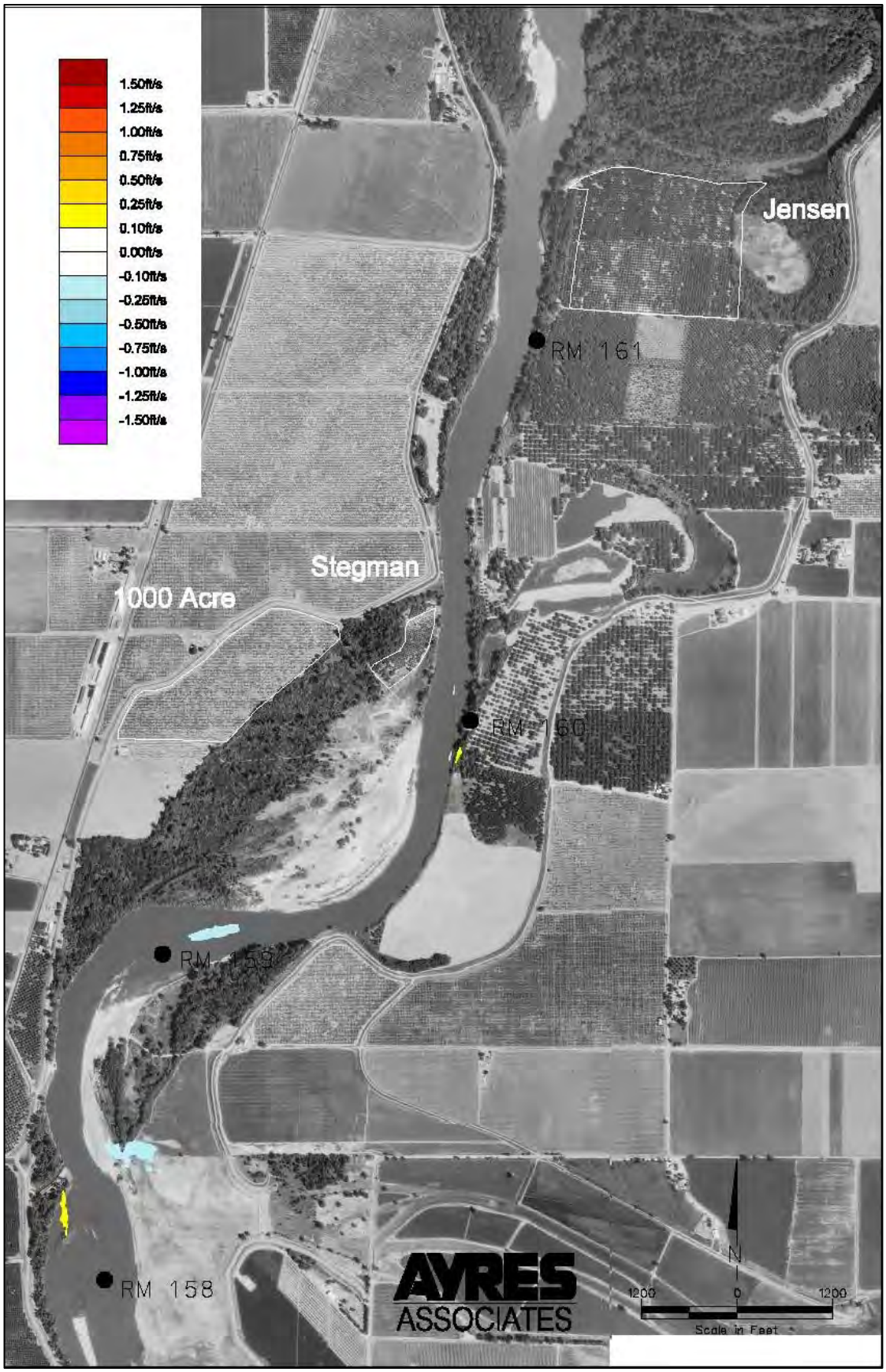

11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
RM 158
RM 157
RM 156
RM 155
RM 154
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES


AYRES
ASSOCIATES
11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
RM 154
RM 153
RM 152
RM 150
RM 151
RM 149
RM 148
Boeger
N
1200
0
1200
Scale in Feet

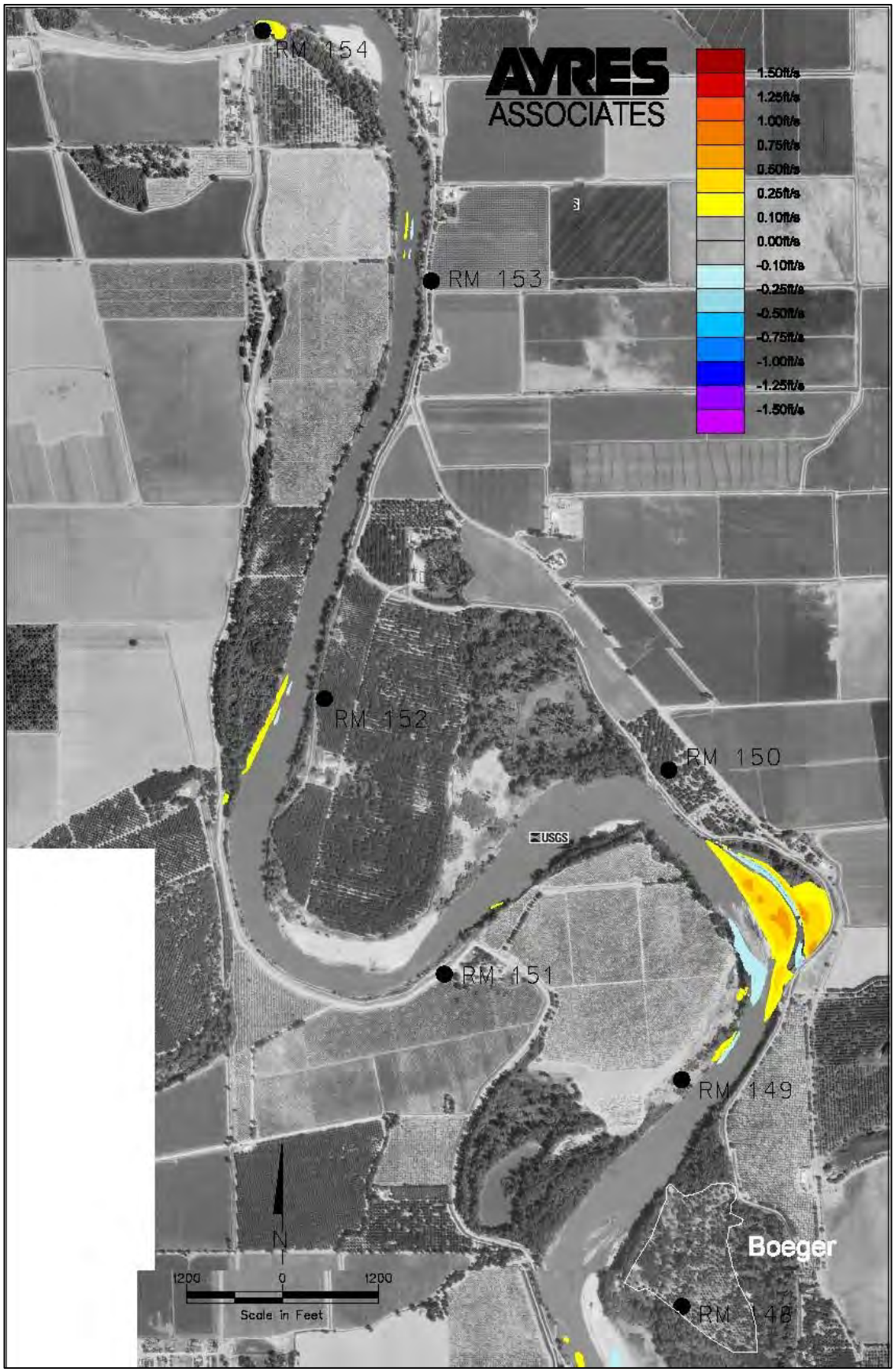

11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
Colusa North
Ward
Cruise'n Tarry
RM 147
RM 146
RM 145
RM 144
RM 143
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES

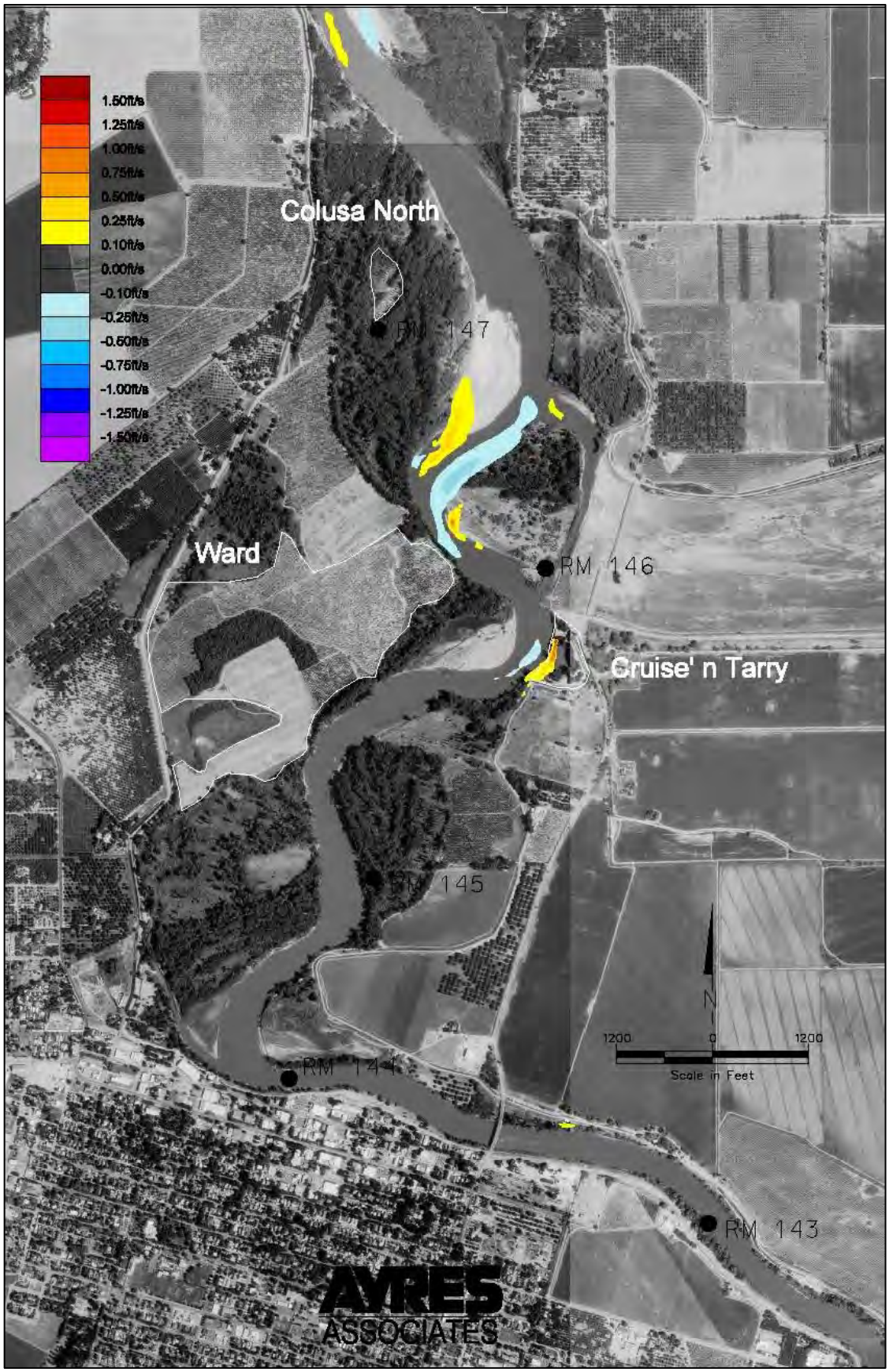
Appendix G – Velocity Differential Plots
Debris Run to Existing Conditions


RM 165
1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.50ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.50ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
N
1200
0
1200
Scale in Feet
RM 164
RM 163
RM 162
Womble
AYRES
ASSOCIATES

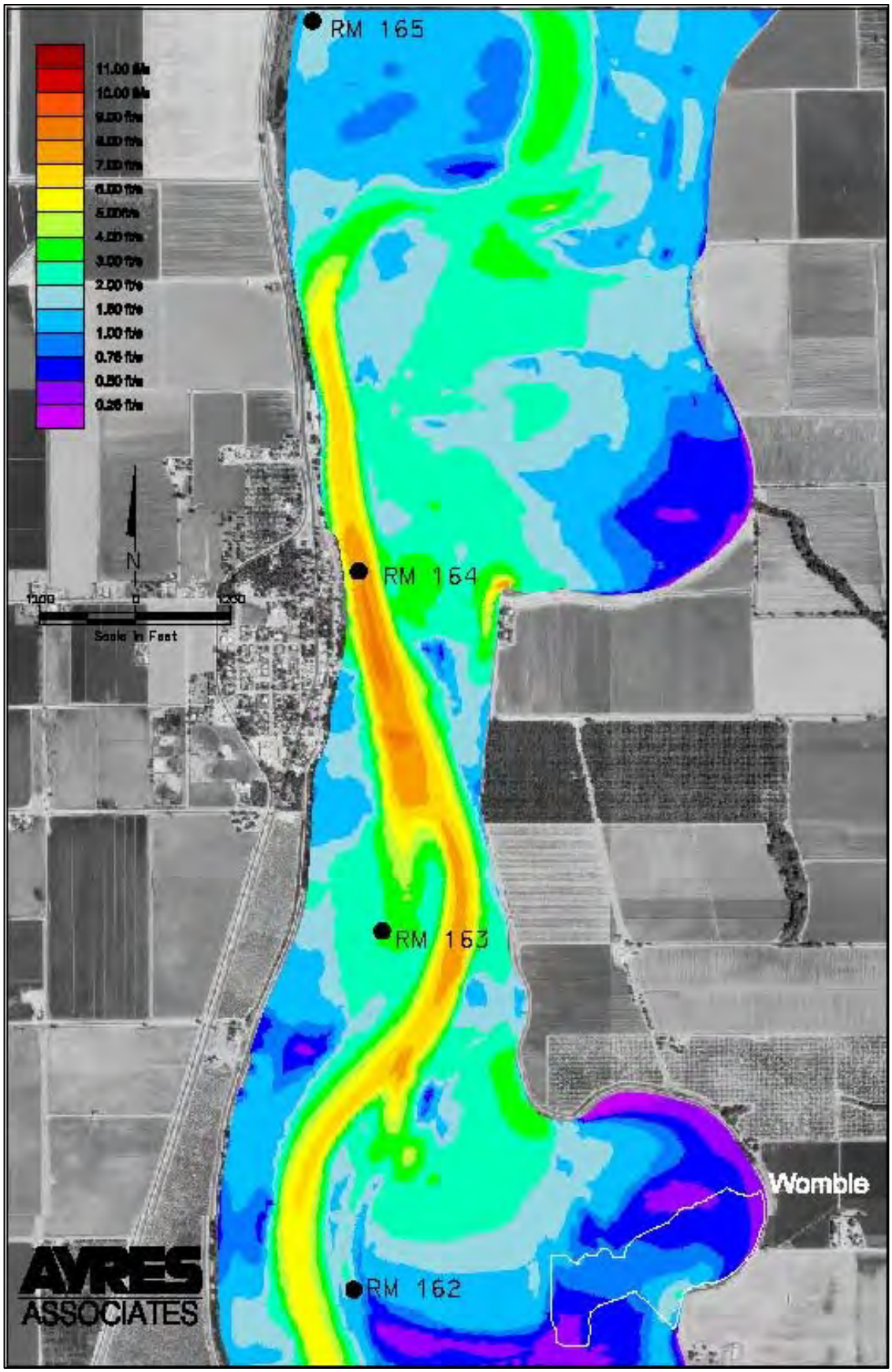

1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.50ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.50ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
Jensen
RM 161
Stegman
1000 Acre
RM 160
RM 159
RM 158
AYRES
ASSOCIATES
N
1200
0
1200
Scale in Feet

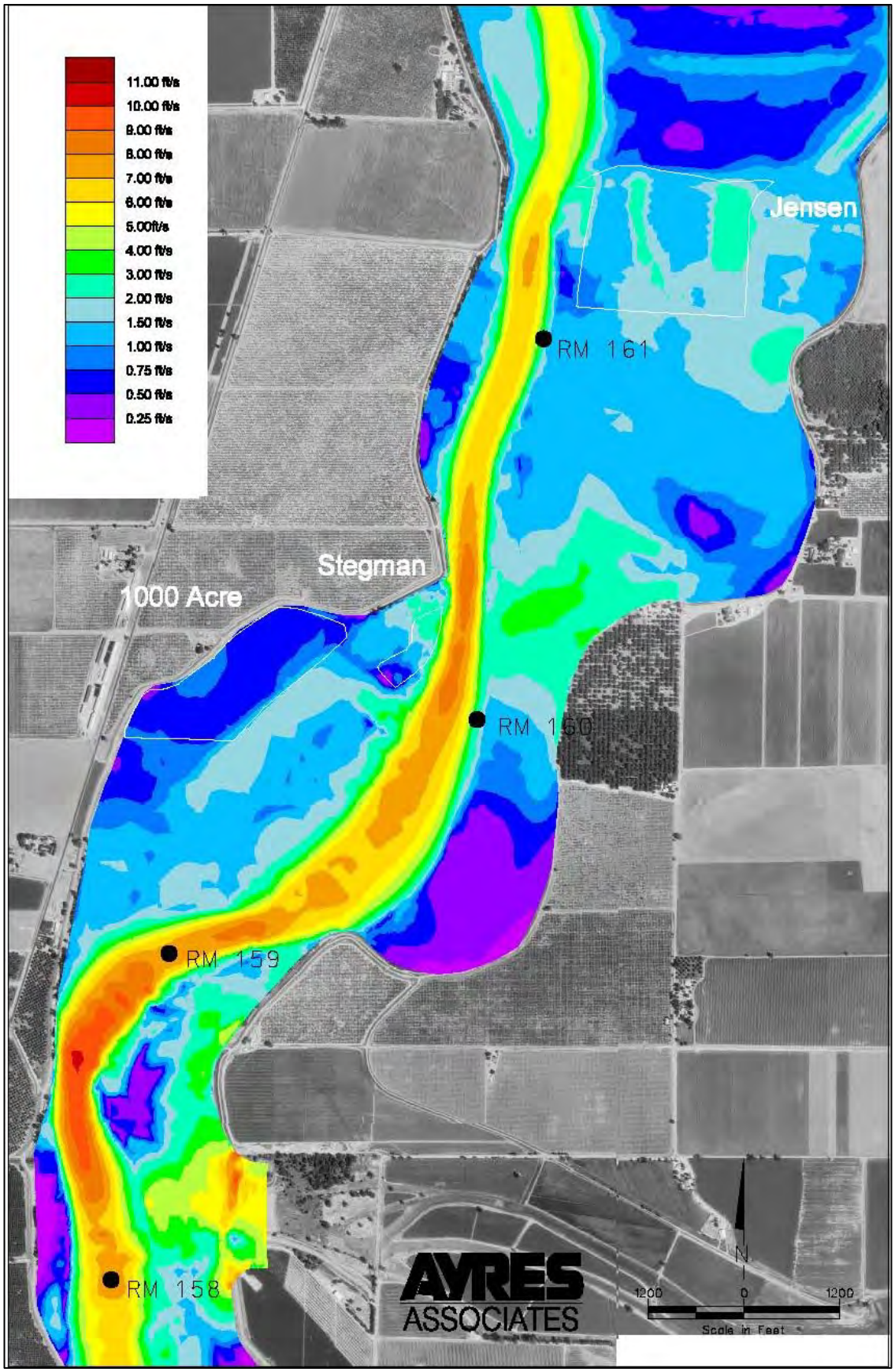
1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.50ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.50ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
RM 158
RM 157
RM 156
RM 155
RM 154
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES

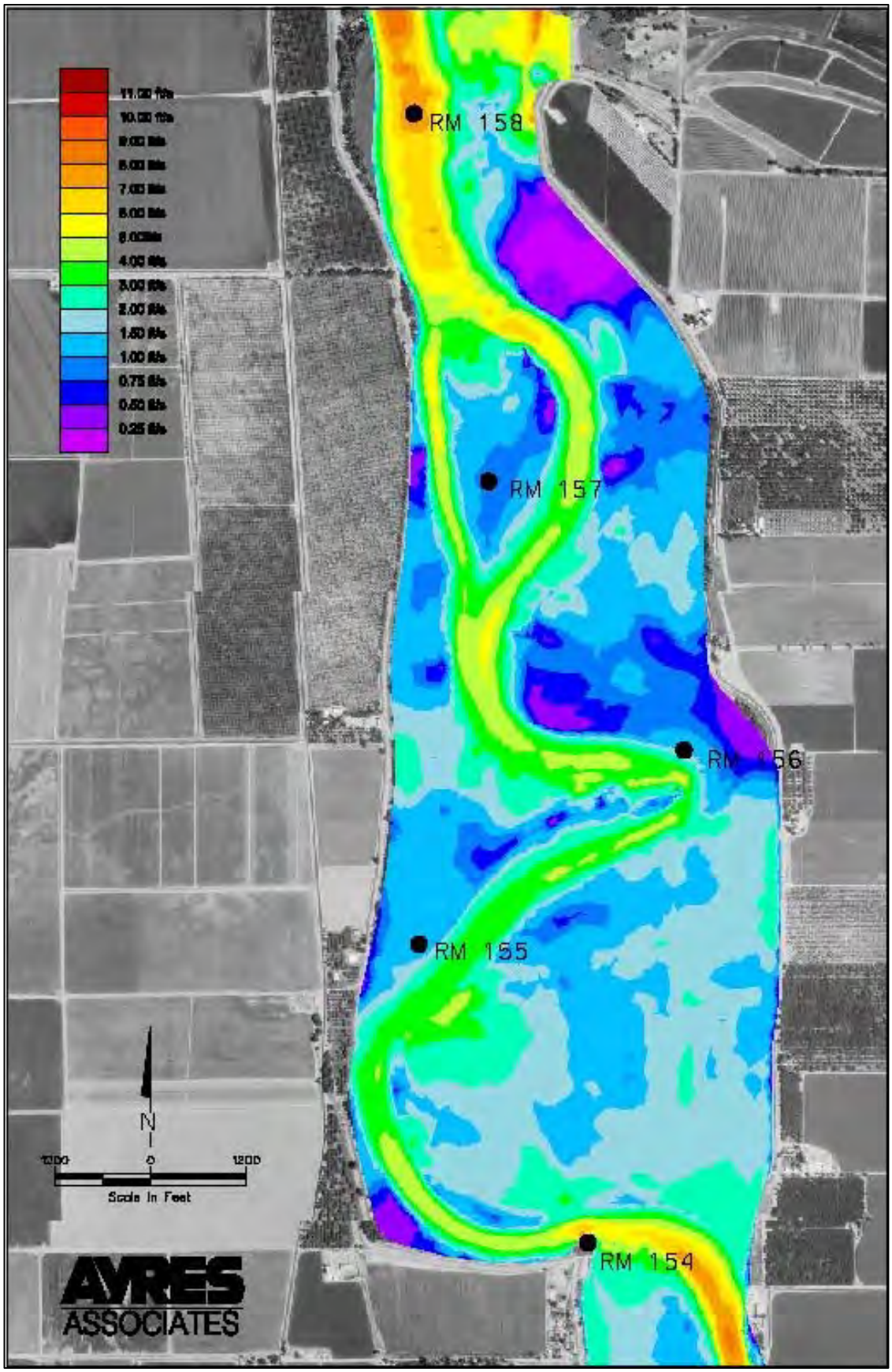

AYRES
ASSOCIATES
1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.50ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.50ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
RM 154
RM 153
RM 152
RM 150
RM 151
RM 149
RM 148
USGS
Boeger
N
1200
0
1200
Scale in Feet

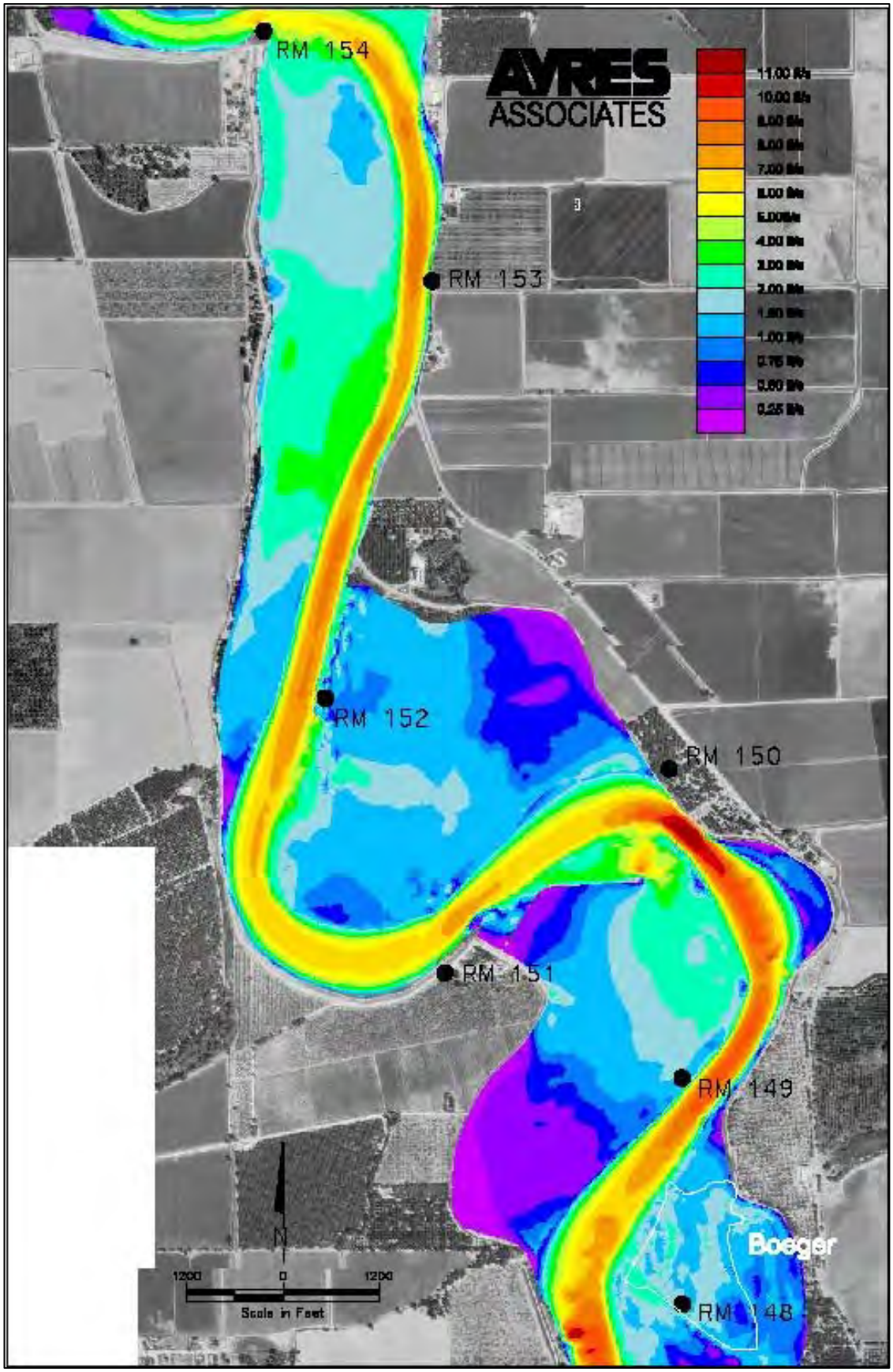

1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.50ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.50ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
Colusa North
RM 147
Ward
RM 146
Cruise' n Tarry
RM 145
RM 144
RM 143
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES

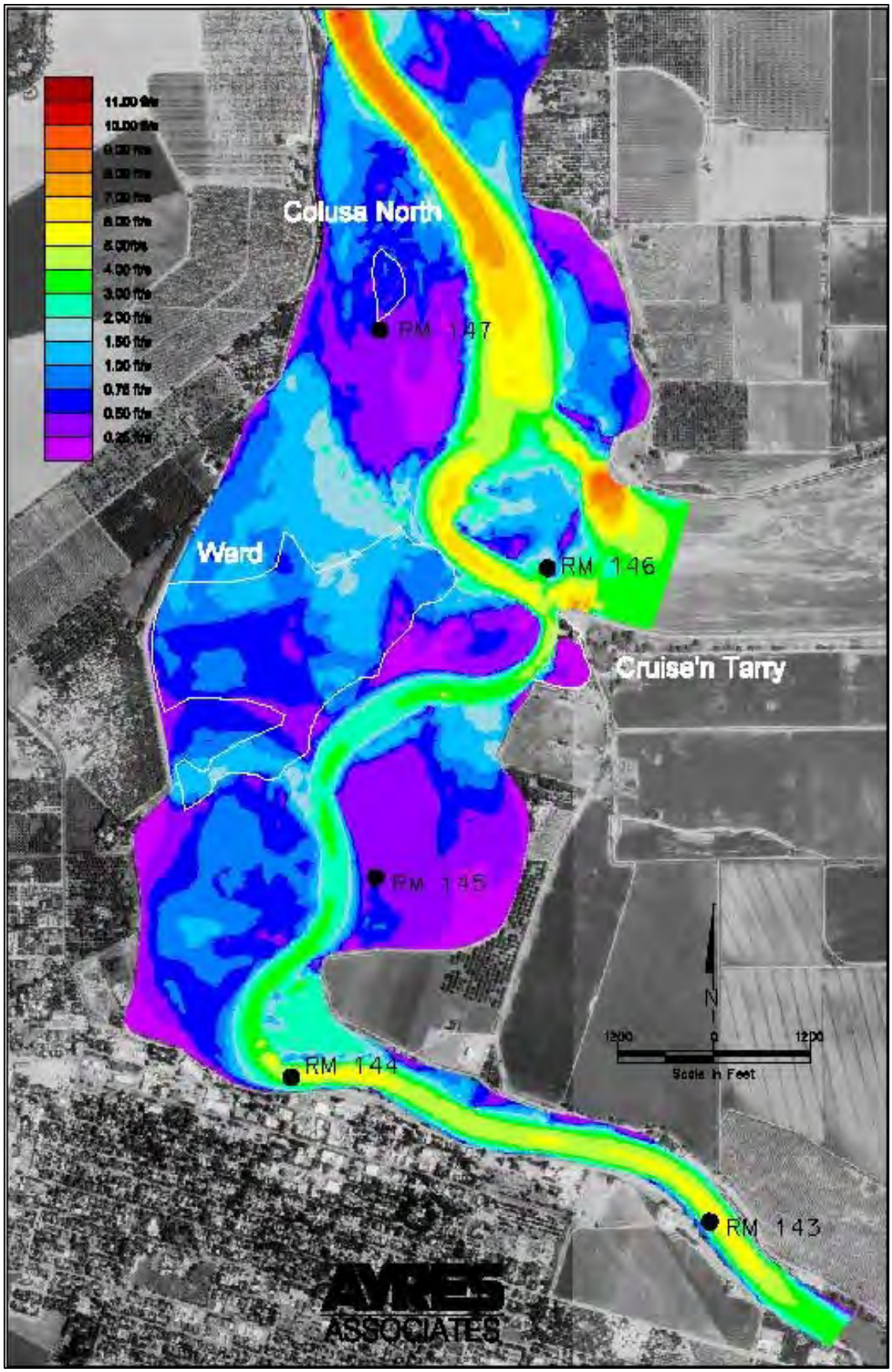
Appendix H – Velocity Plots
With-Project Conditions


RM 165
RM 164
RM 163
RM 162
Womble
N
Scale in Feet
AYRES
ASSOCIATES


11.00 ft/s
10.00 ft/s
9.00 ft/s
8.00 ft/s
7.00 ft/s
6.00 ft/s
5.00ft/s
4.00 ft/s
3.00 ft/s
2.00 ft/s
1.50 ft/s
1.00 ft/s
0.75 ft/s
0.50 ft/s
0.25 ft/s
Jensen
RM 161
Stegman
1000 Acre
RM 160
RM 159
RM 158
AYRES
ASSOCIATES
N
1200
0
1200
Scale in Feet

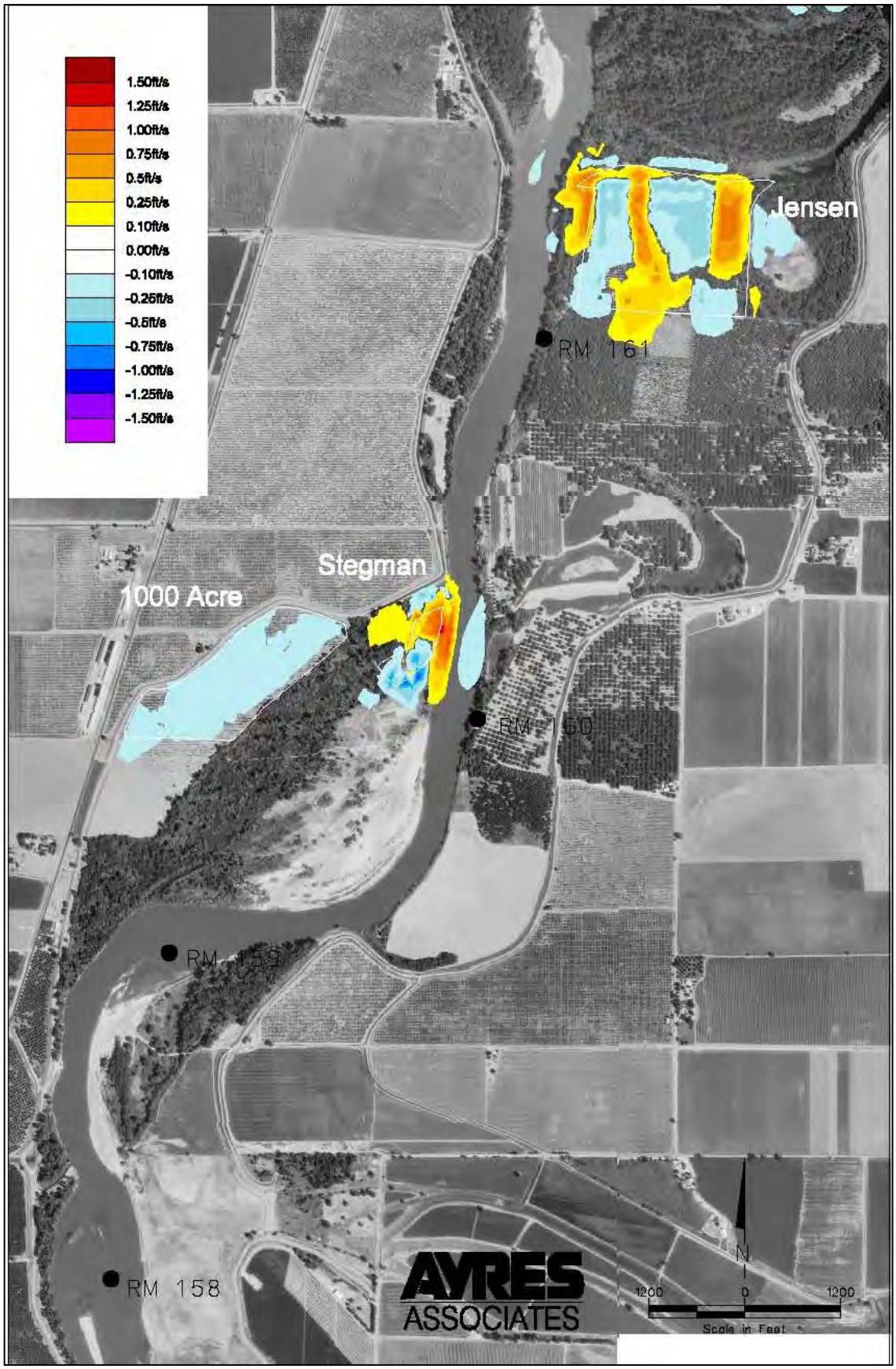

RM 158
RM 157
RM 156
RM 155
RM 154
N
1200
0
1200
Scale In Feet
AYRES
ASSOCIATES


AYRES
ASSOCIATES
RM 154
RM 153
RM 152
RM 150
RM 151
RM 149
RM 148
Boeger
N
1200
0
1200
Scale in Feet

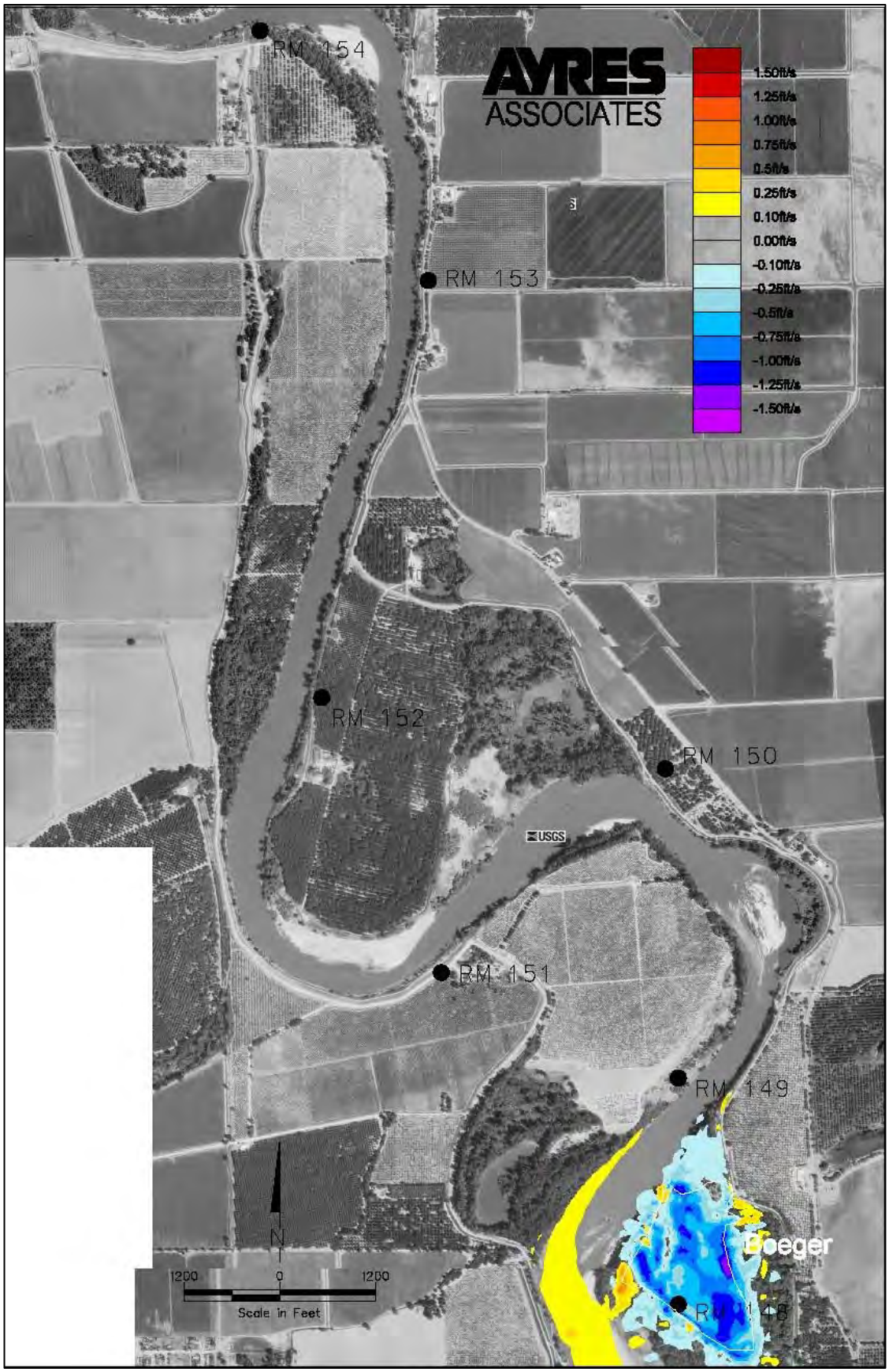

Colusa North
Ward
Cruise'n Tarry
RM 147
RM 146
RM 145
RM 144
RM 143
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES

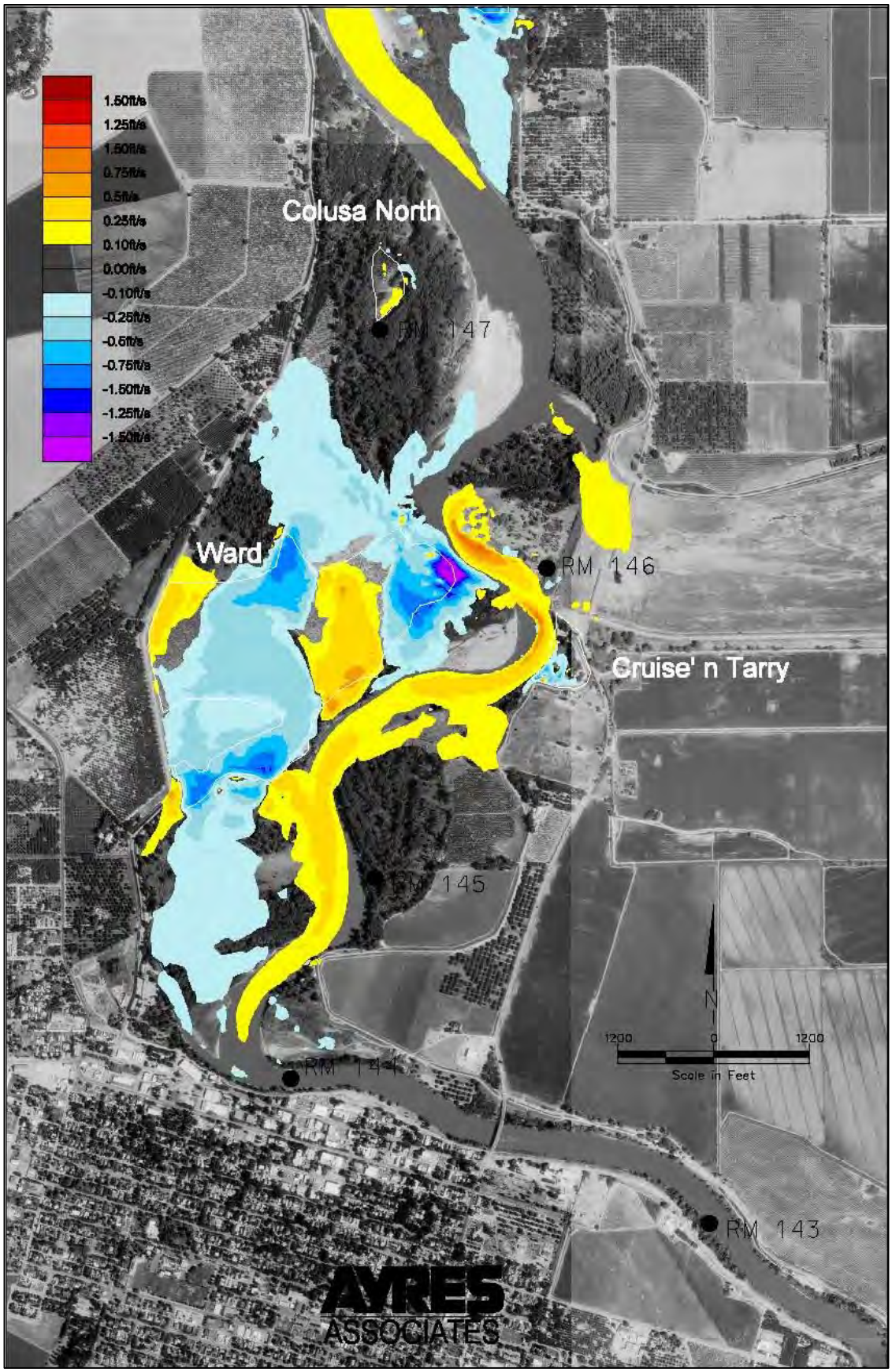
Appendix I – Velocity Differential Plots With-Project Conditions to Existing Conditions

1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.5ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.5ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
N
1200
0
1200
Scale in Feet
RM 165
RM 164
RM 163
RM 162
Womble
AYRES
ASSOCIATES


1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.5ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.5ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
Jensen
RM 161
Stegman
1000 Acre
RM 160
RM 159
RM 158
AYRES
ASSOCIATES
N
1200
0
1200
Scale in Feet

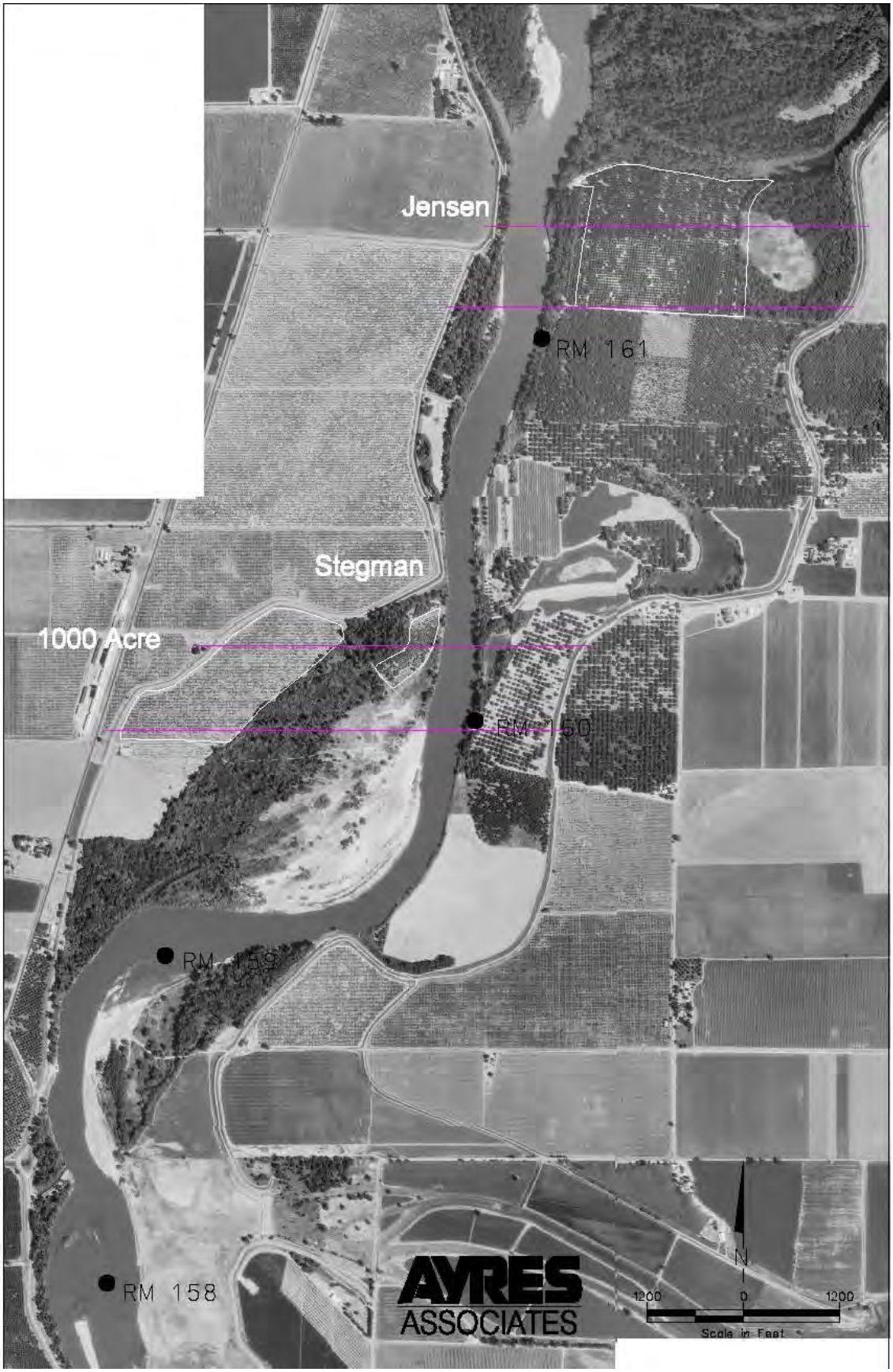
1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.5ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.5ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
RM 158
RM 157
RM 156
RM 155
RM 154
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES

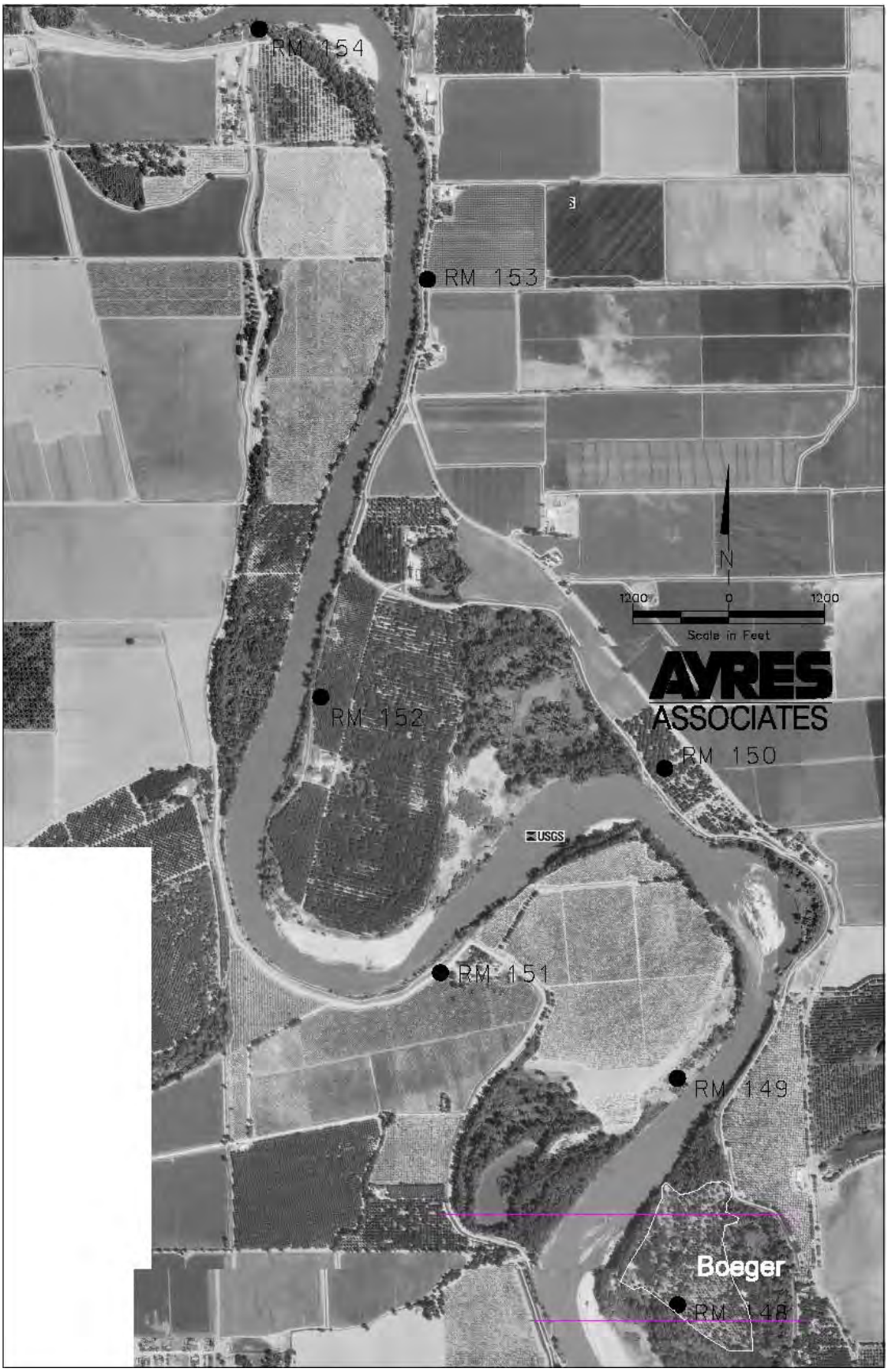

AYRES
ASSOCIATES
1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.5ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.5ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
RM 154
RM 153
RM 152
RM 150
USGS
RM 151
RM 149
RM 148
Boeger
N
1200
0
1200
Scale in Feet


1.50ft/s
1.25ft/s
1.00ft/s
0.75ft/s
0.5ft/s
0.25ft/s
0.10ft/s
0.00ft/s
-0.10ft/s
-0.25ft/s
-0.5ft/s
-0.75ft/s
-1.00ft/s
-1.25ft/s
-1.50ft/s
Colusa North
RM 147
Ward
RM 146
Cruise' n Tarry
RM 145
RM 144
RM 143
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES

Appendix J -
Cross Section Locations
for Water Surface Elevation Comparisons

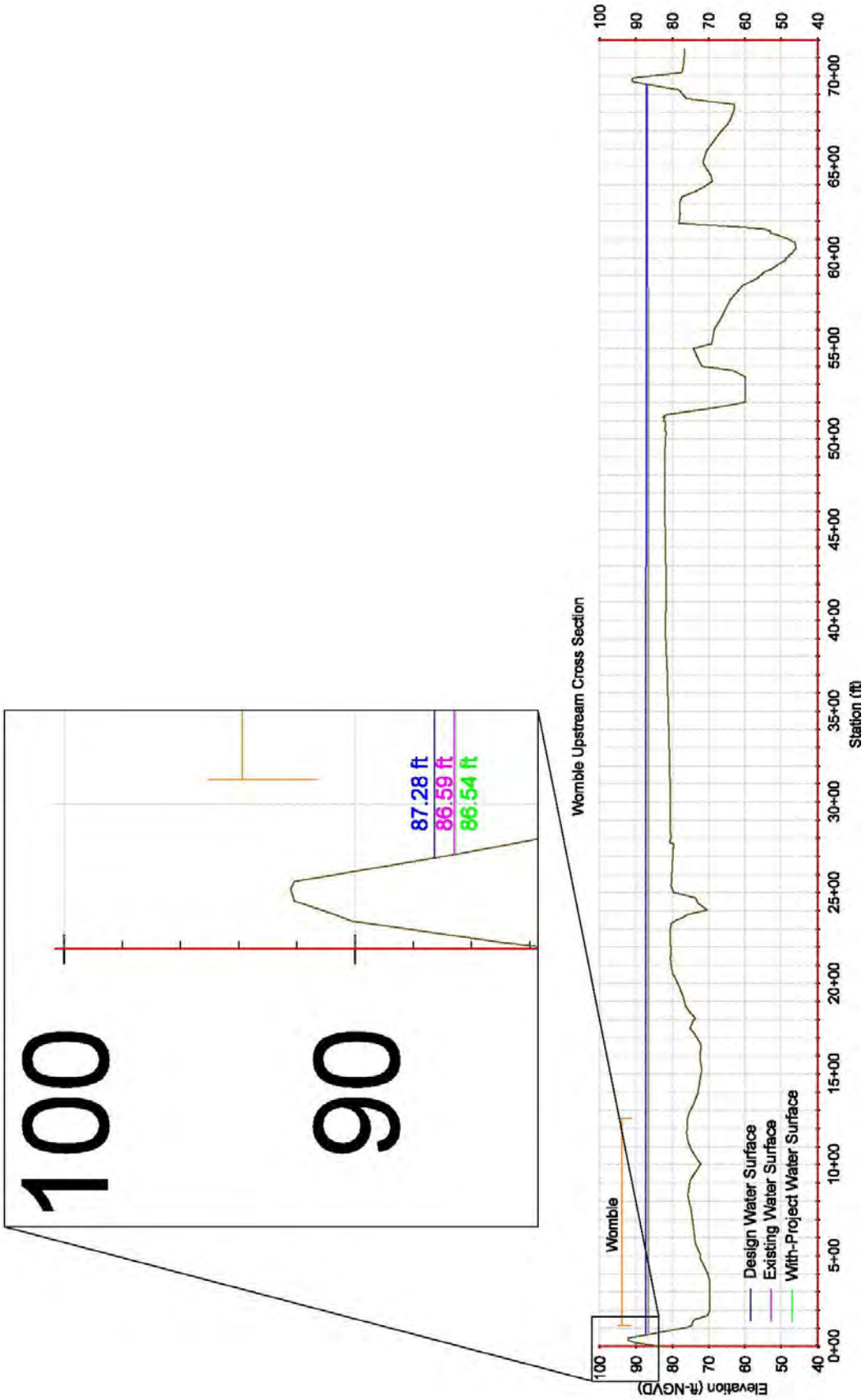
RM 165
RM 164
RM 163
RM 162
N
1200
0
1200
Scale in Feet
Womble
AYRES
ASSOCIATES

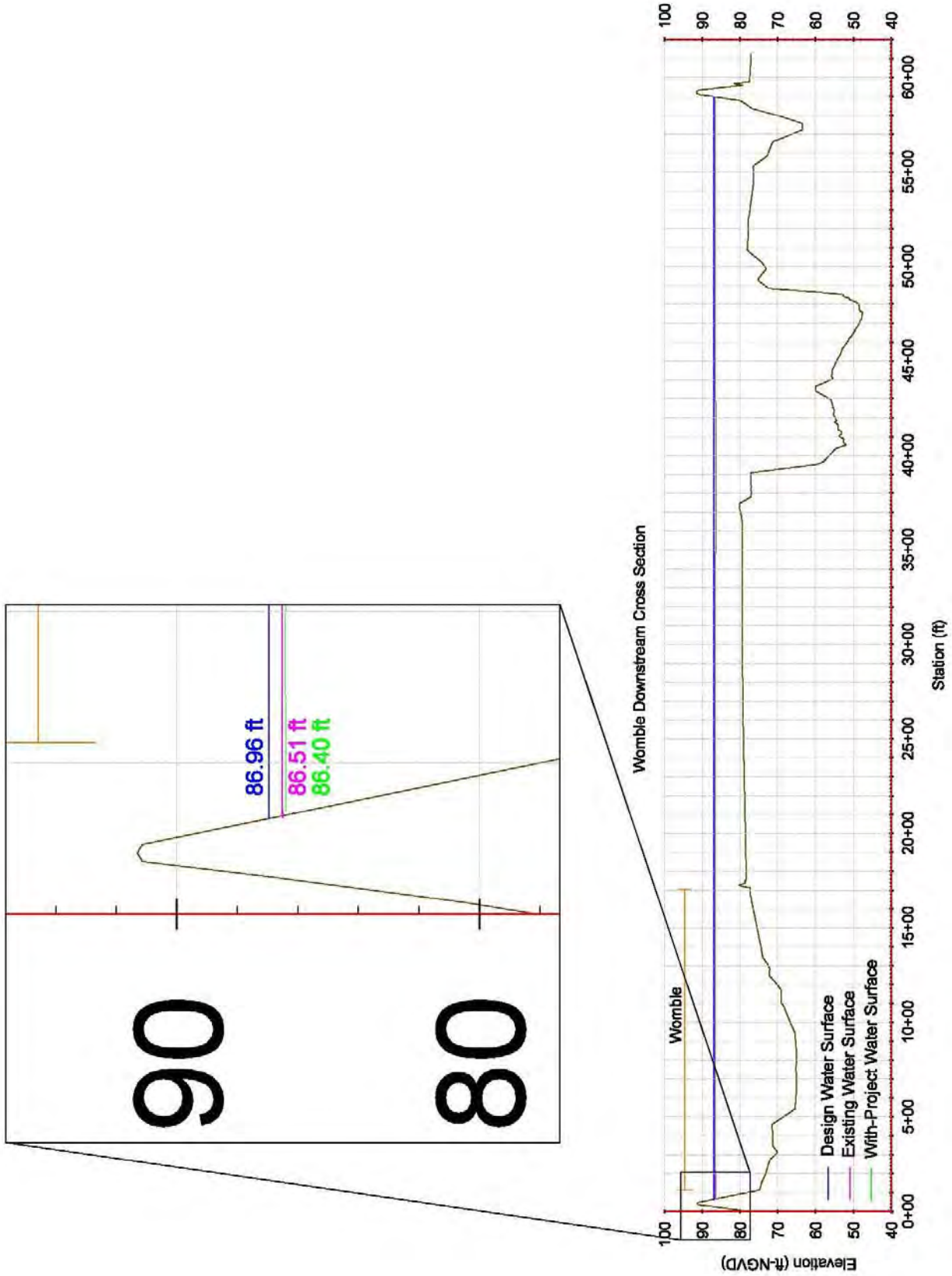

Jensen
RM 161
Stegman
1000 Acre
RM 160
RM 159
RM 158
AYRES
ASSOCIATES
N
1200
0
1200
Scale in Feet

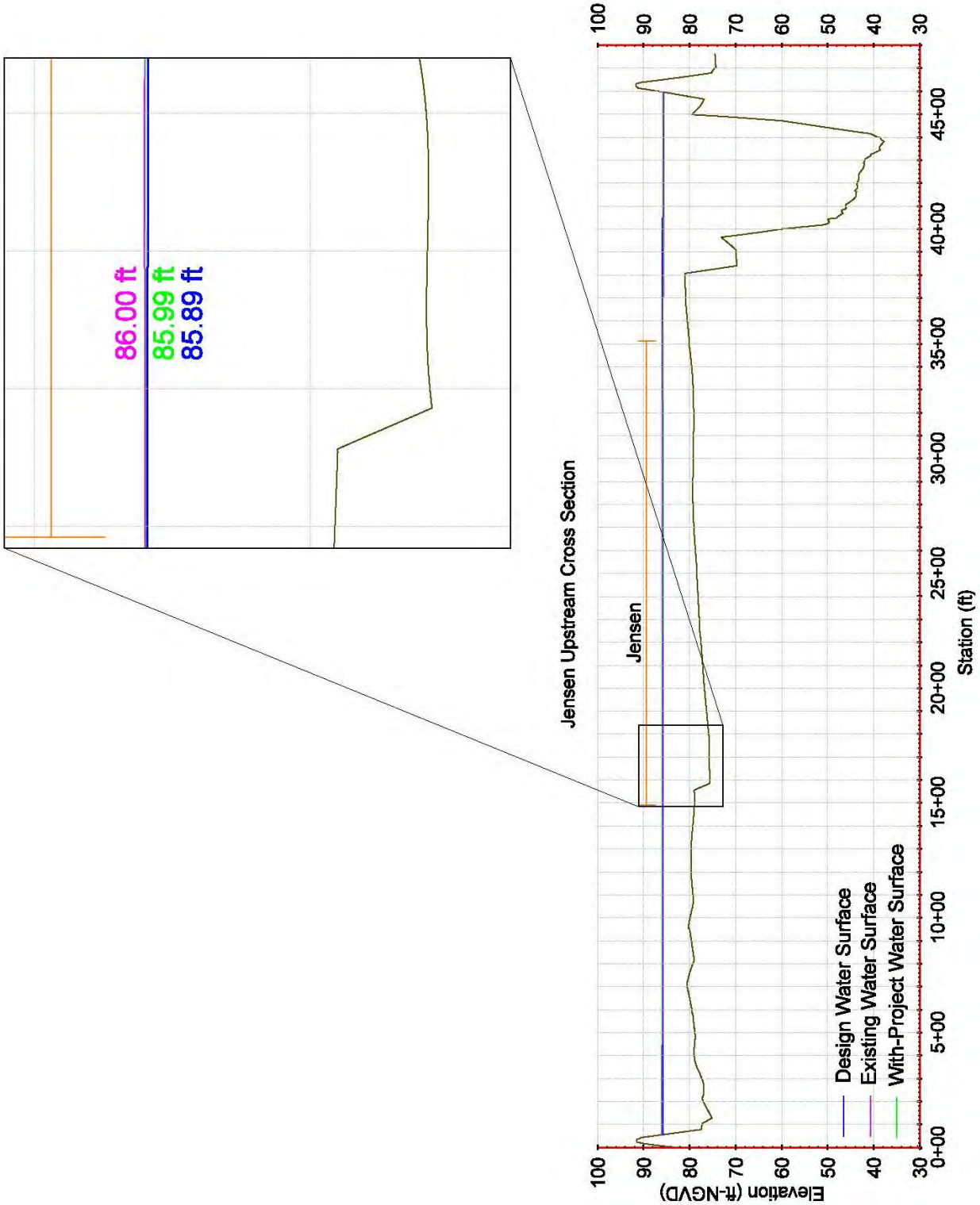

RM 154
RM 153
RM 152
RM 150
RM 151
RM 149
RM 148
Boeger
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES
USGS

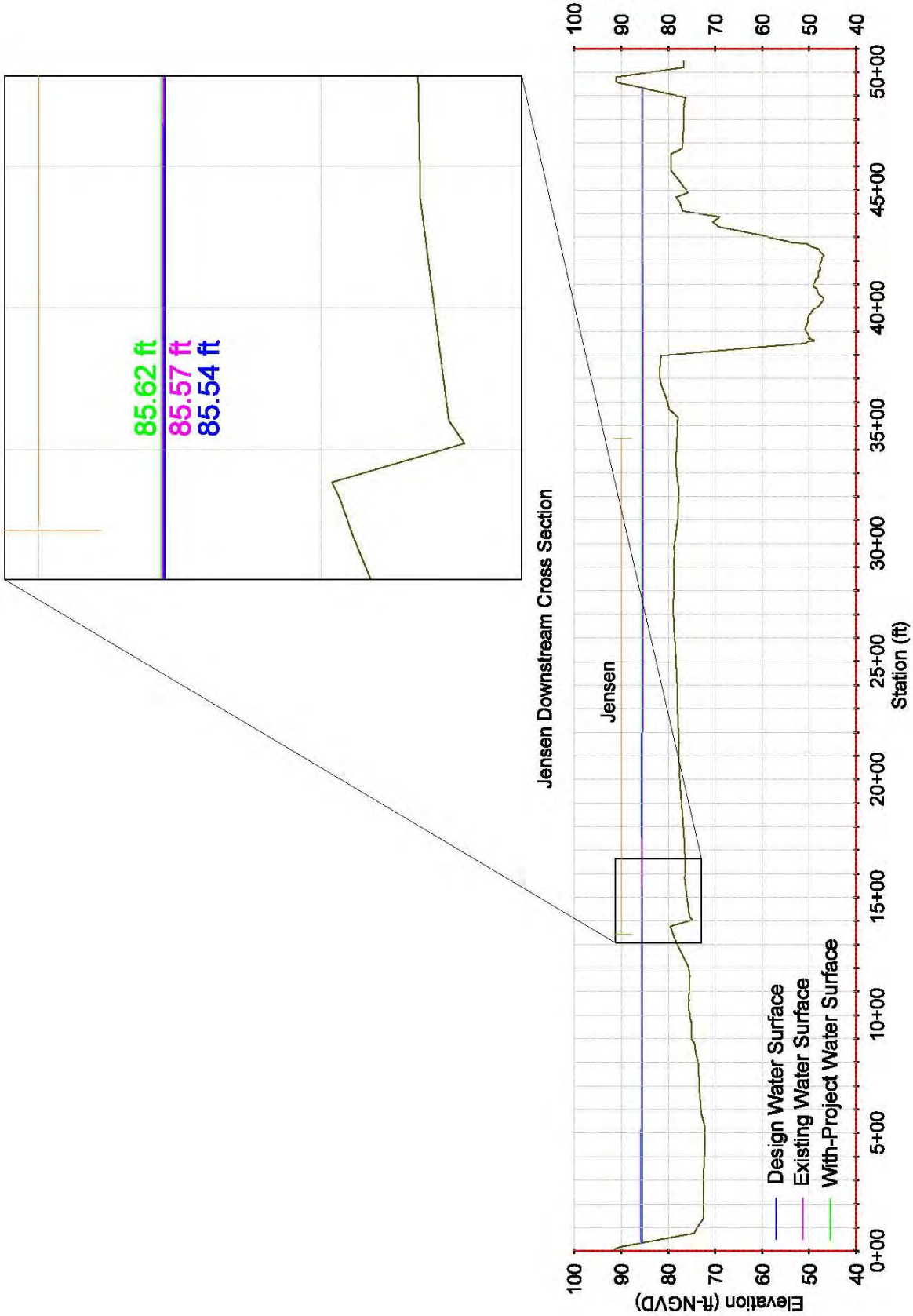
Colusa North
RM 147
RM 146
Ward
Cruise'n Tarry
RM 145
N
1200
0
1200
Scale in Feet
RM 144
RM 143
AYRES
ASSOCIATES

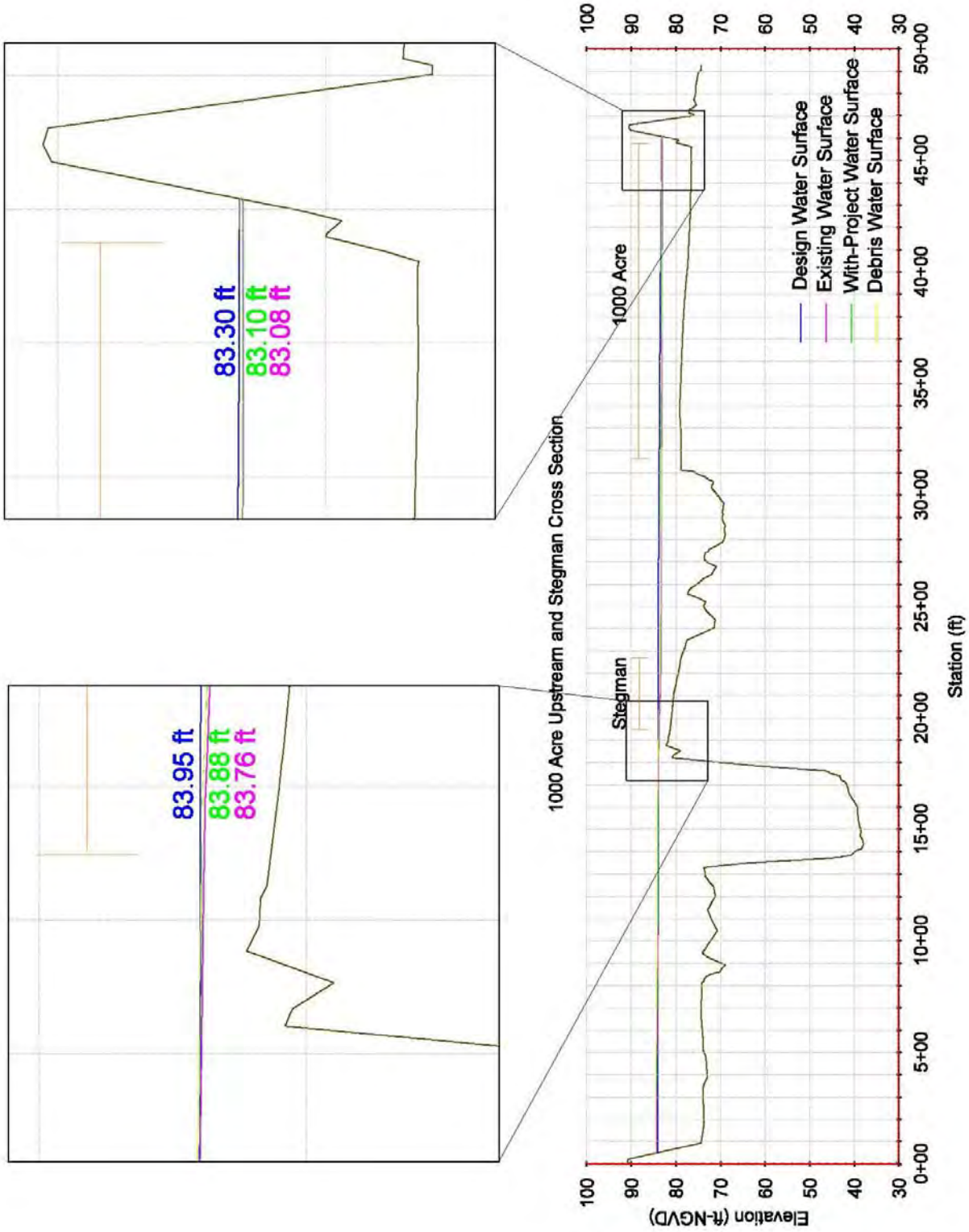
Appendix K -
Water Surface Elevation Cross Sections for Restoration Sites

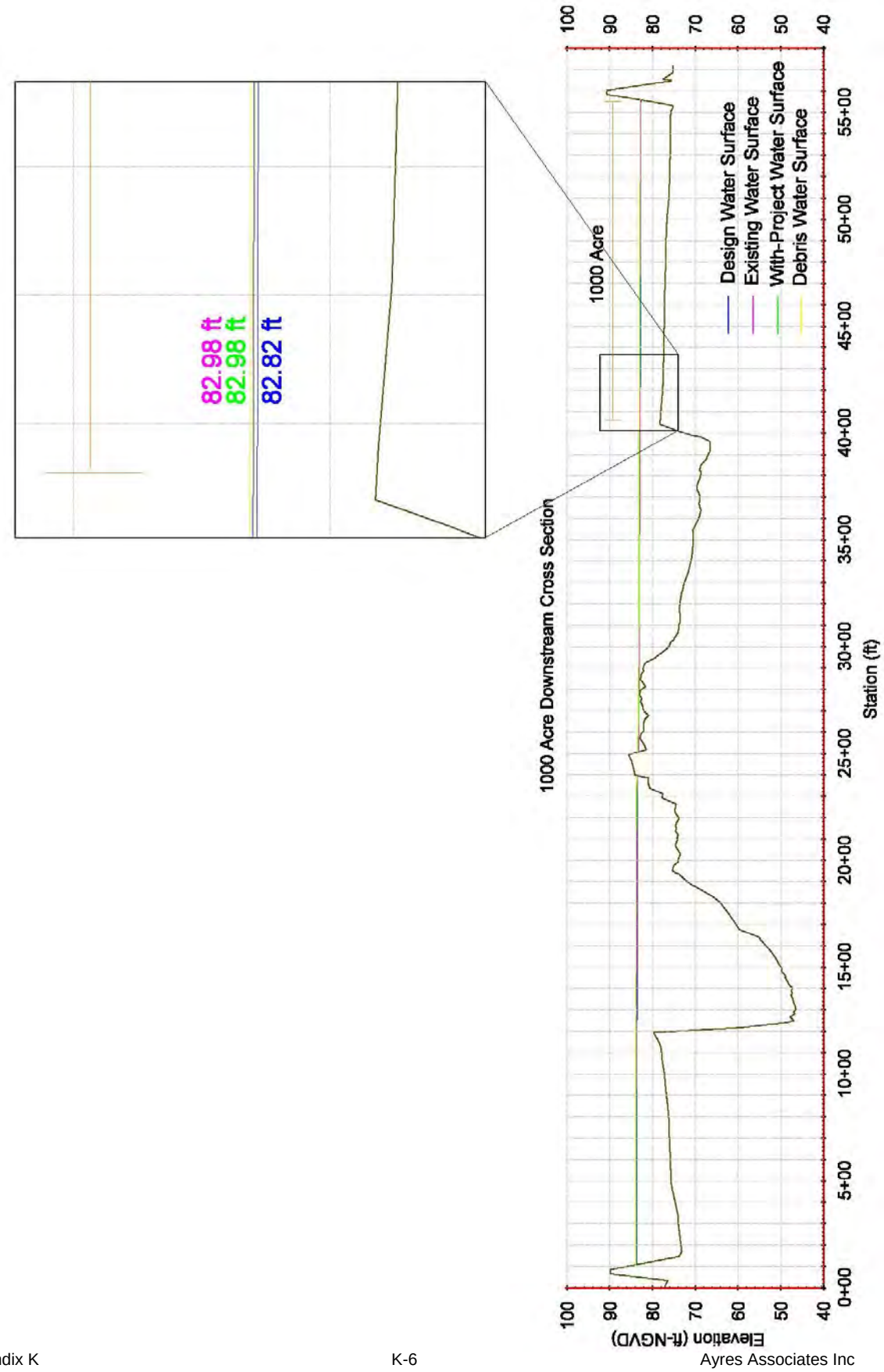

Womble Upstream Cross Section
Elevation (ft-NGVD)
Station (ft)
Womble
Design Water Surface
Existing Water Surface
With-Project Water Surface
87.28 ft
86.59 ft
86.54 ft
100
90
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
50+00
55+00
60+00
65+00
70+00
40
50
60
70
80
90
100

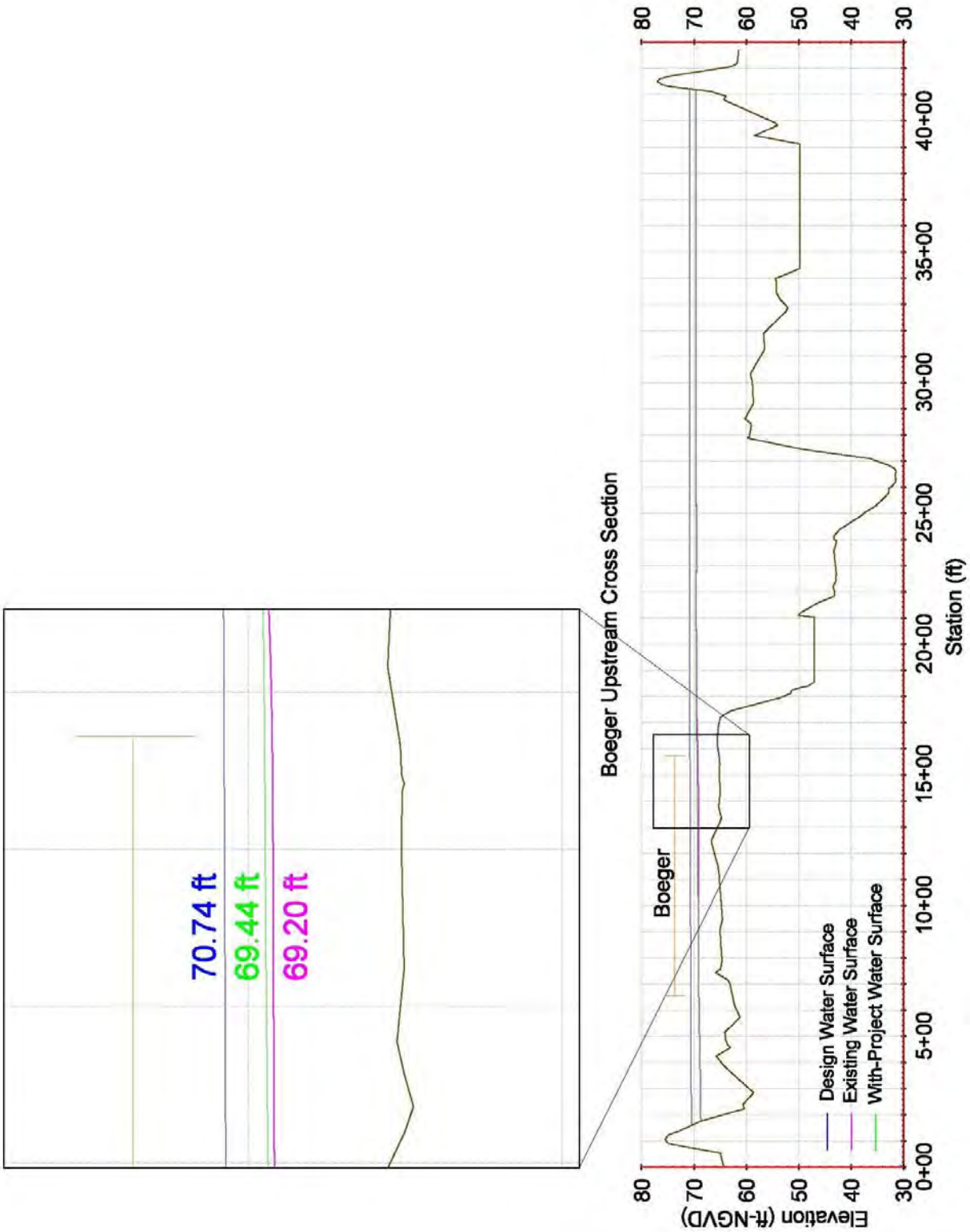

Womble Downstream Cross Section
Elevation (ft-NGVD)
Station (ft)
Womble
Design Water Surface
Existing Water Surface
With-Project Water Surface
86.96 ft
86.51 ft
86.40 ft
90
80
100
90
80
70
60
50
40
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
50+00
55+00
60+00

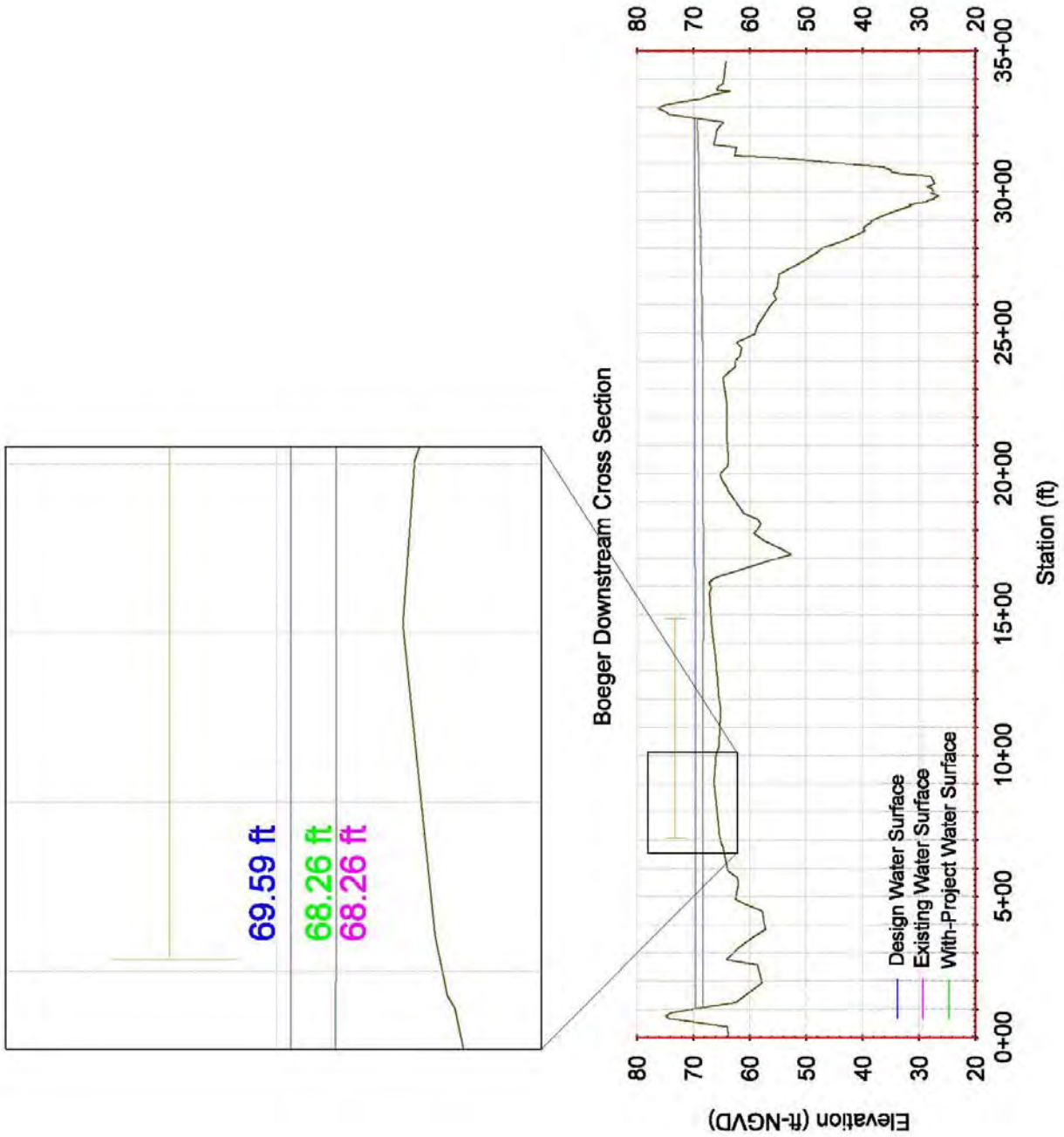

Jensen Upstream Cross Section
Jensen
86.00 ft
85.99 ft
85.89 ft
Design Water Surface
Existing Water Surface
With-Project Water Surface
Elevation (ft-NGVD)
Station (ft)
100
90
80
70
60
50
40
30
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00

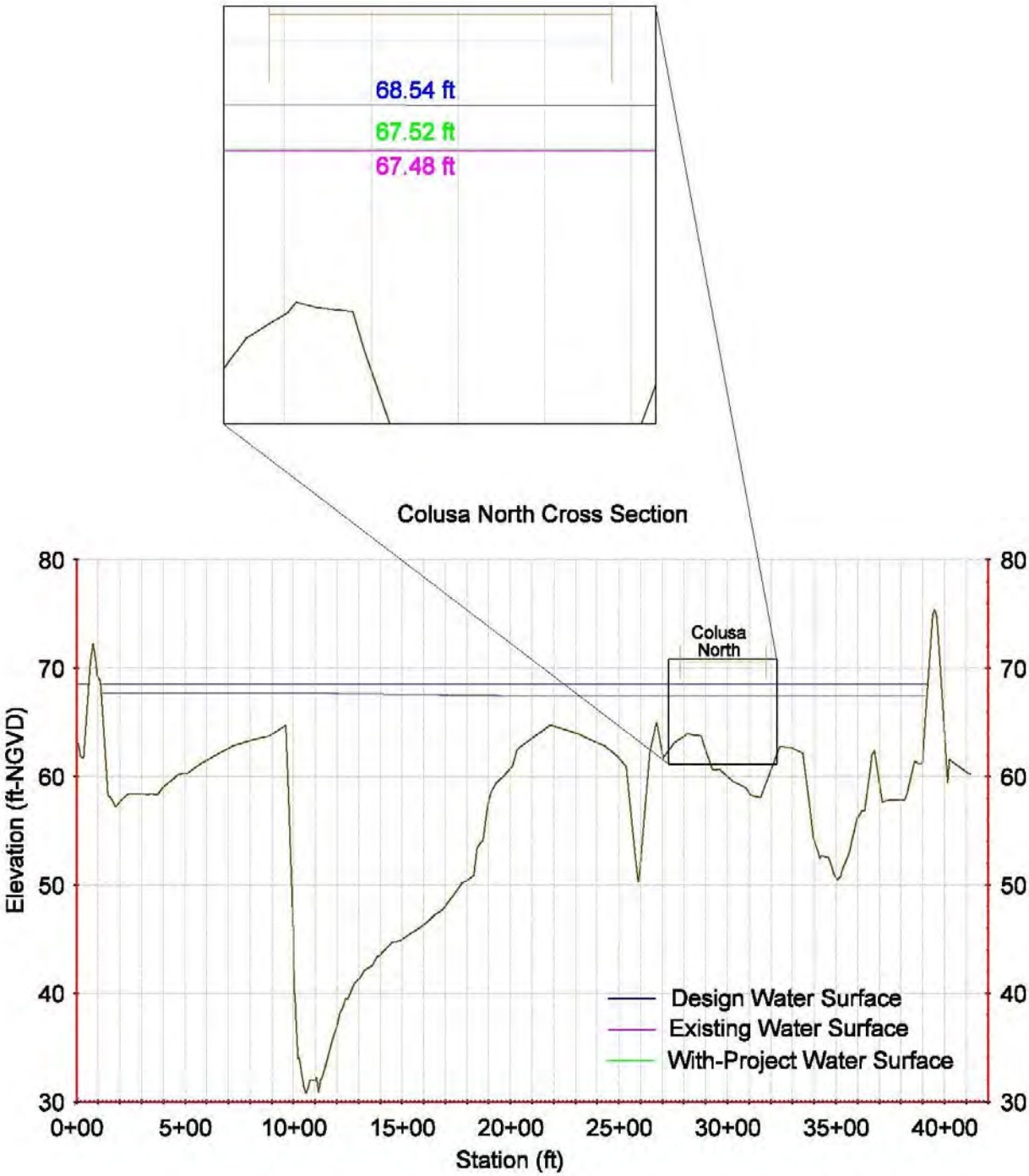

Jensen Downstream Cross Section
85.62 ft
85.57 ft
85.54 ft
Jensen
Design Water Surface
Existing Water Surface
With-Project Water Surface
Elevation (ft-NGVD)
Station (ft)
100
90
80
70
60
50
40
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
50+00

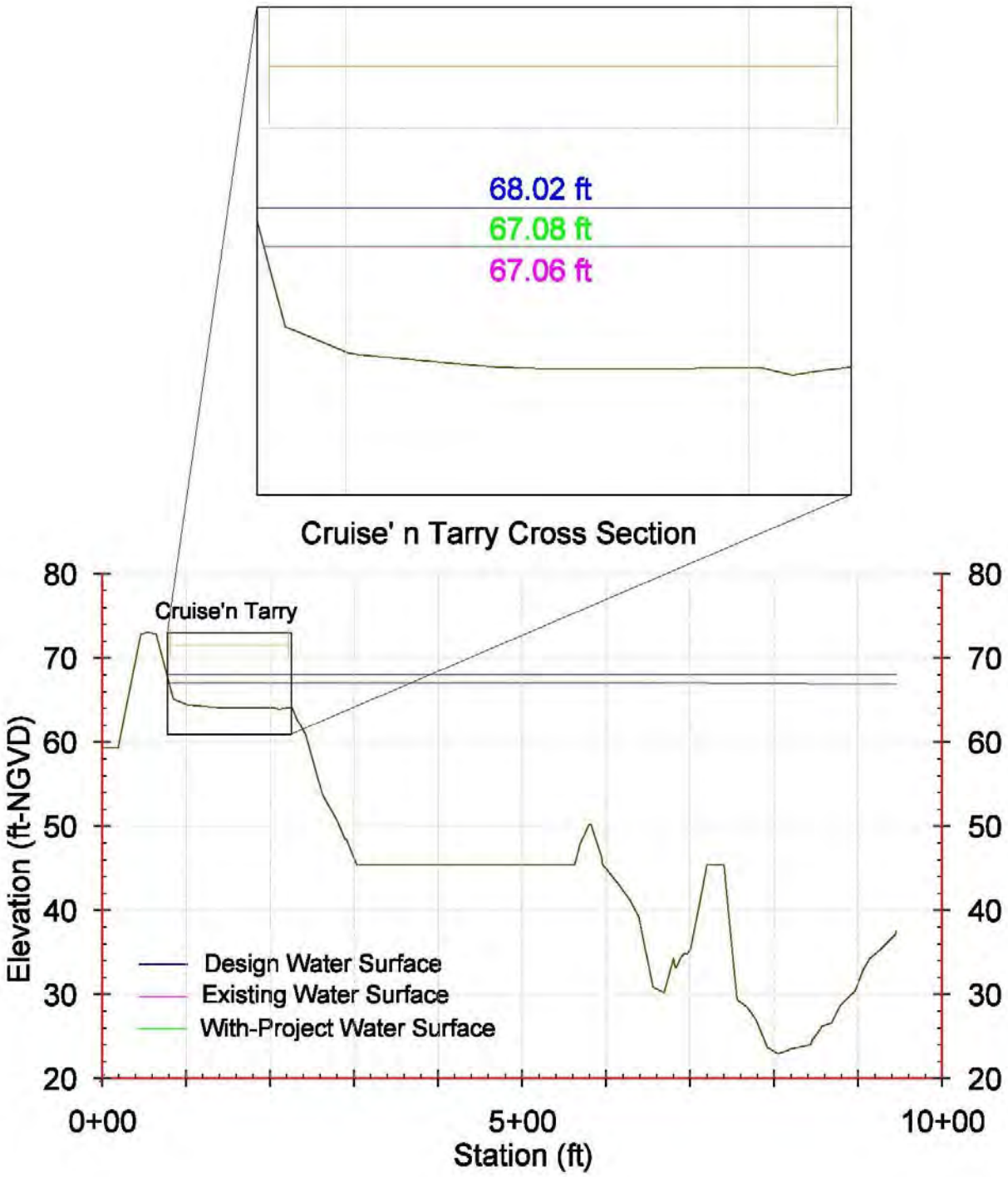

1000 Acre Upstream and Stegman Cross Section
Stegman
1000 Acre
83.95 ft
83.88 ft
83.76 ft
83.30 ft
83.10 ft
83.08 ft
Design Water Surface
Existing Water Surface
With-Project Water Surface
Debris Water Surface
Elevation (ft-NGVD)
Station (ft)
100
90
80
70
60
50
40
30
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
50+00

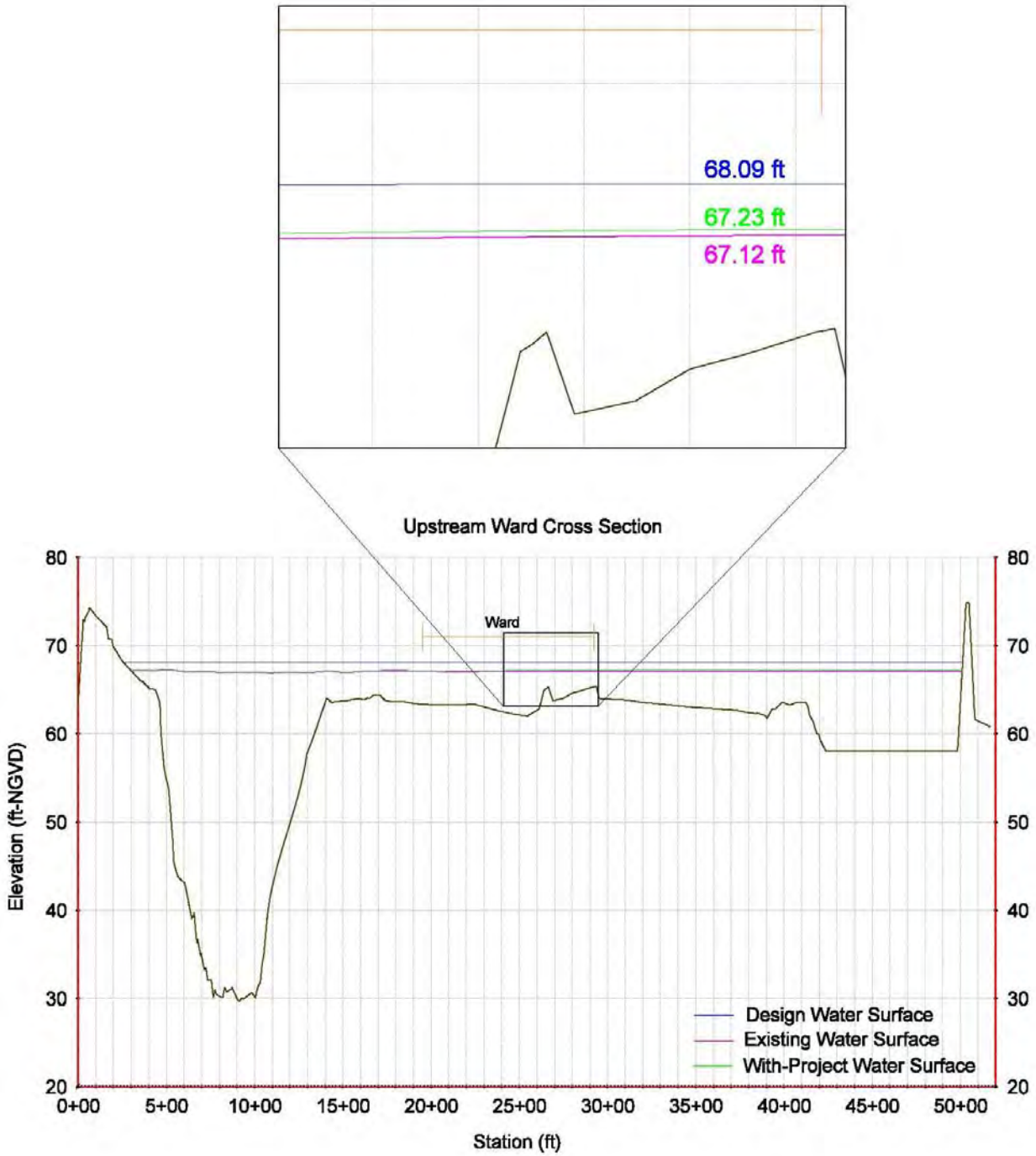

1000 Acre Downstream Cross Section
Elevation (ft-NGVD)
Station (ft)
100
90
80
70
60
50
40
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
50+00
55+00
1000 Acre
Design Water Surface
Existing Water Surface
With-Project Water Surface
Debris Water Surface
82.98 ft
82.98 ft
82.82 ft

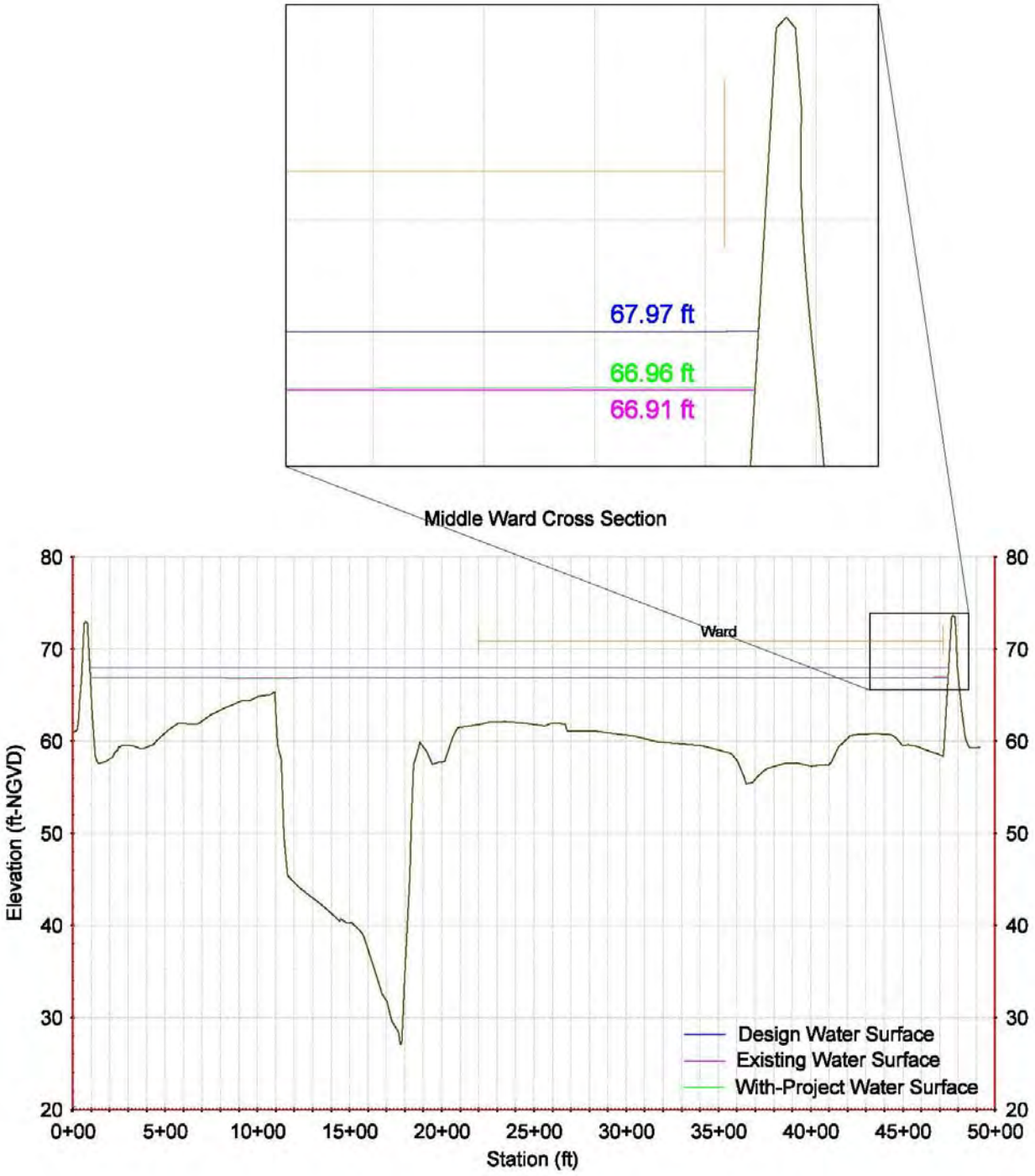

Boeger Upstream Cross Section
70.74 ft
69.44 ft
69.20 ft
Boeger
Design Water Surface
Existing Water Surface
With-Project Water Surface
Elevation (ft-NGVD)
Station (ft)
80
70
60
50
40
30
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00

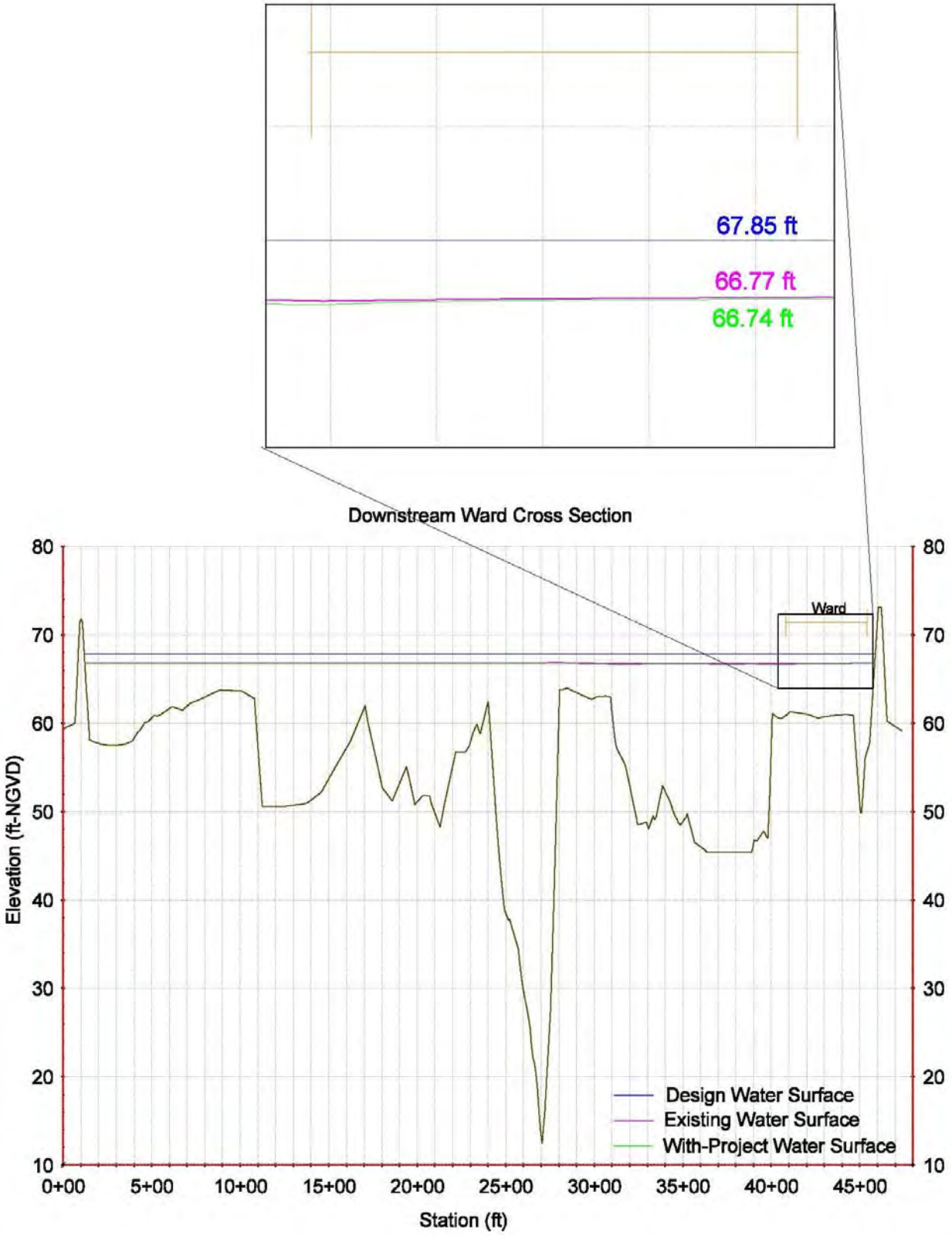

Boeger Downstream Cross Section
69.59 ft
68.26 ft
68.26 ft
Design Water Surface
Existing Water Surface
With-Project Water Surface
Elevation (ft-NGVD)
Station (ft)
80
70
60
50
40
30
20
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00


68.54 ft
67.52 ft
67.48 ft
Colusa North Cross Section
Colusa North
Elevation (ft-NGVD)
80
70
60
50
40
30
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
Station (ft)
Design Water Surface
Existing Water Surface
With-Project Water Surface

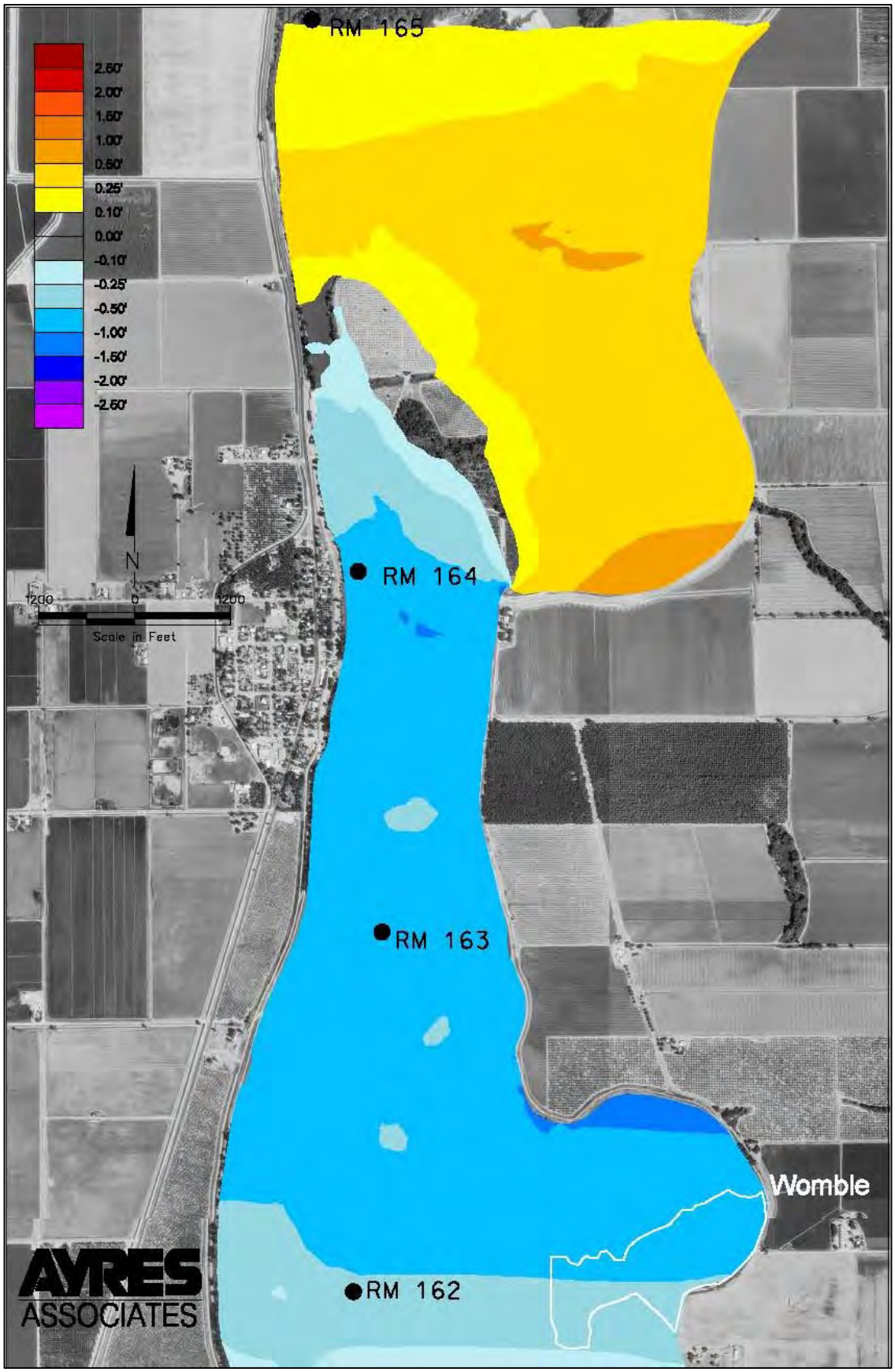

68.02 ft
67.08 ft
67.06 ft
Cruise' n Tarry Cross Section
Cruise'n Tarry
Elevation (ft-NGVD)
80
70
60
50
40
30
20
Design Water Surface
Existing Water Surface
With-Project Water Surface
0+00
5+00
10+00
Station (ft)

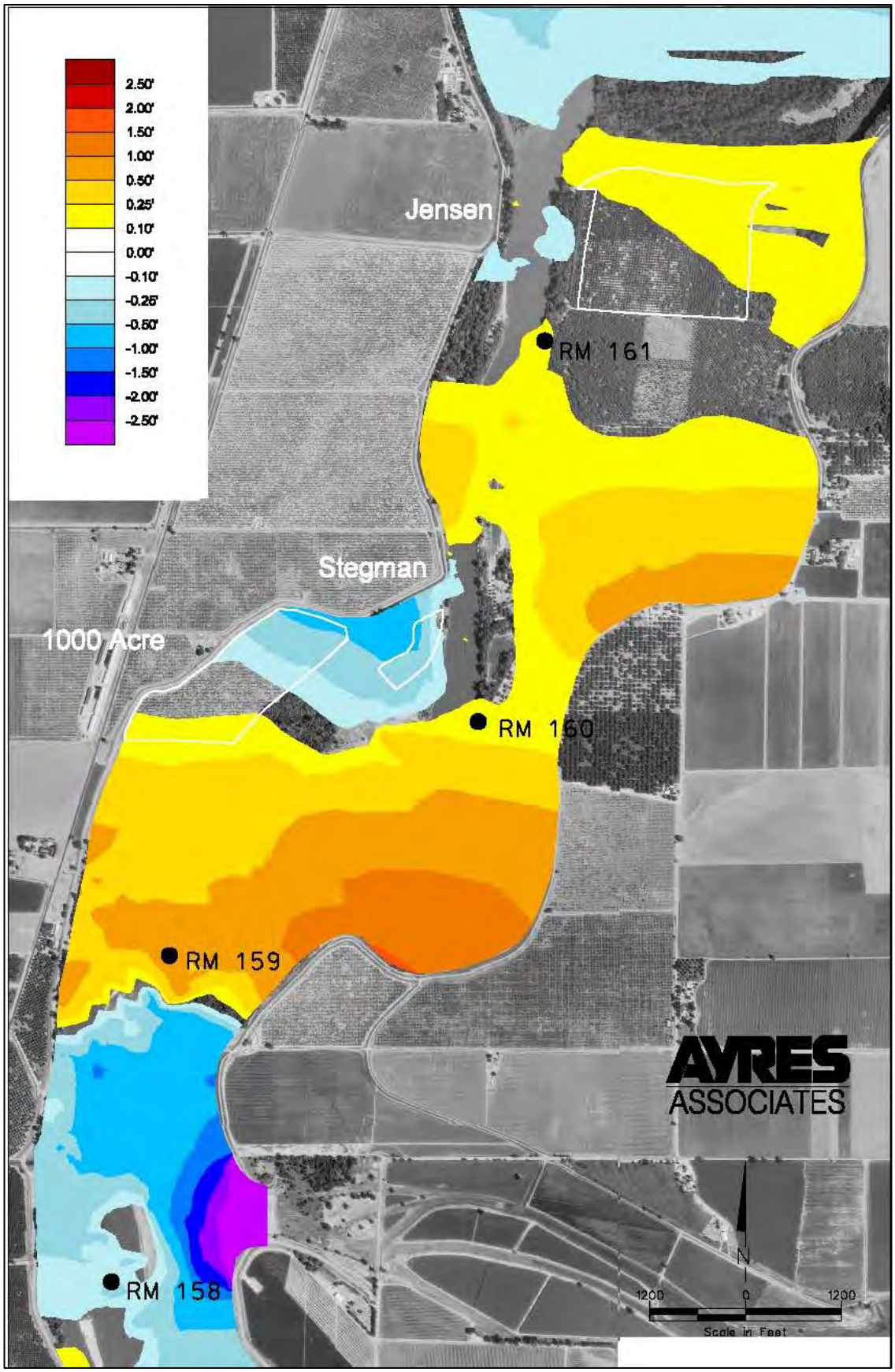

68.09 ft
67.23 ft
67.12 ft
Upstream Ward Cross Section
Ward
Elevation (ft-NGVD)
Station (ft)
Design Water Surface
Existing Water Surface
With-Project Water Surface
80
70
60
50
40
30
20
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
50+00

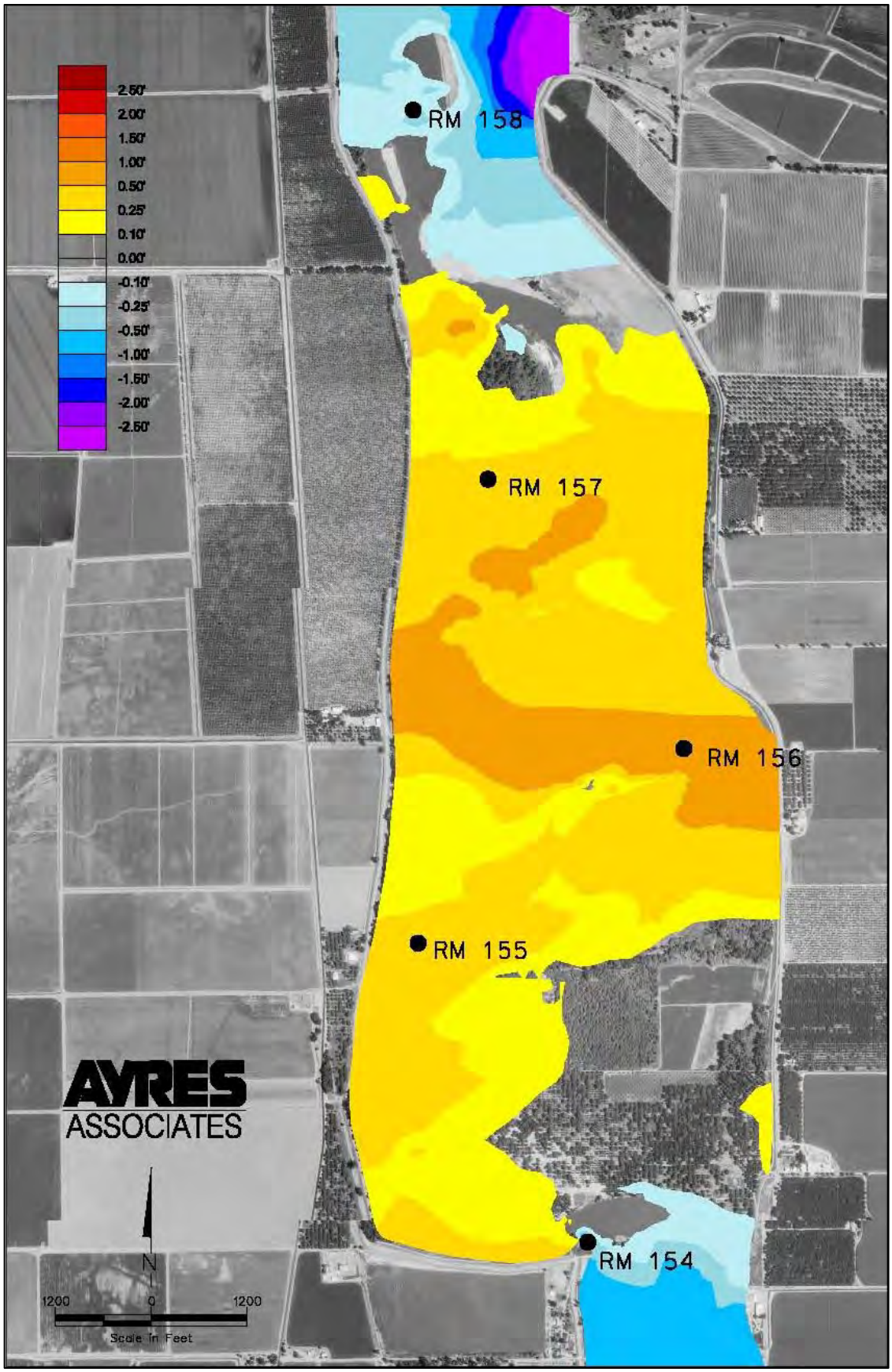

67.97 ft
66.96 ft
66.91 ft
Middle Ward Cross Section
Ward
Elevation (ft-NGVD)
Station (ft)
Design Water Surface
Existing Water Surface
With-Project Water Surface
80
70
60
50
40
30
20
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
50+00

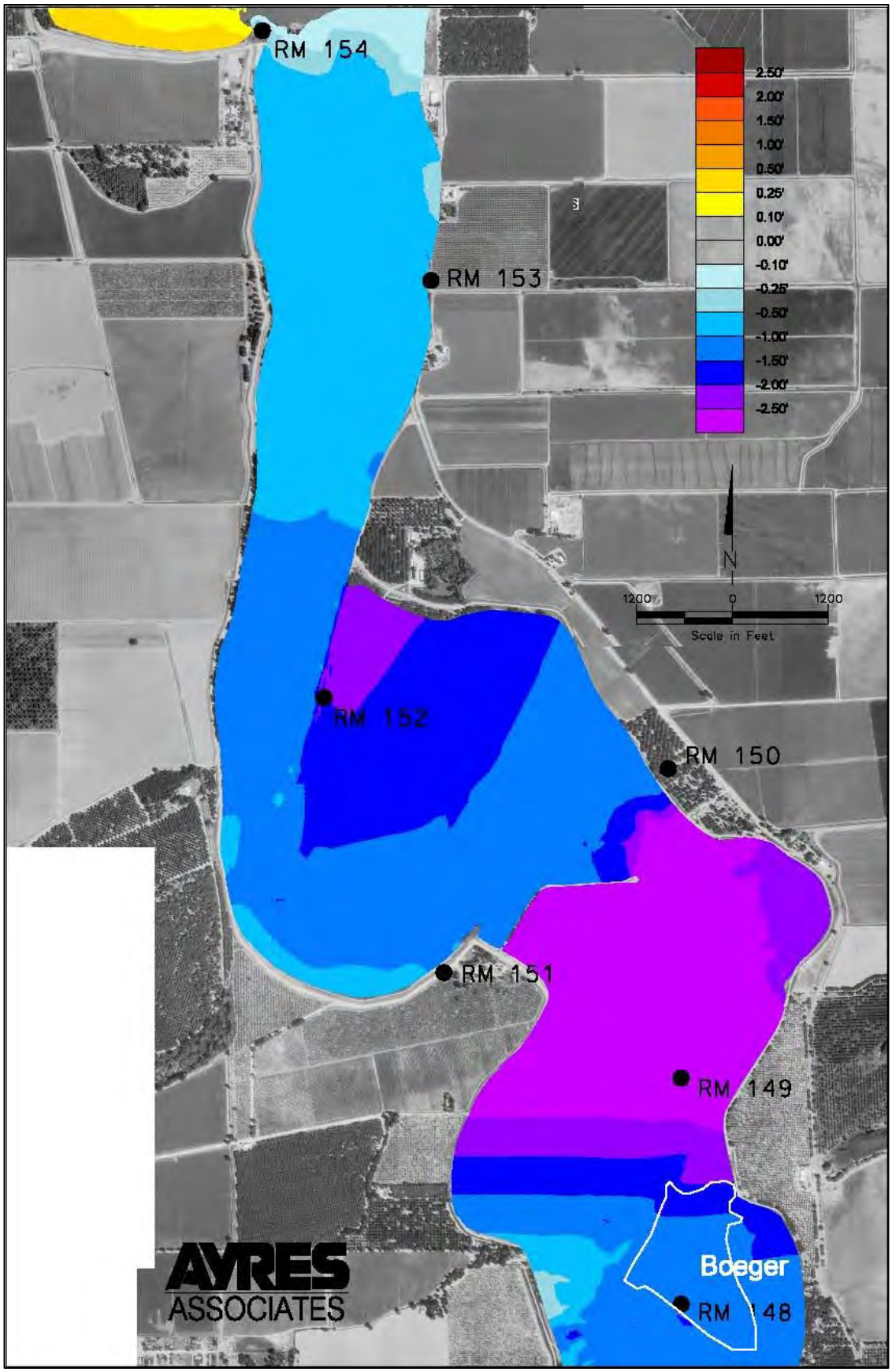

67.85 ft
66.77 ft
66.74 ft
Downstream Ward Cross Section
Ward
Elevation (ft-NGVD)
Station (ft)
Design Water Surface
Existing Water Surface
With-Project Water Surface
80
70
60
50
40
30
20
10
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00

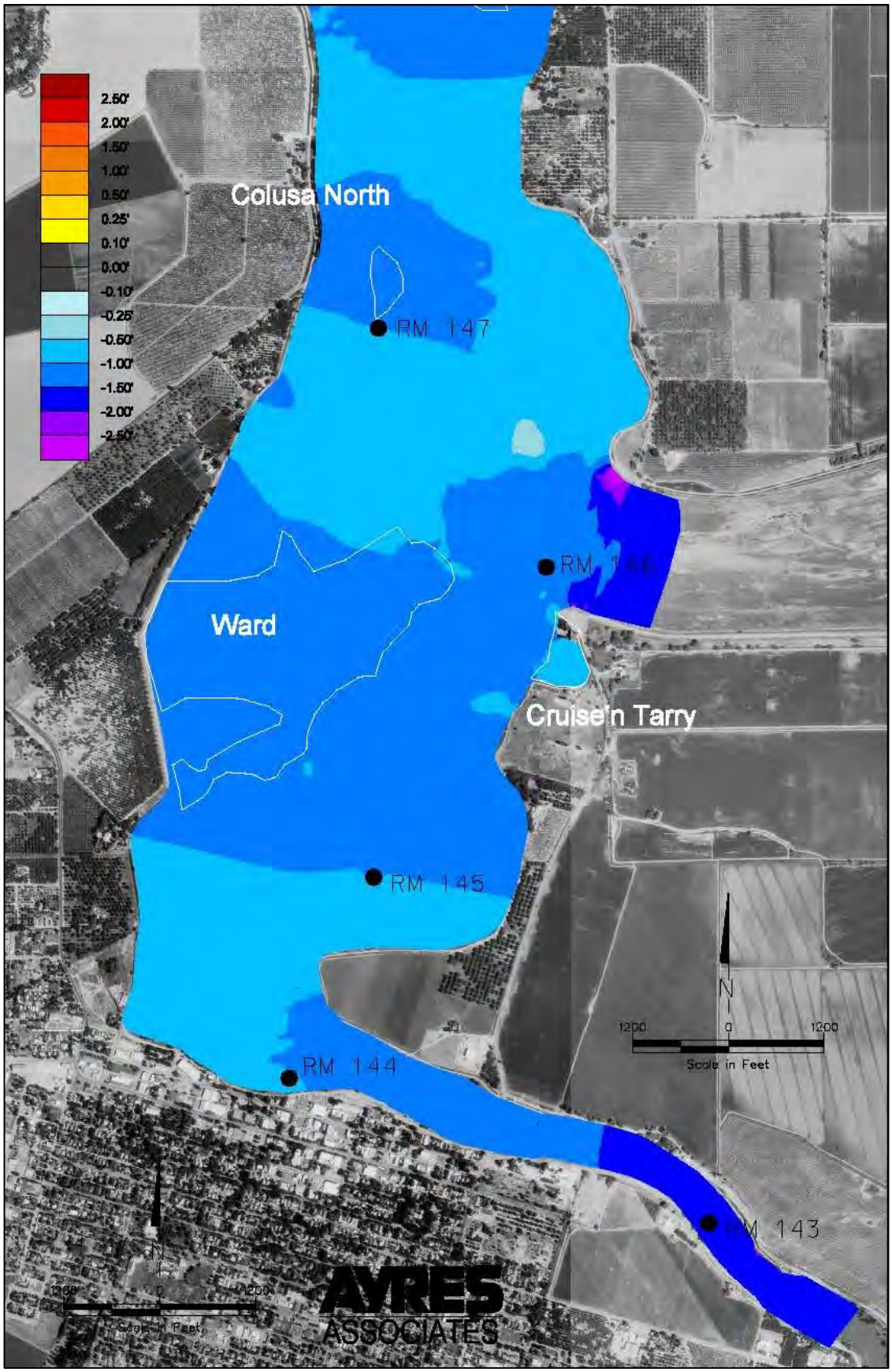
Appendix L -
Water Surface Elevation Differential
Design Elevation to Existing Elevation


RM 165
2.50'
2.00'
1.50'
1.00'
0.50'
0.25'
0.10'
0.00'
-0.10'
-0.25'
-0.50'
-1.00'
-1.50'
-2.00'
-2.50'
N
1200
0
1200
Scale in Feet
RM 164
RM 163
RM 162
Womble
AYRES
ASSOCIATES

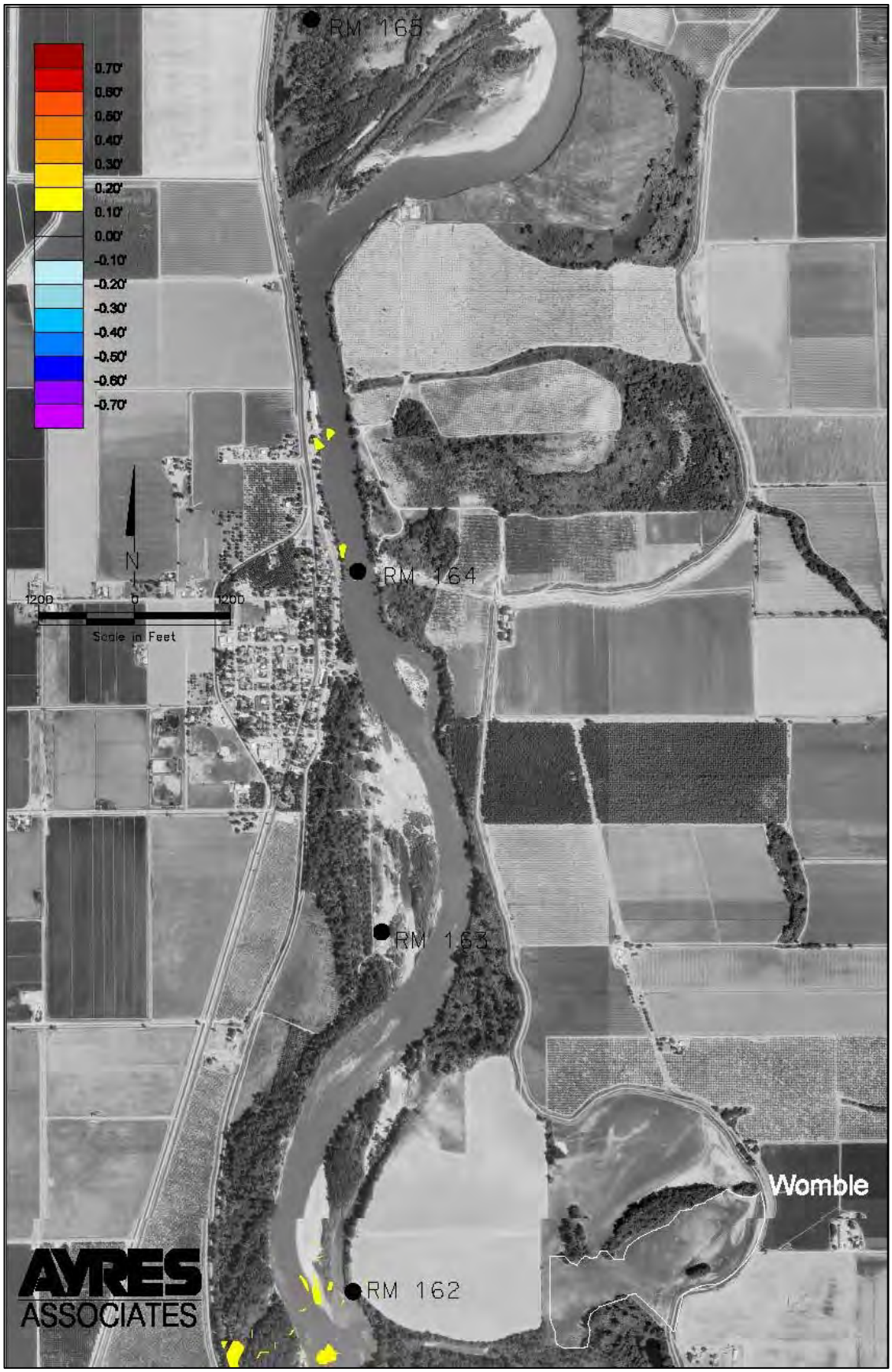

2.50'
2.00'
1.50'
1.00'
0.50'
0.25'
0.10'
0.00'
-0.10'
-0.25'
-0.50'
-1.00'
-1.50'
-2.00'
-2.50'
Jensen
RM 161
Stegman
1000 Acre
RM 160
RM 159
RM 158
AYRES
ASSOCIATES
N
1200
0
1200
Scale in Feet


2.50'
2.00'
1.50'
1.00'
0.50'
0.25'
0.10'
0.00'
-0.10'
-0.25'
-0.50'
-1.00'
-1.50'
-2.00'
-2.50'
RM 158
RM 157
RM 156
RM 155
RM 154
AYRES
ASSOCIATES
N
1200
0
1200
Scale in Feet


RM 154
RM 153
RM 152
RM 150
RM 151
RM 149
RM 148
Boeger
2.50'
2.00'
1.50'
1.00'
0.50'
0.25'
0.10'
0.00'
-0.10'
-0.25'
-0.50'
-1.00'
-1.50'
-2.00'
-2.50'
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES


2.50'
2.00'
1.50'
1.00'
0.50'
0.25'
0.10'
0.00'
-0.10'
-0.25'
-0.50'
-1.00'
-1.50'
-2.00'
-2.50'
Colusa North
RM 147
RM 146
Ward
Cruise'n Tarry
RM 145
RM 144
RM 143
N
1200
0
1200
Scale in Feet
AYRES
ASSOCIATES

Appendix M -
Water Surface Elevation Differential
Existing Elevation to Large Woody Debris Elevation


0.70'
0.60'
0.50'
0.40'
0.30'
0.20'
0.10'
0.00'
-0.10'
-0.20'
-0.30'
-0.40'
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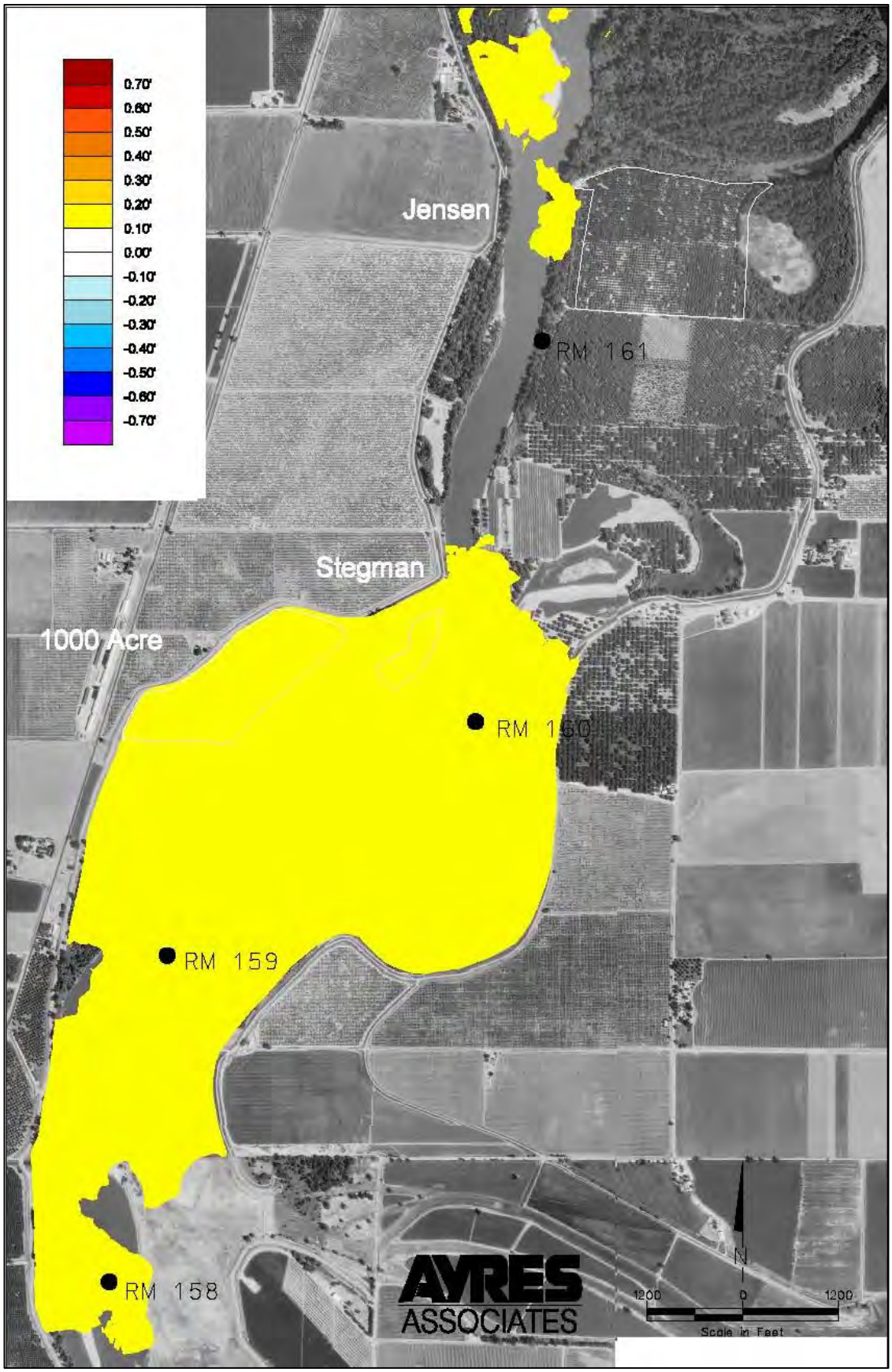
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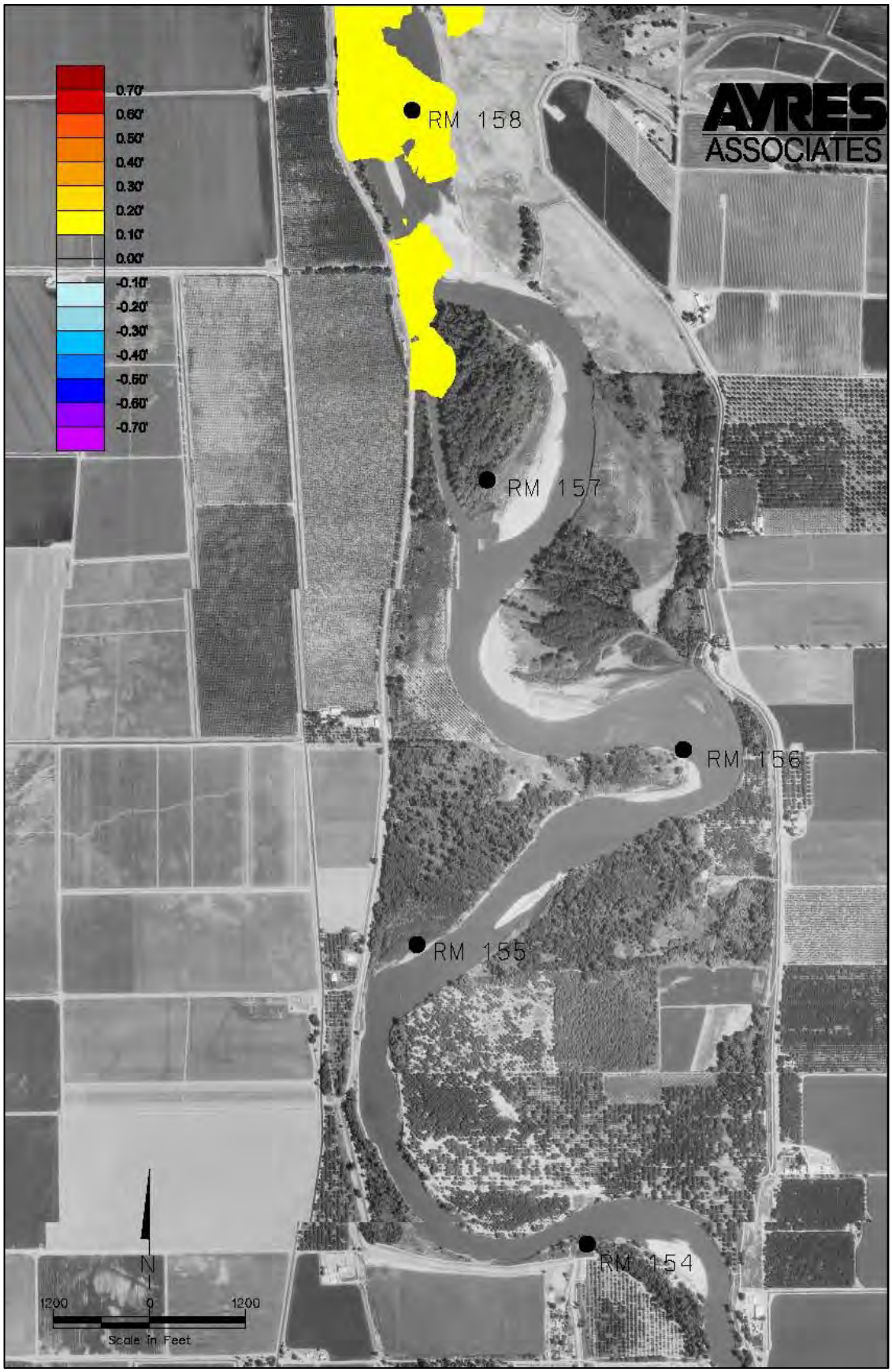
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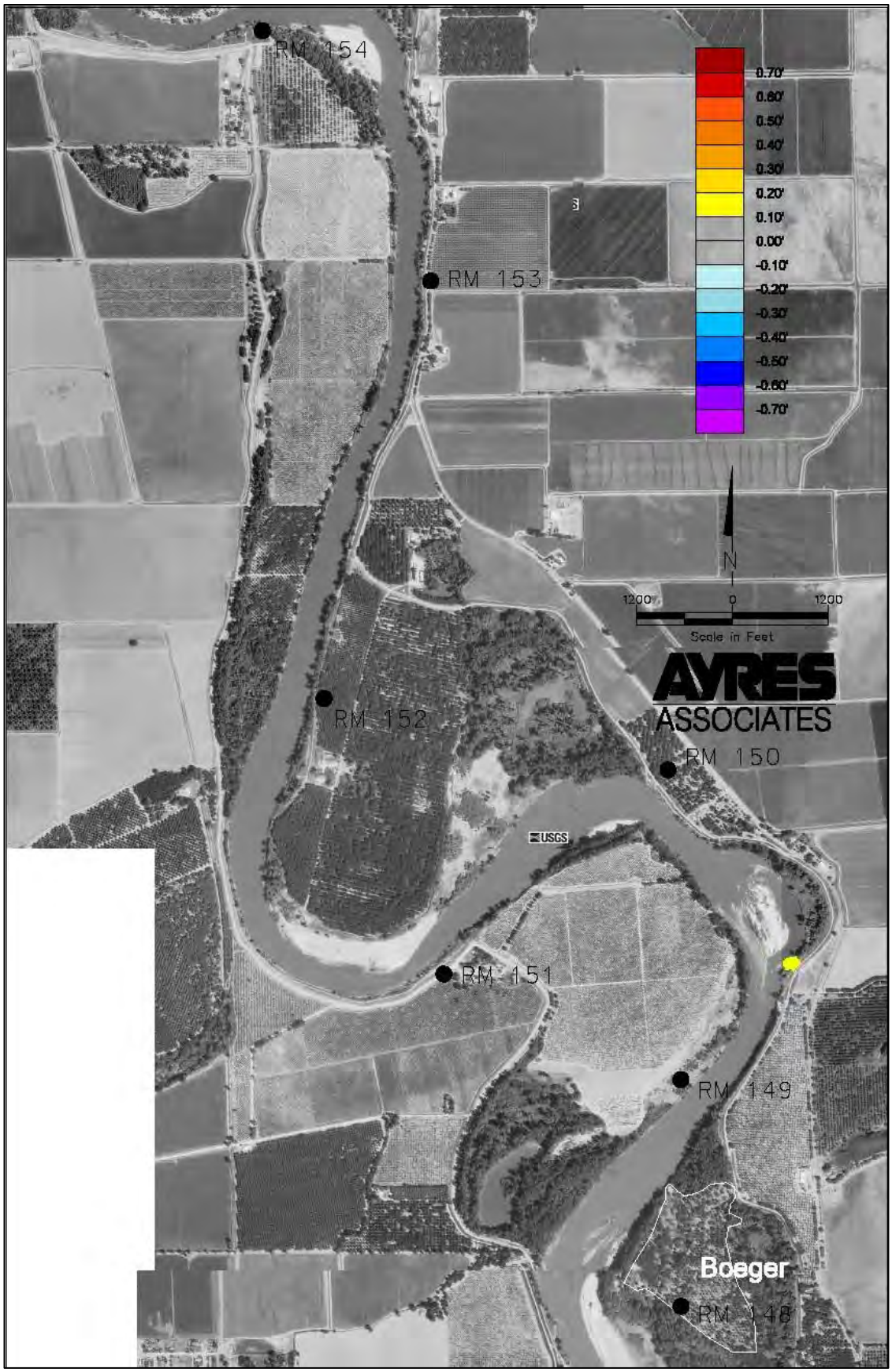
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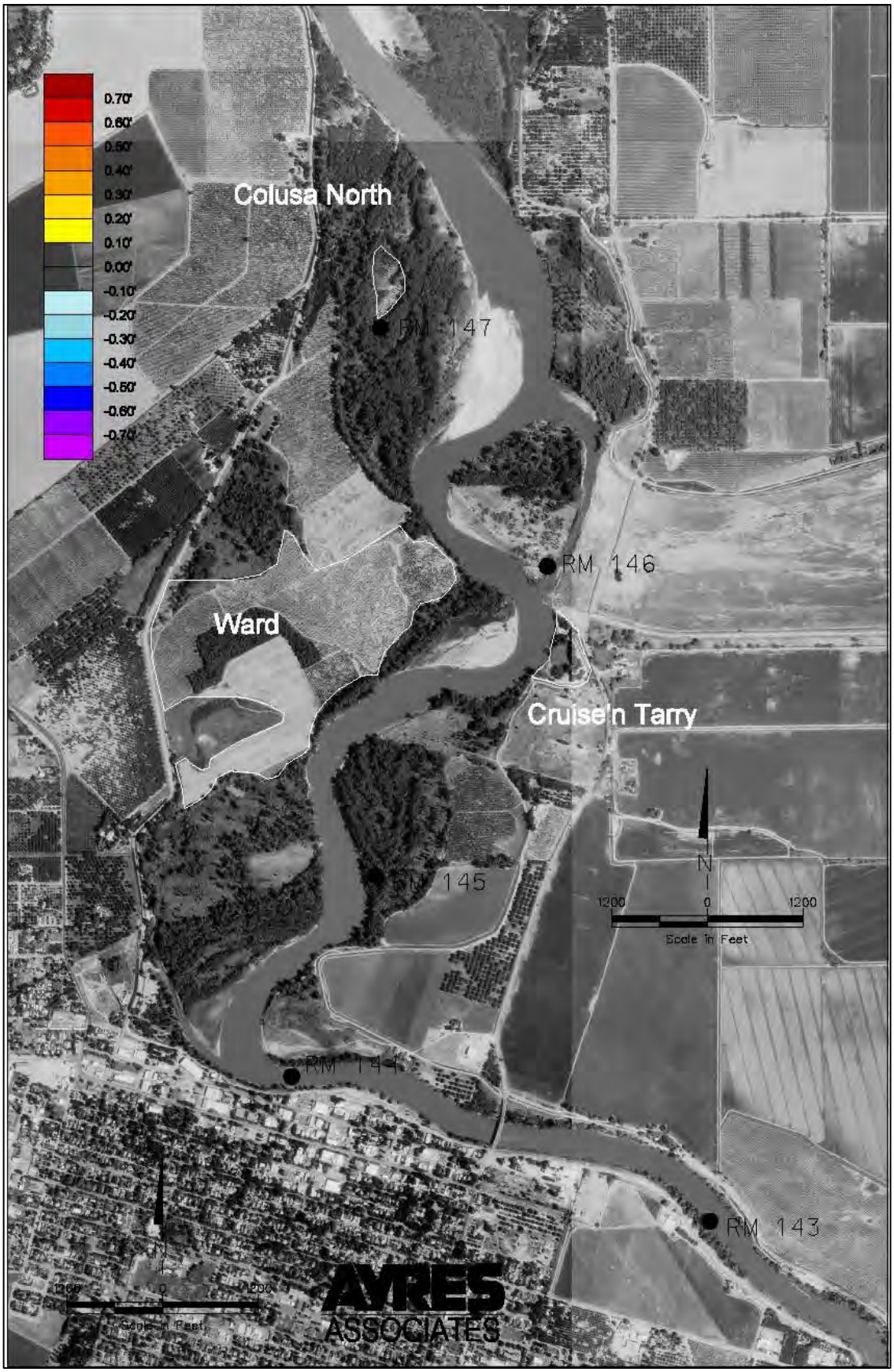
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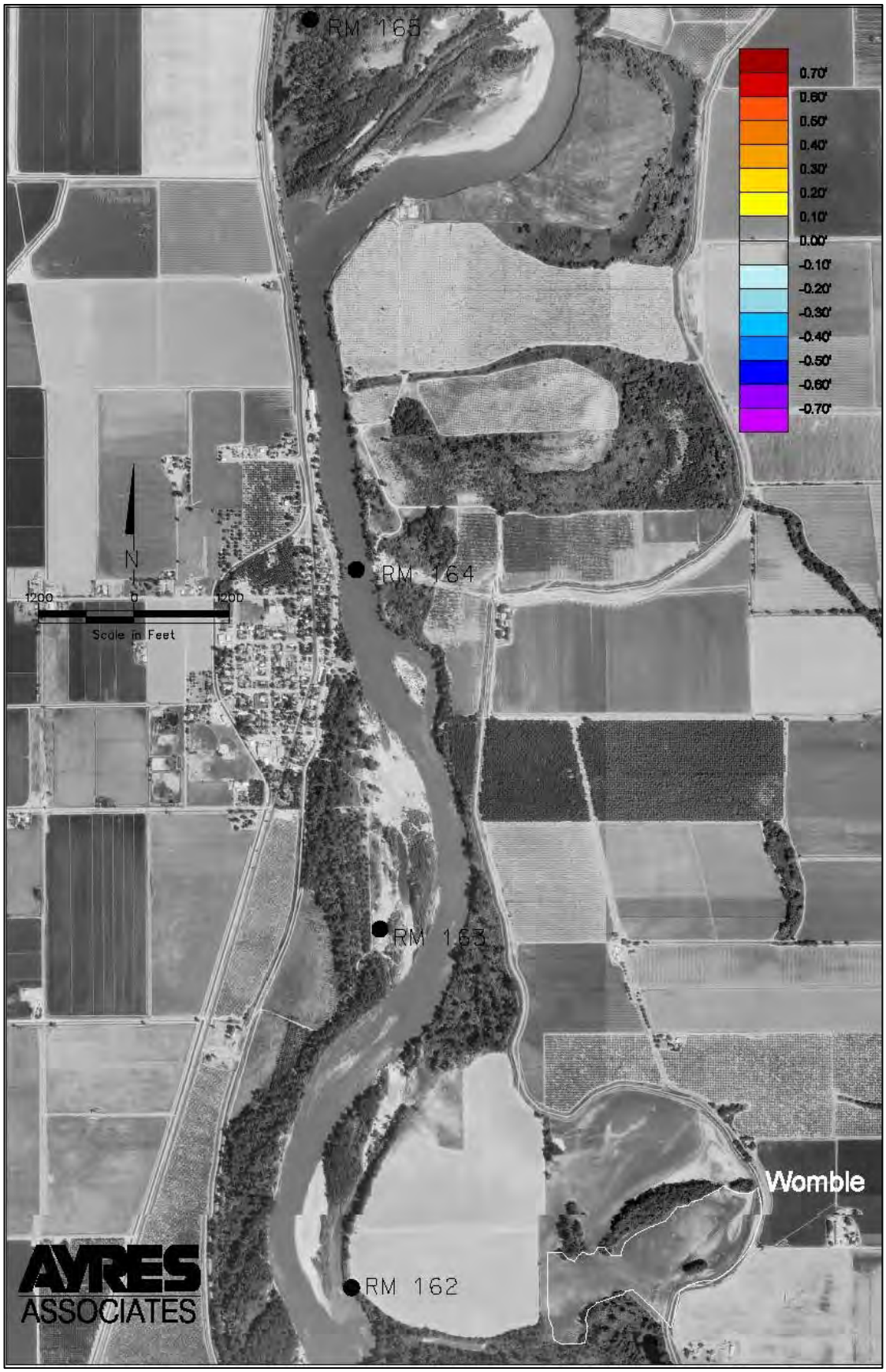
Appendix N -
Water Surface Elevation Differential
Existing Elevations to With Project Elevations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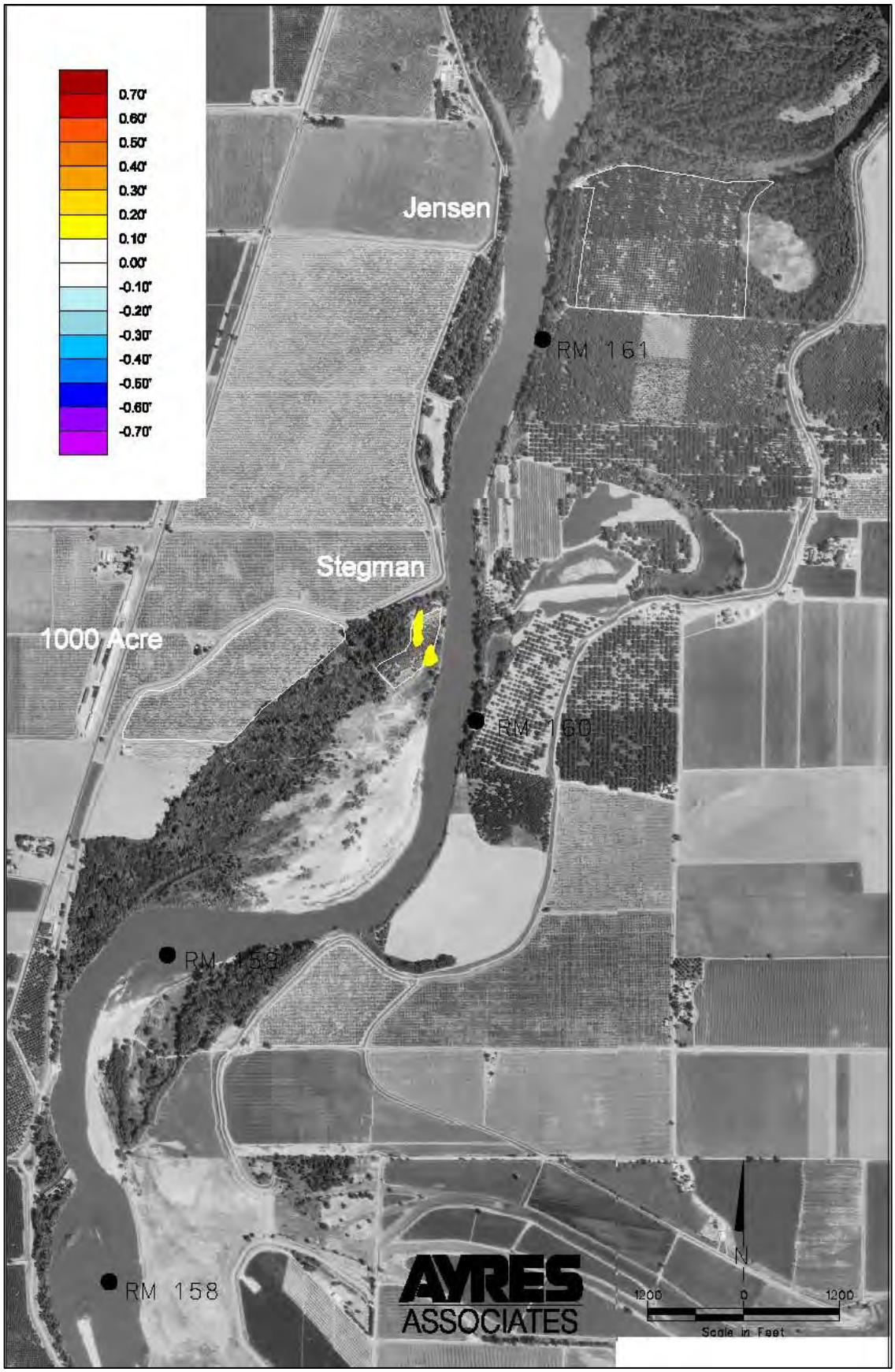
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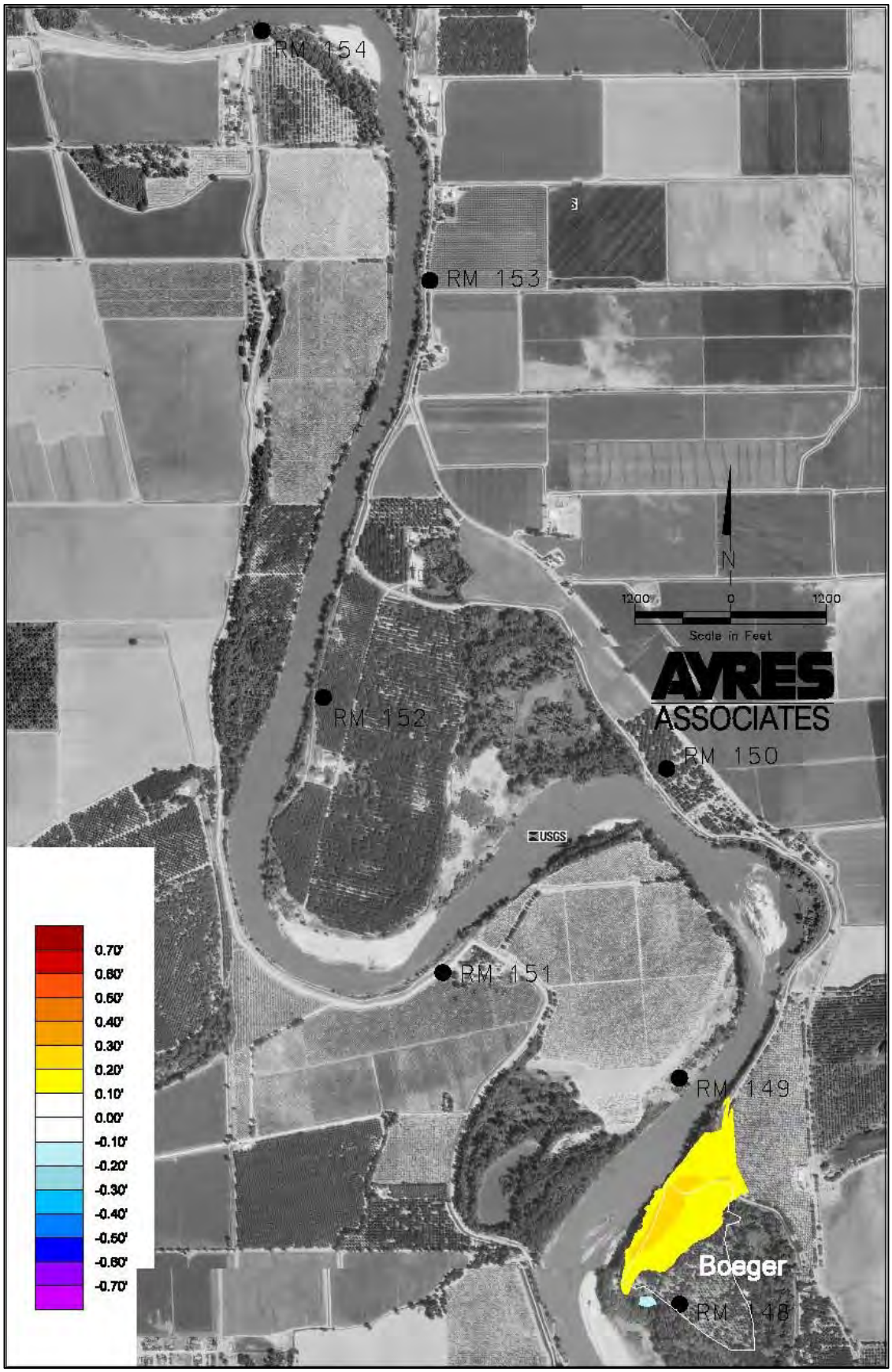
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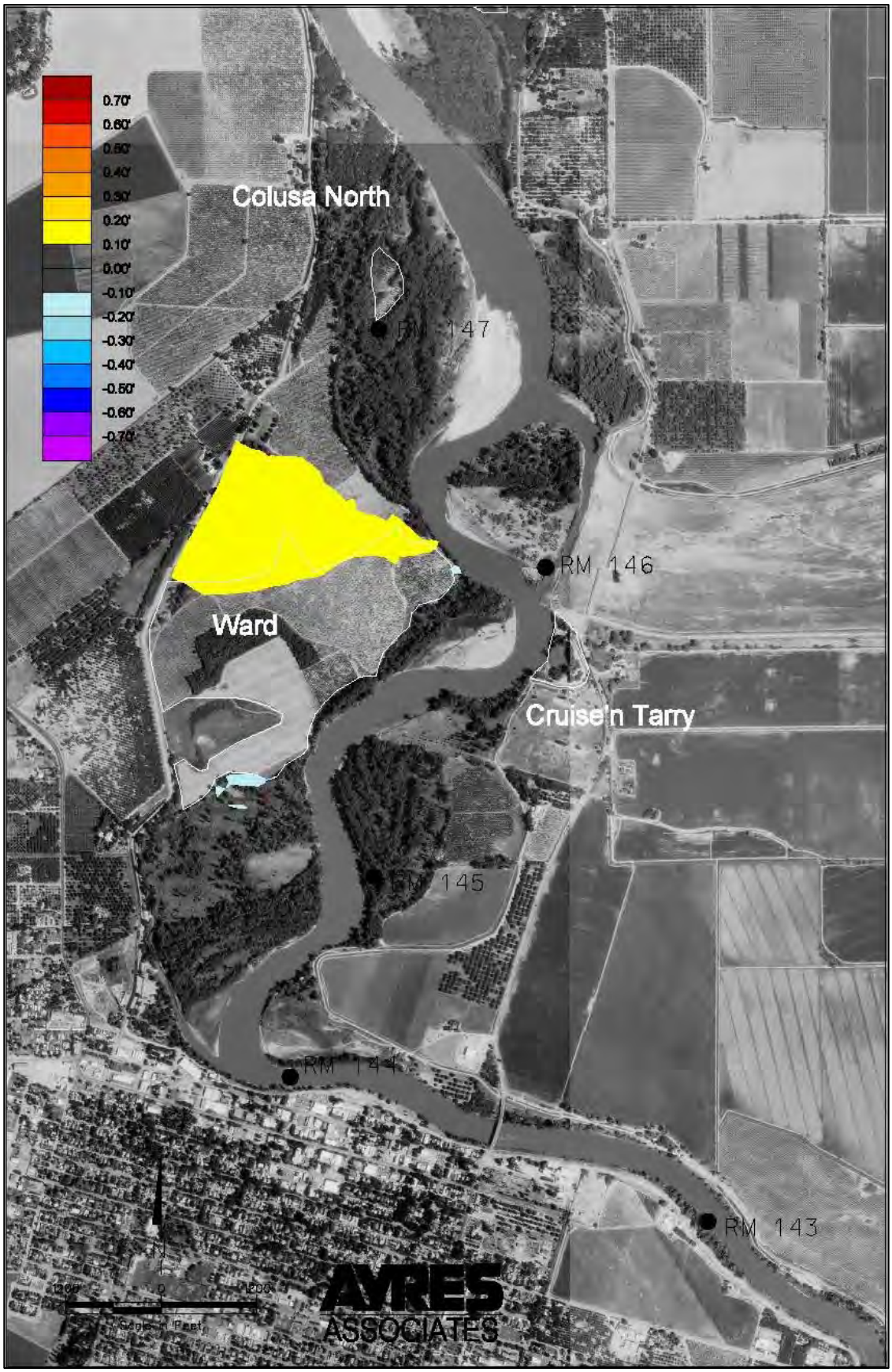
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Colusa North
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Ward
Cruise'n Tarry
RM 145
RM 144
RM 143
N
1200'
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Scale in Feet
AYRES
ASSOCIATES

Appendix O -
Review Comments to Report with Responses by Ayres Associates

Ayres Associates Inc
2150 River Plaza Dr., Suite 330
Sacramento, CA 95833
(916) 563-7700

March 18, 2008

Colusa Planning Subreach Project, Colusa to Hamilton City 2-Dimensional Hydraulic Model, Response to Comments from:

Mr. Francis E. Borcalli, Consulting Civil Engineer

1. Comment: I concur with the conclusions based upon the results of the hydraulic modeling performed in that there is essentially no significant adverse impact from the proposed restoration of wildlife habitat in the floodplain.

   Response: This comment is consistent with our conclusions in the Report.

2. Comment: The determination that the overflow to the Butte Basin through the Moulton Weir and Colusa Weir is significantly different that the 1957 design is important as it relates to the future analyses of the Sacramento River from Colusa to Knights Landing. This will be particularly relevant in hydraulic analyses that will be performed by DWR under its Central Valley Flood0plain Evaluation and Delineation Program, which has been initiated recently.

   Response: We agree. One of the valuable side benefits of this project is that it provides new insight and documentation on how the system currently operates, which is somewhat different from conventional thinking and how it was designed.

3. Comment: Including a cross section showing the extent of the woody debris in relation to the channel and overbank floodplain would help to illustrate the relative significance of the debris in relation to the modeled results under flood conditions.

   Response: This is a good suggestion and a typical cross section has been added as a figure in Section 6.1.2.

4. Comment: Editing the report, especially the conclusions.

   Response: This has been done.

5. Comment: Refining the delineation of the habitat restoration sites on the graphics in the appendices so they are readable.

   Response: This has been done within the limits available to us in the software for making the figures.

6. Comment: Including a list of tables and figures in the Table of Contents.

   Response: This has been done.

Ayres Associates Inc
2150 River Plaza Dr., Suite 330
Sacramento, CA 95833
(916) 563-7700

March 18, 2008

DRAFT - Colusa Planning Subreach Project, Colusa to Hamilton City 2-Dimensional Hydraulic Model, Response to Comments from:

Colusa Indian Community Council, Cahil Dehe Bank of Wintun Indians

1. Comment: The model was calibrated using high water marks from the 1995 storm event. How does this model compare to other high water events along the Sacramento River? Did you consider using other events for calibration?

   Response: The reasons the 1995 event was used for calibration was as follows:
   - *a) Surveyed high water marks were available from DWR*
   - *b) This event was close in time to the river topographic survey (1997)*
   - *c) Aerial photography was available to document over bank land use for roughness*
   - *d) Many people along this reach of the river remember that event and where the water levels were.*

   Other events were not considered primarily because we could not verify the shape or roughness of the river at the time of older events. Also we are unaware of surveyed high water marks for other events.

2. Comment: Would there be any impact to the Tribe's water diversion (located just north of RM 157) due to the lowering of flow at RM 157 and the possibility of deposition? (Section 6.1.2).

   Response: There is no impact to the Tribe's water diversion just upstream of RM 157 from any of the proposed restoration scenarios. Section 6.1.2 discusses a hypothetic run to demonstrate impacts of adding (or for that matter removing) large woody debris within the main river channel.

3. Comment: Section 6.2.3 states that the water surface on the Boeger property is below the 1957 design profile and 0.25 feet above the hydraulic model run of the design flow *(existing conditions with design flow).* While 0.25 feet is small, it is still an increase as shown by the comparison of mode results. There is concern with the statement that the water levels are higher as a result of restoration, but since they are less

that the 1957 design profiles the increase is acceptable. This situation also occurs at Jensen (downstream), Stegman, Colusa North, and Ward sites. It seems that a more straight forward measure of hydraulic impacts of the restoration project is a comparison of model results with and without the restoration projects, as opposed to a comparison of the project model runs and a hybrid of the 1957 design profile and "existing" model results. What is the basis for such a hybrid comparison? In addition, only the impacts for the system design event were considered. What are the impacts of the restoration project for more frequent events?

Response: The guidance used in this report for the determination of hydraulic impacts was provided by the Reclamation Board Staff and called for no infringement into the design freeboard (1957 design flow profile). This is consistent with the recent Reclamation Board ruling that granted a permit for restoration of the Ward property last December. More frequent flow event were not modeled because there is no historic baseline for a comparison. Also, it takes at least a 2-year event to get into the overbank floodplains in most areas, so there is no interaction for this most frequent high flow. For other frequent flows, up to the 10-year event, water depths will be less than those modeled and therefore no effect on freeboard.

This report went beyond the minimums and also looked at the potential effects of changes in velocity, erosion and deposition patterns and seepage and no significant impacts were detected.

4. Comment: Because the velocities are expect to increase on the opposite riverbank of the Boeger property, per Section 6.4, the Tribe world like assurance that the western levee would not be subjected to increase erosion. The model shows an increase in velocity at the design event, but what would the results of the model be if smaller, but more frequent, storm was used? Would the bank be subjected to higher velocities?

Response: The velocity increase on the west levee (0.25 to 0.5 fps) is the result of changing the land use on the Boeger site from crops to a riparian mix. If the historic land use of orchard was used for the Boeger site (1986), it is our opinion that there would be no increase in velocities through this reach from the proposed conversion.

We don't have the installation date of the revetments on the west levee, but they were in place in 1989 (Corps of Engineer, Sacramento River and Tributaries, Bank Protection Maps) and this site doesn't show up as an existing erosion site within the Corps of Engineers, Erosion Inventory of the Sacramento River Bank Protection Project, 2007. We can not, however, provide an "assurance" that erosion will not occur in the future.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

DWR Review of Ayres Associates' Colusa Subreach Model for Ward Tract Restoration

This document was prepared by:

Marianne Kirkland ..... Senior Engineer, Water Resources
Teresa Fong .....Engineer, Water Resources
Trevor Greene .....Engineer, Water Resources
Christopher Jones.....Geotechnical Engineer/Engineer, Water Resources

Under the direction of:

Noel Lerner… .....Acting Chief, Flood Maintenance Office

Division of Flood Management
3310 El Camino Avenue
Sacramento, CA 95821

December 4, 2007

Introduction

The Nature Conservancy (TNC) and the Sacramento River Conservation Area Forum (SRCAF) collaborated in Colusa Subreach Planning to engage the public in considering restoration of portions of the leveed section of the Sacramento River north of Colusa. Ayres Associates (Ayres) performed hydraulic analysis to review the existing floodplain capacity and determine the hydraulic effects of restoring habitat at eight potential sites. As guided by the Colusa Subreach Planning Advisory Workgroup and consulted Reclamation Board staff, the analysis includes modeling of the entire Colusa Subreach from Princeton to Colusa so that cumulative effects are considered.

This model review report focuses on one of the eight modeled sites, Ward Tract, which DWR proposes to restore in cooperation with The Nature Conservancy and California State Parks and Recreation (California Parks). The Ward property has been deeded to the California Parks for continuing stewardship of the land. A portion of the restoration at Ward Tract is to serve as mitigation for riparian habitat lost when DWR performed maintenance of Tisdale Bypass during 2007. Although all eight potential TNC restoration sites were evaluated in Ayres' hydraulic analysis in order to analyze their hydraulic effects along the river, DWR proposes only to restore Ward Tract. This report focuses on the modeling analysis of the Ward Tract, in support of securing an encroachment permit from the Reclamation Board.

Under contract to TNC, Ayres performed modeling to compare existing conditions with proposed restored conditions. When Ward Tract was acquired, it contained a mature walnut orchard. After acquisition, TNC converted the land to field crops in preparation for restoration. Field crops is the land use type that was input as the existing condition at Ward Tract in Ayres' model. This represents the more conservative case for purposes of change detection. The property is proposed to be restored to a mix of grassland, oak savannah, and riparian forest habitats, with maintenance requirements such as mowing to maintain the grassland explicitly identified in permitting. This report reviews Ayres' modeling assumptions and results.

Review of Modeling Assumptions

Before using Ayres' model results in their application to the Reclamation Board, DWR reviewed Ayres' modeling assumptions, as well as the modeled stage and velocity results. Modeling assumptions examined included consideration of the boundary conditions and roughness values used. To gauge appropriateness of how site conditions were characterized, DWR performed a literature review of roughness values, field-checked vegetation at several locations throughout the full reach, photo-documented site conditions, and compared what was observed to the vegetation uses assigned in the "existing conditions" model geometry file. DWR also verified the design and historical flows used, and contacted several experts with 'institutional memory' to investigate differences between design and objective flows, and the fairly wide range of flow splits recorded in historical hydrology.

Review of model methods and results was largely based on access to Ayres Draft Report and Ayres' presentation on calibration, existing conditions, and restored conditions runs. DWR staff did not re-run the model.

Boundary Conditions

The term 'boundary conditions' encompass choices modelers make about the extent of the system to model (i.e. the location of boundaries), the stage and flow to specify at the edges of the model, and which variables the model will solve for.

Model Assumptions

- The 22-river-mile model is inclusive of all eight potential restoration sites.
- The upstream boundary condition (inflow) was set to the 1957 design inflow of 160,000 cfs. Historical flow splits were specified at the weirs to achieve calibration. The boundary conditions used at Moulton and Colusa weirs were scaled up from the 1958 flow splits, at 35,700 and 73,000 cfs (+/- 500 cfs) respectively. Flow splits were scaled up from 1958 measurements because 1958 inflows to the subreach were only 2,000 cfs less than the design flow.
- The downstream boundary condition (stage) was set based on stage measurements at Colusa Bridge, adjusted for the distance between the Colusa bridge and the downstream boundary condition using the slope exhibited in the design water surface downstream of Colusa Bridge.
- Ayres checked for flow conservation within 5% through the modeled reach.

Review

- The model extent included the entire 22-river-mile reach, inclusive of all eight potential restoration sites.
- DWR verified the 1957 design inflow of 160,000 cfs and 1958 historical flow splits at Moulton and Colusa weirs Ayres reported. DWR further investigated the non-standard use of historical flow splits at Moulton and Colusa weirs. Using historical flow splits at the weirs has the effect of reducing the flow in the main stem of the river at Colusa. DWR concluded that it was acceptable to use historical flow splits at the weirs because:
    - 1) Longtime DWR and USACE engineers [Mel Yarwood, Dan Tibbitts, Don Twiss, Bob Childs, Wayne Johnson, Bud Pahl] who have worked on the Sacramento Flood Control System were asked about the potential discrepancy between design flows over Moulton and Colusa Weir, and modeled flows there. None of the engineers contacted was surprised that the system appears to be functioning differently now than at the time of Authorization. The engineers agreed that:
        - a) The Flood Control System has changed since it was first designed. Accretion in some areas and erosion others is expected to have modified capacity throughout the length of the system.
        - b) It is the Project Design Profile that is authorized, not the design flows. Project design flows were back-calculated from the Project Design Profile with much less sophisticated methods than are currently available.
    - 2) Current analysis tools allow inclusion of a greater level of detail to hydraulic analysis than was available when the Flood Control System was designed. For example, the design profile shows no water surface effect of the Colusa Bridge.
    - 3) In the three highest recorded historical events in the area, where inflow to the Colusa Subreach ranged from 157,000 cfs to 170,000 cfs, measured flow at Colusa Bridge Gage was only 44,800 to 51,800 cfs. Under the modeled flow splits 50,800 to 51,800 cfs passed the Colusa Bridge Gage.
- The downstream boundary condition (stage) was set by adjusting the rating curve value at the Colusa Bridge to account for the distance from the bridge to the downstream boundary condition.
- Summing the outflows at each outflow area (Moulton, Colusa, and the south end of the model) and comparing that total to the inflow, Ayres found conservation of flow to be well within 5%.

Bathymetry and Material Roughness

The wetted surface that water flows over, the bathymetry of the channel, is another 'boundary' of sorts that must be input to the model. Characteristics of materials (e.g. vegetation, soils, and structures) along this surface affect the resistance presented to the water as it flows. Hydraulic roughness, often referred to as Manning's 'n', represents this resistance to flow, and is an important input variable in modeling.

Model Assumptions

- The bathymetry of the reach is represented with a finite element network, or mesh. The mesh was formed from two data sources: a 1997 bathymetric survey by Ayres and 2006 LIDAR topography provided by TNC. The size and orientation of elements was varied to represent hydraulic features, structures, and topographic changes.
- Assignation of material types to elements of the mesh was based on 1998 USGS aerial photography and 2005 Natural Resource Conservation Service aerial imagery.
- Hydraulic roughness: Manning's 'n' roughness values were initially set in the high range of appropriate values based on literature review. Hydraulic roughness needed to be modified (decreased) in order to achieve a good fit in calibration of the model.
- The model is calibrated to the January 10, 1995 high flow (143,000 cfs), for which high water marks are available.
- In the existing conditions (without project) run, the Ward Tract restoration area was represented as being in crops (n = 0.035). (See **Figure 1 a**).
- In the restored conditions (with project) run, the Ward Tract restoration area was represented as being in a mix of vegetation types: grassland (n = 0.032), savannah (n = 0.045), and riparian forest (n = 0.090). (See **Figure 1 b and Figure 2**).

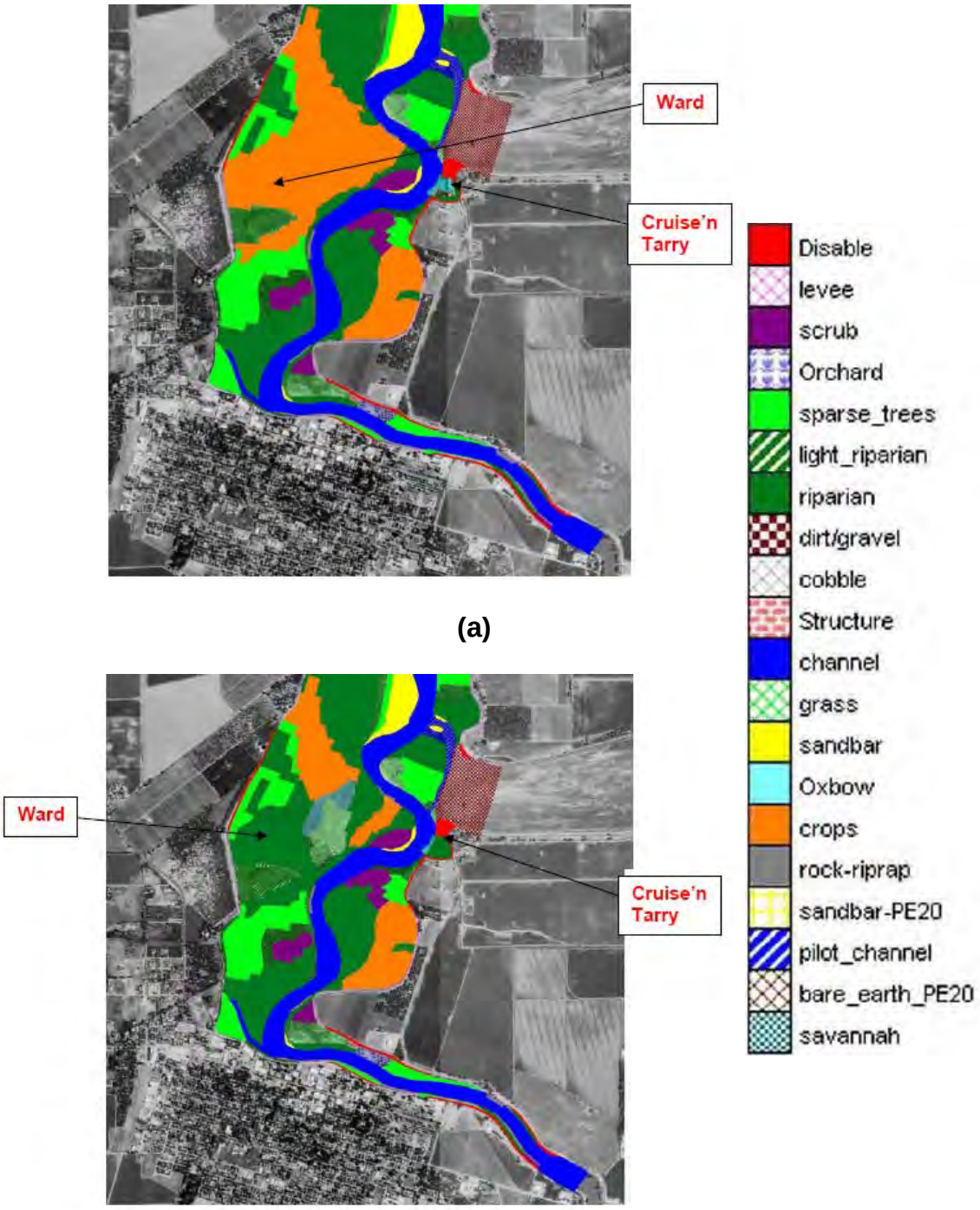

Figure 1: (a) Existing Conditions (Without Project) and (b) Restored Conditions (With Project) Land Use in the vicinity of Ward Tract, as represented in the model. (adapted from Ayres Associates)

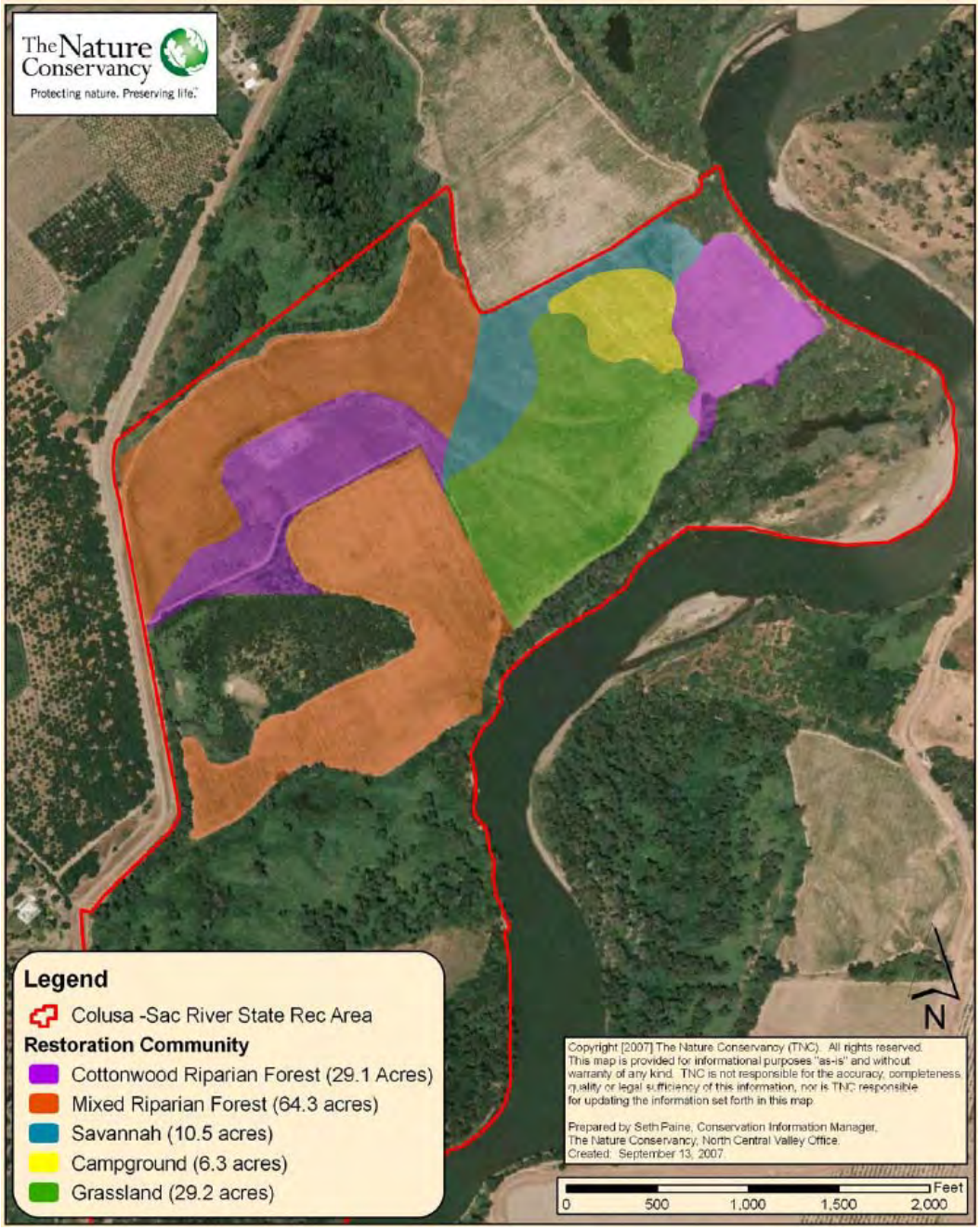

Figure 2: Representation of Land Use Types in the Restored Conditions (With Project) Model in the vicinity of Ward Tract. (The Nature Conservancy). Note that the Colusa-Sacramento River State Recreation Area property is larger than the portion of Ward Tract that is modeled to undergo changes in land use type.

Review

- The data sources are appropriate, and the bathymetry appears to capture hydraulic features, structures, and topographic changes.
- DWR staff compared the existing land use material types present in the field between RM 142.5 and 164 with those represented in the model by spot-checking the 22-mile Colusa Subreach from levees and available access points. Photographs as well as GPS readings were taken at 18 locations. DWR found that the categories used in the model closely approximated the field conditions. The modeled land use types and location of the field sites as well as select photographs can be seen in **Appendix A**.
- DWR considered both whether the current land use type matched the land use assigned in the model, and whether the roughness value assigned to that land use type appeared consistent. In **Appendix B**, a direct comparison of multiple locations with the same land use designation is displayed, to offer a sense of the similarity and variability of a given land use designation. Crops, orchard, and sand bar appear quite similar, while light riparian, riparian, and sparse trees show more variation between sites.
- The reasonableness of Manning's 'n' roughness coefficients used in the model was placed in context by reviewing five hydraulics literature sources. Overall, the values were reasonable. A table showing the literature review results is included in **Appendix C**.
- Calibrating to available high water marks for a similarly high flow event (143,000 cfs in 1995 vs. the 160,000 cfs design flow) is appropriate.
- Starting at the high end of potentially representative hydraulic roughness values and modifying them to calibrate the model is an acceptable way of achieving calibration. DWR also created a table showing typical hydraulic roughness values used for the land use types similar to those Ayres used in their model.
- The model calibration trends at or slightly above the measured high water marks, at most locations, especially along the downstream half of the model, where the Ward Tract is located. (See **Figure 3**) Ward Tract is located between River Miles 145 and 146. The calibration of the model trending at or slightly above the measured high water marks is both conservative, and an indication that raising hydraulic roughness values would reduce the closeness of fit of the model calibration.

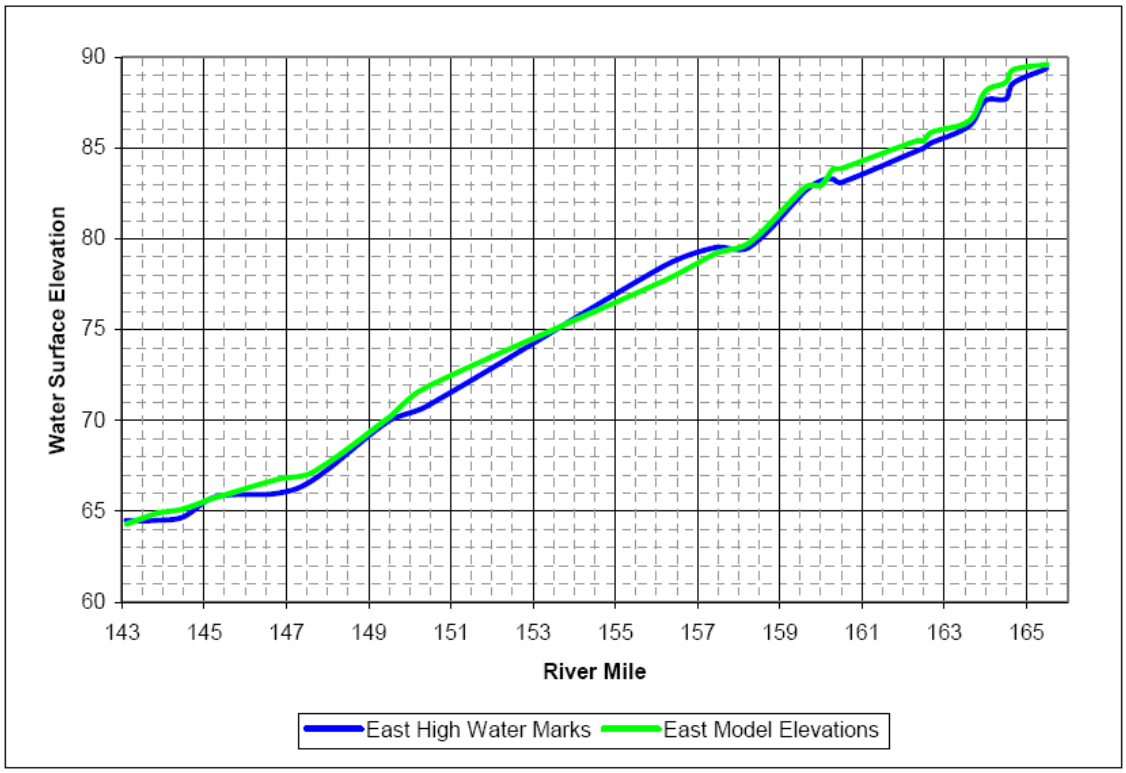

Figure 3: Comparison of Modeled Water Surface Profile with High Water Marks on the East Bank. (Ayres Associates) Note that model calibration trends at or slightly above the measured high water marks at most locations, including the vicinity of Ward Tract (RM 145 to RM 146)

- It is conservative to reflect the existing conditions, crops (n = 0.035), rather than the conditions of Ward Tract when it was purchased for restoration, orchard (n = 0.075), in the existing conditions (without project) model run. (See **Figure 1**). Setting material roughness to the lower value in the existing conditions run will predict greater change when comparing restored condition results with existing condition results.
- The distribution of vegetation types in the restored condition (with project) run creates an overbank flow corridor where the low hydraulic roughness of the grassland (n = 0.032) and savannah (n = 0.045) are placed. (See **Figure 2**). This will encourage some of the water that would otherwise have flown around Cobb's Bend to short-cut across Ward Tract. This will tend to keep stage low.

Interpretation of Model Results

Having considered the modeling assumptions, it is also important to interpret model results carefully, and to consider model results in context. To understand how to compare the design profile with modeled results, one needs to consider the level of detail inherent in each. Some guidance on how to interpret color-coded figures is also provided in this section.

USACE Flood Control Project requirements are specified in terms of a design water surface elevation profile (design profile). The design profile is specified along the Sacramento River with a single elevation at any given cross-section. The design profile is provided in graphic format (as contrasted with tabular format) and values at any given location may be interpolated, by eye, from the graphic. **Figure 4** shows the level of detail specified in the USACE channel design profiles, which are available electronically on the Reclamation Board web page at http://recbd.ca.gov/profiles/ Hatch marks delineate elevation change every 2.5 feet.

The format of the water surface elevation results from the model is very different; model results are two dimensional, showing more of the actual complexity of flow patterns. (See **Figure 5**). The shades of blue in **Figure 5** represent ranges of water surface elevation. Two dimensional modeling examines localized results that it would not be possible to discern in one dimension, where every cross-section would use average values. For use in the two dimensional model, the one dimensional information contained in **Figure 4** was applied across the finite element mesh shown in **Figure 6**.

In graphics of model results that follow **Figure 6**, color coding is used to illustrate differences in water surface elevations among the USACE 1957 design profile, existing conditions (without project), and restored conditions (with project). Cool colors (greens, blues and purples) on comparison plots indicate negative values, areas where the modeled condition compared is below the design profile. Comparison plots also leave areas where values within a specified range transparent, allowing the background aerial photograph to show through. Higher values are indicated by the warm end of the color spectrum.

Similar conventions are used to portray velocity distributions and changes in velocity distribution. Existing conditions, as well as changes in velocity distributions, affect resultant conditions. For example, an increase in velocity of 0.5 ft/sec could result in erosion or deposition, depending on the initial conditions in an area. Unlike the water surface elevation results, the velocity results contain no comparison to design conditions because there are no design velocity conditions with which to compare. In interpreting results, it is important to be mindful of whether a given plot illustrates water surface elevation or velocity. Attention to the units used (ft or ft/sec) is useful in differentiating between water surface elevation and velocity-related plots.

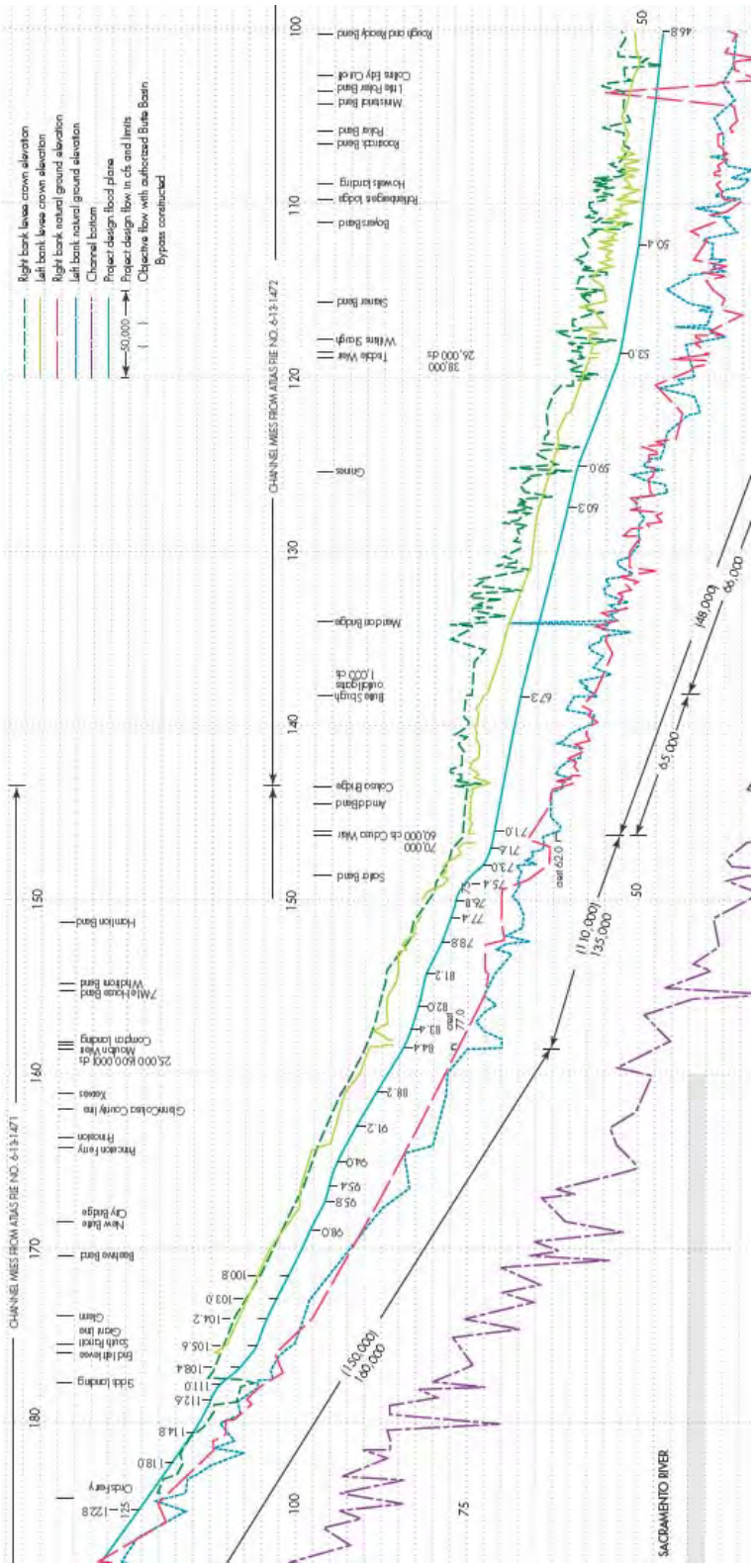

Figure 4: Excerpt from Sacramento River channel design profiles (Reclamation Board electronic conversion of original USACE profiles)

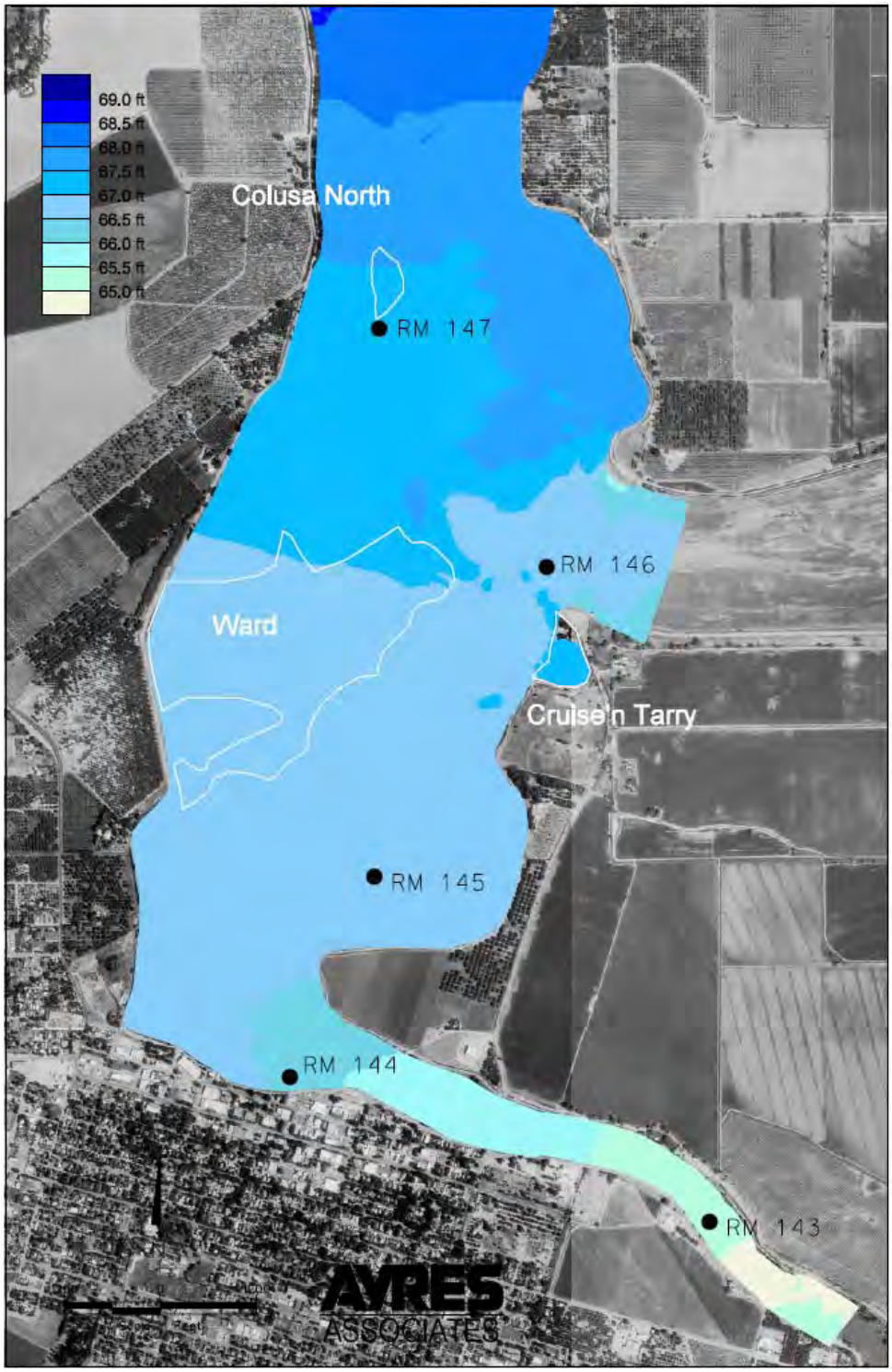

Figure 5: Example of two dimensional results: modeled water surface elevation, Existing Conditions (Without Project) (Ayres Associates)

While two dimensional modeling shows much more detail than one dimensional modeling, the scale of the elements in the model is on the order of thousands of square feet, not small enough to represent individual trees, nor fine enough to perfectly represent a curving levee wall. (See **Figure 6**).

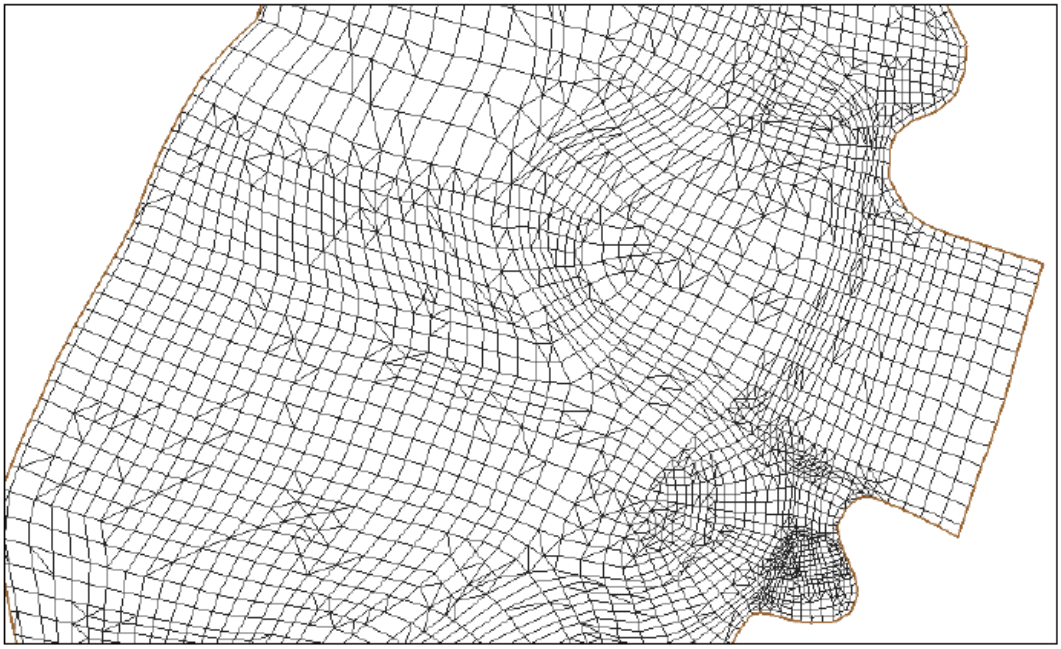

Figure 6: Example of finite element mesh (Ayres Associates)

One should also be aware that there is error in field measurement of land and water elevations, and calculation of flows. Confidence in measured flow measurements may range from +/- 5% to +/- 15%. While the modeled restored conditions did result in a slight (1,000 cfs, ~1 %) increase in flow over Colusa Weir, this change is small when considering potential flow measurement error.

	Existing Conditions Model	Restored Conditions Model
Inflow to Subreach	160,000 cfs	160,000 cfs
Moulton Weir	35,700 cfs	35,700 cfs
Colusa Weir	72,500 cfs	73,500 cfs
Channel below Colusa	51,800 cfs	50,800 cfs

There are several potential sources of error in stage measurement. High water marks pose a special problem where wind waves may be significant, and it may be difficult to tell whether high water reached the top or bottom of a wide swath of debris. There is also rounding error inherent to intensive calculation methods. Just because computer results can be generated to many places past the decimal does not mean those are all significant digits. Taking results to be meaningful to approximately 1/10th of a foot is common practice.

Stage

Model Results

- Model results indicate that for eight river miles upstream of the Ward Tract property, and three river miles downstream of it, under existing vegetation conditions, when 160,000 cfs enters the Colusa Subreach, the water surface ranges from 0.25 to 3 feet below the design profile. (See **Figure 7** to view River Miles 144 through 147, and Ayres' report for graphics of more distant sites). In the immediate vicinity of Ward Tract, the water surface ranges from -0.5 to -1.5 feet below the design profile. Note that the design profile itself is at least 3 ft below the levee crest.
- With the project's proposed restored vegetation conditions, the water surface remains 0.25 to 3 feet below the design profile (See **Figure 8**). There are some slight localized water surface differences (both positive and negative) compared to modeled existing conditions (Compare **Figure 7** and **Figure 8**)
- **Figure 9** isolates the difference between existing conditions and restored vegetation conditions. The yellow triangle indicates the area upstream of Ward Tract where there would be an approximately 0.1 ft rise in water surface elevation. The maximum rise in water surface elevation along the west levee is 0.12 ft. The maximum rise in water surface elevation within the yellow triangle shown is 0.15 ft. The maximum rise in water surface elevation along the eastern levee, north and south of the Colusa Bypass is 0.03 and 0.01 ft respectively.
- The cross section shown in **Figure 10** compares the differences among the design profile, existing conditions (without project) water surface elevations, and restored condition (with project) water surface elevations. This cross-sectional location along the upstream portion of Ward Tract was selected for illustration because it cuts through the area that is modeled to undergo 0.1 to 0.2 ft of water surface elevation rise, as shown by the yellow triangle in **Figure 9**.
- **Figure 10** also illustrates freeboard at the levees, and the typical water depth over Ward Tract under the modeled high flow scenario. It indicates a typical difference between the restored conditions (with project) water surface elevation and the design profile of 0.86 ft. The difference shown between existing (without project) and restored (with project) water surface elevation at this cross section is 0.11 ft.
- **Figure 11** provides a map key showing the location of the cross section provided in **Figure 10**.

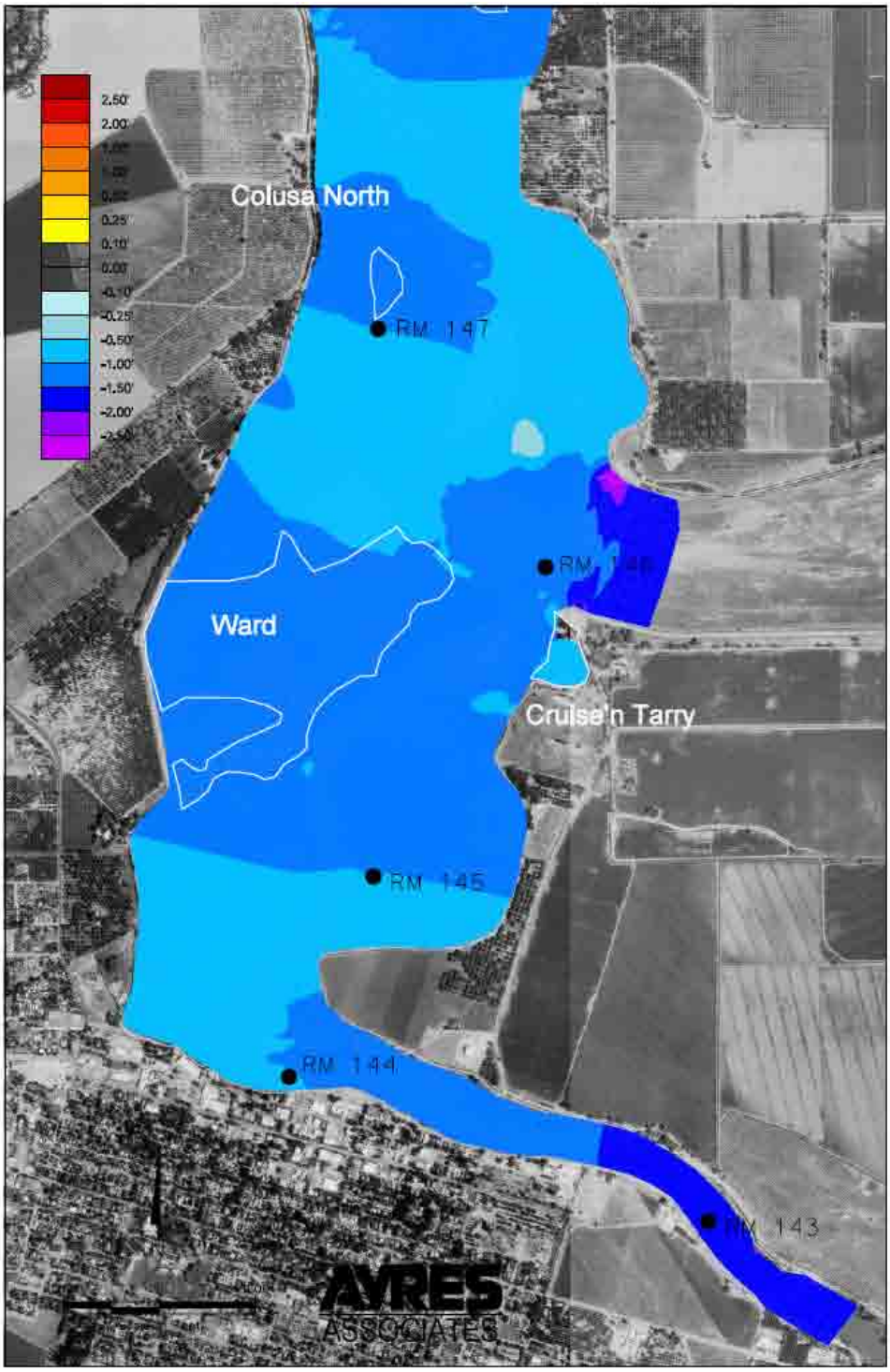

Figure 7: Difference between Design Profile and Existing Conditions (Without Project) modeled water surface elevations (Ayres Associates)

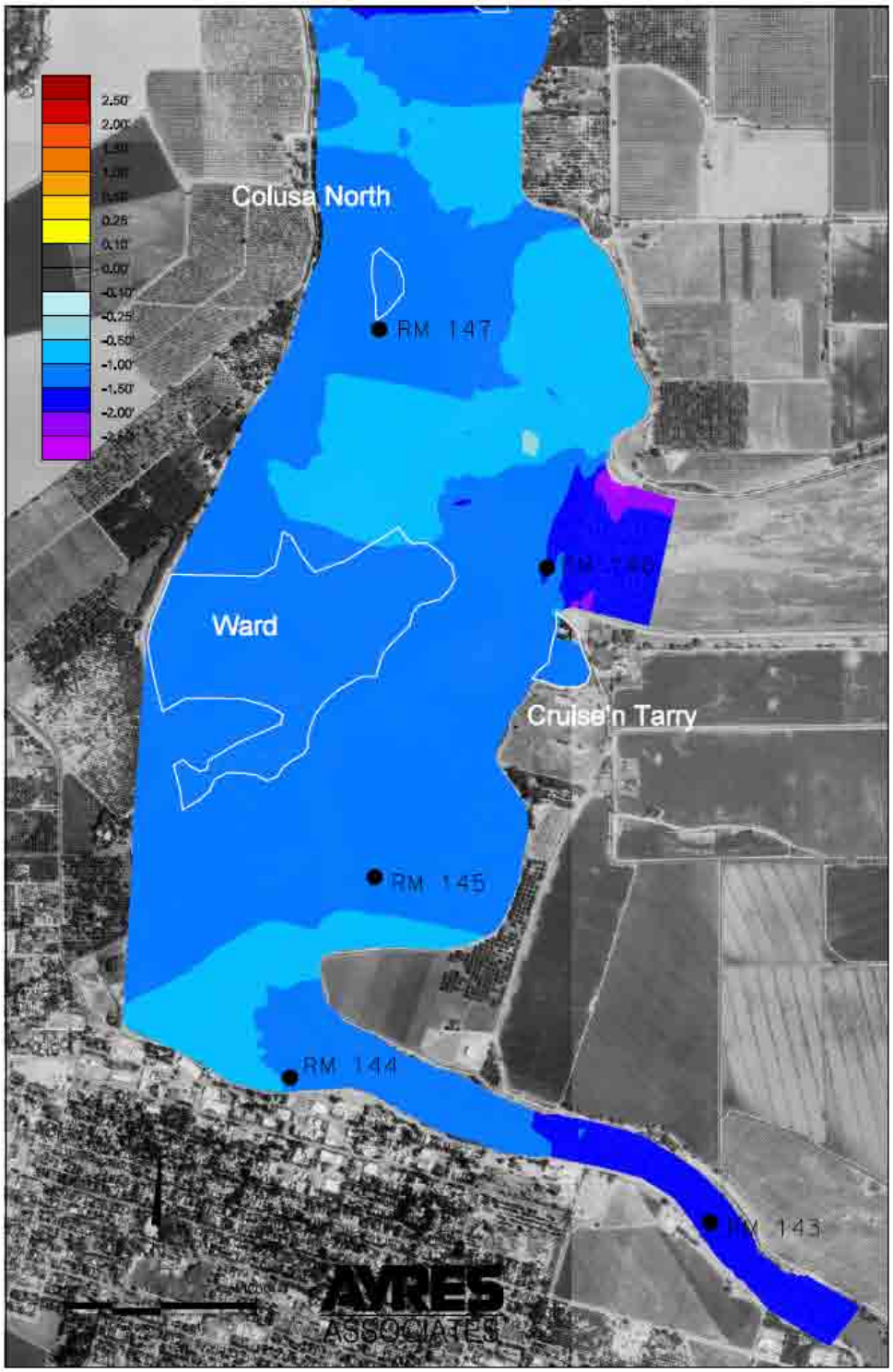

Figure 8: Difference between Design Profile and Restored (With Project) modeled water surface elevations (Ayres Associates)

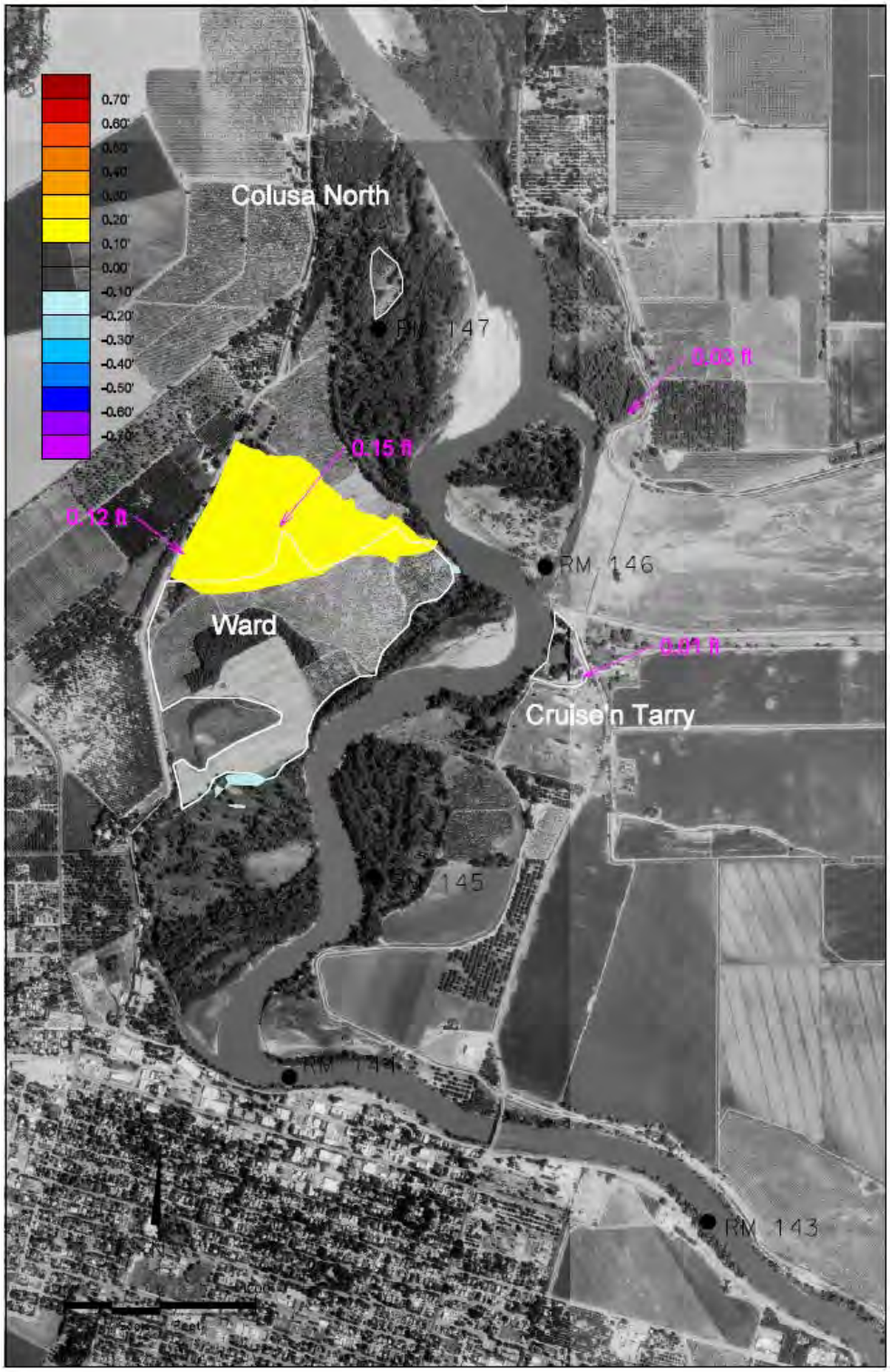

Figure 9: Net change in Water Surface Elevation; Difference between modeled Existing Conditions (Without Project) and Restored (With Project) water surface elevations (Ayres Associates)

Appendix C

Memorandum: Review of Upper Sacramento River Two-Dimensional Modeling Result at the Boggs Bend Unit of the Sacramento River National Wildlife Refuge (formerly known as the Jensen site)

RiverSmith

ENGINEERING

MEMORANDUM

To: Ryan Luster, Project Director, The Nature Conservancy, Chico, CA

From: Thomas W. Smith, PE, GE

Date: February 17, 2015

Re: Review of Upper Sacramento River Two-Dimensional Modeling Result at the Boggs Bend Unit of the Sacramento River National Wildlife Refuge (formerly known as the Jensen Site)

REGISTERED PROFESSIONAL ENGINEER THOMAS WESTON SMITH No. 20,525 exp 9/30/15 CIVIL STATE OF CALIFORNIA

INTRODUCTION AND SCOPE

At the request of The Nature Conservancy (TNC), I have performed a subsequent review of the two-dimensional modeling results specifically in regards to the Boggs Bend Unit of the Sacramento River National Wildlife Refuge. At the time of the modeling in 2008, the property was known as the Jensen Site. For the remainder of this memo, the Jensen Site is referred to as the Boggs Bend Unit.

The hydraulic modeling results are from the report titled "***Two-Dimensional Hydraulic Modeling of Riparian Habitat Restoration from Colusa to Princeton",*** dated March 28, 2008. The hydraulic modeling and final report were done by the Sacramento office of Ayres Associates and I was the principal author and stamped the final version of that report. A copy of the title page of that report is included for reference as an attachment to this memo.

The request was to specifically review the modeling results for the Boggs Bend Unit and explain the impacts of any changes in water surface elevation and any changes in flow velocities that result from the proposed restoration project. No new modeling has been performed for this review and there have been no proposed changes to the restoration planting layout.

The original hydraulic modeling was performed for the TNC and covered a 22.5 mile reach of the upper Sacramento River from Colusa to Princeton. Originally there were eight proposed restoration sites that were analyzed for impacts to the flood control system. The report also analyzed changes in velocity that could affect erosion and sedimentation patterns. These considerations will be looked at again specifically for the river reach of the Boggs Bend Unit.

The hydraulic model was originally calibrated using the 1995 high flow and associated surveyed high water marks. The Corps of Engineers 1997 bathymetry and overbank topography were used for the base mapping. Once calibrated, the model was run using the 1957 Corps of Engineers Design flow of 160,000 cfs for this reach for both the existing land use conditions and then using the eight proposed restoration scenarios. The full report contains additional details on the full calibration process for the model.

RiverSmith Engineering Inc
1104 Corporate Way, Sacramento, CA 95831
Voice (916) 395.4455, Fax (916) 395.4401

BOGGS BEND UNIT RESULTS

The following figure is from the original report and shows the location of the Boggs Bend Unit located just upstream of river mile (RM) 161.0 on the right over bank of the Sacramento River floodplain inside the project levees. The property is approximately 82 acres and the existing land use at the time of the modeling was orchard. The proposed conversion was to a mix of riparian forest and a grassland/shrub.

Discussion of Water Surface Elevations for the Design Flow

The following figure (N-2 from the original report) displays differential water surface elevations between the results from the existing condition model and the proposed restoration condition model. The graphic shows no change within the Boggs Bend Unit using a differential contour interval of 0.1 ft. Changes of less than 0.1 ft have been commonly considered to be within the limits of modeling accuracy and considered less than significant.

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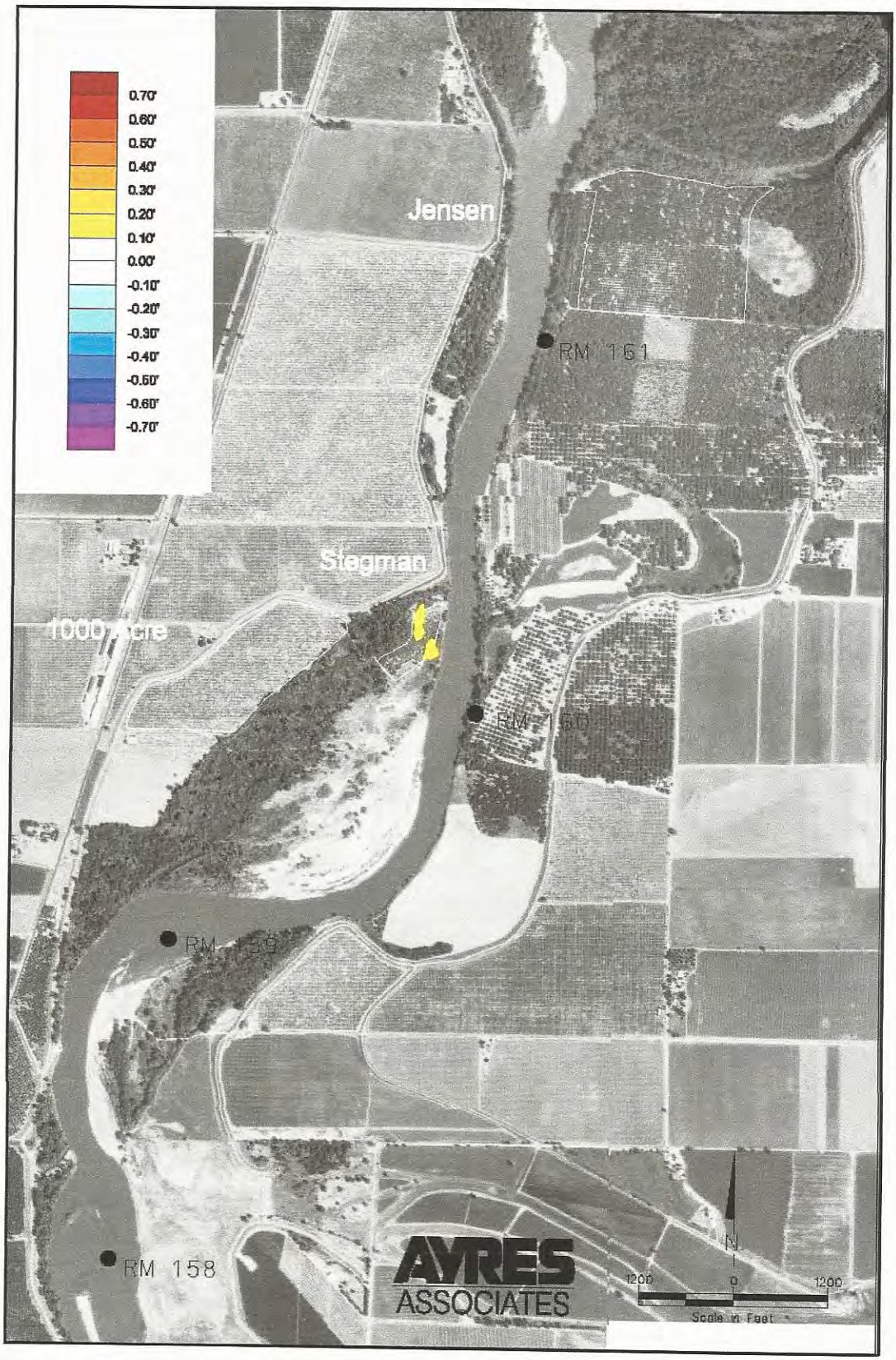

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From the original report:

"On the Jensen property, the with-project condition is slightly less than the existing condition, but greater than the 1957 design by a maximum of 0.36 ft on the upstream edge (Figures K-3 in the Appendix), and at the downstream end it is above the existing and the design conditions elevation by no more than 0.15 ft (Figure K-4), however this increase is confined to the center of the floodplain and does not extend to the levee, so there is no impact on freeboard."

There are two small area of less than 0.1 ft differential that was noted in the original model and two river cross sections were cut across the river and floodplain to take a more detailed look at these differences in water surface for the proposed restoration planting. The location of these cross sections is shown below and the results shown graphically on the following pages.

The detailed examination did find a small increase of 0.05 ft isolated within the parcel itself and on the downstream cross section. However this increase is limited to a small area near the eastern edge of the Jensen parcel and does not extend to the levee. The result is that there is no impact on existing freeboard at the levee.

It can also be noted that from the detail within these two cross sections, the existing and restoration water surface elevations are both slightly above the design water surface. However, as noted before, these areas are away from the levee and freeboard at the levee is not affected.

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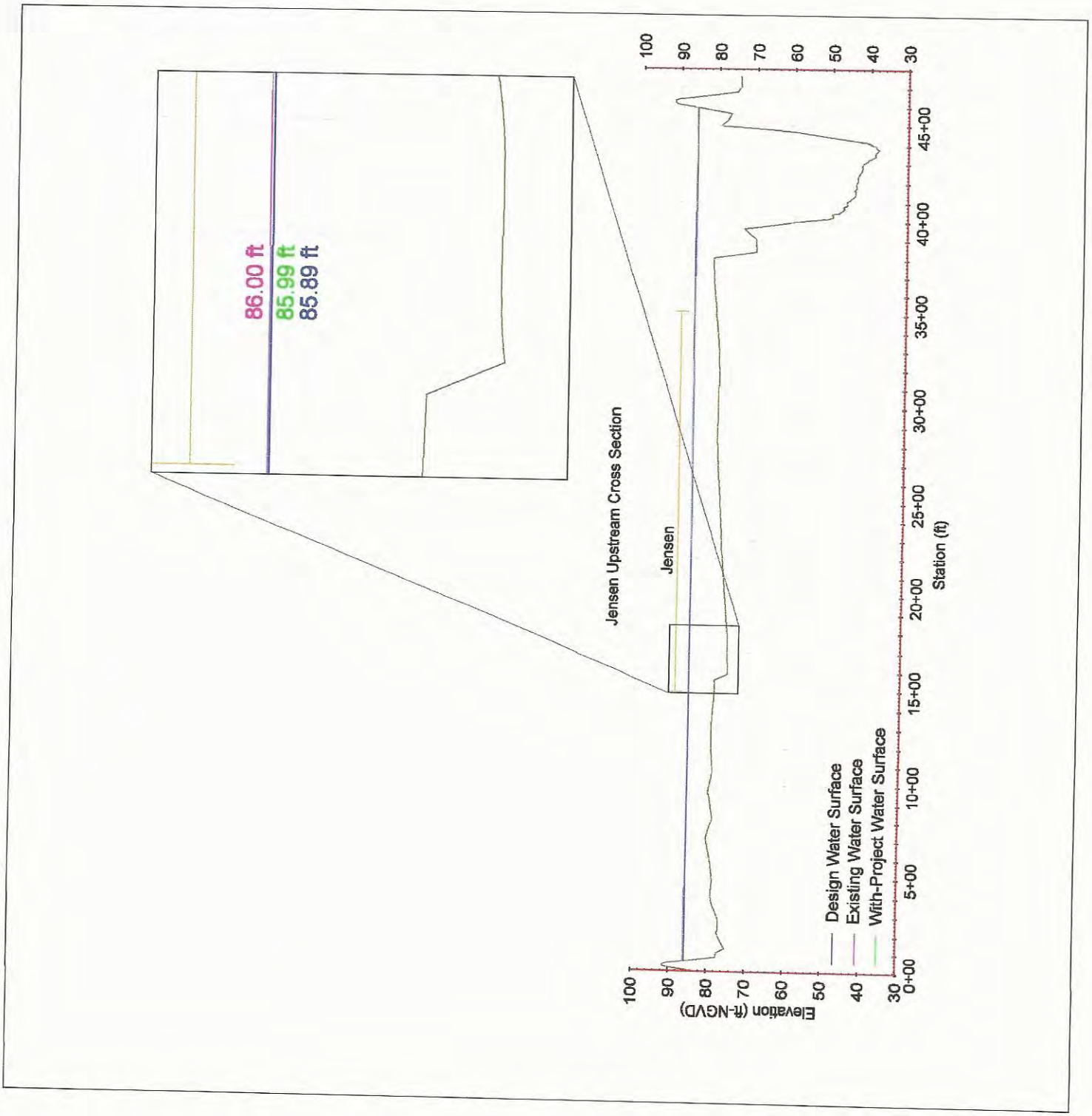

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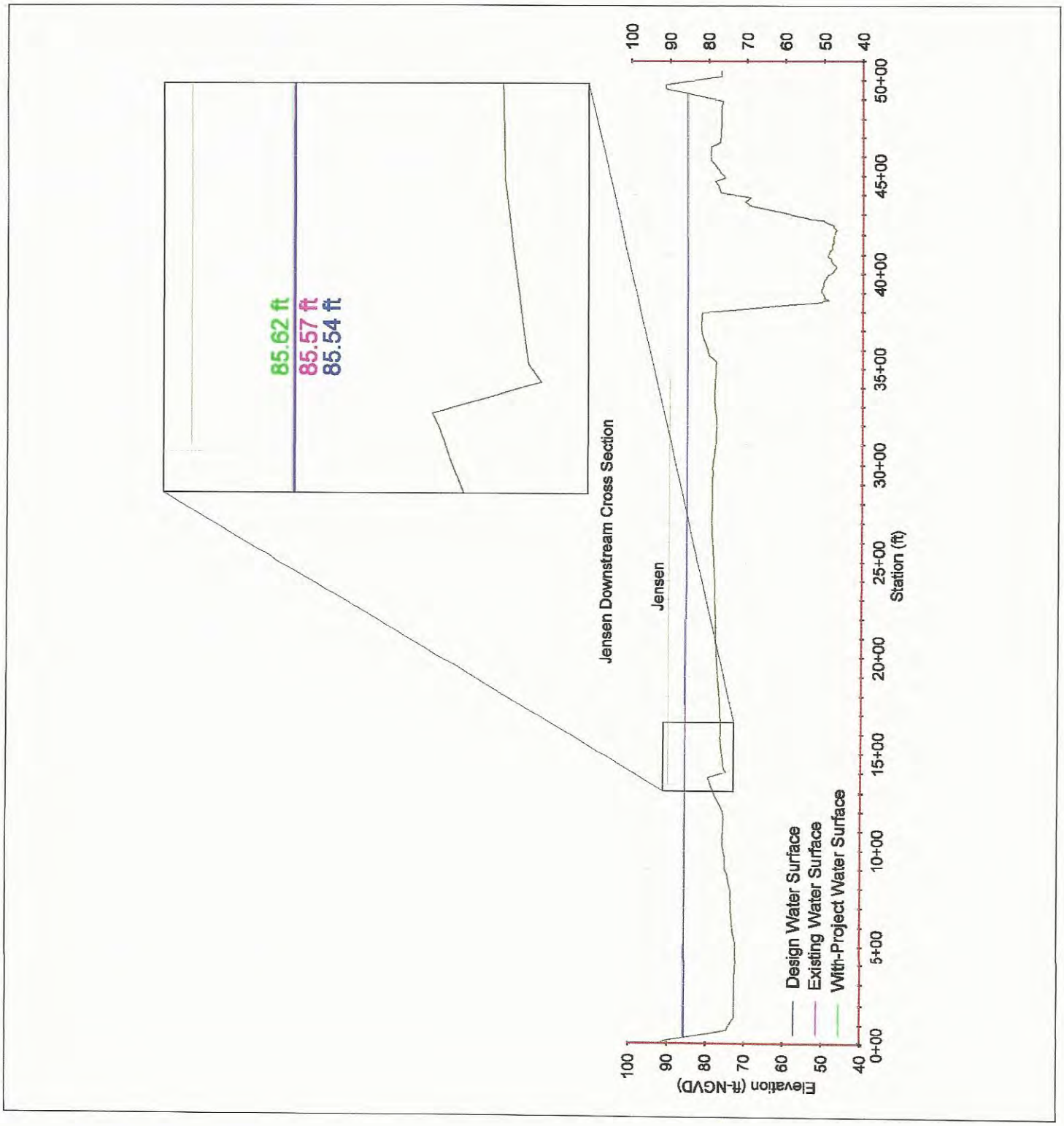

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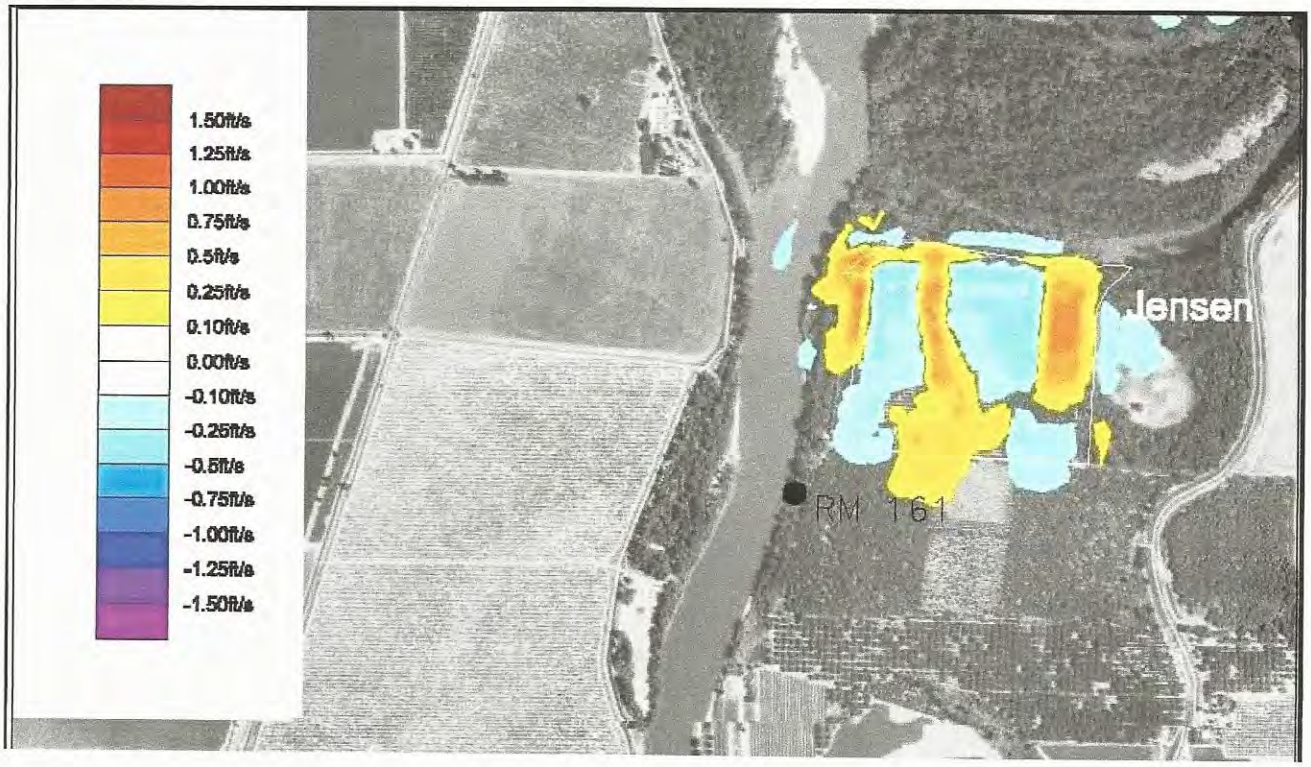
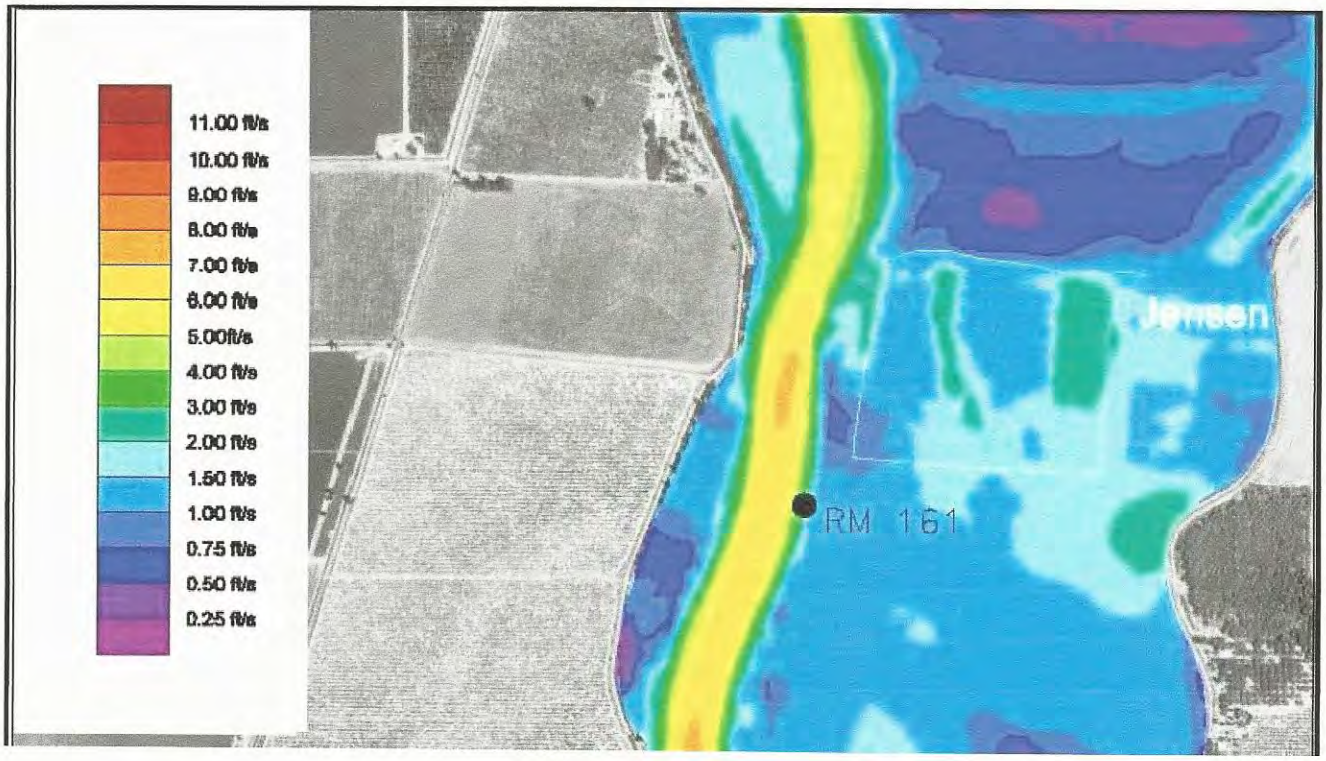
Discussion of Velocities for the Design Flow

The following plot depicts how average velocities will change within and adjacent to the Boggs Bend Unit for proposed restoration at the design flow. There are some increases (up to 0.75 fps) and some decreases (0.5 fps) which are a direct result of the varying densities within the restoration planting plan.

Most of the increases are within the more open planting areas and the decreases within the more dense riparian forest areas. The proposed restoration was able to maintain flow capacity by balance the planting layouts with a mix of densities that maintained conveyance without increasing the flow depths.



The graphic on the following page shows the actual velocities in this area for the proposed restoration condition and the design flow. The highest average velocities through the site are in the more open areas and are in the range of 2 to 3 fps and are in the grassland/shrub areas. Allowable velocities for annual and native grasses are in the range of 4 – 6 fps (Fischenick, Stability Thresholds for Stream Restoration Materials, 2001) and 3.5 fps (Natural Resource Conservation Service, Threshold Channel Design, 2007) Even though there are some increases in velocity, no erosion is expected for grasslands area of the restoration areas since the with-project velocities are less than published allowable values. Velocities in the riparian forest areas and off the site (except for the river channel itself) are less than 2 fps which in non-erosive even for bare soil.



CONCLUSIONS

This subsequent review of the 2008 hydraulic modeling results confirms that there is no impact to the existing freeboard in this reach of the Sacramento River Flood Control System for the proposed restoration of the Boggs Bend Unit. While there is a small area with a small increase (less than 0.1 ft), it is within the parcel and not adjacent to the levee. Existing freeboard is not affected by the proposed restoration.

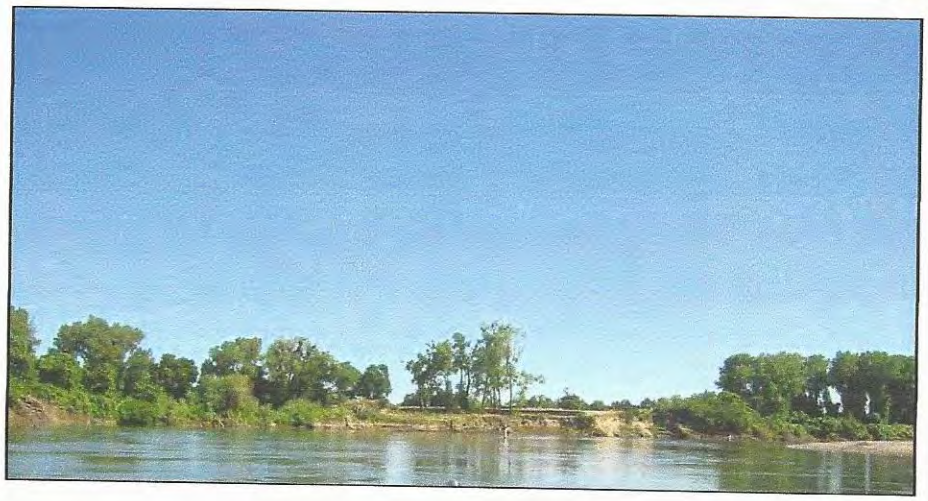
A review of the before and after velocities on the site and adjacent to the site shows that while there are some changes in the velocity patterns, the resulting velocities are non-erosion for native grasses (where the velocities are the highest) and no change in erosion or deposition patterns is predicted.

COVER PAGE FROM ORIGINAL REPORT

TWO-DIMENSIONAL HYDRAULIC MODELING OF RIPARIAN HABITAT RESTORATION FROM COLUSA TO PRINCETON

SACRAMENTO RIVER, RM 142.5 TO RM 164.5
GLENN AND COLUSA COUNTIES, CA

March 28, 2008



Prepared For:

The Nature Conservancy.
Protecting nature. Preserving life.

500 Main Street
Chico, CA 95928

REGISTERED PROFESSIONAL ENGINEER
THOMAS WEST SMITH
No. 20,525
Exp. 09.30.09
CIVIL
STATE OF CALIFORNIA

AYRES ASSOCIATES

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Appendix D

Memorandum: Request for Amendment to 2005 Sacramento River NWR CCP to include the Bogg's Bend Unit

Compatibility Determination Amendment (April 2015): Wildlife Observation, Wildlife Photography, and Interpretation

Compatibility Determination Amendment (April 2015): Fishing

Compatibility Determination Amendment (April 2015): Hunting

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Sacramento National Wildlife Refuge Complex
752 County RD. 99W
Willows, California 95988

Memorandum

To: Assistant Regional Director, Refuges, Region 8

From: Project Leader , Sacramento National Wildlife Refuge Complex
Willows, California

Subject: Request for Amendment to 2005 Sacramento River NWR CCP to include the Bogg's Bend Unit

Sacramento River National Wildlife Refuge (Refuge) recently acquired one parcel of land totaling 129 acres within the approved project boundary. This memorandum serves as an amendment to the Refuge's Comprehensive Conservation Plan (CCP) to incorporate this property as required by the National Wildlife Refuge System Improvement Act of 1997 and Service policy. The CCP is not scheduled to be revised for five years, therefore, we are amending the CCP to integrate the Bogg's Bend Unit of the Refuge (Figure 1) and implement approved management strategies for 129 acres.

Background/Need for Amendment:

The National Wildlife Refuge System Improvement Act of 1997 and Service policy (Fish and Wildlife Service Manual chapters 602 FW 1 and 3) identify the need to periodically review and revise Comprehensive Conservation Plans. Specifically the Service Manual chapter 602 FW 3, (Comprehensive Conservation Planning Process) Section 3.2 states "We will revise the CCP every 15 years … or earlier if monitoring and evaluation determine that we need changes to achieve planning unit purpose(s), vision, goals, or objectives".

The addition of the Bogg's Bend property is considered a minor amendment to the 2005 CCP. The addition of the Bogg's Bend property does not alter the original intent of any part of the CCP. This is considered a minor CCP revision because it would include the addition, deletion, and/or modification of CCP strategies without changes to any objectives or goals and the modification of the numerical target values associated with one or more objectives, without changing the overall intent of the objective(s).

This memorandum complies with the National Wildlife Refuge System Improvement Act of 1997, which states that the "Secretary shall … revise the plan at any time if the Secretary determines that conditions that affect the refuge or planning unit have changed significantly." Examples of new information or changed conditions include but are not limited to the following: 1) changes in the acreage of a specific habitat type; 2) changes in water management or availability; 3) changes in the status of a listed species; 4) the need for changes to wildlife management or public use programs; 5) changes to Service policy; 6) the need to construct new facilities, and/or 7) changes in sea level or other climate related changes.

Description of Acquired Parcels:

Sacramento River NWR is not complete. The approved acquisition boundary includes 18,000 acres of Sacramento River floodplain habitat between Red Bluff and Colusa. The Refuge CCP includes management and visitor services activities for 10,304 acres in fee title. In 2014, the Service acquired the Bogg's Bend property comprising 129 acres. This property is within the approved acquisition boundary of the Sacramento River NWR. This acquisition resulted in minor increases in riparian floodplain habitat compared to the Refuge as a whole.

<u>Bogg's Bend Property</u>
The Bogg's Bend Property is a mix of approximately 48 acres of mostly native remnant riparian habitat and 81 acres of recently abandoned production walnut orchard covered with non-native invasive species. The Service is currently developing an environmental assessment for restoration activities on the 81 acres of recently abandoned walnut orchard.

Management Strategies:

Goals 1, 2, 3 and 4 in the CCP address objectives and strategies for managing riparian habitat and wildlife, visitor services, partnerships, and resource protection. These goals are descriptive, open-ended, and are broad statements of a desired future condition that convey a purpose but do not define measurable outcomes. Goals translate Refuge purposes into management direction. Each goal is supported by measurable, achievable objectives with specific strategies needed to accomplish them. The Bogg's Bend Unit is incorporated into the Sacramento River NWR and the strategies identified in the CCP.

The management for the Bogg's Bend Unit of the Sacramento River NWR will follow Goal 1, Objectives 1.1, 1.3, 1.4, 1.5, 1.8, and 1.9; Goal 2, Objective 2.1 2.2, 2.3; and Goal 3, Objective 3.1, 3.2; Goal 4, Objective 4.1 and 4.2 as described below:

Goal 1: Wildlife and Habitat Goal

> Contribute to the recovery of endangered and threatened species and provide a natural diversity and abundance of migratory birds and anadromous fish through the restoration and management of viable riparian habitats along the Sacramento River using the principles of landscape ecology (Figure 2).

<u>Objective 1.1: Riparian Vegetation and Habitat</u>
Prepare and implement site assessment and restoration plans to restore an additional 3,255 acres of riparian vegetation and habitats (Great Valley willow scrub, Great Valley cottonwood forest,

Great Valley mixed riparian forest, Great Valley valley oak riparian forest, Valley oak savannah, elderberry savanna, and grassland, herbland, and wetland), as well as maintain existing and newly restored riparian habitats for riparian-dependent species by 2015.

Objective 1.3: Threatened & Endangered Species
Evaluate the response of Federal and State threatened and endangered species to habitat restoration projects. Implement eight surveys by 2005 (least Bell's vireo, valley elderberry longhorn beetle, bald eagle, giant garter snake, bank swallow, western yellow-billed cuckoo, willow flycatcher, and Swainson's hawk) and four additional surveys by 2015 (winter-run Chinook salmon, spring-run Chinook salmon, fall-run and late-fall run Chinook salmon, and Central Valley ESU steelhead).

Objective 1.4: Migratory and Resident Landbirds
Enhance, restore and monitor breeding migratory and resident landbird populations to source population levels (40 percent recruitment) through habitat restoration on 3,255 acres by 2015. Source populations are those where recruitment (annual increase) is high enough to replace the local breeding population with a surplus, which can repopulate other areas. Source populations recruit at levels above 35 percent for most species.

Objective 1.5: Winter Migratory Landbirds
Implement monitoring surveys for wintering migratory landbird populations on up to 8,000 acres of riparian habitat on the Refuge by 2010.

Objective 1.8: Native Plant Species
On up to 9,000 acres of the Refuge, locate and map six populations of rare and important native plants by 2005 and 24 populations by 2010; maintain and enhance native plant populations through restoration and conservation of 3,225 acres; and restore two native wildflower patches by 2005 and up to 100 patches by 2010.

Objective 1.9: Exotic, Invasive Species Control
Locate and map exotic invasive species on five units of the Refuge by 2010. Implement control programs (treatment and monitoring) for exotic invasive species on 7 units of the Refuge by 2010.

Goal 2: Visitor Services

> Encourage visitors of all ages and abilities to enjoy wildlife-dependent recreational and educational opportunities and experience, appreciate, and understand the Refuge history, riparian ecosystem, fish, and wildlife.

Objective 2.1: Hunting
Provide high quality opportunities for 1,500 annual hunting visits on 3,356 acres by 2005 and an additional 1,967 acres within two to 10 years, to total 5,323 acres (52 percent)

Objective 2.2: Fishing
Open gravel bars, sloughs, oxbow lakes, and the inundated floodplain on all Refuge units to

fishing. Provide 23 river-front miles for 1,000 annual fishing visits. By 2005, open all seasonally submerged areas below the ordinary high water mark to the public for fishing

Objective 2.3: Wildlife Observation and Photography
Provide quality opportunities for 1,000 wildlife viewing and photographic annual visits on 5,096 acres by 2005 and an additional 3,165 acres by 2015 to total 8,261 acres (80 percent).

Goal 3: Partnerships

> Promote partnerships to preserve, restore, and enhance a diverse, healthy, and productive riparian ecosystem in which the Sacramento River Refuge plays a key role.

Objective 3.1: Partnerships
Create opportunities for 25 new and maintain existing partnerships among Federal, State, local agencies, organizations, schools, corporations, and private landowners to promote the understanding and conservation of the Sacramento River Refuge resources, activities, and management by 2015.

Objective 3.2: Cooperation with Adjacent Landowners
By 2015, create opportunities for new and maintain existing partnerships with private landowners to promote cooperation and address mutual concerns.

Goal 4: Resource Protection

> *Adequately protect all natural and cultural resources, staff and visitors, equipment, facilities, and other property on the Refuge from those of malicious intent, in an effective, professional manner.*

Objective 4.1: Law Enforcement
Provide visitor safety, protect resources, and ensure compliance with regulations through law enforcement. Increase the number of law enforcement officers (from 1 to 2) and increase the monitoring of significant resource sites from quarterly to monthly by 2010.

Objective 4.2: Safety
By 2005, provide Refuge facilities and lands that are safe for public use and management activities through annual inspections and routine maintenance.

Additionally, this property will be included in general operations and management programs outlined in the CCP including but not limited to, prescribed fire, wildlife monitoring, research or other compatible use activities.

Figure 1.

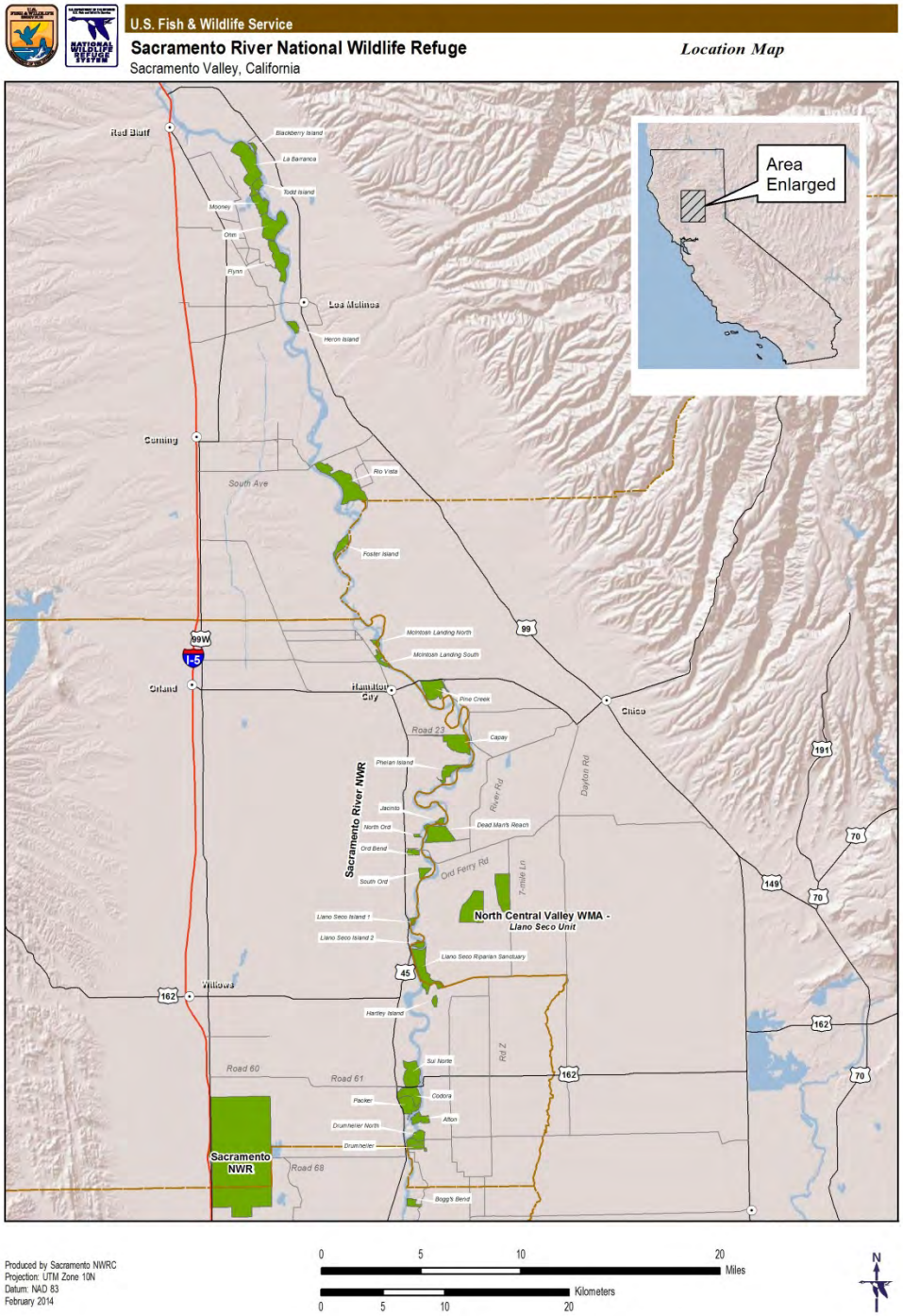
U.S. Fish & Wildlife Service
Sacramento River National Wildlife Refuge
Sacramento Valley, California
Location Map
Area Enlarged
Red Bluff
Blackberry Island
La Barranca
Todd Island
Mooney
Olen
Flynn
Los Molinos
Heron Island
Corning
Rio Vista
South Ave
Foster Island
McIntosh Landing North
McIntosh Landing South
99W
I-5
99
Orland
Hamilton City
Pine Creek
Chico
Road 23
Capay
Phelan Island
Sacramento River NWR
River Rd
Dayton Rd
Jacinto
North Ord
Dead Man's Reach
Ord Bend
Ord Ferry Rd
South Ord
7-mile Ln
191
70
149
North Central Valley WMA -
Llano Seco Unit
Llano Seco Island 1
Llano Seco Island 2
Llano Seco Riparian Sanctuary
45
Willows
162
Hartley Island
Rd 2
Sui Norte
Road 60
Road 61
Codora
Packer
Afton
Drumheller North
Drumheller
Sacramento NWR
Road 68
Bogg's Bend
Produced by Sacramento NWRC
Projection: UTM Zone 10N
Datum: NAD 83
February 2014
0 5 10 20 Miles
0 5 10 20 Kilometers
N

Figure 2.

U.S. Fish & Wildlife Service
Sacramento River National Wildlife Refuge
Bogg's Bend Unit Visitor Services Plan
USFWS Boundary
Public Uses
Open to: hunting (Aug - May), fishing, wildlife observation, photography, interpretation, and environmental education.
Currently Closed - to be opened to hunting, fishing, wildlife observation, photography, interpretation, and environmental education upon completion of restoration activites.
California Dept of Fish and Game
Facilities
Parking (on CDFW Princeton Southeast Unit)
Information Kiosk (on CDFW Princeton Southeast Unit)
Cartop Boat Launch (on CDFW Princeton Southeast Unit)
River Miles
CDFW - Princeton South Unit*
CDFW - Princeton Southeast Unit*
River Rd.
Bogg's Bend Unit
161
Produced by Sacramento NWRC
Projection: UTM Zone 10N
Datum: NAD 83
0 0.125 0.25 0.5 Miles
0 0.25 0.5 1 Kilometers
N

Refuge Manager/
Project Leader: _____ _____
(Signature) (Date)

Concurrence:

Chief, Natural
Resources Division: _____ _____
(Signature) (Date)

Refuge Supervisor: _____ _____
(Signature) (Date)

Approval:

Assistant Regional
Director, Refuges: _____ _____
(Signature) (Date)

COMPATIBILITY DETERMINATION AMENDMENT (April 2015)

Use: Wildlife Observation, Wildlife Photography, and Interpretation

Refuge Name: Sacramento River National Wildlife Refuge, located in Tehama, Butte, Glenn and Colusa counties, California.

Establishing and Acquisition Authority(ies): Sacramento River National Wildlife Refuge (SRNWR) was established in 1989. Approximately 11,000 acres of the approved 18,000 acres have been acquired. Legal authorities used for establishment of the Refuge include: the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), the Emergency Wetlands Resources Act of 1986 (16 U.S.C. 3901(b) and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Refuge Purpose(s): Sacramento River Refuge purposes include:

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. Sec. 1534 (Endangered Species Act of 1973)

".. the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."16 U.S.C. 3901(b) (Emergency Wetlands Resources Act of 1986)

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f (a) (4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. Sec. 742f (b) (1) (Fish and Wildlife Act of 1956)

National Wildlife Refuge System Mission: "To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use:

Expansion of wildlife observation, wildlife photography, and interpretation uses to include the Bogg's Bend Unit.

Availability of Resources: The following funding/annual costs (based on FY 2015 costs) would be required to administer and manage operations specifically related to the inclusion of the Bogg's Bend Unit in the current wildlife observation, wildlife photography, and interpretation program:

	One-Time Costs	Annual Costs
Outreach, Education, Monitoring	$500	$100
Signs, brochures, and maintenance	$1000	$100
TOTAL	**$1,500**	**$200**

Refuge operations funds are currently available through the Service budget process to administer public uses, including the addition of the Bogg's Bend Unit. Furthermore, California Department of Fish & Wildlife will partner in initial startup cost for facilities and co-manage visitor service facilities under an existing Memorandum of Understanding on an annual basis.

Anticipated Impacts of Use:

The primary impacts to wildlife from opening the Bogg's Bend Unit to wildlife observation, wildlife photography, and interpretation would be from disturbance. These potential impacts were thoroughly evaluated in the March 2005 compatibility determination which is incorporated by reference. There are no direct, indirect, or cumulative effects to natural or cultural resources anticipated from opening the Bogg's Bend Unit to wildlife observation, wildlife photography, and interpretation uses.

Public Review and Comment: This CD Amendment will be available to the public for a 30- day comment period beginning XXXX, 2015. Comment should be addressed to Daniel W. Frisk (Refuge Project Leader) 752 County RD. 99W, Willows, CA 95988 or dan_frisk@fws.gov.

Determination:

_____Use is Not Compatible

___X__Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

The stipulations described in the March 2005 compatibility determination are incorporated by reference. No additional stipulations are needed to ensure the compatibility of hunting at the Bogg's Bend Unit.

Justification: Wildlife observation, wildlife photography, and interpretation are wildlife-dependent recreational uses listed in the National Wildlife Refuge System Improvement Act. By facilitating these uses on the Bogg's Bend Unit of the SRNWR, we will increase the visitors' knowledge and appreciation of fish and wildlife, which may lead to increased public stewardship of wildlife and their habitats on the Refuge and along the Sacramento River. Increased public stewardship will support and complement the Service's actions in achieving the SRNWR's purposes and the mission of the National Wildlife Refuge System.

Mandatory Re-Evaluation Date (March 2030):

___X___Mandatory 15-year Re-Evaluation, (for priority public uses)

_____ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

___ __ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

___X__Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

COMPATIBILITY DETERMINATION AMENDMENT (April 2015)

Use: Fishing

Refuge Name: Sacramento River National Wildlife Refuge, located in Tehama, Butte, Glenn and Colusa counties, California.

Establishing and Acquisition Authority(ies): Sacramento River National Wildlife Refuge (SRNWR) was established in 1989. Approximately 11,000 acres of the approved 18,000 acres have been acquired. Legal authorities used for establishment of the Refuge include: the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), the Emergency Wetlands Resources Act of 1986 (16 U.S.C. 3901(b) and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Refuge Purpose(s): Sacramento River Refuge purposes include:

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. Sec. 1534 (Endangered Species Act of 1973)

".. the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."16 U.S.C. 3901(b) (Emergency Wetlands Resources Act of 1986)

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f (a) (4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. Sec. 742f (b) (1) (Fish and Wildlife Act of 1956)

National Wildlife Refuge System Mission: "To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use:

Expansion of fishing uses to include the Bogg's Bend Unit.

Availability of Resources: The following funding/annual costs (based on FY 2015 costs) would be required to administer and manage operations specifically related to the inclusion of the Bogg's Bend Unit in the current fishing program:

	One-Time Costs	Annual Costs
Outreach, Education, Monitoring	$500	$100
Signs, brochures, and maintenance	$1000	$100
TOTAL	**$1,500**	**$200**

Refuge operations funds are currently available through the Service budget process to administer public uses, including the addition of the Bogg's Bend Unit. Furthermore, California Department of Fish & Wildlife will partner in initial startup cost for facilities and co-manage visitor service facilities under an existing Memorandum of Understanding on an annual basis.

Anticipated Impacts of Use:

The primary impacts to wildlife from opening the Bogg's Bend Unit to fishing would be from disturbance. These potential impacts were thoroughly evaluated in the March 2005 compatibility determination which is incorporated by reference. There are no direct, indirect, or cumulative effects to natural or cultural resources anticipated from opening the Bogg's Bend Unit to fishing uses.

Public Review and Comment: This CD Amendment will be available to the public for a 30- day comment period beginning XXXX, 2015. Comment should be addressed to Daniel W. Frisk (Refuge Project Leader) 752 County RD. 99W, Willows, CA 95988 or dan_frisk@fws.gov.

Determination:

_____Use is Not Compatible

___X__Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

The stipulations described in the March 2005 compatibility determination are incorporated by reference. No additional stipulations are needed to ensure the compatibility of hunting at the Bogg's Bend Unit.

Justification: Fishing is wildlife-dependent recreational uses listed in the National Wildlife Refuge System Improvement Act. By facilitating this use on the Bogg's Bend Unit of the SRNWR, we will increase the visitors' knowledge and appreciation of fish and wildlife, which may lead to increased public stewardship of wildlife and their habitats on the Refuge and along the Sacramento River. Increased public stewardship will support and complement the Service's actions in achieving the SRNWR's purposes and the mission of the National Wildlife Refuge System.

Mandatory Re-Evaluation Date (March 2030):

___X___Mandatory 15-year Re-Evaluation, (for priority public uses)

_____ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

___ __ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

___X__Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

COMPATIBILITY DETERMINATION AMENDMENT (April 2015)

Use: Hunting

Refuge Name: Sacramento River National Wildlife Refuge, located in Tehama, Butte, Glenn and Colusa counties, California.

Establishing and Acquisition Authority(ies): Sacramento River National Wildlife Refuge (SRNWR) was established in 1989. Approximately 11,000 acres of the approved 18,000 acres have been acquired. Legal authorities used for establishment of the Refuge include: the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543: 87 Statute 884), the Emergency Wetlands Resources Act of 1986 (16 U.S.C. 3901(b) and the Fish and Wildlife Act of 1956 (16 U.S.C. 742).

Refuge Purpose(s): Sacramento River Refuge purposes include:

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." 16 U.S.C. Sec. 1534 (Endangered Species Act of 1973)

".. the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."16 U.S.C. 3901(b) (Emergency Wetlands Resources Act of 1986)

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f (a) (4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. Sec. 742f (b) (1) (Fish and Wildlife Act of 1956)

National Wildlife Refuge System Mission: "To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd-ee]).

Description of Use:

Expansion of hunting uses to include the Bogg's Bend Unit.

Availability of Resources: The following funding/annual costs (based on FY 2015 costs) would be required to administer and manage operations specifically related to the inclusion of the Bogg's Bend Unit in the current hunting program:

	One-Time Costs	Annual Costs
Outreach, Education, Monitoring	$500	$100
Signs, brochures, and maintenance	$1000	$100
TOTAL	**$1,500**	**$200**

Refuge operations funds are currently available through the Service budget process to administer public uses, including the addition of the Bogg's Bend Unit. Furthermore, California Department of Fish & Wildlife will partner in initial startup cost for facilities and co-manage visitor service facilities under an existing Memorandum of Understanding on an annual basis.

Anticipated Impacts of Use:

The primary impacts to wildlife from opening the Bogg's Bend Unit to hunting would be from disturbance. These potential impacts were thoroughly evaluated in the March 2005 compatibility determination which is incorporated by reference. In addition, cumulative impacts were analyzed and addresses in the 2007 Sacramento River National Wildlife Refuge Environmental Assessment Supplemental Cumulative Impact Analysis of Hunt Program. There are no direct, indirect, or cumulative effects to natural or cultural resources anticipated from opening the Bogg's Bend Unit to hunting uses.

Public Review and Comment: This CD Amendment will be available to the public for a 30- day comment period beginning XXXX, 2015. Comment should be addressed to Daniel W. Frisk (Refuge Project Leader) 752 County RD. 99W, Willows, CA 95988 or dan_frisk@fws.gov.

Determination:

_____Use is Not Compatible

___X__Use is Compatible with the Following Stipulations

Stipulations necessary to ensure compatibility:

The stipulations described in the March 2005 compatibility determination are incorporated by reference. No additional stipulations are needed to ensure the compatibility of hunting at the Bogg's Bend Unit.

Justification: Hunting is wildlife-dependent recreational uses listed in the National Wildlife Refuge System Improvement Act. By facilitating this use on the Bogg's Bend Unit of the SRNWR, we will increase the visitors' knowledge and appreciation of fish and wildlife, which may lead to increased public stewardship of wildlife and their habitats on the Refuge and along the Sacramento River. Increased public stewardship will support and complement the Service's actions in achieving the SRNWR's purposes and the mission of the National Wildlife Refuge System.

Mandatory Re-Evaluation Date (March 2030):

___X___Mandatory 15-year Re-Evaluation, (for priority public uses)

_____ Mandatory 10-year Re-Evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

___ __ Categorical Exclusion without Environmental Action Statement

_____ Categorical Exclusion and Environmental Action Statement

___X__Environmental Assessment and Finding of No Significant Impact

_____ Environmental Impact Statement and Record of Decision

Appendix E

Response to Comments