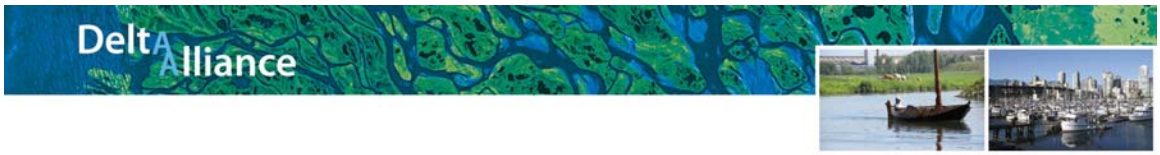

CASE STUDY REPORT
SHERMAN ISLAND DELTA PROJECT

November 2013

Written by Bradley Angell, Richard Fisher & Ryan Whipple

a project of
Ante Meridiem Incorporated
with the direct support of the
Delta Alliance International Foundation

ABSTRACT

This report is an official beginning to a model design for Sherman Island, an important land mass that lies at the meeting point of the Sacramento and San Joaquin Rivers of the California Delta system. As design is typically dominated by a particular driving discipline or a paramount policy concern, the resulting decision-making apparatus is normally governed by that discipline or policy. After initial review of Sherman Island, such a "single" discipline or "principle" policy approach is not appropriate for Sherman Island. At this critical physical place at the heart of California Delta, an inter-disciplinary and equal-weighted policy balance is necessary to meet both the immediate and long-term requirements for rehabilitation of the project site.

Exhibiting the collected work of a small team of design and policy specialists, the Case Study Report for the Sherman Island Delta Project outlines the multitude of interests, disciplines and potential opportunities for design expression on the selected 1,000 acre portion of Sherman Island under review. Funded principally by a generous grant from the Delta Alliance, the team researched applicable uses and technologies with a pragmatic case study approach to the subject, physically documenting exhibitions of each technology as geographically close to the project site as possible.

After study and on-site documentation, the team compiled this wealth of discovery in three substantive chapters: a site characterization report, the stakeholders & goals assessment, and a case study report. In its final iteration, seven cases are published in this report as having valid potential for the project site in meeting the critical demands for the project. These cases include the Far Niente Winery Floating Solar Array; Feather River Setback Levee; Mayberry Farms Subsidence Reversal & Carbon Sequestration Project; Nimbus Hatchery & Visitor's Center; Rio Viento RV Park Wind Turbine; Sherman Lake Marina; and the Yolo Bypass Wildlife Area. Further, after the team's review was complete, five additional case studies were identified for future research and potential application in completion of the project. These cases include the Yolo Bypass as Integrated Flood, Agricultural & Wildlife Sanctuary; Hydroponics Floating Greenhouse; Floating Markets of Bangkok; Anaerobic Digestion Food Waste Processing Center; and the Floating Charter School of Lagos.

The Case Study Report for the Sherman Island Delta Project, as presented in the following chapters is principally a foundation document to guide the specialist team, stakeholders and agency officials in creating a model design scheme for the project site. As equal, coordinated investment is necessary from each interest category, the following Case Study Report allows all parties to review, reflect and invest in those design solutions they find both physically *and* politically ideal for this critical property. From this body of exhibited design success that has been demonstrated by like proximate developers, an approach to rehabilitating this 1,000 acre portion of Sherman Island can be defined without risking the continued marginalization of the island community.

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Chapter 1. Introduction

Completed November 2013

Introduction

In 2010 a team of four engineering students at University of California at Berkeley set out to develop a sustainable design solution for the Sacramento-San Joaquin River Delta as their capstone systems engineering project. From the onset of the project, the team has been driven to address diverse stakeholder inputs with a holistic, adaptable solution to the many issues facing the Sacramento-San Joaquin River Delta. The issues of greatest concern in the California Delta are not entirely unique to the American West Coast, but rather, represent the same serious concerns faced by policy managers, designers and local populations of the major deltas throughout the world. Upon graduation, two of the original four-member team continued the pursuit of the course's goal to investigate and propose a sustainable solution for the Sacramento-San Joaquin River Delta, focusing on the critical Sherman Island located at the very meeting point of the two major river systems. The project was then dignified as the Sherman Island Delta Project.

In the fall of 2011, these two post-graduation designers Richard Fisher and Ryan Whipple presented the capstone project at the International Constructed Environment Conference at the University of Chicago hoping to raise awareness about the issues facing deltas and their believed latent opportunity to create change with research-based design. In the audience was Bradley Angell who at the time was a Ph.D. student and co-executive for the San Francisco Bay Area nonprofit Ante Meridiem, Inc. Ante Meridiem, Inc. is a 501(c)3 California non-profit that was formed in 2007 as a start-up research organization focused on the pursuit of critical design investigation. The organization's founders have from the beginning taken an especially high interest in sustainable, interdisciplinary urban development projects proposed to alleviate local communal marginalization. After the conference, an informal partnership was formed with the members of Ante Meridiem to expand the depth of the project team's professional breadth, now including geotechnical and environmental engineers, an architect and a lawyer. Since January 2012, the Sherman Island Delta Project has been organized and supported as a major endeavor for the Ante Meridiem, Inc. non-profit organization.

In March of 2012, the Sherman Island Delta Project compiled two years of research analysis and project development into a single preliminary design proposal for submission to the Delta Alliance. Representing the primary project proponents since the capstone course, Richard Fisher and Ryan Whipple applied for consideration in the Delta Alliance's Young Professionals competition. In June 2012, the Sherman Island Delta Project Team won the Delta Alliance Young Professional's Award, an honor that allowed the two principle designers the privilege of presenting the project's scope at the Rio+20 United Nations Conference for Sustainable Development. This was great honor and privilege for the Sherman Island Delta Project Team, and since the presentation has fueled the team's passion to create an innovative design solution.

In addition to this recognition and the unique presentation experience organized by the Delta Alliance, the granting institution has made the following technical suggestion for the continued development of the project:

> In the further development of the presented solution, the jury suggests to pay attention to a full integration of the various elements of innovation and alternative land and water use, the impacts on the neighbouring areas in the delta and a sound cost-benefit analysis. In this respect potential positive effects on upstream communities could help to increase the feasibility of the solution.

With these suggestions in mind, the Sherman Island Delta Project Team set out to develop a

series of local development project evaluations which included site visits, economic, environmental, and engineering characterization culminating in the development of feasibility studies for the leading design option. Best presented as a "case study report", the following document was compiled as the direct response to this suggestion as well as the team's serious consideration of the sponsoring organization's valuable insights for innovative, sustainable design investigation.

Organized as three major chapters, the following case study report includes a thorough site characterization report, a stakeholder and goals assessment, and finally, an enumerated case study analysis. The results of these locally-sourced case studies are intended for use in the development of a single most practical, sustainable and feasible system of coordinated design elements for suggested implementation on Sherman Island in the Sacramento-San Joaquin Delta. In producing this document, the team endeavors to balance specific site necessities, the cost of implementation, and the potential stakeholder benefits from the outset so as to expedite an appropriate, research-backed development proposal. The contents of this report are the results of the work over the past year and are based on the tireless work of the project team who could not pursue this subject without the financial backing of the Delta Alliance. Again, the project team would like to extend a special note of appreciation to the Delta Alliance and their partners for both their financial and technical support.

Chapter 2. Site Characterization Report

Completed July 2013

Lead author: Ryan Whipple
Contributing authors: Richard Fisher
Bradley Angell

Introduction

The Sacramento-San Joaquin Delta (SSJD) is located at the confluence of the Sacramento and San Joaquin Rivers in Northern California of the United States. The SSJD is home to approximately 515,000 people, 500 unique plant and animal species, major transportation and utility infrastructure and supplies more than 25 million people with fresh water. Sherman Island is located on the western edge of the SSJD and is one of the key geographic features in the preservation and protection of the delta system as a whole. The island is located northeast of the city of Antioch, California, and lies within the jurisdiction of Sacramento County. The Sacramento and San Joaquin Rivers meet at its western boundary, and are bordered to the northeast by Three-Mile Slough.

This report seeks to review the site resources located on Sherman Island and will describe the potential impacts of a "no action" outcome for the island and the greater SSJD should Sherman Island continue on its current trajectory. The need for an Adaptive Water Management and Agricultural Diversification System [hereafter "AWMADS"] is paramount on the island due to a greater potential for levee failure and its high suitability as a project site. Special site consideration will be given to the southwest portion of the island bounded by Mayberry Slough, Highway 160, and the Sacramento and San Joaquin Rivers as this portion of the island is most critical in protection of the SSJD from salt intrusion. Sherman Lake Marina is situated at the north westernmost portion of the project site, and the project site encompasses Scour Lake. **Figures 1** and **2** illustrate the geometrics of this specific site.

Brief History

The development of the Sacramento-San Joaquin River Delta began in late 1850 when the Swamp and Overflow Act transferred ownership of tall swamp and overflow land from the federal government to the State of California. In 1859, reclamation of Sherman Island began as local property owners constructed small 3' – 4' levees along the banks of the Sacramento River and Mayberry Slough. The subsequent draining of the island for agricultural purposes exposed the highly organic peat soil, leaving the interior of the island prone to oxidation and subsidence.

With the interior of Sherman Island sinking due to subsidence and substandard levee protection, Sherman Island experienced five major floods between years of 1871 and 1880. Following the 1880 flood, most of the land was kept underwater until 1894 when reclamation efforts were renewed.

Through the early 1900's, as the island was noted as Reclamation District #341, district agents conducted levee upgrade and restoration projects on Sherman Island. Despite these efforts, major levee breaches inundated the island with water in 1904, 1906, 1909 and 1969. After the 1969 breach, the U.S. Army Corps of Engineers spent approximately $600,000 in emergency funds to repair, reslope and regrade the levees. Since 1969, seepage and settlement along interior of the island have been ongoing issues that have required constant levee improvements. Moreover, continued subsidence has given Sherman Island the dubious distinction as the most subsided island in the Delta region with 142 million cubic yards of subsided volume.

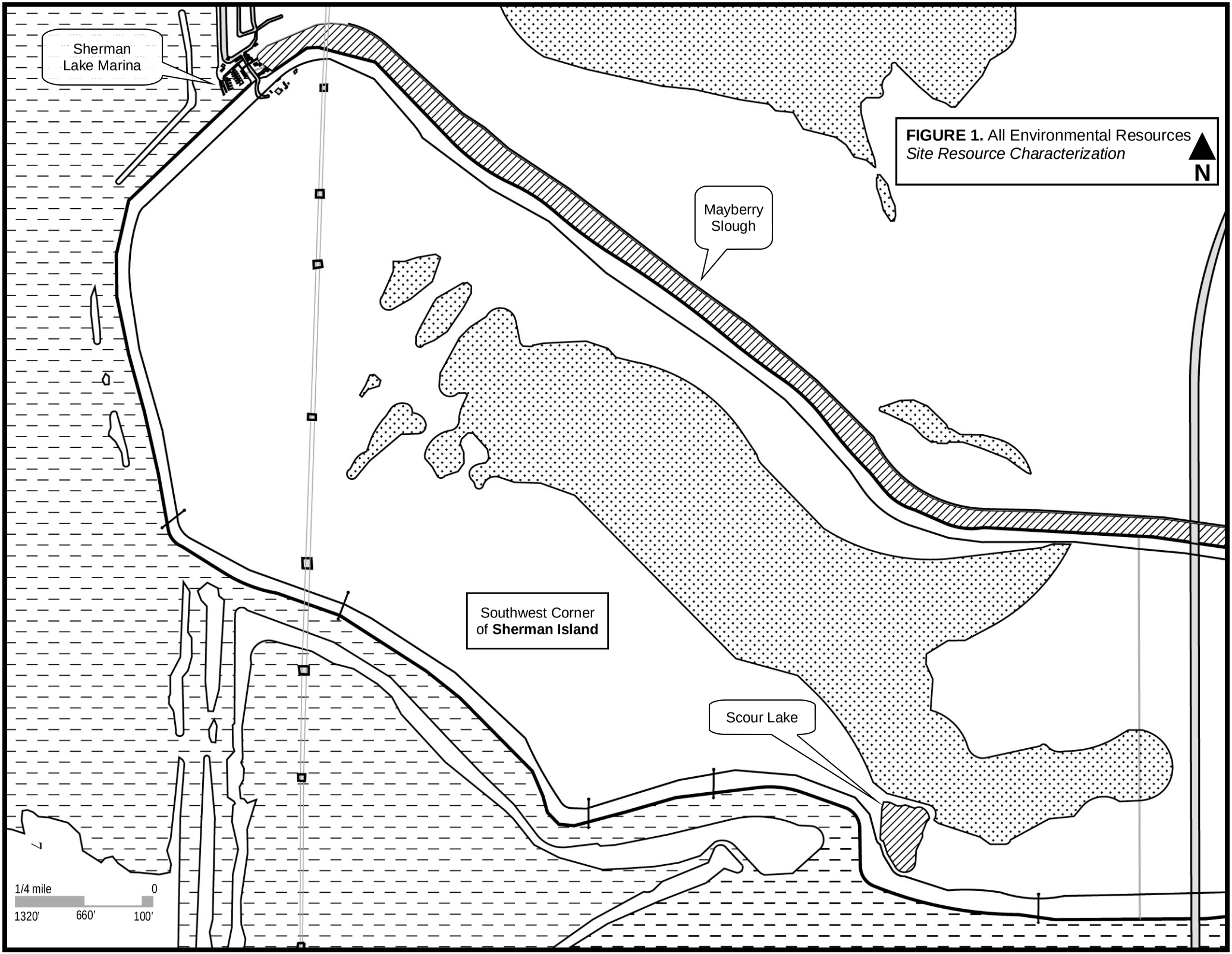

FIGURE 1. All Environmental Resources
Site Resource Characterization

N

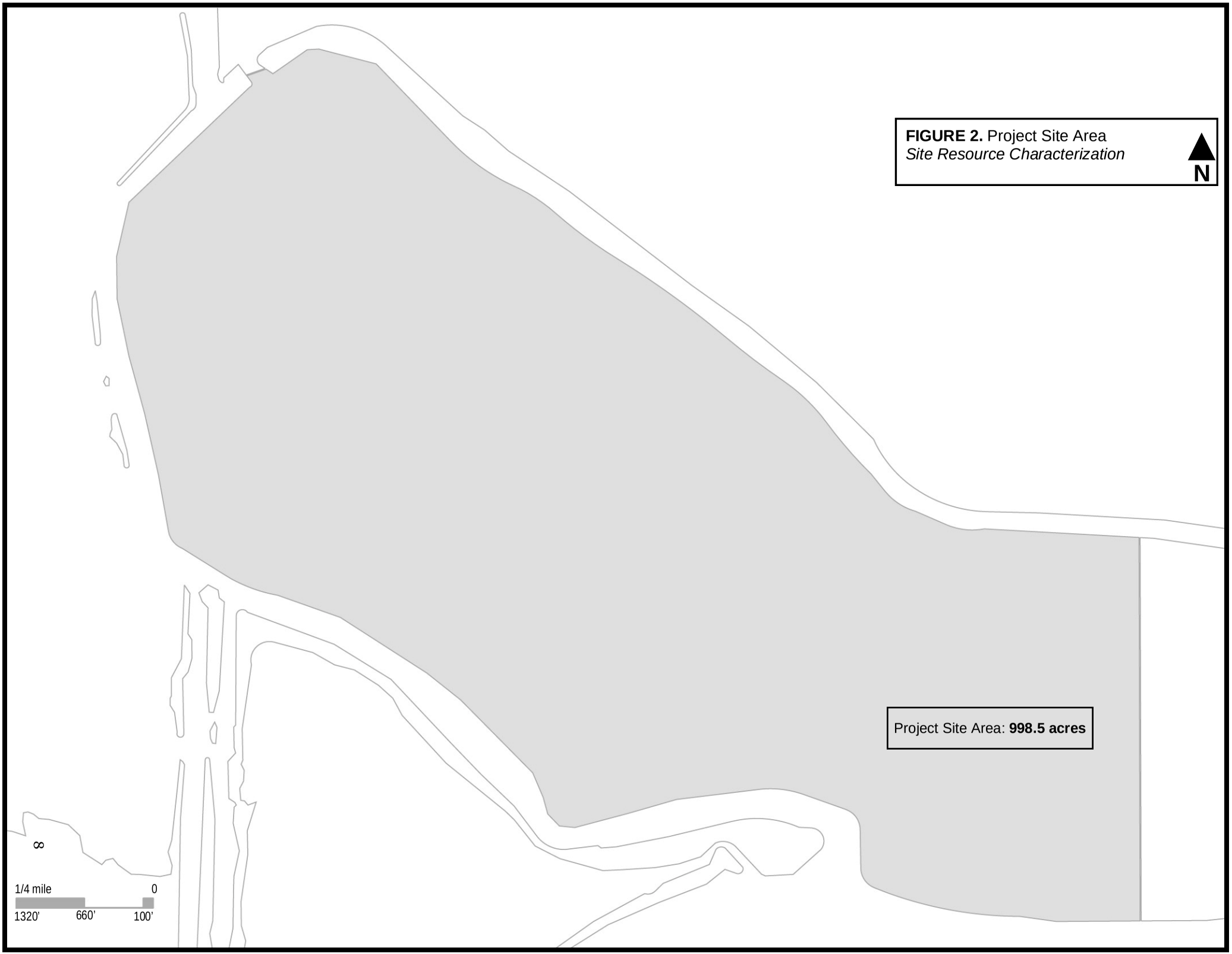
FIGURE 2. Project Site Area
Site Resource Characterization
N
Project Site Area: 998.5 acres
8
1/4 mile
0
1320'
660'
100'

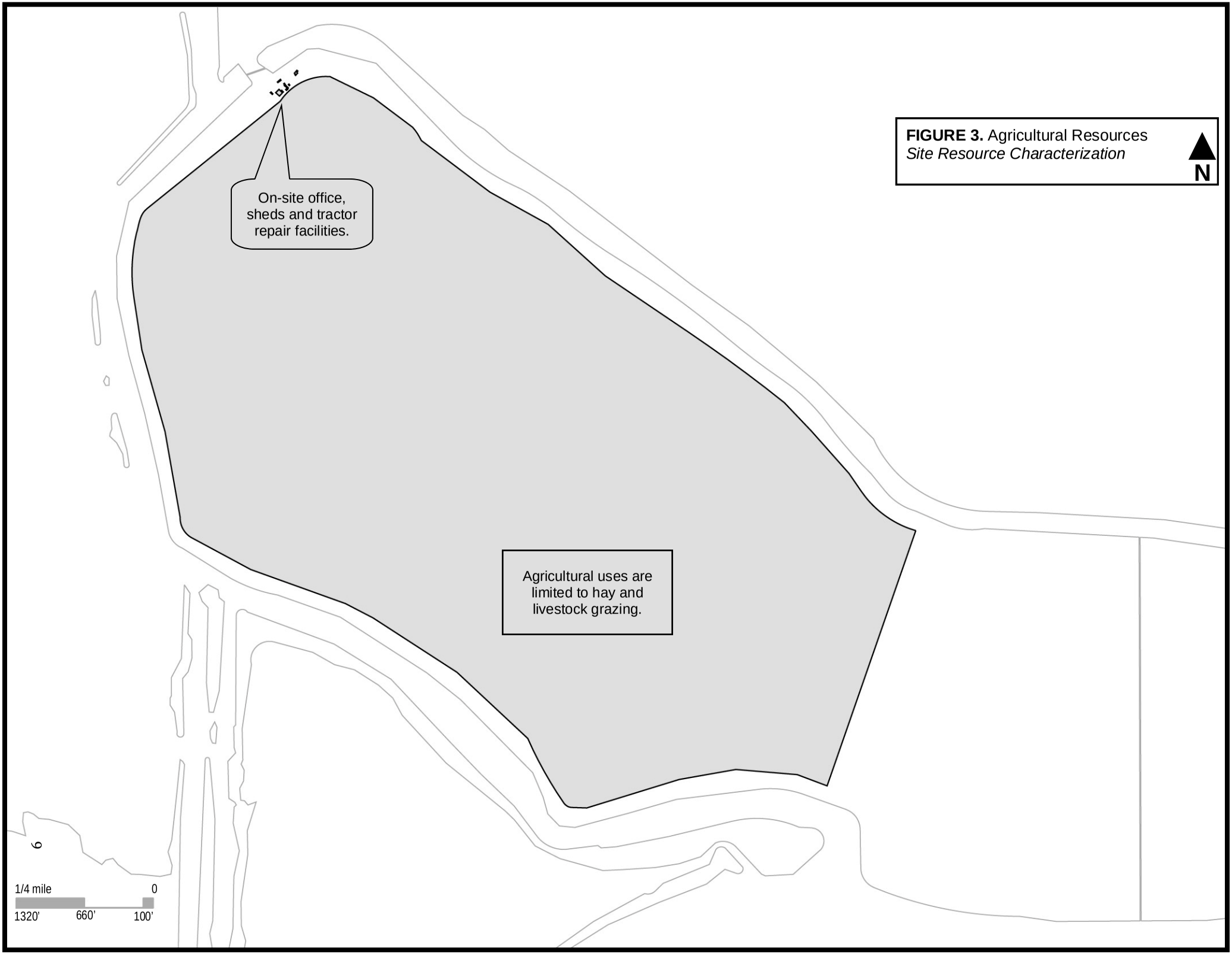

FIGURE 3. Agricultural Resources
Site Resource Characterization

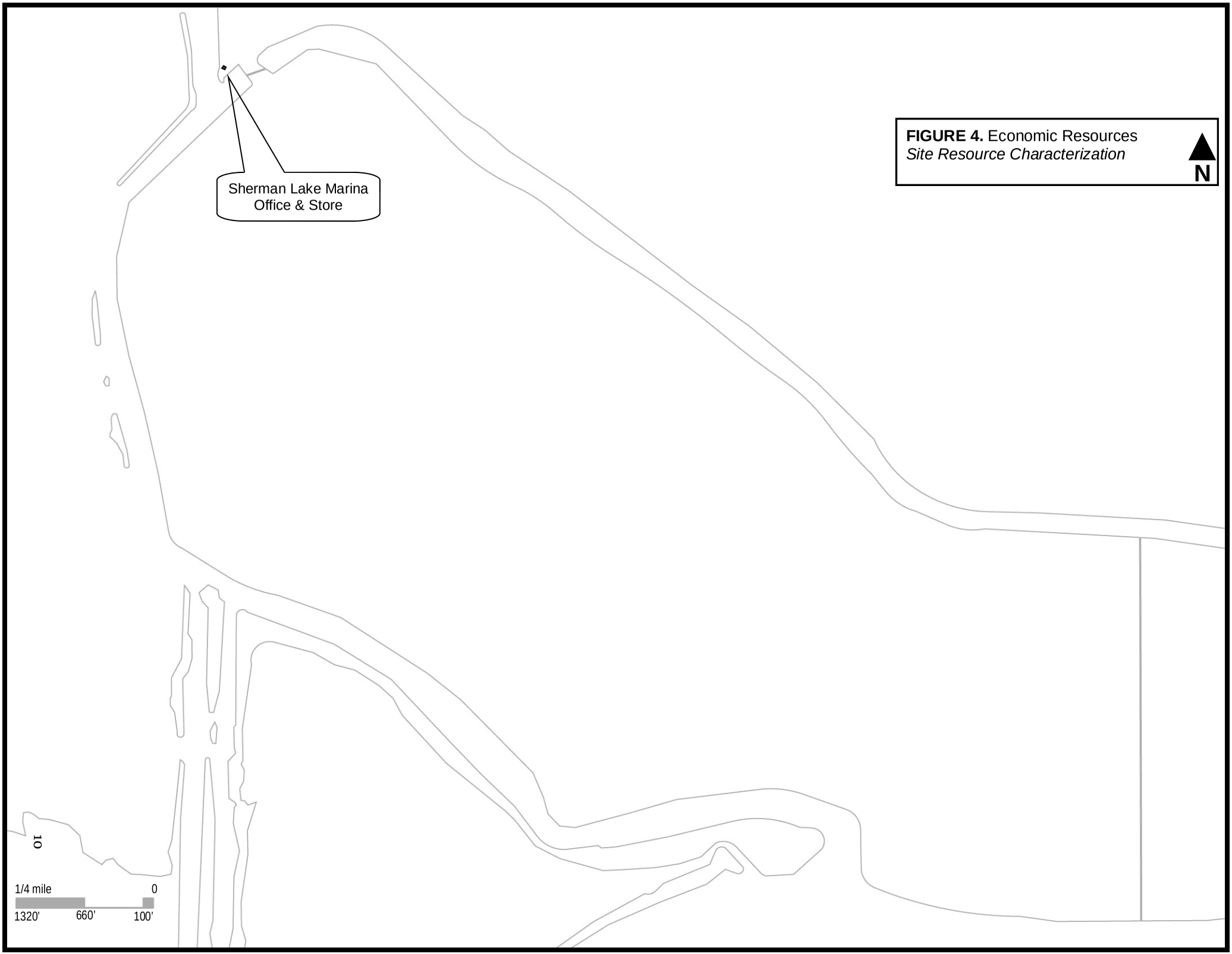

FIGURE 4. Economic Resources
Site Resource Characterization

N

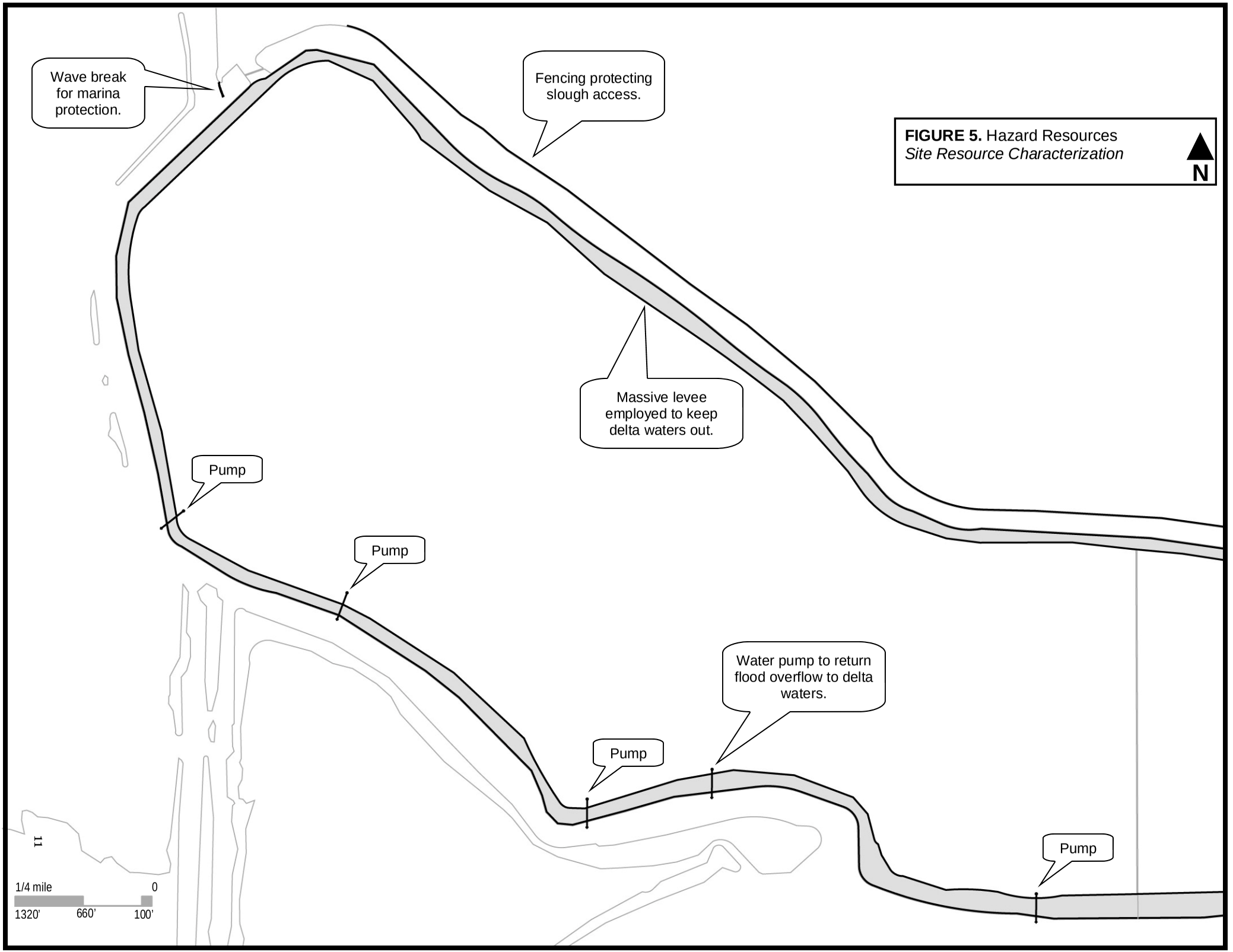

FIGURE 5. Hazard Resources
Site Resource Characterization

N

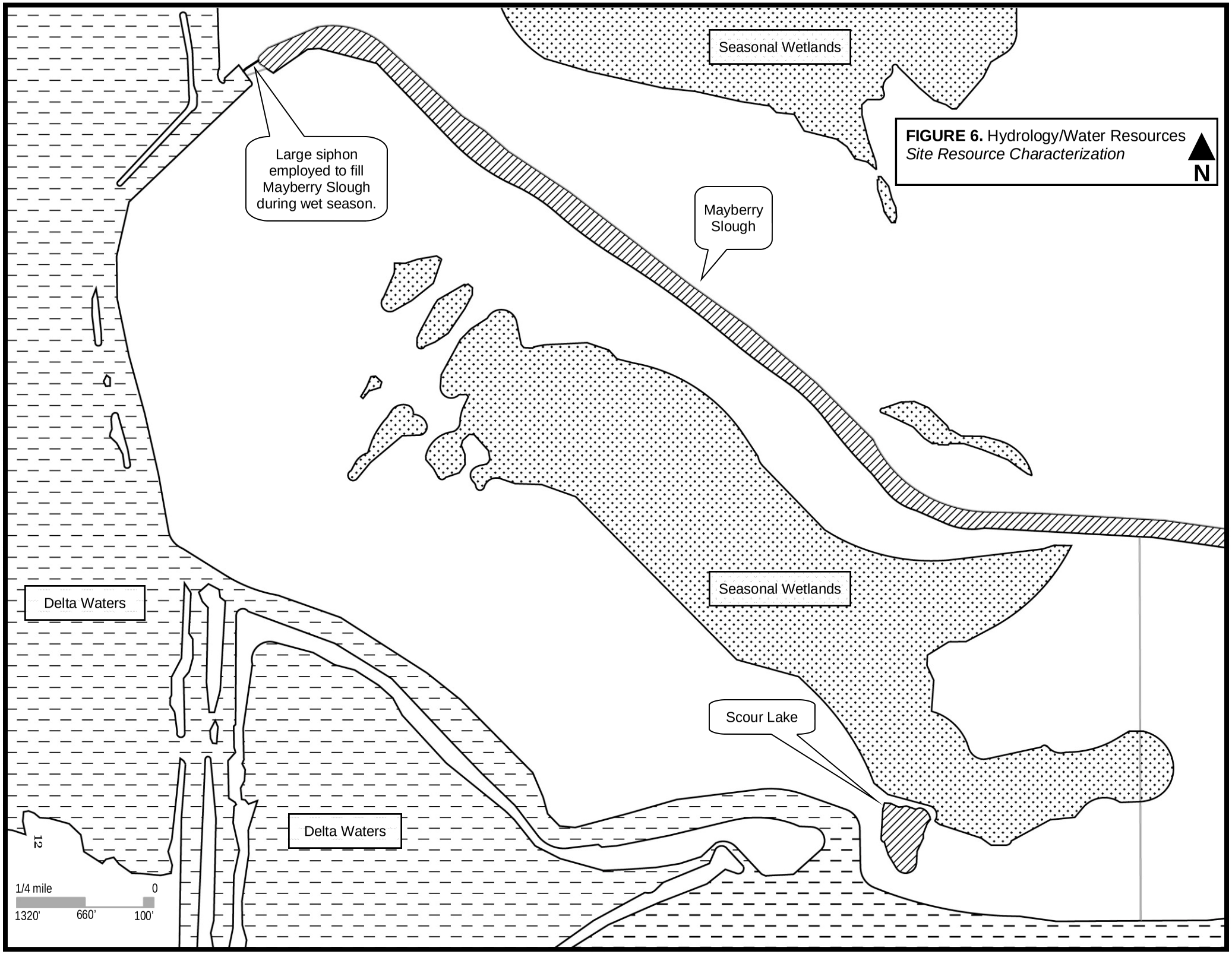

FIGURE 6. Hydrology/Water Resources
Site Resource Characterization

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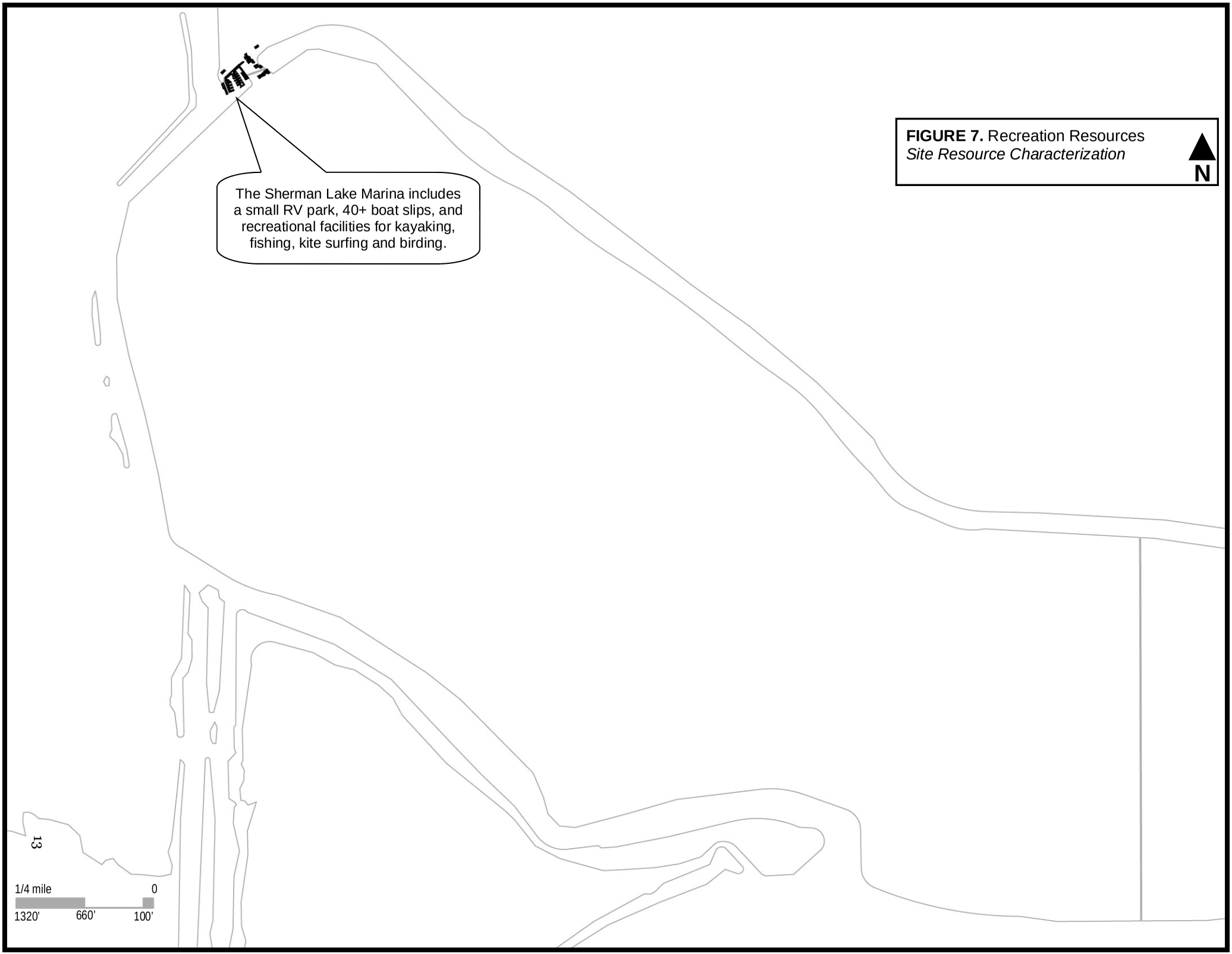

FIGURE 7. Recreation Resources
Site Resource Characterization

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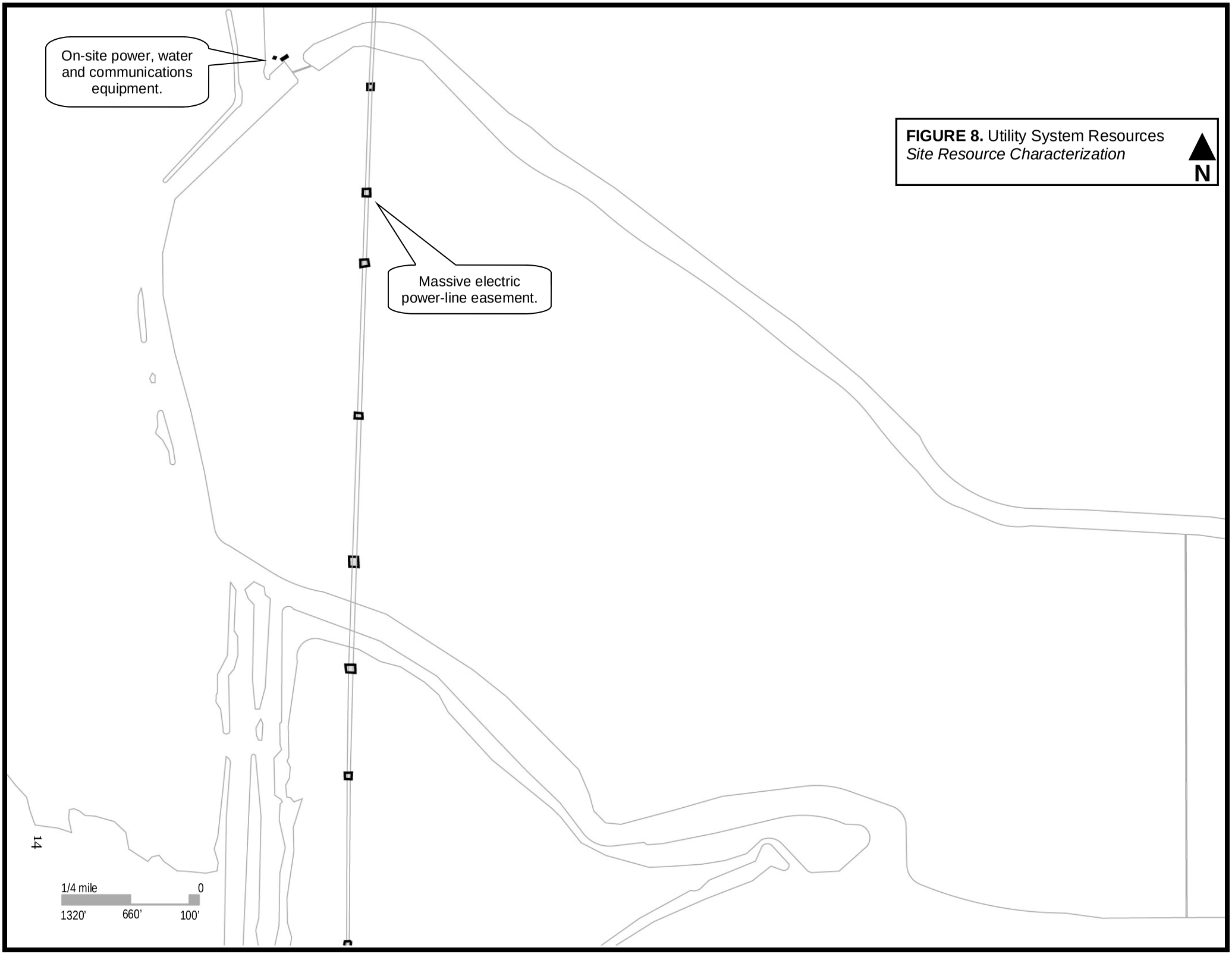

On-site power, water and communications equipment.
Massive electric power-line easement.
FIGURE 8. Utility System Resources
Site Resource Characterization
N
1/4 mile
0
1320'
660'
100'
14

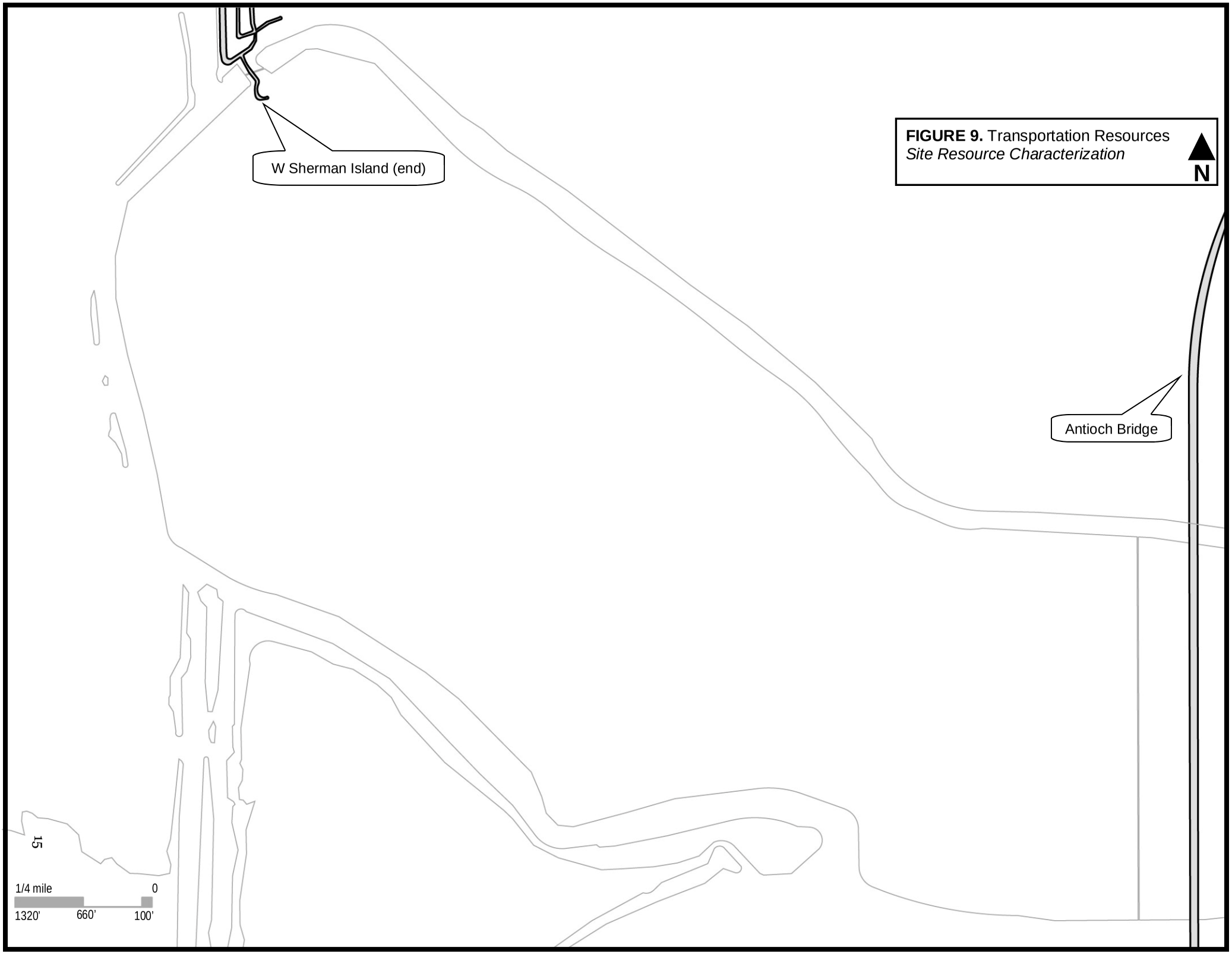


FIGURE 9. Transportation Resources
Site Resource Characterization

N

Settings

In the following section, all applicable urban resource categories are discussed in relation to Sherman Island. Special consideration is given to the project site and its potential role in the improvement of the SSJD.

Aesthetics

The aesthetics of Sherman Island have diminished due to continued subsidence and the rising salt content of the river waters that encircle the island. Differential settlement results in standing pools of water following rain events and the brackish water content has diminished plant and crop diversity on the island.

The surrounding landscape is defined by the Antioch Bridge, Sacramento Municipal Utility District's wind turbine farm, utility easements, massive industrial plants across the San Joaquin River, and "delta-life" amenities such as abandoned boats and levee bolstering materials that include among others the aesthetically distinctive rip rap.

Agricultural Resources

In the past 30 years, agricultural output has diminished from its maximum capacity and diversity, which was reached through the 1950s and 1960s. Today, the brackish water conditions have resulted in the majority of local production to shift to salt tolerant agriculture and livestock rearing. As of 2009, the following crops and use were employed on Sherman Island: alfalfa production at 3,500 acres; sundry hay species at 3,500 acres; livestock grazing at 3,500 acres; grain production at 1,500 acres; and remaining acreage is used for a variety of crops. Livestock grazing dominates the proposed project site with limited portions of the area dedicated to hay production. **Figure 3** illustrates the agricultural resources currently located on the site of focus.

Air Quality

The lack of concentrated livestock pens, the absence of light, medium or heavy industry on the island, and the constant flow of wind through the area eliminates air quality as an issue of concern on Sherman Island.

Biological Resources

Habitat loss has been occurring throughout the SSJD including Sherman Island since the mid-1800s. Agricultural practices and levee construction have destroyed large tracts of seasonally flooded wetlands and have diminished water quality due to pesticide and nutrient runoff. Additionally, water pumped out of the SSJD has exacerbated salt water intrusion, changing the balance of saltwater and freshwater in the Delta.

With respect to wildlife, there is a diversified population throughout the Delta. Two-thirds of California's migrating salmon population and half of its migrating waterfowl and shorebird populations pass through the Delta. Different aquatic species depend on the Delta for space to breed, spawn, feed, and grow. Forty-six species of fish, 19 native and 27 alien, take refuge in these waters. In general, native species populations have been declining and many are near extinction. The Delta Smelt, the Sacramento Chinook salmon, longfin smelt, Sacramento splittail, California red-legged frog, tiger salamander, giant garter snake, and western pond turtle are among species in the Delta listed as endangered. Declines in SSJD are also associated with local intensity of human and industrial uses in the region.

In an effort to restore wetland habitat to regions of the Delta, and more specifically Sherman

Island, multiple wetland restoration projects have been occurring on and around the island. The Mayberry Farms wetland restoration and subsidence reversal project just north of Mayberry Slough as well as constructed wetlands at Scour Lake near the Antioch Bridge are two examples of wetlands constructed within the interior of the island. Additionally, wetlands have also been constructed on the immediate exterior of the island to complement levee rehabilitation, an act that was executed to improve the aesthetic nature of this infrastructure and aid in the dissipation of wave action against the levees themselves.

Cultural Resources
Currently there are no cultural resources of interest on Sherman Island.

Economic and Commercial Resources
The Sacramento County General Plan designates an area of 10,000 acres for agricultural cropland and resource conservation uses on Sherman Island. Brackish water has decreased crop yield and crop diversity on the island, with the primary crops today being alfalfa and other salt-resistant field crops. Decreased yields have also increased the dependency on subsidies for farmers and the livestock ranchers that lease island lands.

In addition to agricultural and resource conservation, the general plan designates roughly 500 acres of the island for recreational uses. Currently there are a number of recreational vehicle parks and marinas. As of 2008, the island provides 368 marina berths, a boat launch and extensive fishing access. In addition to fishing, boating and camping, other recreational uses on the island include hunting and wind surfing.

The proposed project site currently only has one commercial resource, the Sherman Lake Marina and store. The marina houses RVs, fishing boats and is a launch point for wind surfing and other recreational activities. **Figure 4** illustrates the current economic resources located along the southwestern portion of Sherman Island.

Geology/Soils
The subsurface geological profile of Sherman Island is very similar to that of the rest of the SSJD. Approximately 40 feet of highly organic, compressible, variable, and pervious peat soil makes up the top layer of soil on Sherman Island. This nutrient rich layer is extremely susceptible to oxidation and due to historic agricultural practices, has been the primary cause for subsidence on the island. Beneath the peat is an approximately 10 foot clay layer, followed by a 40+ foot deep sand layer and a larger deep silt layer. These layers pose different issues in terms of geological stability for the integrity of the levees that protect the island.

Hazards/Hazardous Materials
The primary hazard that endangers Sherman Island on a day to day basis is the potential for catastrophic levee failure. The pervious nature of the peat layer makes the levees surrounding Sherman Island is susceptible to the failure mode of underseepage. Additionally, the deep sand layer found beneath the peat and clay is extremely susceptible to liquefaction in an earthquake event, a condition that could cause catastrophic levee failure. Due to the heavily subsided nature of Sherman Island, a catastrophic failure would not only flood the interior of the island, but would also cause extensive saltwater intrusion. This failure would not only destroy the local infrastructure and regional utilities, it would have a state-wide impact that could jeapordize the water supply for 2/3's of California's population. Pumps are located throughout the island to pump flood waters back into the Sacramento and San Joaquin Rivers. In addition to this primary hazard, potential heavy metal content from dredged materials used in levee repair can be found both in and around Sherman Island.

At the project location, levees encircle the vast majority of the 998.5 acre site and five pumps are located on-site to remove flood waters from the island interior as necessary. Fencing is located along the levees and Mayberry Slough to limit access to the levee structures. A wave break exists at Sherman Lake Marina to protect the marina berth. **Figure 5** illustrates the locations of these resources surrounding the considered site.

Hydrology/Water Quality
Sherman Island sits on the western edge of the SSJD, and due to its geographic shape and resulting in the fast flow of the Sacramento and San Joaquin Rivers along its borders, Sherman Island stands as a key geographic feature in the balance of saltwater and freshwater into and out of the Delta. Fresh water pumped from the SSJD provides water to more than 25 million people, and as such, the water quality for the majority of California's population depends on the island's resilience.

Despite this important role as the gateway to the SSJD, the water quality around Sherman Island has decreased due to saltwater intrusion caused by freshwater pumping. The water is extremely brackish in comparison to its historical freshwater nature. Additionally, due to the pervious nature of the peat soil, the island's water table is extremely close to the ground surface. These combined factors allow for seasonal wetlands to thrive on heavily subsided, interior portions of the island, as heavy rainfall inundates these regions with significant amounts of standing water.

To assist the agricultural resources that exist on the island, a large siphon is used to fill Mayberry Slough during winter months when rain is abundant and the adjacent rivers are predominantly fresh water. Seasonal wetlands and Scour Lake are also within the project site and are illustrated in **Figure 6**.

Land Use/Planning
There are currently multiple plans that directly impact Sherman Island. The Sacramento County General Plan outlines basic land use throughout the island, designating the majority of the island to cropland, resource conservation, and recreation. Sherman Island is 90% owned by the California Department of Water Resources (DWR) and as is governed significantly by DWR's 30 year plan for Sherman Island. Most recently, the California Natural Resources Agency, the parenting branch of DWR, has released the Bay Delta Conservation Plan (BDCP). With the primary goals of water security for the state and endangered species protection and rehabilitation, the BDCP is the critical path planning document for any project development in and around Sherman Island.

Mineral Resources
Sherman Island is a resource for underground petrochemical extraction. As of 2008, Sherman Island alone hosted 60 oil and natural gas wells throughout the interior of the island. There are currently no oil or gas wells on the proposed project site.

Noise
Currently, noise impacts are primarily experienced due to the traffic of Highway 160. In addition, boat traffic along both the Sacramento and San Joaquin River, as well as industrial uses surrounding the island potentially contribute noise pollution. However, despite numerous sources for noise generation, the strong winds that blow across the island dissipate the noise sources that are generated nearby.

Population/Housing
Currently, over 200 people take up residence on Sherman Island. Marina facilities and RV parks operate with variable numbers of seasonal campers and seasonal recreational instructors. The Sherman Lake Marina operates with variable numbers of campers and hosts wind surfing instructors as well, especially during the spring and summer.

Public Services
There are no schools, libraries, fire departments, or police departments located on Sherman Island. Game wardens from the California Department of Fish and Wildlife frequent the island to police recreation activities.

Recreation Resources
Sherman Island features an extensive and diverse array of recreation resources that support a variety of activities. Marina berths are located throughout the island to support fishing, boating, kayaking and kite surfing. RV parks are also located throughout the island to support the seasonal influx of people for many of these river-based activities. Recreational agriculture, foraging, and bird watching are among other recreational activities conducted on or around Sherman Island. The recreation resources located within the proposed site are illustrated in **Figure 7.**

Utility System Resources
Sherman Island levees also serve to protect major utility infrastructure critical to both the local island's economic and commercial sustainability as well as the SSJD as a whole. Three major 500 kV transmission lines pass through the island serve to interconnect the California power grid to generation sources of the Pacific Northwest. Additionally, Sherman Island is home to 145,614 feet of a natural gas pipeline. A major utility easement crosses the focus site whose location is illustrated in **Figure 8.**

Transportation/Traffic Resources
Sherman Island levees serve to protect transportation infrastructure that is critical to the SSJD region. Highway 160 connects Contra Costa and Sacramento Counties via the Sacramento River-spanning Antioch Bridge as well as a lift bridge that spans Three Mile Slough. Highway 160 also functions as an emergency evacuation route for many Delta communities, and as such, its protection is fundamental to the safety and security of the Delta region. The monumentally-scaled Antioch Bridge borders the project site, a roadway that connects to Sherman Island Road. This Sherman Island Road ends at Sherman Lake Marina and is the only vehicular access to the project site. These transportation resources are illustrated in **Figure 9.**

Impacts of No Action Alternative

To determine the necessity of a plan of action for Sherman Island, a business-as-usual model should first be analyzed. In a no-action case, the precarious levee condition would remain as it exists currently. Should the levee fail, there is no current plan for limiting the amount of floodwater entering and flooding the entire island. As such, a low-estimate cost for pumping out and restoring Sherman Island after a catastrophic flood event is approximated at $22 million. This estimate includes the capital replacement cost for the transportation and utility infrastructure, but does not include the lost revenue experienced throughout the region as a result of the disruption.

In terms of industry and economy, the primary agricultural crops will remain field crops, grains, and alfalfa. Even with these salt-resistant crops, yield will remain low due to salt contact in adjacent rivers, and agriculture will need continued significant subsidy. With salt levels increase, crop yields will continue to decrease as the plants struggle to maintain homeostasis. Additionally, the gradual change from agriculture to livestock rearing will continue as formerly farmable lands succumb to the brackish qualities of the adjacent Sacramento and San Joaquin Rivers. Despite switching to gain additional revenue, livestock rearing is not a self-sustaining venture as it cannot compete with traditional agriculture.

In addition, subsidence will also continue at a rate of approximately three inches per year on Sherman Island. Traditional planting in the area will require tillage and the top layer of peat will continue to oxidize. These methods perpetuate subsidence and levee instability on Sherman Island, thereby increasing the flood risk and potential damage to the Island, the greater Delta, and California's primary source of freshwater.

Conclusion

Sherman Island and the greater SSJD face a myriad of issues that cannot be remedied should a business-as-usual approach be continued. Degrading environmental conditions, diminishing economic revenue and the risk of catastrophic levee failure all must be addressed in any solution proposed for Sherman Island as a component of the SSJD. Moreover, the high number of stakeholders, local as well as state government agencies, recreational enthusiasts, farmers throughout California, and the state's dependence on the system necessitates a design that is dynamic, holistic, and adaptable to the changing needs of the region.

To address these goals, the Sherman Island Delta Project Team has proposed the design of an Adaptive Water Management and Agricultural Diversification System (AWMADS). This system features a restored wetland that is enclosed to provide additional floodway and has the potential to host many adaptive uses such as hydroponics (soil-less agriculture), aquaculture (concentrated production of aquatic species), and other optional components throughout the system's life. The ability to dynamically interchange components to fit the changing needs and demands of Sherman Island and the greater SSJD necessitates the demand for such an AWMADS solution.

Chapter 3. Stakeholders & Goals Assessment

Completed July 2013

Lead author:	Richard Fisher
Contributing authors:	Ryan Whipple
	Bradley Angell

Introduction

In order for the design of a system at Sherman Island to be successful, it must be dynamic and adaptable for a sustainable result for economic, social and environmental stakeholders. To create a sustainable design result, it was necessary to synthesize and assess stakeholder inputs. In the development of this goal, the Technology Delivery System (TDS) as developed by Dr. Ed Wenk, Jr. (Professor Emeritus, University of Washington) and adapted by Dr. Robert Bea (Professor Emeritus, University of California, Berkeley) was used as a guide to identify key stakeholders and their goals. There are four components to the TDS: Public, Industry, Environment, and Government. Learning from the stakeholders played an important role in understanding the complexity of the project issues. Each component and their given interface method is crucial to designing a sustainable solution. Larger scale solutions must consider the smaller components while localized solutions must contribute to greater overall change. Further, sustainable design assumes that each component must work together in application. So as to coordinate all such issues in development, the following paper idenifies key stakeholders affecting change and their relation to Sherman Island. Further, this assemssment provides a thorough review and compilation of key goals for the Sacramento-San Joaquin River Delta [hereafter "SSJD"] based on related projects and stakeholder interviews.

Key Players Affecting Change

The key federal stakeholders affecting change include the US Army Corps of Engineers [hereafter "USACE"], the US Coast Guard [hereafter "USCG"], and the US Environmental Protection Agency [hereafter "EPA"]. As for key state stakeholders, California's Department of Natural Resources [hereafter "DNR"], Department of Water Resources [hereafter "DWR"], California Department of Fish and Wildlife [hereafter "CDFW"], and Department of Transportation [hereafter "Caltrans"] all have an important stake in the project on Sherman Island. In identifying the project site by local governing authority, DWR dictates the key designation for the site as Reclamation District #341 [hereafter "RD341"].

Sherman Island Context

Sherman Island falls within the boundaries of Sacramento County but is closely bordered by both Solano and Contra Costa Counties. Politically, it falls under the jurisdiction of the 11th Congressional District, 4th Legislative District, and 8th State Assembly District of the State of California. Sherman Island's approximately 9,937 acres of land is protected by 18 miles of levees on the island itself (Hanson 2009). Sherman Island contains nine miles of levees constructed and maintained by USACE and an additional nine miles of non-project levees maintained by RD341.

Presently, there are two major water supply systems surrounding Sherman Island. The first is the federal Central Valley Project [hereafter "CVP"], which is managed by the US Bureau of Reclamation. Noted as one of the largest water transport and storage systems in the world, CVP has the capacity for 11 million acre-feet of storage. The second system is the California State Water Project [hereafter "SWP"], operated by DWR. SWP is on a smaller scale compared to CVP, with a storage capacity of only 5.8 million acre-feet (DWR 2008). Both aim to provide California with enough water resources to sustain its economy, especially with respect to agriculture and urban development. Most importantly, both projects rely heavily on the SSJD as a major source for state-wide water exports.

As previously mentioned, DWR owns approximately 90% of Sherman Island and is thus intensely involved in its protection. A majority of the land is leased to private agricultural contractors. To support these contractors, RD341 operates and maintains five pumping stations

on the island: three on the San Joaquin River side, one on the Sacramento River side, and one on Sherman Island's northwest corner (Hanson 2009). Since 2007, however, pumping from the SSJD system has been severely restricted due to a federal ruling aimed at protecting a local fish species, the endangered Delta smelt. The ruling limits the amount of water delivered through the system from December until June so as to reduce fish deaths caused by pumping.

Adjacent to Sherman Island is the Sherman Island Waterfowl Management Area and the Lower Sherman Island Wildlife Area, both operated by CDFW. CDFW oversees environmental management of the area to ensure that agriculture and shipping impacts on the Sherman Island ecosystem result in minimal damage. These habitats on the western edge of the island are what remain of portions of Sherman Island that were inundated by massive flooding during the storm season of 1969.

Surface transportation for Sherman Island is under the jursidiction of Caltrans. State Highway 160 traverses Sherman Island and connects Contra Costa and Sacramento Counties via the Antioch Bridge. The current bridge was completed in 1978 and spans 460 feet with a length of 1.8 miles and vertical clearance of 135 feet. A $4 toll is charged northbound traffic along the bridge, collecting nearly $3.5 million in the 2007-2008 fiscal year (Bay Area Toll Authority 2009). In the northeast corner of the island, Highway 160 connects Sherman Island to Brannan Island by means of a lift bridge that spans Three Mile Slough. As a whole, the highway is the major connection for Sherman Island to both the East San Francisco Bay metropolitan area as well as "mainland" Sacramento County.

On the northern edge of the island is the Sacramento Deep Water Ship Channel. This is the main access route for shipping to the Port of Sacramento. Constructed by USACE in 1963, the channel is roughly 30 feet deep, 200 feet across, and 43 miles long. Along the southern edge of Sherman Island, the San Joaquin River is another key shipping route. Its waters connect with the Stockton Deep Water Ship Channel in the lower SSJD, thus providing access to the Port of Stockton from San Francisco Bay. Both major shipping channels fall under the police jurisdiction of the USCG.

Related Projects

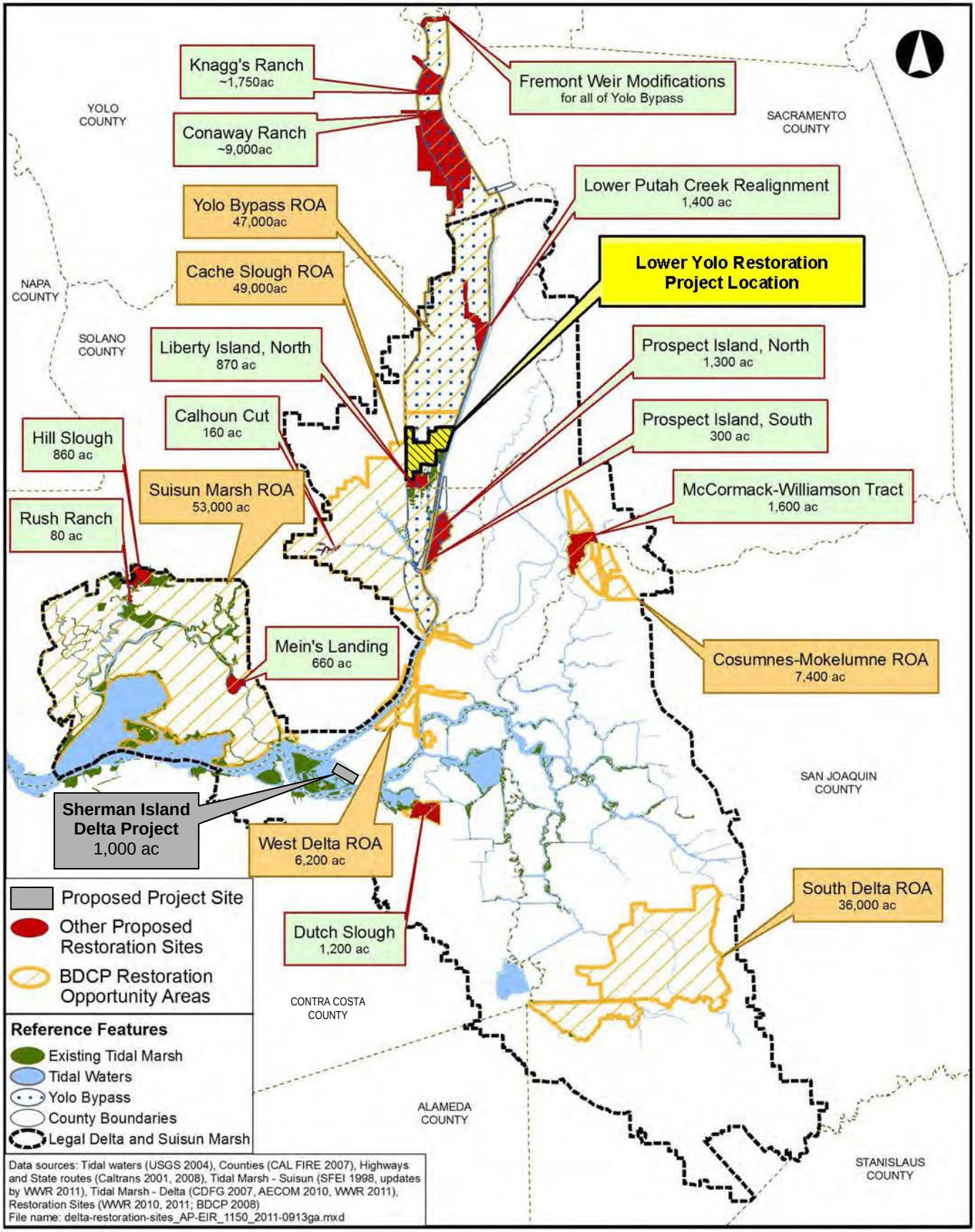
In order to understand the goals of the stakeholders, related projects were analyzed and categorized to show emergent trends and guiding principles. The following review of related projects is modified from the Lower Yolo Restoration Project (Lower Yolo Restoration Project Draft Environmental Impact Report, Section 4.10 Cumulative Impacts) and is based on documentation of current and proposed project information gathered from Yolo County, Solano County, Sacramento County, USACE, DWR, member agencies of SFCWA, Bay Delta Conservation Plan, Delta Plan, Suisun Marsh Plan, CDFW, and USFWS. This review includes both public and private projects that may yet require approvals. Several of the projects are under consideration to be included in the CALFED Ecosystem Restoration Program as part of the 8,000-acre restoration requirement contained with the Reasonable and Prudent Alternatives of the USFWS Delta Smelt Biological Opinion of December 2008 and the National Marine Fisheries Service [hereafter "NMFS"] Salmonid Biological Opinion of June 2009. Additionally, other projects are identified as part of fulfilling the 55,000-acre restoration requirement currently being considered for incorporation into the Bay Delta Conservation Plan (BDCP). Each project has been categorized with the following project areas: Agriculture, Invasive Species Control, Species Conservation, Habitat Restoration, Water Diversion, Flood Protection and Control, Levee Stabilization, Contamination Management, Risk Assessment, Education, Recreation, and Research. See **Table 1** for summary of goal categories.

PROJECT	Agriculture	Invasive Species Control	Species Conservation	Habitat Restoration	Water Diversion	Flood Protection and Control	Levee Stabilization	Contamination Management	Risk Assessment	Education	Recreation	Research
Bay Delta Conservation Plan (BDCP)			X	X	X							
Anadromous Fish Screen Program (AFSP)			X	X	X							
Biological Opinions and Conference Opinions on the Long-term Operations of the Central Valley Project and State Water Project for Delta Smelt and Salmonids			X	X					X			
Aquatic Weed Control Program		X										
California Invasive Species Program		X								X		
Cache Creek, Bear Creek, Sulfur Creek, Harley Gulch Mercury Total Maximum Daily Load (TMDL) Plan								X				
Campbell Ranch Conservation Bank			X	X								
Cache Creek Resources Management Plan Program(CCRMP), Off-Channel Mining Plan(OCMP), Cache Creek Area Plan(CCAP), and Cache Creek Improvement Program(CCIP)	X		X	X							X	
CALFED Ecosystem Restoration Program Conservation Strategy/Delta Regional Ecosystem Restoration Implementation Plan			X	X								
Calhoun Cut/Lindsay Slough Tidal Habitat Restoration Project			X	X								
CALFED Delta Risk Management Strategy (DRMS)												
Capitol Conservation Bank			X	X								
Central Valley Flood Protection Plan-2012						X						
Conaway Ranch Floodyway Corridor and Habitat Enhacement Project			X	X		X					X	
Davis-Woodland Water Supply Project					X							
Delta Plan			X	X	X	X	X					
Delta Smelt Permanent Refuge			X	X								
Delta Wetlands Project			X	X								
Delta Wetlands Project Place of Use			X	X	X							
Dutch Slough Tidal Marsh Restoration Project			X	X						X	X	X
Fish Screen Project at Sherman and Twitchell Islands			X	X	X							
FloodSAFE Strategic Plan						X						
Franks Tract Project			X	X	X							
Fremont Landing Conservation Bank (Central Valleu Anadromous Salmonid Umbrella Conservation Bank)			X	X								
Fremont Weir Modification Project			X	X	X							
Knaggs Ranch Project (Formerly known as the Elkhorn Basin Ranch)	X		X	X								
Knaggs Ranch Project: Experimental Agricultural Floodplain Pilot Study	X		X	X								
Levee Failure (Natural Event): Liberty Island			X	X		X						
Levee Failure (Natural Event): Little Holland Tract			X	X		X						
Liberty Island Conservation Bank (Formerly known as the Kerry Parcel Project)			X	X								
Lisbon Weir Fish Passage Enhancement	X		X	X	X							

Table 1. Related Projects Grid.

PROJECT	Agriculture	Invasive Species Control	Species Conservation	Habitat Restoration	Water Diversion	Flood Protection and Control	Levee Stabilization	Contamination Management	Risk Assessment	Education	Recreation	Research
Little Holland Tract Restoration			X	X		X						
Lower Cache Creek, Yolo County Woodland Area Feasibility Study	X				X	X		X				
Lower Putah Creek Realignment Project			X	X								
Mayberry Farms Subsidence Reversal and Carbon Sequestration			X	X								X
North Bay Aqueduct Alternative Intake Project					X	X						
Northern Liberty Island Fish Conservation Bank (North Delta Fish Conservation Bank)			X	X			X					
Pope Ranch Conservation Bank Project			X	X								
Prospect Island Restoration Project			X	X			X					
Putah Creek Wetland Mitigation Bank			X	X								
Remanded Biological Opinions on the Coordinated Long-term Operation of the Central Valley Project and State Water Project			X	X	X							
Restoring Ecosystem Integrity in the Northwest Delta			X	X								
Ridge Cut Giant Garter Snake Conservation Bank			X	X								
Sacramento River Deep Water Ship Channel (SRDWSC) Project			X	X				X				
Sacramento River Ranch Conservation Bank			X	X								
Sacramento San Joaquin Delta Islands and Levee Feasibility Study			X	X		X						
Southport Sacramento River Early Implementation Project						X	X					
Tule Canal Fish Passage Enhancement			X	X								
Update to the 2006 Water Quality Control Plan for Bay-Delta Estuary (Bay-Delta Plan)	X			X	X			X				
West Sacramento Levee Improvements Program			X	X		X	X					
Yolo Bypass Salmonid Habitat Restoration and Fish Passage			X	X								
Yolo Bypass Wildlife Area Land Management Plan			X	X								
Yolo County Natural Heritage Program Habitat Conservation Plan/Natural Commun Conservation Plan			X	X								

Table 1. Related Projects Grid (cont.).



Only Phase 1 of the Project is being pursued at this time; Phase 2 is included here as part of the reasonably foreseeable build out.

SFCWA
State & Federal Contractors Water Agency

1:570,420 (1" = 9mi at letter size)

0 4.5 9 mi

0 7 14 km

Figure 1

Delta and Suisun Potential Restoration Sites

Bay Delta Conservation Plan [hereafter "BDCP"]

Categories: Species Conservation, Habitat Restoration and Water Diversion.
Lead Agencies: DWR, U.S. Bureau of Reclamation
Goals and Description: To provide comprehensive conservation and management of 54 covered species in the Delta including the restoration and enhancement of ecological functions in the SSJD, and improvement of current water supplies and the reliability of water supply delivery conveyed through the SWP and the CVP Project. If approved, BDCP would restore at least 55,000 acres of tidal wetlands. Specific projects are not defined at this time, however there is a great deal of focus on restoration targets and meeting them through partnerships between the BDCP and other organizations. The revised Administrative Draft BDCP released February 2013 and the public draft BDCP and EIR/EIS is expected summer of 2013 with a construction target in 2014. The BDCP is the most coprenhensive approach to the SSJD and if passed will largely govern the majority of projects in the Delta (*See* **Figure 4.10-1**).

Anadromous Fish Screen Program

Categories: Species Conservation, Habitat Restoration and Water Diversion.
Lead Agencies: U.S. Bureau of Reclamation, USFWS, and CDFW
Locations: Multiple Delta counties, including Yolo County
Goals and Description: To protect juvenile Chinook salmon, steelhead, green and white sturgeon, striped bass and American shad in the Sacramento and San Joaquin rivers, their tributaries, the Delta, and the Suisun Marsh. Eligible projects for cost-share funds under the AFSP include: construction of fish screens on unscreened diversions; rehabilitating existing fish screens; replacing existing non-functioning fish screens; and relocating water diversions to less fishery-sensitive areas throughout the Central Valley.

Biological Opinions and Conference Opinions on the Long-term Operations of the Central Valley Project and State Water Project for Delta Smelt and Salmonids

Categories: Species Conservation, Habitat Restoration and Risk Assement.
Lead Agencies: USFWS 2008 and NMFS 2009
Locations: Multiple counties including Yolo County
Goals and Description: To research the effects of long-term operations of the Central Valley Project and State Water Project on fish species to develp biological opinions (BiOPs) that can be used to better protect fish species. Findings by each regulatory agency showed that continued operations of the CWP and SWP would likely jeopardize several listed species, including the delta smelt and salmonids. These agencies identified alternatives that would reduce the likelihood of jeopardizing the continued existence of those listed species. Alternative Actions such as the restoration of 8,000 acres of land to intertidal habitat for the delta smelt and 17,000 to 20,000 acres of seasonal floodplain habitat for the salmonids were included in these opinions.

Aquatic Weed Control Program

Categories: Invasive Species Control.
Lead Agencies: Ca. Dept. of Boating and Waterways
Locations: Delta and its tributaries (multiple Delta counties, including Yolo County)
Goals and Description: To implement both short and long term measures to control Brazillian waterweed (Egeria densa) and water hyacinth (Eichhornia crassipes). During the 2012 Legislative session, authority to control the South American spongeplant (Limnobium laevigatu) was added to the program.

California Aquatic Invasive Species Management Plan

Categories: Invasive Species Control.
Lead Agencies: CDFW
Locations: State of California, including the Delta counties
Goals and Description: To establish a management plan for controlling aquatic invasive species, and to provide a framework for developing and implementing a rapid response plan. CDFW has identified at least 312 species of aquatic invaders, that have the potential to cause major impacts. These 312 species have the potential to disrupt agriculture, shipping, water delivery, fishing; undermine levees, docks and environmental restoration activities; impede navigation; and damage native habitats and species.

California Invasive Species Program

Categories: Invasive Species Control and Education.
Lead Agencies: CDFW
Locations: Throughout California within the jurisdiction of CDFW
Goals and Description: To prevent the introduction of non-native invasive species in California, to detect and respond to introduction when they occur, and prevent the spread of species that have already become established. Program activities include development of the California Aquatic Invasive Species Management Plan, the Marine Invasive Species Program, and information activities for quagga/zebra mussels, New Zealand mudsnails, and dwarf eelgrass.

Cache Creek, Bear Creek, Sulfur Creek, Harley Gulch Mercury Total Maximum Daily Load (TMDL) Plan

Categories: Contamination Management.
Lead Agencies: Central Valley Regional Water Quality Control Board
Locations: Cache Creek watershed
Goals and Description: To develop and implement a plan to reduce mercury loads. Actions include cleaning up mines, sediments, and wetlands. Additional goals include identifying engineering options to manage and remmediate contaminant loads, to undertake erosion reduction actions, and to perform studies and monitoring of efforts.

Campbell Ranch Conservation Bank

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: USFWS
Locations: 12 miles south of Dixon in Solano County
Goals and Description: To protect approximately 19 acres of vernal pools and swales with several sensitive plants and wildlife onsite within a 160-acre parcel utilizing a conservation easement.

Cache Creek Resources Management Plan Program (CCRMP), Off-Channel Mining Plan (OCMP), Cache Creek Area Plan (CCAP), and Cache Creek Improvement Program (CCIP)

Categories: Agriculture, Species Conservation, Habitat Restoration and Recreation.
Lead Agencies: Yolo County
Locations: Yolo County
Goals and Description: To develop and implement a framework of goals and objectives for viewing the creek as a total system; covering agriculture, aggregate resources, riparian and wildlife resources, water resources, floodway and channel stability, open space, recreation and the cultural landscape.

CALFED Ecosystem Restoration Program Conservation Strategy/Delta Regional

Ecosystem Restoration Implementation Plan

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: CDFW
Locations: Delta and Suisun Marsh/Bay
Goals and Description: To address the critical environmental conditions in the Delta and Suisun Marsh/Bay during the first phase of CALFED Stage 2 implementation (2009-2020). The strategy includes an ecosystem restoration program (ERP) plan, a multi-species conservation strategy, a strategic implementation plan that includes adaptive management, and monitoring of performance measures and performance targets.

Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: CDFW and DWR
Locations: Lindsey Slough, Solano County
Goals and Description: To enhance approximately 165 acres of tidal marshes on a 927 acre parcel by removing features that restrict flow through the slough. Starter channels will be excavated to initiate channel evolution and promote tidal flow, and Calhoun Cut will be potentially blocked. This project will be potentially implemented in 2013 or later as a part of the Cache Slough Area Restoration effort and DWR's Interim Delta Actions.

CALFED Delta Risk Management Strategy [hereafter "DRMS"]

Categories: Risk Assement, Levee Stability, Water Diversion as well as Flood Protection and Control.
Lead Agencies: DWR
Locations: Delta counties.
Goals and Description: To assess the sustainability of the Delta by evaluating major risks to resources from floods, seepage, subsidence, and earthquakes. Phase 1 of DRMS was completed in March 2009 and evaulated the risk and potential consequences to the Delta and the entire state of California. The evaluation assessed the total risk as well as the risks for individual islands within the Delta. Risks to levees, infrastructure, property, and the ecosystem associated with the failure of Delta levees were assessed based on exposure to hazards including seismic, flood, subsidence, seepage and sea-level rise, under present as well as foreseeable future conditions were evaluated. Key risks include water export disruption and the economic impact associated with this disruption.

Capital Conservation Bank

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: Rrivate conservation trust
Locations: North end of County Road (CR107, east of 152 in the Southern Yolo Bypass, Yolo County.
Goals and Description: To etablish and manage a giant garter snake conservation bank on 320 acres of land. The project would involve about 480,000 cubic yards of earthmoving with the excavation and disposal of the soils onsite.

Central Valley Flood Protection Plan – 2012

Categories: Flood Protection and Control.
Lead Agencies: DWR and CVFPB
Locations: Central Valley, multiple Delta counties
Goals and Description: To guide California's participation from the federal to the local level in the management of flood risk along the Sacramento and San Joaquin Rivers. The project employs a as system-wide investment approach for sustainable, integrated flood

management in areas currently protected by facilities of the State Plan of Flood Control.

Conaway Ranch Floodway Corridor and Habitat Enhancement Project

Categories: Species Conservation, Habitat Restoration, Flood Protection and Control, and Recreation.
Lead Agencies: Unknown
Locations: North-central Yolo Bypass, Yolo County
Goals and Description: Project currently under development, with the intent to establish approximately 17,300 acres of seasonal floodplain habitat for both flood protection and habitat restoration. The flood protection stratey includes transitory flood water storage of over 66,000 acre-feet for water precipitated during large storm events. Additionally, the project will recreate historical floodplain habitat for salmon, splittail, and other native fish spawning and juvenile rearing. Construction improvements to the New Sacramento River Bypass/Weir will provide for fish passage. Other opportunities include integrated water management and recreation/open space.

Davis-Woodland Water Supply Project

Categories: Water Diversion.
Lead Agencies: City of Davis, City of Woodland, and UC Davis
Locations: East-central portion of Yolo County
Goals and Description: To divert up to about 45,000 acre-feet annually of surface water from the Sacramento River and convey it for treatment and subsequent use in the cities of Davis and Woodland, and the University of California at Davis campus. Project activities include construction and operation of a water intake and diversion, conveyance, and water treatment facilities. Water rights for this project were granted in March 2011, subject to conditions imposed by the state. Water diversions would be limited during summer and other dry periods. The Final EIR was certified in 2009 and the project is scheduled for design in 2013 and for construction from 2013 to 2015.

Delta Plan

Categories: Species Conservation, Habitat Restoration, Water Diversion, Flood Protection and Control as well as Levee Stabilization**.**
Lead Agencies: Delta Stewardship Council
Locations: Sacramento-San Joaquin Delta region
Goals and Description: To bring the water-related measures passed by the State Legislature in 2009, including the Delta Reform Act, to fruition. This plan relys on the integration of multiple policies and recommendations to prioritize actions and strategies for improved water management, ecosystem restoration, and levee maintenance. Environmental analysis is ongoing with a re- circulated PEIR. It is anticipated that the Final PEIR will be certified in Spring 2013 with implementation slated to occur in Summer 2013.

Delta Smelt Permanent Refuge

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: UC Davis, DWR, CDFG, USFWS, and Bureau of Reclamation
Locations: Possibly in Rio Vista, Solano County
Goals and Description: Developing a plan to create a permanent Delta Smelt Refuge facility, possibly at the proposed USFWS Science Center in Rio Vista.

Delta Wetlands Project

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: USACE

Locations: Contra Costa and San Joaquin Counties
Goals and Description: This proposal is the same as the project below, Delta Wetlands Project Place of Use, with the caviat that it is being assessed via the National Environmental Policy Act (NEPA) process. The original USACE regulatory permit for the Delta Wetlands Project Place of Use was issued on June 26, 2002, however the permit stipulated that construction be completed no later than on December 31, 2007, hence the permit has since expired. Therefore, the applicant (Delta Wetland Properties) is applying for a new permit under Clean Water Act, Section 404 and the Rivers and Harbors Act, Section 10.

Delta Wetlands Project Place of Use

Categories: Species Conservation, Habitat Restoration and Water Diversion.
Lead Agencies: Semitropic Water Storage District
Locations: Contra Costa and San Joaquin counties
Goals and Description: To provide water to counties by exporting Delta water through diversion, water storage on Bacon Island and Webb Tract, and supplemental water storage south of the Delta. The project contains a habitat conservation plan on Bouldin Island and Holland Tract.

Dutch Slough Tidal Marsh Restoration Project

Categories: Species Conservation, Habitat Restoration, Education, Recreation and Research.
Lead Agencies: DWR and California State Coastal Conservancy
Locations: Oakley, Contra Costa County
Goals and Description: To extablish and manage about 1,200 acres of tidal marsh and lowland grasslands with th following three goals: (1) to provide ecosystem benefits including habitats for sensitive aquatic species; (2) to assess the development these habitats and to measure ecosystem responses so that future Delta restoration projects will be more successful; and (3) to provide opportunities for public access, education, and recreation. The Final EIR was certified March 2010 and applicants have applied for a USACE regulatory permit and anticipate receiving it in June/July 2013. If all permits are obtained in the Summer of 2013, construction would be anticipated to begin in 2014.

Fish Screen Project at Sherman and Twitchell Islands

Categories: Species Conservation, Habitat Restoration and Water Diversion.
Lead Agencies: DFG and DWR
Locations: Sacramento County
Goals and Description: To install fish screens on up to ten (10) currently unscreened DWR-owned agricultural intakes used to irrigate state-owned lands on Sherman and Twitchell islands. This project will contribute to the protection of the delta smelt and other sensitive aquatic species, and the restoration of habitat in the Delta. Currently, applicants are moving through the environmental regulatory process.

FloodSAFE Strategic Plan

Categories: Flood Protection and Control.
Lead Agencies: DWR and multiple stakeholders
Locations: Multiple Delta counties
Goals and Description: To fund flood system repairs and improvements, repair critical erosion sites, address the backlog of statewide subventions claims, and conduct inspection and maintenance of levees and channels in the Central Valley. DWR is assessing the FloodSAFE Implementation Plan to help organize and manage FloodSAFE work, and completion of the draft implementation plan, the strategic plan will be refined and finalized.

Franks Tract Project

Categories:, Species Conservation, Habitat Restoration and Water Diversion.
Lead Agencies: DWR, U.S. Bureau of Reclamation
Locations: Sacramento and Contra Costa counties
Goals and Description: To install and operate a flow control gate on potentially both Three- mile Slough and West False River to protect fish resources and reduce salt water intrusion into the Delta. The project gates would be operated seasonally and during specific hours daily, depending on fisheries and tidal conditions. Boat passage facilities would allow for passage of watercraft during gate operation. The Draft Feasibility Report is due April 2013 however preparation of a joint EIR/EIS has been delayed.

Fremont Landing Conservation Bank (Central Valley Anadromous Salmonid Umbrella Conservation Bank)

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: CDFW
Locations: Yolo County
Goals and Description: To restore, enhance, and preserve of 100 acres of habitat for both federal and state listed Chinook salmon and Central Valley steelhead. The project is designed to preserve and enhance 40 acres of existing riparian and wetland habitat, and restore/create 60 acres of riparian woodland and wetland sloughs within the floodplain of the Sacramento River. This project involves the excavation of 60,000 cubic yards at Oxbow Slough channels to prevent fish stranding.

Fremont Weir Modifications Project

Categories: Species Conservation, Habitat Restoration and Water Diversion .
Lead Agencies: CDFW
Locations: Northern end of Yolo Bypass, Yolo County
Goals and Description: To create and manage approximately 21,500 acres of seasonal floodplain habitat. Aditionally, to increase the duration of Yolo Bypass flooding in winter and spring by modifying the Fremont Weir to allow lower-stage flows of the Sacramento River to pass through the Yolo Bypass. Modification will occur either by the installation of an inflatable barrier to induce overbank flooding out of the Tule Canal/Toe Drain or by to by excavating the Tule Canal/Toe Drain to create a shallow flooded region. This project is an early action measure identified in the CalFed's Ecosystem Restoration Program Plan: Strategic Plan for Ecosystem Restoration.

Knaggs Ranch Project (Formerly known as the Elkhorn Basin Ranch)

Categories: Agriculture, Species Conservation and Habitat Restoration.
Lead Agencies: Sacramento Area Flood Control Agency
Locations: Northern Yolo Bypass, Yolo County
Goals and Description: To develop and manage approximately 1,750 acres of seasonal floodplain habitat for Swainson's hawk, while allowing continued agricultural production on the remaining portion of the ranch. Such agricultural prodution must be compatible with the Swainson's hawk foraging needs and may include grazing or row crop production. The potential implementation date is estimated to be 2015 or later.

Knaggs Ranch Project: Experimental Agricultural Floodplain Pilot Study

Categories: Agriculture, Research, Species Conservation and Habitat Restoration.
Lead Agencies: DWR
Locations: Northern Yolo Bypass, Yolo County

Goals and Description: To evaluate the growth of juvenile Chinook salmon in flooded agricultural fields as initiated in the winter of 2011-2012. This pilot study is investigating the biological and physical parameters of fish habitat, as well as the relationships between habitat, growth, and survival. Study is scheduled to expand over time as a multi-phased, multi-year research project. Information collected over the life of this project is essential to the development of Yolo Bypass rearing habitat for salmonids at appropriate temporal and spatial scales.

Levee Failure (Natural Event): Liberty Island

Categories: Species Conservation, Habitat Restoration, and Flood Protection and Control.
Lead Agencies: Solano County
Locations: Solano County
Goals and Description: Natural levee failure occurred in 1998 resulting in approximately 4,300 acres of subsided land to be restored by tidal inundation. Natural restoration continues to occur.

Levee Failures (Natural Events): Little Holland Tract

Categories:, Species Conservation, Habitat Restoration, and Flood Protection and Control.
Lead Agencies: Yolo County
Locations: Yolo County
Goal and Description: Natural levee failures occurred in 1983 and 1992 breaches resulting in approximately 1,500 acres of subsided land to be restored by tidal inundation. Natural restoration contiues to occur.

Liberty Island Conservation Bank (f*ormerly the* **Kerry Parcel Project**)

Categories: Species Conservation, and Habitat Restoration.
Lead Agencies: Reclamation District #2093
Locations: Northern portion of Liberty Island, Yolo County
Goals and Description: To preserve, enhance, and restore approximately 186 acres of native fish species including Chinook salmon, Central Valley steelhead, and delta smelt habitat. This project is under the designation of a wetlands mitigation bank. This ongoing program had its Mitigated Negative Declaration completed in 2009 and constructed and breach occured in late 2010.

Lisbon Weir Fish Passage Enhancement

Categories: Agriculture, Species Conservation, Habitat Restoration and Water Diversion.
Lead Agencies: Yolo County
Goals and Description: To improve agriculture and habitat water control structure for fish and wildlife benefits. This project is only a concept at this time.

Little Holland Tract Restoration

Categories: Species Conservation, Habitat Restoration, and Flood Protection and Control.
Lead Agencies: DWR and USACE
Locations: Yolo County
Goals and Description: To continue restoration efforts to complement the natural restoration that has occured since levee failures that occurred in 1983 and 1992. This activity is part of the Cache Slough Area Restoration effort and DWR's Interim Delta Actions.

Lower Cache Creek, Yolo County Woodland Area Feasibility Study

Categories: Agriculture, Water Diversion, Flood Protection and Control, and

Contamination Management.
Lead Agencies: Cities of Woodland and Davis
Locations: Yolo County
Goals and Description: To evaluate the modifications made to the Cache Creek Settling Basin and other facilities to determine their feasibility and contribution toward achieving urban and rural agricultural flood improvement in the area. Also to evaluate the Cache Creek Settling Basin and identify a long-term program for managing sediment and mercury to maintain the flood conveyance capacity of the Yolo Bypass.

Lower Putah Creek Realignment Project

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: Possibly CDFW – not yet established
Locations: Lower Putah Creek from the Toe Drain to Monticello Dam in central Yolo Bypass, Yolo County.
Goals and Description: To remove fish barriers on 25 miles of Lower Putah Creek, restore and enhance anadromous fish spawning and migration access, and reroute Lower Putah Creek east of Davis through five miles of new stream channel and seasonal wetlands. The project would establish between 300 to 700 acres along five miles of streams, floodplain and tidal marsh habitat.

Mayberry Farms Subsidence Reversal and Carbon Sequestration

Categories: Species Conservation, Habitat Restoration and Research.
Lead Agencies: Reclamation District #341
Locations: Sherman Island, Sacramento County
Goals and Description: To create 274 acres of permanently flooded wetlands on a nearly 308 acre parcel owned by the state. Approximately 191,700 cubic yards of peat soil were excavated to create ponds and channels, and then compacted to make the berms, levees and islands onsite. This project is ongoing. See SIDP Case Study for additional details.

North Bay Aqueduct Alternative Intake Project

Categories: Water Diversion, and Flood Protection and Control.
Lead Agencies: DWR
Locations: Solano and Yolo counties
Goals and Description: To construct and operate an alternative intake on the Sacramento River, generally upstream of the Sacramento Regional Wastewater Treatment Plant in Fairfield, and connect it to the existing North Bay Aqueduct (NBA) system by a new segment of pipe. The proposed alternative intake would be operated in conjunction with the existing NBA intake at Barker Slough. The project would be designed to improve water quality and to provide reliable deliveries of SWP supplies to its contractors, the Solano County Water Agency and the Napa County Flood Control and Water Conservation District. The Notice of Preparation for the EIR was published on November 24, 2009, release of the Draft EIR is still pending.

Northern Liberty Island Fish Conservation Bank (North Delta Fish Conservation Bank)

Categories: Species Conservation, Habitat Restoration and Levee Stabilization.
Lead Agencies: Reclamation District #2093
Locations: Northern Liberty Island, Yolo County
Goals and Description: To establish approximately 808 acres of tidal marsh by degrading approximately 4,200 linear feet of the east-west private levee along Shag Slough within the Yolo Bypass. Breaches, branches and small channels will be further excavated, tule plugs will

be planted along a portion of the northern project boundary, and seeding of existing levee upland areas with native and naturalized species will occur. Mitigated Negative Declaration was adopted on February 10, 2011 and currently permits and approvals are being secured.

Pope Ranch Conservation Bank Project

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: Reclamation Board
Locations: Near City of Davis, Yolo County
Goals and Description: To replicate natural conditions by creating a mosaic pattern of shallow, permanent ponds interspersed with seasonally inundated swales and uplands. This project will create aquatic, emergent marsh, and grassland habitats throughout the 391 acre project and provide suitable habitat for a diversity of wetlands-dependent wildlife species. A notice of exemption was issued in April 2001, however, this bank is currently noted in a USFWS list as either inactive or sold out.

Prospect Island Restoration Project

Categories: Species Conservation, Habitat Restoration and Levee Stabilization.
Lead Agencies: DWR and USACE
Locations: East of Sacramento Deep Water Ship Channel (SRDWSC), Solano County
Goals and Description: To restore 1,620 acres of tidal marsh and shallow tidal aquatic habitat for fish species and other native species, such as the delta smelt. Project construction would involve the creation of long sinuous interior islands, channels, dead-end sloughs, and interior levee benches. Plans are still conceptual at this time but construction is estimated to be 2016 or later.

Putah Creek Wetland Mitigation Bank

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: County of Yolo
Locations: North of Yolo Bypass Wildlife Area, Yolo County; at the intersection of County Road 36 and 106, near the City of Davis, Yolo County
Goals and Description: To construct 72.2 acres seasonal wetlands and playa pools, restore riparian habitat, and preserve upland habitat at the Putah Creek Mitigation Bank. Eight constructed wetlands and six upland mounds are proposed. The project would involve about 180,000 cubic yards of earth moving in two phases. The project site is located within a larger 433.7 acre property at Muzzy Ranch. A majority of the property, with the exclusion the project site, includes upland areas, originally purchased by ASB Southport II to preserve Swainson's hawk foraging habitat as mitigation for a development project in West Sacramento. Mitigated Negative Declaration was processed by Yolo County in 2011 and regulatory approvals are being secured at this time.

Remanded Biological Opinions on the Coordinated Long-term Operation of the Central Valley Project and State Water Project

Categories: Species Conservation, Habitat Restoration and Water Diversion.
Lead Agencies: U.S. Bureau of Reclamation
Locations: Counties containing CVP and SWP service areas and facilities
Goals and Description: To continue the operations of the CVP in coordination with the SWP as described and modified in the 2008 Biological Assessment. Operations will be altered to meet the authorized purpose in a manner consistent with federal reclamation law, applicable statutes, previous agreements/permits, contractual obligations and listed species, such that it does not result in destruction or adverse modification of designated critical habitat. While specific activities have not been defined at this time, efforts would involve the

restoration of up to 8,000 acres. The Notice of Intent to Prepare an EIS was released on March 28, 2012, with a series of public scoping meetings conducted in April and May 2012. Public comments were extended to June 28, 2012 and NEPA alternatives are currently being developed for operational components of the 2008 USFWS and 2009 NMFS Reasonable and Prudent Alternatives for delta smelt and salmonids, respectively.

Restoring Ecosystem Integrity in the Northwest Delta

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: CDFW
Locations: Yolo and Solano counties
Goals and Description: To acquire conservation easements within the Cache Slough complex, along the Barker, Lindsey and Calhoun sloughs, located west of the Yolo Bypass. The acquisition of conservation easements would be on 1,100 acres of existing riparian, wetland and agricultural lands. The project would manage and restore up to 1,300 acre of perennial grassland/vernal pool complex in Solano County.

Ridge Cut Giant Garter Snake Conservation Bank

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: Yolo County
Locations: Yolo County
Goals and Description: To restore and preserve approximately 186 acres of habitat for the Giant Garter Snake by creating 48.4 acres of perennial marsh, 57.4 acres of open water, and 80.1 acres of uplands. The project is an active habitat conservation bank and work is ongoing. A Mitigated Negative Declaration adopted on December 17, 2009.

Sacramento River Deep Water Ship Channel (SRDWSC) Project

Categories: Species Conservation, Habitat Restoration and Contamination Management.
Lead Agencies: USACE and Port of West Sacramento
Locations: Within the Sacramento River Deep Water Ship Channel, Yolo, Solano, Sacramento, Contra Costa counties
Goals and Description: To improve the navigation of the 46.5 mile shipping channel via dredging and establishing wetland/riparian habitat on Prospect and lower Sherman Islands. The project would involve both deepening portions of the SRDWSC to a depth of -35 feet MLLW and selective widening from River Miles (RMs) 0.0 to 35.0, completing the construction that was suspended in 1990 and conducting maintenance dredging from RMs 35.0 to 43.4. This project would involve the excavation and disposal of between 8.1 and 10 million cubic yards of material. The dredging is proposed for six month segments between June 1st and December 31st over four years. A revised Draft EIS and Subsequent EIR is anticipated to be re-circulated in response to comments in 2013. The construction target is on or before 2015.

Sacramento River Ranch Conservation Bank

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: CDFW
Locations: Yolo County
Goals and Description: The project involves the development and minor alteration of 108.5 acres to create wetlands habitat while maintaining agricultural activities on the property outside of the created wetlands. The four types of conservation and mitigation activities on the property: (1) species banks for the Valley Elderberry Longhorn Beetle, (2) species banks for salmonids, (3) conservation easement for Swainson's hawk habitat, and (4) a federal wetlands bank at the low-lying, southern end of the property. This program is

ongoing and is an active mitigation bank. A Notice of Exemption was issued on July 2007.

Sacramento-San Joaquin Delta Islands and Levee Feasibility Study

Categories: Species Conservation, Habitat Restoration, and Flood Protection and Control.
Lead Agencies: USACE
Locations: SSJD, Suisun Marsh, and adjacent areas
Goals and Description: To evaluate alternatives to meet the study goals of restoring sustainable ecosystem functions and improving flood risk management in the Delta, Suisun Marsh, and adjacent areas. The various measures and alternatives will depend on the information received during the scoping process. A Notice of Intent for the preparation of an EIS was published on January 31, 2013, and the Draft EIS is expected to be released in 2014.

Southport Sacramento River Early Implementation Project

Categories: Flood Protection and Control and Levee Stabilization.
Lead Agencies: USACE and West Sacramento Area Flood Control Agency
Locations: Yolo County
Goals and Description: To implement flood risk-reduction measures on the west bank of the Sacramento River south of the Barge Canal downstream approximately 6.4 miles to the South Cross Levee, protecting the Southport community of West Sacramento. The 3.3 square mile study area encompasses the area of levee improvement along the river corridor and the potential soil borrow sites east and west of southern Jefferson Boulavard. Certification of the Final EIS/EIR is anticipated for late 2013 and construction is scheduled for sometime between 2014 and 2015.

Tule Canal Fish Passage Enhancement

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: Yolo County
Locations: Yolo County
Goals and Description: To identify passage impediments and evaluate the feasibility of improving fish passage or removing fish passage impediments. This enhancement project is only conceptual at this time.

Update to the 2006 Water Quality Control Plan for the Bay-Delta Estuary (Bay-Delta Plan)

Categories: Agriculture, Species Conservation, Habitat Restoration, Water Diversion and Contamination Management.
Lead Agencies: State Water Resources Control Board
Locations: Bay-Delta Estuary
Goals and Description: To update the existing 2006 Bay-Delta Plan with the following four objectives: (1) to focus on San Joaquin River flow requirements and southern Delta water quality objectives; (2) to examine fish and wildlife beneficial uses; (3) to study possible modifications to water rights; and (4) to develop and implement flow requirements for priority Delta tributaries. Project is currently underway.

West Sacramento Levee Improvements Program

Categories: Species Conservation, Habitat Restoration, Flood Protection and Control, and Levee Stabilization.
Lead Agencies: West Sacramento Area Flood Control Agency and USACE
Locations: Sacramento levees, Yolo County
Goals and Description: To improve the levee system within the entire West Sacramento Area Flood Control Agency boundaries, including the Sacramento River, the Yolo Bypass,

the Sacramento Bypass, and the SRDWSC. The Final Program EIR/EIS was certified in March 2011. This program is ongoing.

Yolo Bypass Salmonid Habitat Restoration and Fish Passage

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: Bureu of Reclamation and DWR
Locatios: Yolo Bypass, Yolo County (within the Sacramento Valley region)
Goals and Description: To create more suitable conditions for fish in the Yolo Bypass and/or lower Sacramento River basin by implementing the Reasonable and Prudent Alternative actions as described in the 2009 NMFS BiOp and the 2012 Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan. The Notice of Intent and Notice of Preparation for the Draft EIS/EIR was released on March 4, 2013.

Yolo Bypass Wildlife Area Land Management Plan

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: CDFW
Locations: About 16,770 acres managed in the Yolo Bypass, Yolo County
Goals and Description: To guide the management of habitats, species, public use and programs to achieve CDFW's mission; direct an ecosystem approach in coordination with the objectives of the CALFED ERP; promote cooperative relationships with adjoining private property owners; establish a species inventory; create an O&M program with personnel requirements; and meet all applicable environmental regulations. The Negative Declaration was adopted in 2007, and this program is ongoing.

Yolo County Natural Heritage Program Habitat Conservation Plan/Natural Community Conservation Plan

Categories: Species Conservation and Habitat Restoration.
Lead Agencies: Yolo County HCP/NCCP Joint Powers Agency and USFWS
Locations: Yolo County
Goals and Description: To develop a comprehensive, county-wide plan for 653,820 acres designed to provide long-term conservation and management of natural communities, sensitive species, and the habitats upon which those species depend, while accommodating other important uses of the land. The Plan would set out a conservation strategy that includes measures to ensure that impacts on the 35 covered species and habitats related to covered activities are avoided, minimized, or mitigated, as appropriate. The Plan also proposes to provide conservation for 31 additional species of local concern. The Notice of Intent and Notice of Preparation for the Draft EIS/EIR was released on October 21, 2011. The completion target for plan is 2013.

Summary of Key Stakeholder Goals by TDS Components

Based on the review of related projects and stakeholder interviews with local Sherman Island residents, UC Berkeley, RESIN researchers, representatives from Department of Water Resources Reclamation District #341, and representatives from the Department of Naturals Resources regarding the BDCP, the following summary of goals was created.

Public

The needs of both the local and regional public must be addressed to create a sustainable approach to the SSJD. Public pressure throughout the state potentially play a crucial role in development by providing the political pressure to bring a change in the region. The primary

focus of the local residents are safety, a return to high-profit crop agriculture and the departure from the livestock industry. The localized issues as described by the residents offer a more palpable reality than envisioning a total meltdown of the system by which California delivers water throughout the state. However, issues facing the greater population of California are extreme and a solution must secure water quality and safety for the entire public.

Industry

Stakeholders in industry value bolstering the local economy while contributing to regional economic security and longevity. The primary players in industry on Sherman Island include agriculture, transportation, recreation, electric and gas transmission. The concerns of these groups include the protection of the transportation and utility infrastructure, maintaining habitats for recreational activities including fishing hunting, boating, windsurfing, and bolstering the area's agricultural investments.

Government

The sitution in the SSJD is a topic of considerable debate given the region's numerous political, economic and environmental stakes. Key issues of governmental concern for Sherman Island are the protection of water resources, the environment, transportation infrastructure, and public safety.

Environment

There are numerous public and private environmental groups defending the ecological well-beaing of the SSJD, with various goals to protect different aspects of the delta's natural environment. While meeting with the Department of Natural Resources and further investigating environmental concerns and proposed projects, habitat restoration and species conservation emerged as a top priority in design.

Synthesis of Stakeholder Inputs

Considering the stakeholders and their project goals, the design concept will be based on the following identified shared stakeholder needs: human and infrastructure safety, economic stimulation, and environmental resource protection. Consequently, the design goal of the proposed system is to reverse subsidence, stabilize the fragile levee systems, increase economic productivity, promote habitat restoration with on-site conservation measures, as well as to develop research, education and recreation activities on Sherman Island.

References

Lower Yolo Restoration Project Draft Environmental Impact Report, Section 4.10 Cumulative Impacts [http://www.sfcwa.org/wp-content/uploads/4-10_CumulativeImpacts.pdf] State and Federal Contractors Water Agency, Sacramento, California: 2013.

Hanson, J.C., *Reclamation District 341, Sherman Island Five-Year Plan*, San Francisco, California: 2009.

California State Water Project and the Central Valley Project [http://www.water.ca.gov/swp/cvp.cfm] California Department of Water Resources, Sacramento, California: 2008. (February 23, 2010)

Bridge Facts – Antioch Bridge [http://bata.mtc.ca.gov/bridges/antioch.htm] Metropolitan Transportation Commission, Bay Area Toll Authority, Oakland, California: 2009.

Chapter 4. Case Study Report

Completed July 2013

Lead author:	Bradley Angell
Contributing authors:	Richard Fisher
	Ryan Whipple

Introduction

Since the genesis of the Sherman Island Delta Project [hereafter "SIDP"], a design has been sought to holistically address the serious and seemingly insurmountable challenges facing the Sacramento-San Joaquin Delta [hereafter "SSJD"]. Fortunately, Californians have in recent history consistently faced paradoxical urban resource difficulty with scientific study, practical experimentation and reflective scholarship. For the SIDP team, such openness to innovative environmental practice provides an impressively specific sampling of applicable projects for study in the development of the project site at Sherman Island.

In their focus on Sherman Island, the team members have endeavored to pursue a technology delivery system which addresses four principle components: the public, industry, environment and government. A synthesis of stakeholder issues has been developed as a layered goal network titled the Adaptive Water Management and Agricultural Diversification System [hereafter "AWMADS"]. A first priority in designing for Sherman Island is maintaining the integrity of the threatened levee on the west end where the channels for the Sacramento and the San Joaquin Rivers merge. Secondary goals are many, including conservation efforts guaranteed by the government, small-scale agricultural and tourism efforts championed by local residents, and water delivery efforts vital to the livelihood of regional farming as well as urban municipalities.

As Northern California has a cross-section of recent projects that simultaneously address flood, stakeholder and industry priorities, applicable cases for study were locally available to the design team. As the team's investigation was carried out, new discoveries led to a refined understanding of contemporaneous conditions at issue in the shifting political landscape surrounding the SSJD. In study of project design, seven existing cases were surveyed by the design team including the Far Niente Winery Floating Solar Array, Feather River Setback Levee, Mayberry Farms Subsidence Reversal & Carbon Sequestration Project, Nimbus Hatchery & Visitor's Center, Rio Viento RV Park Wind Turbine, Sherman Lake Marina, and the Yolo Bypass Wildlife Area. After study, it was determined that the following five cases would satisfy necessary study for further project development and evaluation: the entire Yolo Bypass Flood Control Project, an existing hydroponics floating greenhouse, the famous floating markets of Bangkok, a conceptual anaerobic digestion food waste processing center, and the floating schools of Lagos.

As the design team reviewed stakeholder inputs in the greater effort of designing a sustainable project for the SSJD at Sherman Island, adaptability became an overwhelming necessity to realistically satisfy the shifting political, land ownership, environmental and social demands on this hydrologic gateway for Northern California's principle delta environment. Within a seventy-mile radius of the project site (*See* **Figure 1**), existing projects large and small have been surveyed directly by the design team for specific engineering promise, enlightening operations-ownership relationship details, and management insights regarding the execution of such complex conservation endeavors. The setting, details and potential impacts of each case's applicability follow.

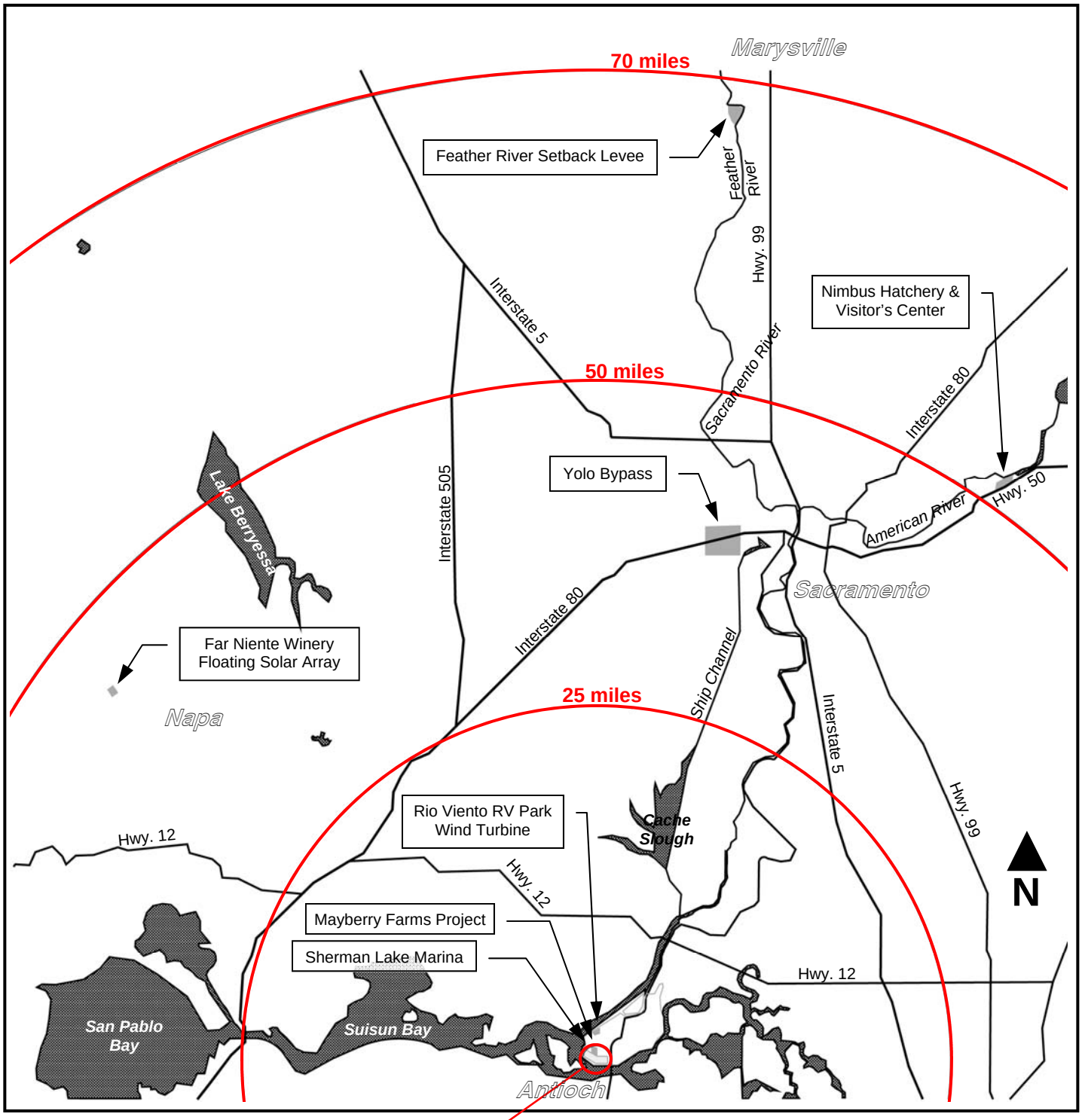


FIGURE 1: Case Study Proximity to Sherman Island.

1. *Cases Reported in Study*

In late April 2013, the SIDP team met in Sacramento and undertook an extensive research trip throughout Northern California. This trip was planned for over a year in the explicit intention of documenting locally-existing evidence of project development that applied directly to the conditions of Sherman Island. After visiting the SIDP site itself, the team visited seven sites all located within a seventy-mile radius from the proposed project. After traveling to Gold River, Marysville, Oakville, Rio Vista, and West Sacramento, seven projects were evaluated in varying degrees of depth based on the access and time given to the team. Ordered in the distance from the project site, the following developments are discussed in the following case study report:

Sherman Lake Marina, Rio Vista, California. Immediately adjacent to the proposed project site on the west side, this commercial operation providing recreational services to visitors has an area of 3.06 acres, whereby marina, RV camper, fishing, kite surfing, tour guidance and convenience store amenities are offered to both short term and extended duration visitors. The Sherman Lake Marina provides the primary access point to the project site.

Mayberry Farms Project, Rio Vista, California. Immediately adjacent to the proposed project site on the north side, this conservation project led jointly by California Department of Water Resources and a private hunting club Ducks Unlimited has been built on an approximately 310 acre site. Already, the pilot project has demonstrated the prospect of subsidence reversal, an effort that mitigates a condition of the soil throughout the California Delta region.

Rio Viento RV Park Wind Turbine, Rio Vista, California. Located on Sherman Island, this RV camping campus is on the north point of the island approximately one and a half (1 ½) miles from the project site. Able to accommodate 71 recreational vehicles, at least 75% of all energy needs for the park is provided by a single, mid-scale wind turbine that greets visitors as they enter the property. Demonstrating that wind energy is a potentially abundant resource on the island, the Rio Viento RV Park provides a persuasive proof of concept.

Far Niente Winery Floating Solar Array, Oakville, California. At the physical center of Napa Valley's lucrative wine-growing region, Far Niente Winery is a historic winery in Oakville that produces for luxury market consumption. Due to the quality, productivity and limited area of property soil, this winery endeavored to provide renewable, on-site energy by floating a solar array on an open grey-water reservoir. Here, on a square acre of water surface, a robust solar energy production system was installed for a cheaper cost than one that would be grounded in the landscape.

Yolo Bypass Wildlife Area, West Sacramento, California. Halfway between the cities of Sacramento and Davis, a massive wetland and bird habitat conservation project lays alongside the Sacramento Deep Water Shipping Channel. Originally created as a flood control measure for both Yolo and Sacramento Counties, the Yolo Bypass hosts a multitude of uses including farming, wetland habitat, species habitat, and increasingly, fish rearing projects for salmon fry. Altogether the Yolo Bypass is a 59,000 acre reclamation project, with 16,700 acres exclusively maintained all year as wildlife habitat.

Nimbus Hatchery & Visitor's Center, Gold River, California. Immediately west of the Nimbus Dam is a massive salmon and trout hatchery built alongside the American River

in the city of Gold River. Constructed in the 1950's, this project was only intended to be necessary for a five year period, but has now become a major tourist and research facility outside Sacramento. On the 14 acre site, all necessary operations for fry production and rearing are centrally located at the facility.

Feather River Setback Levee, Marysville, California. In terms of the safety of California's fresh water supply, the levee at the west end of Sherman Island must find relief from the punishing flood waters that typically occur in the winter. As Sherman Island's interior has subsided over the past century, the hydrologic pressure against its existing levees has only increased in magnitude, thereby increasing the hazard of levee breach. Having faced a similar problem along the Feather River just south of Marysville, a setback levee was installed to protect against the failure of the primary levee. As built, the setback levee runs 5.7 miles and has created an expansive 16,000 acre "new" floodway to protect remaining farmland, urban areas and infrastructure from potential breach.

In the following case study report, each site examined for project design and development has been outlined in alphabetical order.

CASE STUDY A:

FAR NIENTE WINERY & FLOATING SOLAR ARRAY

Location: 1350 Acacia Drive, Oakville, CA 94562
Contact Information: Greg Allen, (707) 484-4261
Date of On-Site Survey: Monday, April 22, 2013
Survey Participants: Richard Fisher, Ryan Whipple, Bradley Angell
Case Study Compiled by Richard Fisher

Site & Environmental Conditions of Case

Located in the Napa Valley, Far Niente and its sister wineries value the production of fine wines; however, they also understand that doing their part to protect natural resources is critical to the continuity of their business. Therefore, they follow an integrated program of sustainable measures from the vineyard to the winery and day-to-day business practices. Sustainable practices include organic agriculture practices, use of bio-diesel farming vehicles, hybrid-engine company cars, and an extensive recycling program. Additionally, Far Niente converts the power of the sun to be net-zero electricity users, annually producing more energy than they consume.

Far Niente Winery & Floating Solar Array

CAPITAL COST (Total):	$ 4,039,908 (2005)
OPERATING COST (Total):	$ 459.20 per year (2012)
ORGANIZATION TYPE:	The solar array is owned as an infrastructural asset by Bank of America (Private Corporation). Bank of America leases it back to the user and underlying property owner, Far Niente Winery (Private Corporation).
USER CAPACITY:	Beyond maintenance personnel, no public tours are afforded visitation of the solar array. Private tours are available to industry personnel.
ANNUAL GROSS REVENUE:	The solar array has been designed and managed as a zero-sum on-site utility. $105,000 worth of electricity is generated and used on-site each year.
ANNUAL NET REVENUE:	Due to the zero-sum nature of on-site solar array, no net revenues are directly earned. Secondary economic benefits flow from cost stability and the improved reputation garnered from using 100% sustainable energy for wine production.
Project Details	
LOT SIZE:	3.7 acres
BUILT ENVIRONMENT:	82,000 sq.ft. (1.9 acres) total
IMPROVED AREA:	3.7 acres, 0.75 acre floating PV array area

TABLE 1. Far Niente Winery & Floating Solar Array Case Study Details.

Unique Characteristics of the Far Niente

Traditionally, solar arrays have been land- or structure-based, but because one (1) acre of fertile grape growing soil has the potential revenue of approximately $150,000 per year in Napa, the owners of Far Niente decided to go solar in a revolutionary way. By installing a Floatovoltaic™ system, winery operators have avoided this opportunity cost. By taking advantage of unused space above a 14 foot deep, 240 foot-squared (.75 acres) irrigation pond, Far Niente in 2008 became the first in the world to float a significant, grid-connected solar installation on water

(*See* **Figure 2**). After installation of the floating solar array, a terrestrial solar array was installed just south of the pond for increased power production.

Construction of Far Niente Solar Electric System

Completed in April of 2008, the solar project had to be constructed within one year in order to maintain eligibility for solar incentives and rebates through the Self Generation Incentive Program [hereafter "SGIP"]. The process for construction of the Floatovoltaic™ system offered some unique advantages to a traditional earthen mounted system**.** Mounting the photovoltaic [hereafter "PV"] installation on a floating platform reduced the site preparation, construction time and cost of installation (*See* **Figure 3**)**.** At installation, the Floatovoltaic™ system was assembled on adjacent shores and then slid gently into the water. The total terrestrial and floating system consists of 2,296 modules (Sharp 208), 994 of which are mounted on 130 pontoon units. The pontoons are constructed of 18-inch diameter corrugated PVC pipe filled with an additional smooth PVC pipe and foam interior (*See* **Figure 6**). The solar panels are fixed at the optimum angle for solar collection, anchored with cabling connected to concrete two (2) feet in diameter at an eighteen (18) foot depth. The conversion of the 478 kWp DC to 400 kWp AC takes place at the 500 kW Satcon inverter adjacent to the pond.

Legal Narrative

The Far Niente Solar Array is a net metered system. Net metering with Pacific Gas and Electric Company [hereafter "PG&E"] allows the electricity that Far Niente produces be subtracted from the total energy bill. When Far Niente produces more than its monthly usage it receives a credit that can be used to offset future needs. If Far Niente's system produces less than their monthly usage the surplus energy "product" will be used to offset the bill. Net metering allows for compensation of produced electricity at the retail rate, an advantageous scenario for Far Niente as the winery is able to sell energy during the day when rates are dramatically higher and later use grid energy at night when energy rate are lower.

Interconnection and operation of con-generation with the utility cannot begin until the conditions of the Standard Interconnection Agreement [hereafter "SIA"] have been met. The customer-generator must obtain an electrical permit, pass inspection and be approved by the utility prior to operation. The SIA sets the guidelines for usage as well as the relationship between generator and utility, outlining a framework for liability and the sequencing of interconnection for both parties. The utility is not required to purchase excess energy; however, net metering shall be credited for such net energy with an applicable kilowatt-hour-credit. PG&E is like many utilities that allow a net metering facility to "zero-out" their energy cost, but will not pay for extra energy. Utilities in other regions pay for remaining surplus energy at the end of the year at an average energy rate that correlates to an avoided cost of production. These specifics are further defined in the PG&E Standard Interconnection Agreement as it applies to the Far Niente Winery.

Operational Narrative

In addition to maintaining the solar array and transmission system, Far Niente is responsible for maintaining the net meters and interconnection facilities in a safe a reliable manner. An average maintenance cost of $0.20 per panel/year routine involves checks and mechanical scrubbing (*See* **Figure 7**). Real time electricity monitoring is available for tracking the customer usage-generation balance as well as the direction of grid power utilization. During installation, a sensor was added to each assemblage to relay power information so as to ensure proper function of each string of panels.

Economic Analysis

In this case, it should be noted that the capital investment includes a huge unexpected cost to upgrade the existing infrastructure including a re-routed transmission line one (1) mile from solar source. Our winery guide estimated that price could be reduced as much as 40% if the cost associated with the transmission line were avoided and if contemporary solar technologies were installed that are significantly less expensive.

	Far Niente Winery	Nickel & Nickel	Combined	
Design Factors				
2005 annual electricity charges	$ 105,000	$ 100,000	$ 205,000	
2005 Energy Usage	715,680	615,360	$ 1,331,040	kWh
2005 Peak Demand	110	160		kW
Proposed System				
Number of Sharp 208 panels	2296	1904	4,200	
Number of floating panels	994 (43%)	0		
Size of Solar System	477	399	876	kW(DC)
SPG Solar Contract Cost	*$ 3,453,163*	$ 2,836,272	$ 6,289,435	
Relative Cost	$ 7.24	$ 7.11	$ 7.18	$/W(DC)
Size of Rebate-Eligible System	400	330	730	kW(AC)
SGIP Rebate Rate	$ 2.80	$ 2.80	$ 2.80	$/W(AC)
Rebate Amount	$ 1,119,479	$ 924,000	$ 2,043,479	
Actual System Costs	$ 4,039,908	$ 2,971,842	$ 7,011,750	
Relative Cost	$ 8.47	$ 7.45	$ 8.00	$/W (DC)
Over-budget	17%	5%	11%	
Net Cost (less rebate)	$ 2,333,684	$ 1,912,272	$ 4,245,956	

TABLE 2. Far Niente Winery Floating Solar Array Cost Breakdown.

The winery received a $2.80/DV watt rebate as part of the PG&E SGIP. Additionally, Far Niente received a 30% federal tax credit and accelerated five (5) year depreciation allowance. Bank of America Leasing and Capital LLC provided a novel lease-back agreement for the winery, whereby the bank maintains ownership of the solar installation while leasing the facility to Far Niente. Far Niente has a buyback option after seven (7) years of leasing the production facility. With an estimated base cost $7.30/DC watt for the floating and land based arrays at both Far Niente and its sister winery Nickel and Nickel, Far Niente expects that the combination of the two solar installations will pay for themselves in as few as thirteen years, but no more than seventeen years.

A simple payback analysis based to check these expectations for the Far Niente Solar Array is shown in **Table 3**. The payback period is calculated based on data provided by Far Niente coupled with the conservative assumption that grid-based electric prices will remain equivalent to 2005 prices. Here, additional tax incentives and refunds are not considered, thereby painting a less favorable payback period scenario than they winery's expectations, but still demonstrating that the floating solar array will easily pay for itself over the 25-30 year lifespan of the PV array.

Cost of Far Niente System	$ 2,333,684.00
Annual Grid Connected Energy Cost	$ 105,000.00
Cost of Operations & Maintenance per Panel	$ 0.20
Annual Expected Output (kWh/y)	715680
Number of Panels	22896
Annual Energy Cost Reduction	$ 105,000.00
Annual Operations & Maintenance	$ 459.20
Total Annual Cost Savings	$ 104,540.00
Years to Payback	22.32

TABLE 3. Payback Period for Far Niente Solar Array.

Opportunities for Application on Sherman Island

The Far Niente System is located under similar solar radiation conditions (S*ee* **Figure 5**) and therefore is a wonderful system for installation at Sherman Island. Incorporation of Floating Solar Array System provided a unique opportunity for multi-use execution on a waterway that could have dramatic changes in depth. The winery's highly successful floating solar array demonstrates the ease of construction and maintenance, cost effectiveness and innovation to take such a typically *land*-intensive design to water. Floating solar arrays can be used to produce electricity for an off grid or grid connected system at the Sherman Island site as an opportunity to make a self sufficient facility or community or a co-generation plant as an economic generator. Further, floating solar arrays could provide an opportunity for education and eco-tourism at the site.

References

Primary sources for this evaluation came from the site survey conducted by Ryan Whipple, Bradley Angell and Richard Fisher on April 22, 2013. Additional resources were found after the survey and include:

Moving Energy Forward, http://64.62.163.92/assets/floatovoltaic.pdf, Thompson Technology Industries, Novato, CA: 2008.

Grace, Mary, *Napa Valley's Far Niente Winery Introduces First-Ever "Floatovoltaic" Solar Array*, http://www.farniente.com/assets/files/pdfs/Floatovoltaic.pdf, Oakville. CA.

Standard Net Energy Metering (NEMS), http://www.pge.com/standardnem/, Pacific Gas and Electric Company, 2013.

Self-Generation Incentive Program, http://www.pge.com/en/mybusiness/save/selfgen/index.page, Pacific Gas and Electric Company, 2013.

Smyth, Mervyn; Russell, James Russell; and Milanowski, Tony; *Solar Energy in the Winemaking Industry*, p. 326, Springer-Verlag, London, UK: 2011.

Sueiro, Susan, *Gundlach Bundschu Installs Floatovaltaic Solar Array*, http://www.gunbun.com/assets/client/File/Gun%20Bun%20solar%20press%20release%2012-2-08.pdf, December 2, 2008, Sonoma, CA.

FIGURE 2: Aerial View of Floating Solar Array.

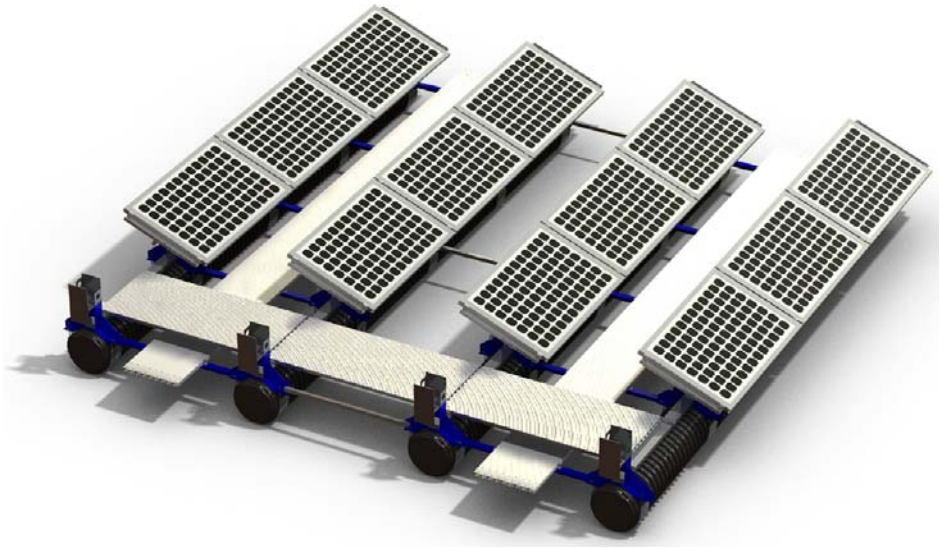


FIGURE 3: Model of Array Design.
See http://64.62.163.92/assets/floatovoltaic.pdf

FIGURE 4: Alternative Concept of Floating Array.

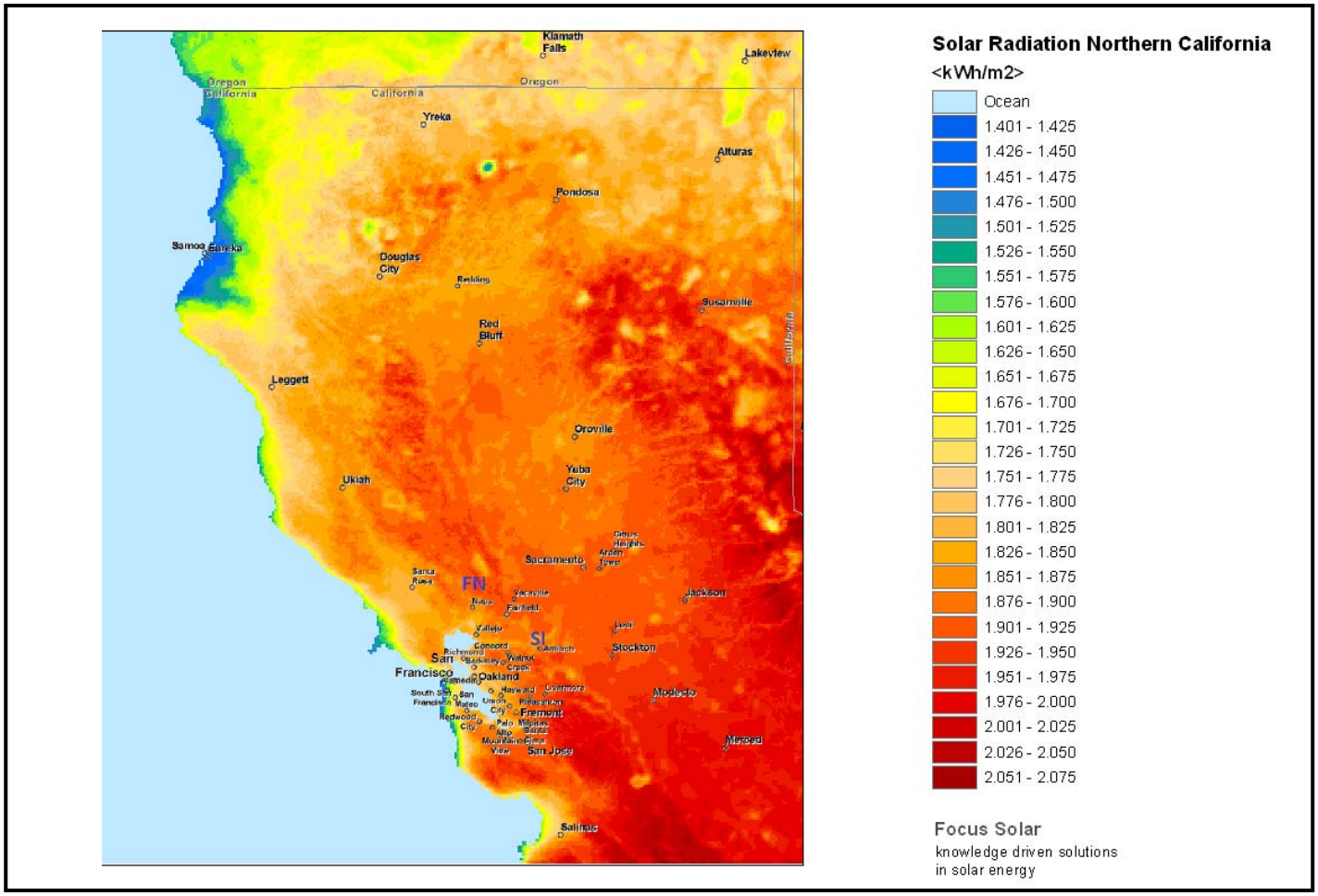


FIGURE 5: Solar Radiation for Northern California.
See http://www.focussolar.de/Maps/RegionalMaps/America/NothernCalifornia

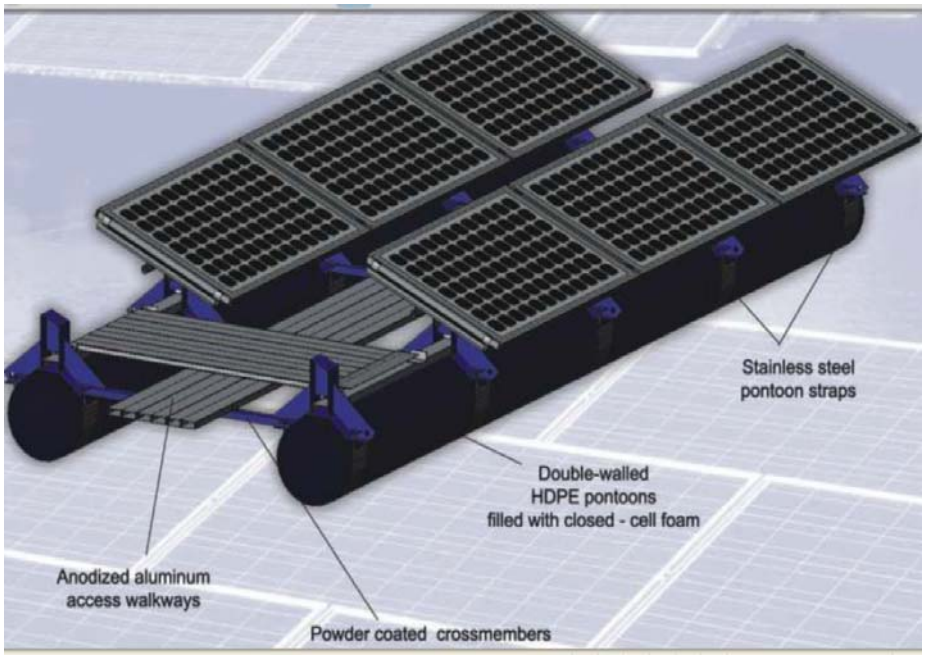


FIGURE 6: Noted Model of Array Design.
See http://64.62.163.92/assets/floatovoltaic.pdf

FIGURE 7: Annual Maintenance.

CASE STUDY B:

Feather River Setback Levee

Location: South of Marysville, CA parallel to the Feather River
Contact Information: Albert Pujols, GEI Consultants, apujol@geiconsultants.com
Date of On-Site Survey: Sunday, April 21, 2013
Survey Participants: Richard Fisher, Ryan Whipple, Bradley Angell
Case Study Compiled by Ryan Whipple

Site & Environmental Conditions of Case

Located 70 miles north of Sherman Island, and 40 miles north of Sacramento, the Feather River Setback Levee project was developed and implemented by the Three Rivers Levee Improvement Authority [hereafter "TRLIA"] to replace an existing deficient levee with a new setback levee. The new setback levee has increased the level of protection in South Yuba County to prepare for a 200-year flood event. Like many of the islands found in the SSJD (Sacramento-San Joaquin Delta), the communities along the Feather, Bear and Yuba rivers have a long history of flooding due to subsided islands and consequent levee failure. The newly installed 5.7 mile long levee provides approximately 1,600 acres of additional land for expanded floodway in the event of high storm waters, and throughout the year a large addition of new ecological habitat. **Figure 8** shows the bounds of the Feather River Setback Levee while **Figure 12** highlights the increase in floodway available after construction.

Feather River Setback Levee

CAPITAL COST (Total):	$ 192,000,000 (2009)
OPERATING COST (Total):	$ 38,575 per mile of levee across RD784 (2011)
ORGANIZATION TYPE:	Managed by the CA. Reclamation District Board 784 with levee operations and maintenance. Assessment district for levee maintenance funding is arranged by the Three Rivers Levee Improvement Authority. Most of the property in the flood control district is privately owned, but limited by easement.
USER CAPACITY:	Provides additional protection for over 40,000 residents and 9,000 future households.
ANNUAL GROSS REVENUE:	Feather River Setback Levee activities are funded with assessment fee payments and other state and federal programs. No business-oriented fees are collected or revenues generated from on-site operations directly.
ANNUAL NET REVENUE:	*See above*.
Project Details	
LOT SIZE:	5.7 mile long setback levee.
BUILT ENVIRONMENT:	Sundry agricultural and ecological rehabilitation outposts exist on the large site.
IMPROVED AREA:	16,000 acres of expanded floodway; majority of site area has been developed either for agricultural endeavors, or for ecological restoration purposes and is state owned and leased to the public.

TABLE 4. Feather River Setback Levee Case Study Details.

Geologic Setting

The levee is located in the eastern portion of the Sacramento Valley within the floodplain of the Feather River, a floodplain that is very wide due to the flat topography of the region. Due to

variable deposits along the 5.7 mile stretch of setback levee alignment, a thorough geological investigation was conducted including but not limited to 204 test borings, 526 excavated test pits, and laboratory testing.

Soil conditions vary significantly throughout the entire alignment due to the meandering nature of the river valley itself. The majority of the levee's length is found on Modesto and Riverbank Formation deposits of the late Pleistocene age or of more recent Holocene alluvial deposits. The more recent alluvial deposits are composed of porous, poorly consolidated silts, clays, sands and gravels. The Modesto and Riverbank formations are significantly older and under the process of consolidation, providing a much more compact, dense and even cemented condition in places. While a homogenous soil profile is not possible through the entire stretch of the setback levee, a generalized description of the "typical" soil condition along the levee alignment is described below.

The Modesto Formation which underlies the majority of the levee consists of an approximate 35 foot thick layer of very soft to medium stiff silt and clays, underlain by a thin layer of highly pervious sand and gravel which is 10-20 feet thick. To a depth of at least 100 feet below this layer lay inter-bedded silt, silty sand, and clay strata. In portions of the northern and central reaches of the levee, recent alluvial deposits overlie the Modesto Formation. **Figure 14** provides a general subsurface geological profile of the Feather River Setback Levee.

Levee Design

The placement of the setback levee sits at a range of 2,000 to 3,000 feet from the existing Feather River Levee. Now completed, the existing levee will soon be decommissioned as portions will be removed to allow water flow into setback areas during high river stages.

The design profile features the levee rising from a crown elevation of 66.2 feet at the south end, to 76.9 feet at the north end to match the elevations on existing levees. This crown elevation places the height of the setback levee between 18 and 30 feet above the ground surface. To account for settlement and consolidation, camber (additional fill material) lines the crown of the levee. Landslide stability berms were constructed as mitigation for differential settlement along a couple of reaches along the embankment. These berms feature a filtered drainage blanket to collect seepage through the levee and prevent piping caused by fast water flow through the levee itself.

The Feather River Setback Levee required approximately 3.4 million cubic yards of compacted soil material. The levee construction material was specified to be:

- More than 20% fines (material passing the #200 sieve), and 2-inch maximum particle size;
- Plasiticity index (PI) equal to or greater than 8 but not exceeding 25;
- Liquid limit (LL) less than 50; and
- Free of organic material.

In addition to these fill design requirements, the borrow soils for the levee were conditioned to a moisture content that maximized compaction to create a dense and strong fill. As such, in general, soils found below the water table were not employed to avoid the cost of drying and appropriate conditioning. To meet design conditions, the levee was constructed as an engineered fill. Each fill was placed in a horizontal lift with a maximum of uncompacted thickness of eight inches. Compaction was then conducted for each lift to a maximum thickness of six inches. Each lift was moisture conditioned and compacted through the use of a tamping-foot roller. Once the embankment was completed, grass cover was applied for erosion

protection on both the riverside and landside slopes of the levee.

Foundation Preparation and Seepage Control
To prepare the foundation of the setback levee, the footprint of the levee and berm were cleared of all interfering matter: i.e. trees, brush, vegetation, stone, structures, pipelines, utilities and any other buried material. Once this initial clearing was completed, additional stripping to a depth of 6 inches was conducted to remove low growing vegetation and top soil. The levee and berm foundation was then proof-rolled and soft materials were removed and replaced with compacted fill. Before placing the first lift of the levee, the foundation surface was scarified and moisture conditioned to create a successful bond between the foundation and the embankment fill.

The pervious nature of the soils throughout the alignment posed the issue of variable seepage throughout the length of the levee. While the determined alignment along the Modesto Formation provided greater strength, less settlement and less permeability, than other potential alignments, additional measures were required to control seepage beneath the levee. To provide significant control against underseepage, a soil-bentonite slurry trench cutoff wall was constructed with the levee, with portions of the wall extending 75 feet deep (*See* **Figure 14**). Where alluvial soils could not be avoided, relief wells were installed in immediate adjacency.

Operations and Maintenance
The first several years after levee construction are the most critical in terms of monitoring the condition and performance of the levee. While the Feather River Setback Levee is currently not holding back any river waters due to its setback distance, regular inspection and maintenance is necessary both now and once the levee begins holding back flood waters. In general, inspections should be conducted immediately prior to the beginning of each flood season while ensuring enough time to complete necessary repairs. Inspections are also necessary following each major high-water period at intervals not exceeding 90 days, and at any intermediate times that may be necessary to ensure levee care. Below, **Table 5** provides basic inspection and maintenance guidelines for the Feather River Setback Levee.

Opportunities for Application on Sherman Island
Yuba County and the levees that border the Feather River share many similarities with basic issues of flood control facing Sherman Island. While the subsurface geological profile varies significantly between Sherman Island and Yuba County largely due to the lack of significant peat soil in Yuba County, the primary failure mode of the levees in both locations are the same due to the constant threat of underseepage. Since installation, the Feather River Setback Levee provides local precedence for constructing levees setback from the river to expand floodway area. This measure of engineering application could provide flood safety, protect the existing Delta infrastructure as well as those public services relying on such facilities, and provide an opportunity for ecological restoration throughout the rest of the setback portion of the island.

Therefore, the incorporation of a setback levee on a smaller scale on Sherman Island provides a unique opportunity to provide additional floodway for the purposes of safety and ecological restoration. Further, by incorporating other complementary floating infrastructure within the floodway could increase the economic viability and ecological virility of Sherman Island specifically within the area proposed for setback protection.

Focus	What to monitor	Corresponding Actions
Levee Crown	Roadways, ramps gates and access roads must be properly maintained. Observe for any ruts, pot holes or depressions along levee crown. Ensure proper drainage is occurring properly without ponding.	Discourage grazing or vehicular traffic along levees. Any instances of ponding or depressions must be reported to qualified engineer.
Rodent Activity	Squirrels, beavers and other burrowing rodents can threaten the structural integrity of levees by loosening soil, increasing erosion and sloughing risk, and piping type erosion failures.	Animal dens and runways should be opened up and backfilled with compacted fill in all cases.
Vegetation Management	Inspections should determine if there is good coverage of sod over levees. Inspections should also ensure that trees and shrubs are not growing on levee slopes, crown, seepage berms, and stability berms. Ensure that no cultivation is occurring within a distance of 15 feet from relief wells or berms.	Note areas that are deficient in sod cover. Trees and shrubs in these locations, as well as any in locations that impede levee monitoring or flood fighting must be removed. Weeds and other growth should be controlled by herbicide spraying within 15 feet of relief wells or seepage berms.
Seepage	Inspections should include travelling the length of the levee and observing the lower levee slope and area along the toe for evidence of seepage, boils or sinkholes.	All evidence that is located should be noted and reported to a qualified engineer immediately
Cracking, Settlement and Slips	Inspections should include travelling the length of the levee and observe levee slopes for indications of cracking, slumping or slippage.	Any evidence of cracks, scarps, slumping, or subsidence should be immediately marked in the ground, reported and evaluated by a qualified engineer.

TABLE 5. Inspection & Maintenance Guidelines.

This case study highlights the design parameters required for the construction of a similar smaller setback levee on Sherman Island. Moreover, it provides a rough estimate of capital costs, operations and maintenance costs for an applicable setback levee. Applied to the project site, a setback levee is *the* critical piece of foundation engineered infrastructure required for any possible holistic and adaptive water management system for Sherman Island.

References

Primary sources for this evaluation came from the site survey conducted by Ryan Whipple, Bradley Angell and Richard Fisher on April 23, 2013. Additional resources were found after the survey and include:

Brunner, Paul, *The Feather River Setback Levee*, Three Rivers Levee Improvement Authority, *First Published in the* U.S. Society of Dams Newsletter, Marysville, California: November 2010.

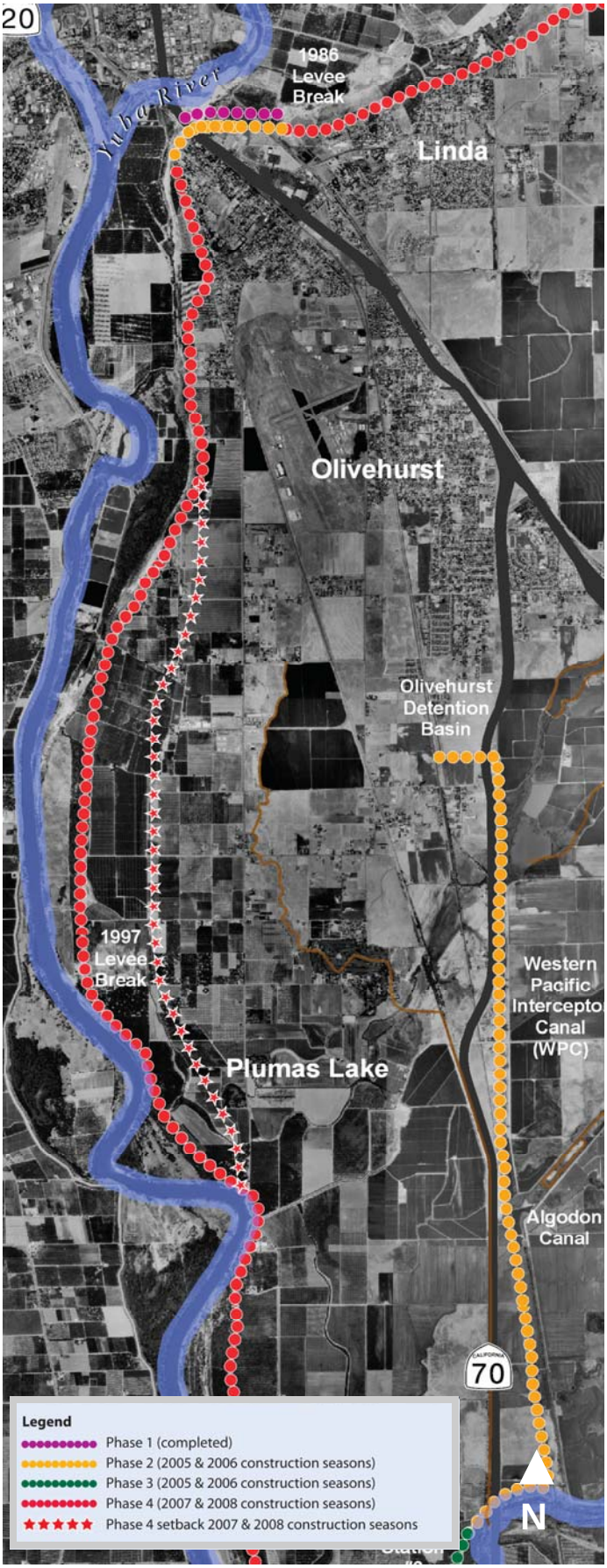


FIGURE 8: Setback Levee Site Plan.

FIGURE 9: Feather River & Antiquated Primary Levee.

FIGURE 10: Backside of Antiquated Sand Levee.

FIGURE 11: New Setback Levee after Completion.

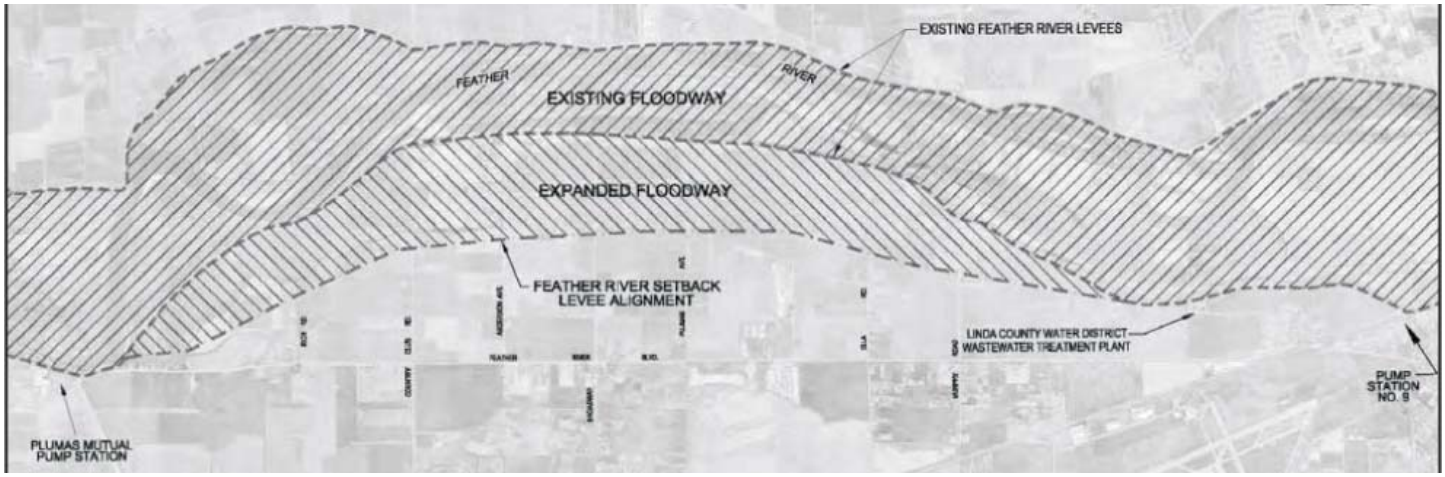


FIGURE 12: Setback Levee Expanded Floodway.

FIGURE 13: Feather River Watershed.

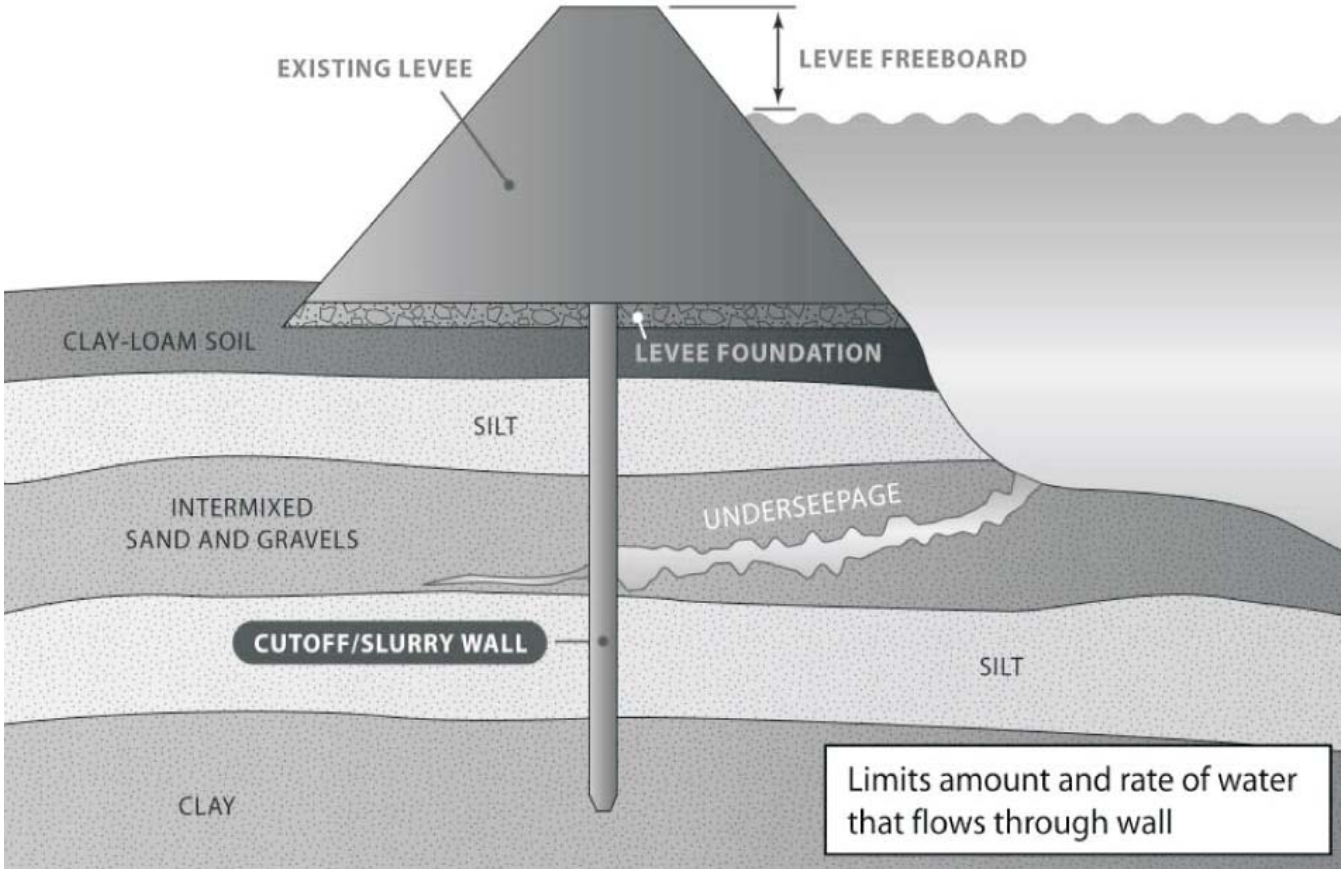


FIGURE 14: Setback Levee Specification Section.

CASE STUDY C:
MAYBERRY FARMS SUBSIDENCE REVERSAL & CARBON SEQUESTRATION PROJECT

Location: Sherman Island, Rio Viento, CA
Contact Information: N/A
Date of On-Site Survey: Sunday, April 21, 2013
Survey Participants: Richard Fisher, Ryan Whipple, Bradley Angell
Case Study Compiled by Richard Fisher

Site & Environmental Conditions of Case

Mayberry Farms borders the project site, just north of Mayberry Slough between Highway 160 and Sherman Lake Marina in Rio Viento, CA (*See* **Figure 15**). The roughly 307 acre property is owned by the California Department of Water Resources [hereafter "DWR"] and jointly managed with Ducks Unlimited with additional operational oversight provided by the California Department of Fish & Wildlife. In 2010, the site was restored from a pepperweed and annual grassland pasture to a wetland, a habitat that is now dominated by tule (Scirpus occidentalis) and broadleaf cattail (Typha latifolia L.). The relatively flat and flooded terrain is comprised of peat, clay and sediment layers in the soil. With clear skies in the summer and high temperatures with low humidity, colder temperatures in the winter and significant amounts of precipitation throughout the year, this Mediterranean climate provides an appropriate balance of temperature and precipitation for a robust exhibition of wetland flora and fauna.

Mayberry Farms Subsidence Reversal & Carbon Sequestration Project

CAPITAL COST (Total):	$ 1,610,00 (2010) Variable cost dependent of research activities.
OPERATING COST (Total):	Operational Cost provided for by Ca. Department of Water Resources, Ducks Unlimited, and research grants.
ORGANIZATION TYPE:	The land is owned by the Ca. Department of Water Resources and is managed jointly by Reclamation District #341(public) and Ducks Unlimited Club (private).
USER CAPACITY:	Small teams of biologists and other science professionals frequent the project. Limited hunting groups are allowed on site. Due to transportation infrastructure, no more than two dozen individuals could be expected onsite at one time.
ANNUAL GROSS REVENUE:	$ 108,872 for recreation and habitat services. $ 1,833,340 for sum of all ecosystem services.
ANNUAL NET REVENUE:	Variable
Project Details	
LOT SIZE:	307 acres
BUILT ENVIRONMENT:	307 acres of constructed channels, berms and levees, perimeter ditches, interior berms, interior water conveyance channels, intake siphons, and water control structures.
IMPROVED AREA:	Approximately 192 acres of emergent wetlands and approximately 115 acres of seasonally flooded wetlands.

TABLE 6. Mayberry Farms Case Study Details.

Unique Characteristics of Mayberry Farm

The Mayberry Farms Subsidence Reversal & Sequestration Project was originally proposed as a demonstration project to provide permanently flooded wetlands for waterfowl habitat, subsidence reversal technology, as well as to demonstrate both the biological and recreational benefits of Delta wetland restoration. Since installation, this project has built an experienced-founded base of knowledge that can be used by operators of private wetlands in the management of properties for water-based recreation. Originally designed to restore approximately 274 acres of winter-flooded emergent wetlands to permanently-flooded wetlands, this 307 acre parcel that was once used for pasture grazing in the summer now hosts ponds, dense vegetation and riparian habitats throughout the calendar year. Divided into two general functions, the project installed an approximate 192 acres of emergent wetlands and approximately 115 acres of seasonally flooded wetlands. While pepperweed and upland grasses still exist, continual flooding will eventually force these species to recede and allow a diversity of wetland plants to propagate naturally, requiring no additional planting or construction to meet the project's long-term objectives.

In order to facilitate appropriate management, the interior of the site is divided into seven wetland management units separated by four existing interior berms (*See* **Figure 17**). These quadrants maintain hydrologic connectedness with excavated conveyance channels that allow free water flow. By designing for permanent flooding, the growth and subsequent decomposition of emergent vegetation is expected to control and reverse subsidence while providing year-round habitat for California Delta species. A similar project at Twitchell Island established in 1997 by U.S. Geological Survey, employs shallow permanent flooding at depths between 25 and 55 centimeters. The Twitchell Island project has successfully yielded elevation gains from organic matter accumulation at a varying depth of 30 to 60 centimeters throughout the project site after ten years, with average annual carbon storage rates of one kilogram per meter squared (*See* Miller).

Construction

In 2007, restoration design was complete with environmental permitting approved by the summer of 2008. Initial upgrades to facilities began in the fall season of 2008, construction began in full by June 30, 2010, and the restoration project was completed on October 7, 2010. During construction, DWR staff acted as resident engineers performing on-site construction management and administration four days per week.

Construction involved improving perimeter ditches, interior berms, interior water conveyance channels, intake siphons, and water control structures. Additionally, a buttress berm and a multitude of seasonally flooded loafing islands for waterfowl were constructed using only material excavated from the project site. A total of 191,717 cubic yards of peat soil was excavated to create ponds and channels, material that was then compacted to make the berms, levees and islands on the site.

Operation and Maintenance

The site is managed by Ducks Unlimited and DWR for recreation and research purposes. DWR staff use bench mark standards to perform annual subsidence surveys, all the while enjoying interagency coordination with the California Department of Fish and Wildlife to monitor flow, mercury and methyl mercury data inside the wetlands. Further, in the employment of a flux tower installed on the island, researchers are able to undertaken real-time analysis of energy, water, carbon dioxide and methane flow rates within the

Mayberry Farms project envelope (*See* **Figure 16**). University of California, Berkeley Biometeorology Laboratory coordinates these experimental measurements with the use of theoretical models hoping to gain insight into the physical, biological, and chemical processes that control trace gas fluxes between the biosphere and atmosphere. Such on-site observations are being used to create a database for publication and to quantify temporal and spatial variations in the project as it was installed. After construction was complete, the wetlands were initially filled with floodwaters using two siphons. Since initiation, water levels in each unit are adjusted independently to assure desired conditions throughout the year, maintaining the flooded status of this thriving wetland (*See* **Figures 18, 19**).

Economics

The Mayberry Farms Subsidence Reversal Project was funded by the Work Agreement SH-08-1.0 of Proposition 84, under grant "WDWM-15 Mayberry Farms." Grant monies provided $1.61 million for the engineering, construction, implementation, and monitoring of the subsidence reversal project on the 307 acre parcel. Based on the area and funding allocated, a cost ratio was established at $5,250 per acre. Employing an established ecosystem service evaluation of wetlands, the annual value of the Mayberry Farms project can be estimated. Wetlands provide gas disturbance, water regulation, water supply, waste treatment, habitat, food production, raw materials, recreation, and cultural ecosystem services to larger society (*See* Costanza, 1997). Using the information given and service evaluation schedule formulas, a payback schedule has been enumerated in **Table 7**. Considering the main objectives of the project were originally for recreation and habitat conservation, the economic value of these functions has been separately noted in the following table, assuming payback periods for each separately is approximately 43 (recreation) and 23 (habitat conservation) years. After complete evaluation, the resultant payback period for project installation is at most 15 years.

Ecosystem Service	Annual Revenue ($US/ha)	Hectacres	Total Value /Service	Payback Period/Service (years)
Gas Regulation	$ 133	124	$ 16,492	97.6
Disturbance Regulation	$ 4,539	124	$ 562,836	2.9
Water Regulation	$ 15	124	$ 1,860	865.6
Water Supply	$ 3,800	124	$ 471,200	3.4
Waste Treatment	$ 4,177	124	$ 517,948	3.1
Habitat	$ 304	124	$ 37,696	42.7
Food Production	$ 256	124	$ 31,744	50.7
Raw Materials	$ 106	124	$ 13,144	122.5
Recreation	$ 574	124	$ 71,176	22.6
Cultural Service	$ 881	124	$ 109,244	14.7
Total	**$ 14,785**	**124**	**$ 1,833,340**	**0.9**
Habitat & Recreation			$ 108,872	14.8

TABLE 7. Ecosystem Service Evaluation & Payback Period for Mayberry Farms.

Opportunities for Application on Sherman Island

Since Mayberry Farms is just north and adjacent to the proposed SIDP site, it is a directly applicable pilot project demonstrating a successfully restored wetland under nearly identical environmental, ownership, and economic conditions. The expansion of such a wetland at the proposed project site would offer a foundation of habitat restoration that could be integrated with other multi-use solutions.

References

Primary sources for this evaluation came from the site survey conducted by Ryan Whipple, Bradley Angell and Richard Fisher on April 22, 2013. Additional resources were found after the survey and include:

Baldocchi, Dennis D. (Principle Investigator), *AmericFlux: Mayberry Wetland*, http://ameriflux.ornl.gov/fullsiteinfo.php?sid=227, Berkeley, California.

Costanza, R. et al., *The value of the world's ecosystem services and natural capital.* NATURE, vol. 387: May 15, 1997.

Miller, Robin L. , and Fugii, Roger, *Re-Establishing Marshes can Return Carbon Sink Functions to a Current Carbon Source in the Sacramento-San Joaquin Delta of California*, pp. 1-34, U.S. Geological Survey, California Water Science Center, Sacramento, California: 2011.

Whitaker, Jennifer (Audit Manager), *Audit Report: Sherman Island Reclamation District 341, Proposition 50 and 84 Bond Programs*, http://www.dof.ca.gov/osae/prior_bond_audits/documents/FinalReportShermanIslandReclamationDistrict341Proposition50and84GrantAudits.pdf, Office of State Audits and Evaluations, Department of Finance, Sacramento, California: February 2012.

Mayberry Farms Duck Club Subsidence Reversal Project (Sherman Island), http://www.water.ca.gov/floodsafe/fessro/environmental/dee/mayberry.cfm, California Department of Water Resources, Sacramento, California: July 2012.

FIGURE 15: Aerial View of Mayberry Farms.

FIGURE 16: UC Berkeley Flux Tower.

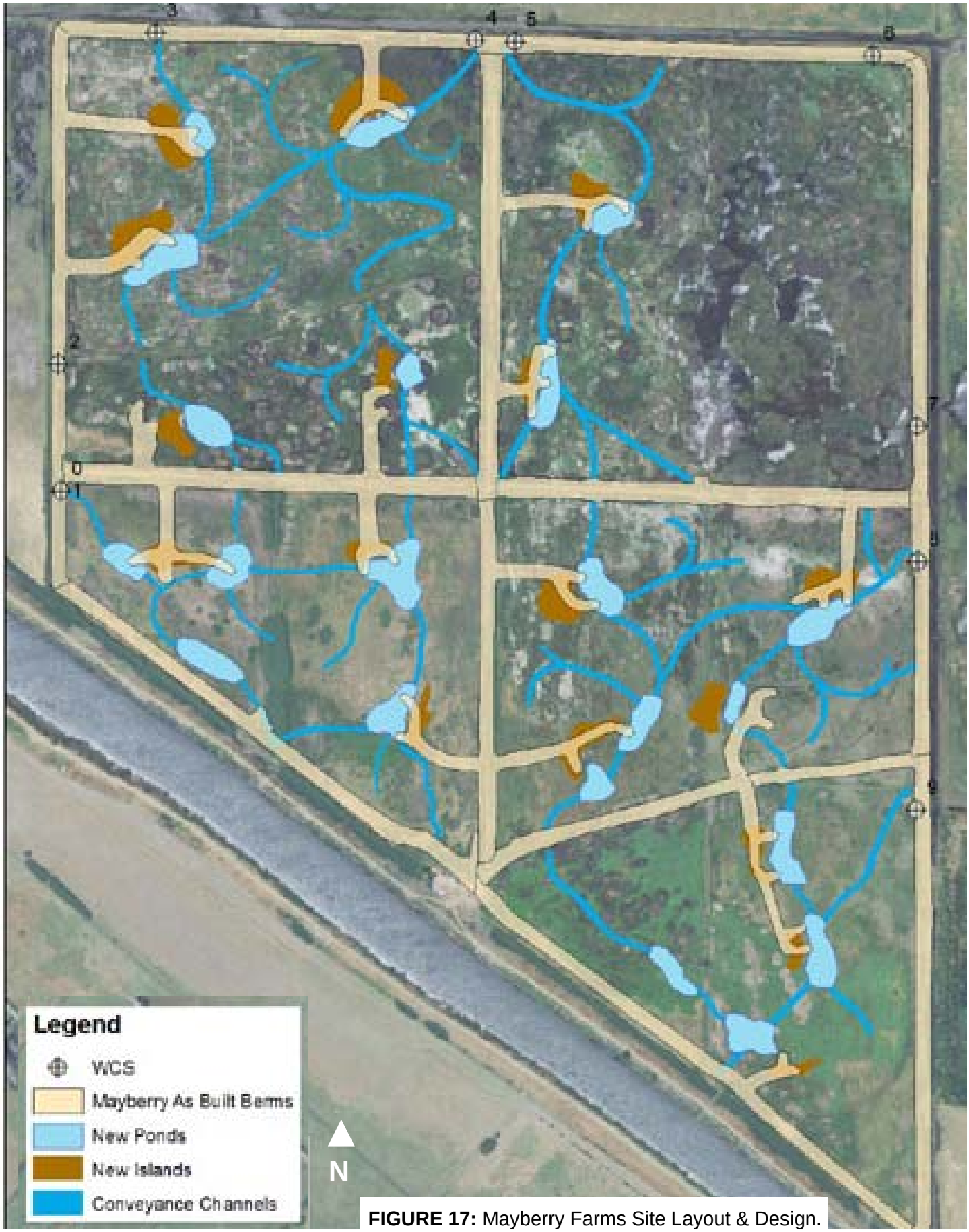


FIGURE 17: Mayberry Farms Site Layout & Design.

FIGURE 18: Wind Turbines, Hawks & Wetland Habitat.

FIGURE 19: Waterways within Mayberry Farms Sequestration Project.

CASE STUDY D:
NIMBUS HATCHERY & VISTOR'S CENTER

Location: 2001 Nimbus Road, Suite F, Gold River, California 95670
Contact Information: Jen Holley, (916) 358-2820
Date of On-Site Survey: Tuesday, April 23, 2013
Survey Participants: Richard Fisher, Ryan Whipple, Bradley Angell
Case Study Compiled by Bradley Angell

Site & Environmental Conditions of Case

Situated on the south bank of the American River in Gold River, California, the Nimbus Hatchery is operated by the California Department of Fish and Game to mitigate the loss of spawning habitat for California's salmon and steelhead fish populations (*See* **Figure 1**). Each year, the hatchery produces over four million Chinook salmon and 430,000 steelhead trout. The hatchery is open to the public throughout the year, operated from a 14.3 acre site that houses a visitor center, weir, ½ mile trail along the American River, three raceways, fish ladder and four holding ponds.

Nimbus Hatchery & Visitor's Center

CAPITAL COST (Total):	$1,000,000 (1955)
OPERATING COST (Total):	$1,400,000 per year (2012)
ORGANIZATION TYPE:	CA Dept of Fish & Game (Public Agency), Leased from the U.S. Bureau of Reclamation
USER CAPACITY:	Maximum at one time: 20,000 visitors; Typical over the year: 1 million – 1.4 million
ANNUAL GROSS REVENUE:	Hatchery and all visitor operations are free to the public. All potential proceeds from fish harvesting are donated to soup kitchen charities.
ANNUAL NET REVENUE:	*See above*.
Project Details	
LOT SIZE:	14.3 acres
BUILT ENVIRONMENT:	25,700 sq.ft. total 8,700 sq.ft. public
IMPROVED AREA:	12.5 acres

TABLE 8. Nimbus Hatchery Case Study Details.

Of the 27,700 square feet of built environment on the site, the visitor's center is an 8,700 square foot facility (*See* **Figure 20**). The hatchery is immediately downstream of the Nimbus Dam, a major blocking agent faced by spawning anadromous fish returning to the region on an annual basis. Adjacent to the Nimbus Hatchery is the American River Trout Hatchery, also run by the California Department of Fish and Wildlife. The American River Trout Hatchery is not open to the public and is employed to provide rainbow trout and kokanee salmon for stocking over 250 lakes and streams of Northern and Central California.

Unique Design Characteristics of the Nimbus Hatchery

The Nimbus Hatchery makes up an "L" shaped design based on vehicular, pedestrian and fish circulation necessary for the unique hatchery enterprise. At the east end of the hatchery is a large parking area for visitors. Connecting the American River to the hatchery at the east end, there is a weir and fish ladder (*See* **Figure 22**), an imperative part of harvesting salmon and trout for fry production. Running west from the weir is a

long riparian pedestrian trail used extensively for the exhibition of fish activities. In the near future, outdoor theatre seating shall be installed on west endpoint of this trail to allow classroom style teaching and evaluation for large groups of school children and research groups (*See* **Figure 27**).

Running on a north-south axis immediately south of the weir, three 400+ foot raceways occupy the majority of the built environment required for hatchery operations (*See* **Figures 23, 24**). Especially important for our investigation is the size and scale of the hatchery's visitor facilities, made up of a campus that includes the previously discussed pedestrian path, the visitor's center, and an expansive salmon-themed playground for schoolchildren. The pedestrian path runs nearly a ½ mile along the American River on a mixed terrain of decomposed granite, rock and compacted dirt. The visitor's center is accessed from the parking lot after meandering a forebodingly fenced yard, herding visitors on a brutal hardscape of 1950's era concrete and gravel (*See* **Figure 23**). Once the entrance is finally found, the interior of the visitor's center is welcoming and domestic, measuring at over 8,000 square feet with audio-visual instruction, presentation sculptures, and helpful docents. Due to the truth that the overwhelming majority of visitors are school children, most materials are aimed at teaching students, between the ages of 8 and 15 the operations, purpose and intrigue of the hatchery.

On the east end of the visitor's center begins a rectangular recreational yard employed for instruction, entertainment and mealtime organization for school children. This yard has an area of 9,000+ square feet, and at 1/5 of an acre, the space can be overwhelmed with chaos when a series of groups occupy the hatchery (*See* **Figure 25**).

Construction & Maintenance Costs of the Nimbus Hatchery

Construction of the Nimbus Hatchery was complete on October 17, 1955, costing just over $1 million. The project was designed and installed so as to mitigate the damming of the American River first at the Nimbus Dam site, and then at Folsom Dam. Although fish stocks were expected by contemporaneous biologists to be replenished in the five years following dam installation, the federal government has since opening paid the State of California for all operational costs involved with executing the Hatchery's mission of propagating steelhead and salmon fry for release in Northern California. Today, the annual operating budget is approximately $1.4 million.

While on-site, discussions with the Hatchery's staff brought to the investigator's attention the self-reliant approach the facility employs for operational maintenance. Most improvements, repairs and unforeseen "environmental" problems are remedied with employment of an on-site staffed fabrication shop. This approach both bolsters agency resilience and provides an unfortunate internal limitation on design options for improving the facility in terms of its day-to-day operations.

User Capacity, Staff and Function of the Nimbus Hatchery

Since the year 2000, the Nimbus Hatchery has hosted at least 1 million visitors per calendar year. The maximum-in-one-day number of patrons arrive each year at the Salmon Festival in early September, where 20,000+ attendees witness the hatchery's operations all at once. The fall is especially dramatic as salmon ascend the ladder from the river to spawn and fertilize based on selection by trained staff and volunteers. Paid staff operations at the Nimbus Fish Hatchery are undertaken by 11.5 permanent employees, a crew that execute both the fall-run salmon and winter steelhead programs.

Opportunities for Application on Sherman Island

Initially, the research team sought a review of the Nimbus Hatchery to investigate the methods and facilities necessary for a large-scale hatchery. Although that function was important, upon reviewing the facility, it is clear that the visitor center presents an important aspect of project application for the SIDP. The hatchery itself appears outdated in contrast to contemporary open water and less brutalist techniques methods of rearing fry for release into the waters of Northern California. The visitor's center function of the hatchery, in contrast, has evolved over the past half-century to both allow for fish-rearing operations and act as a central educational tool for communicating their efforts and the organization's mission.

Due to the importance of creating conservation programs as set forth by the Bay Delta Conservation Plan, the Nimbus Hatchery provides an important "total project" perspective on staffing, potential funding sources, the intended audience, and operational methods for longevity. In combination with contemporary open-water methods of fish rearing, the Nimbus Hatchery's evolving system of managing staff, visitors, budget and operations is insightful in the development of an adaptive project for Sherman Island.

References

Primary sources for this evaluation came from the site survey conducted by Ryan Whipple, Bradley Angell and Richard Fisher on April 23, 2013. Additional resources were found after the survey and include:

Nimbus Fish Hatchery Steelhead Program Report [http://cahatcheryreview.com/] , California Hatchery Review Project, Appendix VIII, California Hatchery Scientific Review Group (California HSRG), Sacramento, California: June 2012.

Brown, Randall L., *Nimbus Salmon and Steelhead Hatchery: The First 50 Years of Chinook Culture with a Note on Steelhead* [cahatcheryreview.com/wp-content/uploads/2012/08/Brown-2006.doc], Water Forum, Sacramento, California: March 2006.

FIGURE 20: Nimbus Hatchery & Visitor's Center.

FIGURE 21: Visitor's Center Interior.

FIGURE 22: Massive Fish Ladder to Harvest Spawning Fish.

FIGURE 23: Brutalist Approach to Fish Rearing.

FIGURE 24: Raceways Employed for Fry Development.

FIGURE 25: Visitor's Outdoor Yard.

FIGURE 26: Sign-Boards Along Improved Visitor Walkways

FIGURE 27: Site of Future Expansion.

CASE STUDY E:
RIO VIENTO RV PARK WIND TURBINE

Location: 4460 W. Sherman Island Road, Rio Vista, CA 94571
Contact Information: Tony DeMattei, (925) 382-4193
Date of On-Site Survey: Sunday, April 21, 2013
Survey Participants: Richard Fisher, Ryan Whipple, Bradley Angell
Case Study Compiled by Richard Fisher

Site & Environmental Conditions of Case

Located at the Eastern Edge of Sherman Island, the Rio Viento RV Park offers camping accommodations for those hoping to enjoy the best wind surfing California has to offer. Just across the Sacramento River from the Sacramento Municipal Utility District's Montezuma Hills Wind Farm, it is no wonder that the park's owner Tony DeMattei saw the potential of harnessing local wind to produce electricity and offset the RV parks electricity demands. The RV Park is equipped with a medium sized wind turbine that meets 75% of the RV Park's energy needs and has become an icon for the campus. The site layout of the Rio Viento RV Park is outlined in **Figure 32** with the location of the wind turbine marked with a caption.

Rio Viento RV Park's Wind Turbine

CAPITAL COST (Total):	$ 130,00 (2007)
OPERATING COST (Total):	$ 2,800
ORGANIZATION TYPE:	The turbine is owned by Rio Viento RV Park as an infrastructural asset.
USER CAPACITY:	The RV park feature 71 sites for RVs and camping.
ANNUAL GROSS REVENUE:	The turbine has been designed and managed so as to provide 75% of on-site utilities. Energy production offsets $ 14,196 worth of electricity each year.
ANNUAL NET REVENUE:	As a net metered site no revenues are directly earned. Secondary economic benefits flow from cost stability and the improved reputation garnered from using sustainable energy.
Project Details	
LOT SIZE:	9.78 acres
BUILT ENVIRONMENT:	9.78 acres
IMPROVED AREA:	71 sites, 35 feet wide by 50 feet deep with 22 foot wide by 45 foot deep parking areas. Each site includes a 50 amp hook up (75% of the electricity is provided by the Vestas V17/90 turbine).

TABLE 9. Rio Viento RV Park Wind Turbine Case Study Details.

Construction

The Rio Viento RV Park purchased the Vestas V17/90 from Halus Power Systems, a supplier specializing in re-manufactured turbines capable of a production range between 5 and 500kW. It took approximately one year for Halus to complete in-house engineering and installation of the turbine. The permit for the project was granted over the counter and did not require a public hearing. The tubular tower was constructed in three 24.6 foot (7.5 meter) sections bolted together for total height of 73.8 feet (22.5 meters). With the addition of the foundation and the turbine rotors, the total height of construction is roughly 100 feet (30 meters). The foundation was designed specifically to

support the 12.82 tons turbine and tower while accommodating the unique circumstances of the underlying soft peat soil characteristic to Sherman Island. **Figure 30** exhibits the as-built dimensions of the wind turbine.

Tower		**Rotors**	
Type:	Tubular	Number of Blades:	3
Height:	22.5m	Rotor Diameter:	17 m
Weight:	5600 kg	Rotational Speed (synchronous) @ Air Density 1.06 kg/m^3:	50.19 RPM 39.52 RPM
Surface:	Hot-galvanized and painted	Material:	Glass Fiber reinforced Polyester
Generators		Airfoil:	NACA 44
Type:	Induction generators	Swept Area:	227 square meters
Main Generator:	110kW, rated power 90kW	Tip Brakes:	Centrifugal force activated
Small Generator:	2kW, rated power 19kW	Rotational Speed @ 90kW:	50.94 RPM
Voltage:	480 V AC	Rotational Direction:	Clockwise
Rotational speed (synchronous):	1200 RPM		
Frequency:	60Hz		

TABLE 10. Vestas Wind Turbine Specifications.

Technical Specifications

The Vestas V17/90 is a horizontal-axis wind turbine with three blades, a fixed pitch rotor that operates upwind of the tower. Rated at a nominal power of 90 kW, the turbine's rotor diameter is 56 feet (17 meters), resulting in a sweep area of 745 square feet (227 square meters). The blades are stall regulated and the rotor can run at two different low speeds depending upon which generator is engaged. The speed-increasing gearbox is a parallel shaft and the twin generator system consists of one large and one small generator connected by a V-belt drive transmission. Both generators are asynchronous and run at a constant rpm allowing them to be directly connected to the utility service at 380-400V AC. The wind turbine is also equipped with an active electric drive yawing system and control unit that can be based on either electro-magnetic relays or microprocessor chips. **TABLE 9** shows the technical specifications for the blades, tower and generators.

Operation and Maintenance

The Vestas V17/90 is rated at 90kW and therefore has a theoretical annual energy production of 788,400 kWh. According the Tony DeMattei, the Vestas V17/90 produces approximately 140,000 kWh per year which supplies approximately 75% of the RV Park's usage, thereby performing at an 18% efficiency. This efficiency occurs because field conditions always vary from theoretical ideal conditions. **TABLE 11** shows the some key operational data for the Vestas V17/90. The cut-in speed is the speed at which the turbine begins producing electricity; this model does not produce electricity at any wind speed below 8.9 mph (4 meters per second). At a wind speed between 34.9 mph (16 m/s) and 58.0 mph (26 m/s), the Vestas V17/90 should operate at rated peak, or in other words, at its theoretical peak. Proper maintenance can extend the life of the turbine and reduce repair costs later in the turbine's life. Basic reoccurring maintenance includes monthly greasing of bearings, checking oil levels in various components, and conducting safety checks.

Cut-in windspeed	8.9 mph (4 m/s) +, - 10%
Rated Windspeed (90kW)	34.9 mph (16 m/s)
Cut-out Windspeed	58.0 mph (26 m/s) +, - 5
Survival Windspeed	112.0 mph (50 m/s)

TABLE 11. Vestas Wind Turbine Operational Data.

Economics Analysis

The cost for design and installation was approximately $90,000 for the turbine and $40,000 for the foundation. The project was completed without incentives or rebates, and according to the owner the turbine has paid for itself within the past 6 years. Using the information provided in the operational manual, maintenance costs can be estimated at approximately $0.02 per kWh produced. With a total upfront cost of $130,000 and a reoccurring maintenance cost of $2,800 per year, a payback schedule can be produced to check the owner's payback claim. Further, such a schedule included here assumes the avoided electricity cost is based on the 2012-2013 commercial cost of electricity in California as shown in **TABLE 12**. Based on this data, the payback period for the Vestas V17/90 is nine (9) years. The variability between this calculation and the Rio Viento's actual payback period can be attributed to variable energy production, as well as the variable cost of electricity both spatially and temporally. In any case, the turbine easily pays for itself well within its 20+ year life span, most likely paying dividends for the owner.

Opportunities for Application on Sherman Island

The Vestas V17/90 wind turbine at the Rio Viento RV Park evidences precedence for the functionality, construct-ability, and economic feasibility of farming wind on Sherman Island. Therefore, incorporation of a limited number of wind turbines within a greater system of energy production provides another unique opportunity for multi-use land management. This case study demonstrates the ease of design, permitting, construction, relative economy, and maintenance for at least a single wind turbine on Sherman Island. Applied to the SIDP site, the wind turbine or a wind farm could be used to produce electricity for either an off-grid or grid-connected system in either a communal setting or to generate revenue locally on the island.

State:	California			Cost of Vestas V17/90	$ 130,000
Residential				Cost of Usage for California per KWh	$ 0.1214
$	0.1577	$	0.1510	Annual Grid Connected Energy Cost	$ 16,996
Commercial					
$	**0.1214**	$	0.1190	Cost of O&M	2%
Industrial				Annual Expected Output (kWh/y)	140,000
$	0.0987	$	0.0976		
Transportation				Annual Energy Cost Reduction	$ 16,996
$	0.0726	$	7.8500	Annual O&M	$ 2,800
All Sectors				Total Annual Cost Savings	$ 14,196
$	0.1305	$	0.1267	**Years to Payback**	**9.16**

TABLE 12. Average Cost & Payback Schedule for Vestas V17/90.

References

Primary sources for this evaluation came from the site survey conducted by Ryan Whipple, Bradley Angell and Richard Fisher on April 22, 2013. Additional resources were found after the survey and include:

Vestas V17-90 Operations & Maintenance Manual, [ftp://ftp.aidea.org/RENEWABLE%20ENERGY%20FUND/Round%206%2009242012/966_High-penetration%20Wind%20Energy%20Project-%20Kokhanok/Kokhanok%20OEM/Volume_1/9.0%20Turbine%20Information/9.001%20Vesta%20O&M.pdf] Vestas Wind Turbines, Aarhus, Denmark: 2011.

Electricity, Independent Statistics & Analysis, [http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_0] U.S. Energy Information Administration, U.S. Department of Energy, Washington, D.C.: 2013.

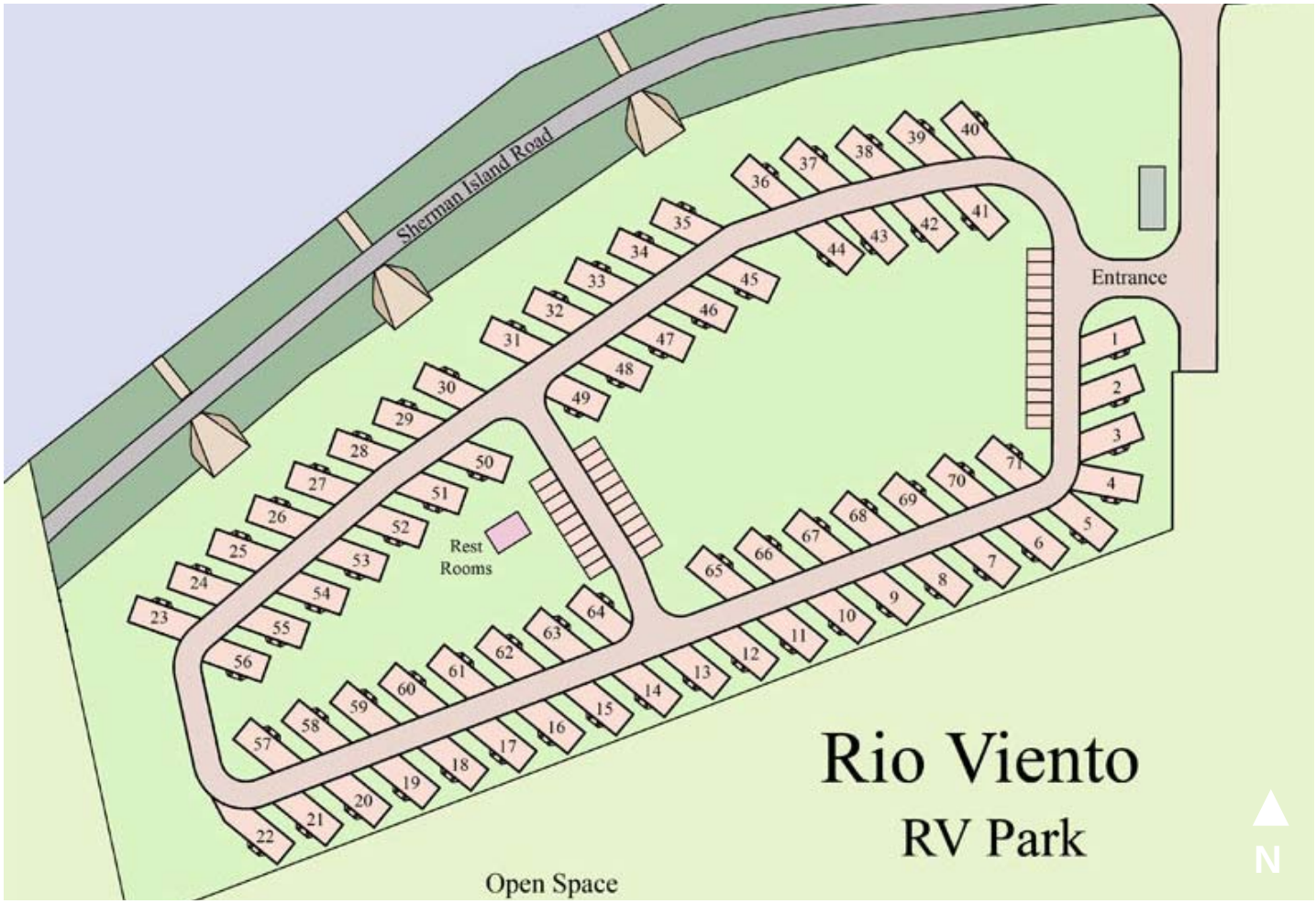


FIGURE 28: Rio Viento RV Park Site Layout.

FIGURE 29: View at Entrance to Park.

FIGURE 30: Medium-Scale Vesta Wind Turbine on Site.

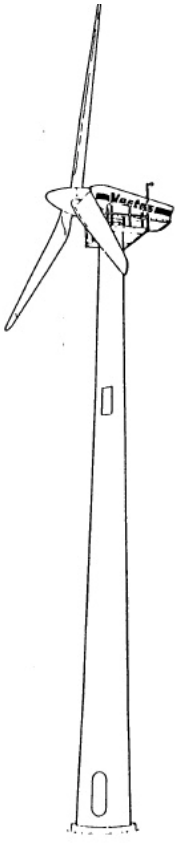


FIGURE 31 (left): Rendering of Turbine.

FIGURE 32 (above): Aerial View of RV Park.

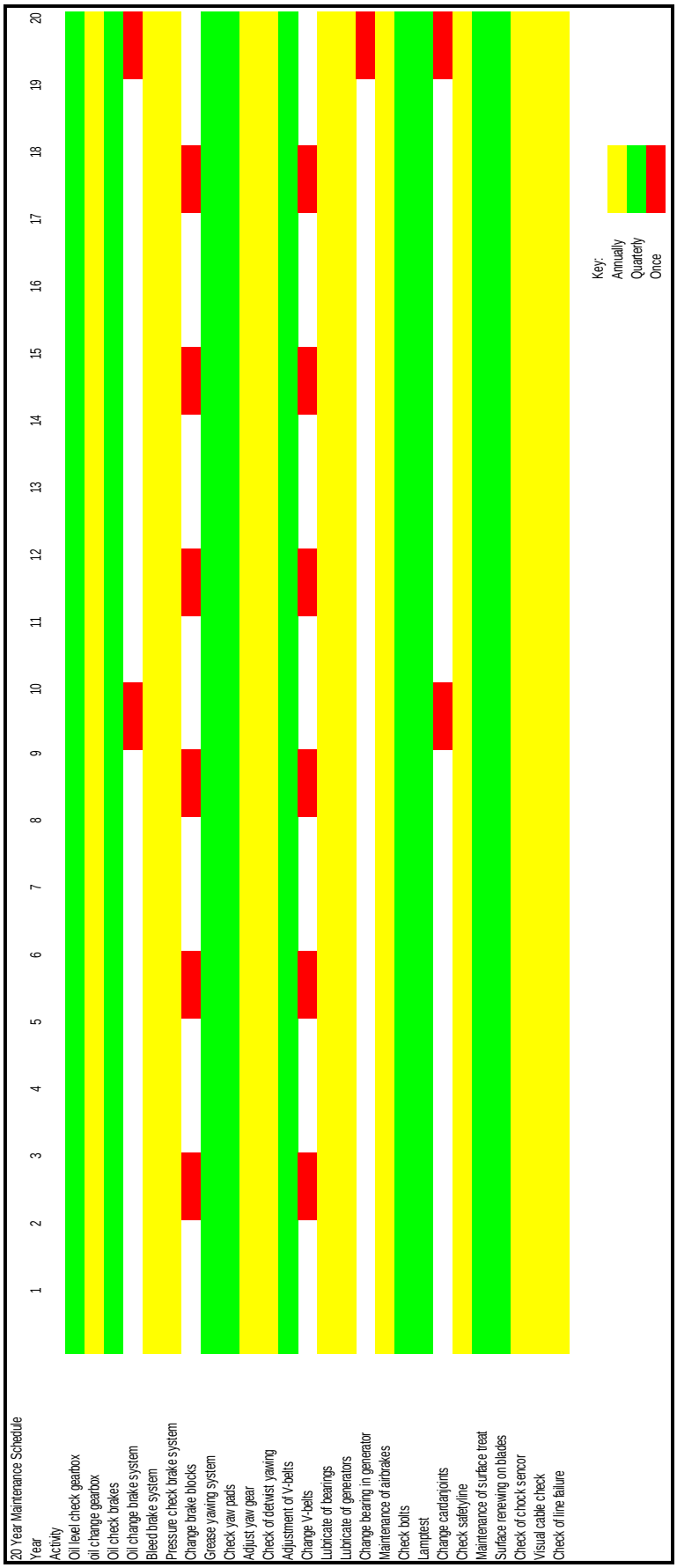


FIGURE 33: 20 Year Maintenance Schedule.

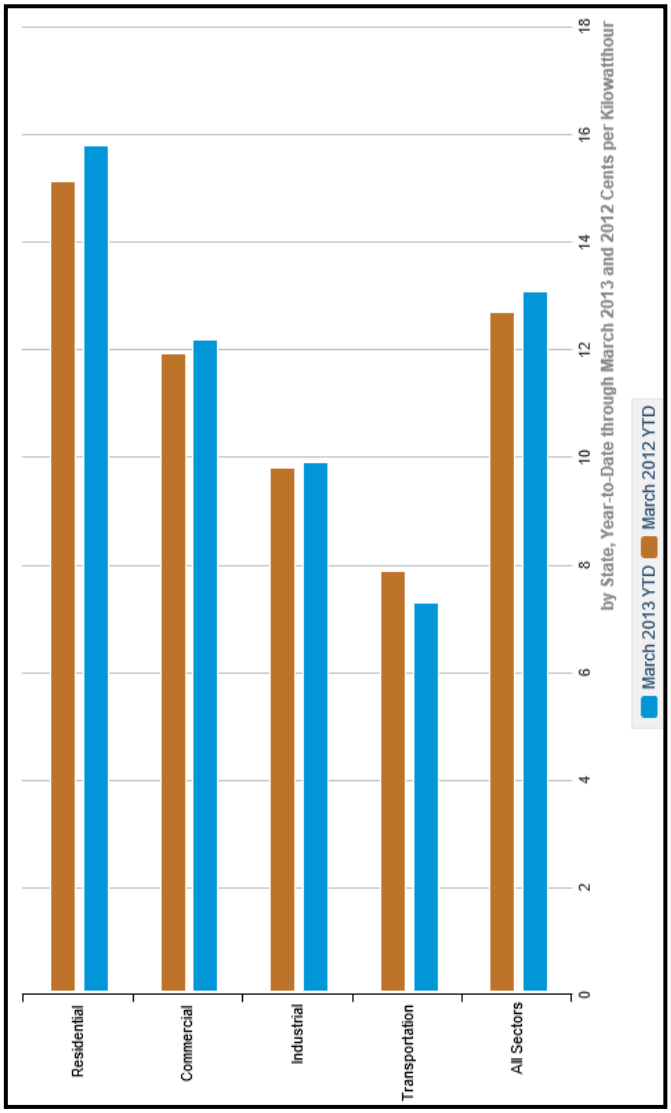


FIGURE 34: Cents per Kilowatt, Year to Date.

CASE STUDY F:
SHERMAN LAKE MARINA

Location: 5140 W. Sherman Island Road, Rio Vista, CA 94571
Contact Information: Robert Vallier, (925) 978-2894
Date of On-Site Survey: Sunday, April 21, 2013
Survey Participants: Richard Fisher, Ryan Whipple, Bradley Angell
Case Study Compiled by Ryan Whipple

Site & Environmental Conditions of Case

Sherman Lake Marina borders the northwestern edge of the project site, at the mouth of Mayberry Slough. The approximately 3.06 acre property is owned by the California Department of Water Resources [hereafter "DWR"], managed by the California State Lands Commission [hereafter "SLC"] and operated privately by Robert (Bob) and Mable Vallier, Trustees of the Vallier Living Trust. With clear skies during the summer, strong winds, high temperatures, low humidity, and direct access to both the Sacramento and San Joaquin Rivers, Sherman Lake Marina provides a perfect vantage point for a host of river-based recreational activities. The services provided to both short term and extended visitors include but are not limited to: marina berths, RV camping, fishing, kite surfing, tour guidance and convenience store shopping.

Sherman Lake Marina

CAPITAL COST (Total):	$ 2,882 per year (lease adjusted annually by the California Consumer Price Index and the State)
OPERATING COST(Total):	Operating costs are not known at this time.
ORGANIZATION TYPE:	The land itself is owned by the CA DWR, and managed by the CA SLC, however the marina boat slips, convenience store, and RV camping spots are managed and operated privately by Robert and Mable Vallier.
USER CAPACITY:	The site is used year round, with a heavy influx of kitesurfers during windy summer months, and fishers in the winter as winds die down.
ANNUAL GROSS REVENUE:	Neither annual gross revenue or annual net revenue is known at this time. The Sherman Lake Marina has been
ANNUAL NET REVENUE:	in operation under the current operators since 2007.
Project Details	
LOT SIZE:	3.06 acres
BUILT ENVIRONMENT:	42-berth commercial marina, a gangway for handicapped access, a 100-foot wooden breakwater, and parking used for vehicles and 17 RV parking spaces including water, electrical and sewer hookups.
IMPROVED AREA:	3.06 acres

TABLE 13. Sherman Lake Marina Case Study Details.

Private Operator – Public Owner Relationship

To protect water interests throughout the state of California, and to provide flood management throughout the Delta region, many islands are owned at least in part by DWR. Where commercial, agricultural or recreational opportunities are available and possible, DWR leases the property back to adjoining property owners. Bob, proprietor of Sherman Lake Marina, owns 30 acres of land on the western edge of Sherman Island. Through this ownership right, DWR can and has leased adjoining lands as necessary for

Bob's interest in the property. While much of Sherman Lake Marina is owned outright by Bob, the area that hosts camper facilities and other outdoor activities is actually leased from DWR. Also, as private operator, Bob is responsible for installing services that improve the property's suitability for improved use.

Lease History

On October 17, 1995, the SLC authorized a 25- year General Lease – Commercial Use to Allan and Peggy Martin for an already existing 42-berth commercial marina, convenience store and adjacent parking spaces. On December 16, 1998 the SLC then authorized the re-assignment of the lease to the River Island Land Company. Then in June of 2007, the SLC authorized the assignment of the lease to Robert P. Vallier and Mable R. Vallier, Trustees of the Vallier Living Trust, dated July 10, 1996. As part of the transfer in lease, a proposed amendment was added for the new operators to remove a 125-foot long vessel on site that was to be used as a floating restaurant. On February 22, 2013, a quitclaim deed was authorized and a new, 20 year General Lease – Commercial Use was authorized for the Valliers.

Lease Terms, Considerations, and Provisions

The current lease began on February 22, 2013, and has a 20 year term. The yearly consideration is $2,882 per year, adjusted annually by the California Consumer Price Index. Under the lease, liability insurance is required with coverage of no less than $1,000,000, as well as a surety bond requirement in the amount of $20,000. The Lessee is also required to implement the SLC's "Best Management Practices (BMPs) for Marina Owners/Operators" and encourage the implementation of the SLC's "BMPs for Berth Holders and Boaters," including additional BMPs the SLC subsequently deems appropriate for either of the above categories. The Lessee shall provide the SLC, on the first anniversary of the lease and on every third anniversary thereafter, a report on compliance with all BMPs.

Opportunities for Application on Sherman Island

Since Sherman Lake Marina is directly northwest and adjacent to the proposed SIDP site and is dependent on revenues generated from its 42-berth marina, it is an applicable model for a potential floating revenue generating system within the project site, under the same environmental, ownership, and economic conditions. More research is necessary to conceptualize the operations and maintenance costs associated with boat slips in later development of a realistic model. Moreover, Robert and Mable Vallier are potential operators as their property is directly adjacent to the proposed project site and are veterans of the private operator – public owner relationship arrangement.

References

Primary sources for this evaluation came from the site survey conducted by Ryan Whipple, Bradley Angell and Richard Fisher on April 22, 2013. Additional resources were found after the survey and include:

Acceptance Of A Lease Quitclaim Deed And Issuance Of A General Lease - Commercial Use [http://archives.slc.ca.gov/Meeting_Summaries/2013_Documents/02-22-13/Items_and_Exhibits/C33.pdf], State Lands Commission, Sacramento, California: February 22, 2013.

Assignment and Amendment of Lease, [http://archives.slc.ca.gov/Meeting_Summaries/2007_Documents/06-28-07/Items/062807C20.pdf], State Lands Commission, Sacramento, California: June 28, 2007.

FIGURE 35: Aerial View of Sherman Lake Marina.

FIGURE 36: Sherman Lake Marina Office & Store.

FIGURE 37: Sherman Lake Marina.

FIGURE 38: Access & Management Point of the Mayberry Slough.

FIGURE 39: Sherman Lake Marina Camper Services.

CASE STUDY G:
YOLO BYPASS WILDLIFE AREA

Location: Between the California cities of West Sacramento and Davis, the Yolo Bypass is north and south of Interstate 80 between Tule Jake Road (east side) and Levee Road (west side), of Yolo and Sacramento Counties.
Contact Information: *N/A*
Date of On-Site Survey: *N/A*
Survey Participants: On-site s*urvey has not been conducted by team*
Case Study Compiled by Bradley Angell

Site & Environmental Conditions of Case

The Yolo Bypass has an extensive history on the west side of Sacramento, created as the principle component of the Sacramento River Flood Control Project in diverting flood waters from north of Sacramento directly to the SSJD (Sacramento-San Joaquin River Delta). Bifurcated by Interstate-80, the bypass begins at the Fremont Weir north of I-80 and ends 41 miles south at the Egbert Tract. To maintain the utility of the Sacramento River Deep Water Ship Channel and avoid flooding caused by the Sacramento River within the urban watershed, the Yolo Bypass has been employed since the early 1900s to divert winter flows through agricultural and otherwise open lands. Due to this regular, seasonal flooding on such a large area of the Central Valley, the conditions within the Yolo Bypass closely resemble historic wetland, habitat and stream flow conditions that were ubiquitous of California before the Gold Rush of 1849.

Yolo Bypass

CAPITAL COST (Total):	Value difficult to ascertain due to nature of project
OPERATING COST (Total):	$ 801,000 per year for wildlife area only (2006)
ORGANIZATION TYPE:	Managed by the CA. Reclamation Board with controlling conservation easements. Wildlife functions are performed by the CA. Dept. of Fish & Wildlife. Most of the property in the flood control district is privately owned, but limited by easement.
USER CAPACITY:	Approximately 27,000 on an annual basis (wildlife area only)
ANNUAL GROSS REVENUE:	Yolo Bypass activities concerning conservation are funded with land trust banking payments and other government programs. No business-oriented fees are collected or revenues generated from on-site operations directly.
ANNUAL NET REVENUE:	*See above*.
Project Details	
LOT SIZE:	59,000 acres
BUILT ENVIRONMENT:	Sundry agricultural and habitat conservation outposts exist on the large site.
IMPROVED AREA:	16,700 acres designated wildlife area; majority of site area has been developed either for agricultural, recreational (hunting), or for habitat conservation purposes and is privately owned.

TABLE 14. Yolo Bypass Case Study Details.

Although today's Yolo Bypass continues to have its principle purpose in flood control,

since the late 1990s this large area of regularly inundated land has become a model of habitat conservation, stakeholder cooperation, agricultural use and integrated ecological management. In the past year, the Yolo Bypass has become a testing ground for integrating agricultural production and fish rearing; specifically, allowing salmon fry to develop within flooded rice fields during the wet season (*See* **Figure 41**). So far, the amended natural setting has proven mutually beneficial to the farmer, biologist and fish.

Unique Design Characteristics of the Yolo Bypass

The Yolo Bypass is an immense infrastructural enterprise with a complex ownership and use program. Although flood control is the primary purpose of the Yolo Bypass, a growing family of secondary purposes for the controlled flood plain is exhibited on the site. Such uses include farming, wetland banking, bird habitat conservation, fish habitat conservation, and recently, integrated farm-fish habitat co-management. Due to the size and unique features of the bypass, a multitude of studies are possible within the same designated "Yolo Bypass" area. Perhaps most visible to the public, the Yolo Bypass Wildlife Area allows direct interaction on a pedestrian scale for Northern California residents to experience the property as a unique natural resource.

Construction & Maintenance Costs of the Yolo Bypass

Construction costs for the Yolo Bypass in its iterative process of development since the late 19th century until the present date are beyond the scope of our study. In further development of this case under study, a chronological account of capital improvement costs would be helpful for study. In addition, deciphering the "end" intention of such capital improvements shall be categorically defined and examined for success. In its most current iteration, the Yolo Bypass Wildlife Area did receive an $8 million federal grant for wetland conservation activities. Further, in the same study, the estimated operational costs for necessary personnel were estimated at $801,303 per year. Continued enhancements and operational improvements have a variety of federal, state, local and private sources for monetary backing as it concerns the Yolo Bypass. This diverse spread of financial opportunities and potential directions for land use on the site create for the researcher a difficult framing of specific construction and maintenance costs for the Yolo Bypass on the whole.

User Capacity, Staff and Function of the Yolo Bypass

Based on numbers compiled in 2008, over 3,000 hunters visit the Yolo Bypass each year to harvest bird wildlife. The wildlife area has a multitude of other programs for visitors that draw thousands of students as well as those that are interested in the ecological development of the large area. Birders, hikers, fishermen, bird hunters, and biology enthusiasts frequent the area more often now that the project is proving increasingly successful in the integrated management of agricultural, public and ecological resources.

The Yolo Bypass Wildlife Area has a meager staff of four permanent employees and five part-time employees. Their job descriptions include Senior Biologist Supervisor, Wildlife Biologist, Wildlife Habitat Supervisor II, Wildlife Habitat Supervisor I, Wildlife Habitat Assistant, Tractor Operator, Fish & Wildlife Technician, Fish & Wildlife Interpreter II, Fish & Wildlife Interpreter I, and an Office Technician.

Opportunities for Application on Sherman Island

Due to the importance of creating unique fish conservation programs in the Bay Delta Conservation Plan, the Yolo Bypass provides an important lesson in the development and management of the SIDP site. In combination with contemporary open-water

methods of fish rearing, the aim of meeting multiple stakeholders' desires within a single large property provides key design attributes for the success of Sherman Island project's expression of natural, conservation, landscape and built environmental components.

References

Yolo Bypass Wildlife Area: Land Management Plan, California Department of Fish and Game [California Department of Fish and Game in association with EDAW], June 2008.

A Framework for the Future: Yolo Bypass Management Strategy, Final Report, CALFED Bay-Delta Program [Yolo Bypass Working Group, Yolo Basin Foundation & Jones & Stokes], August 2001.

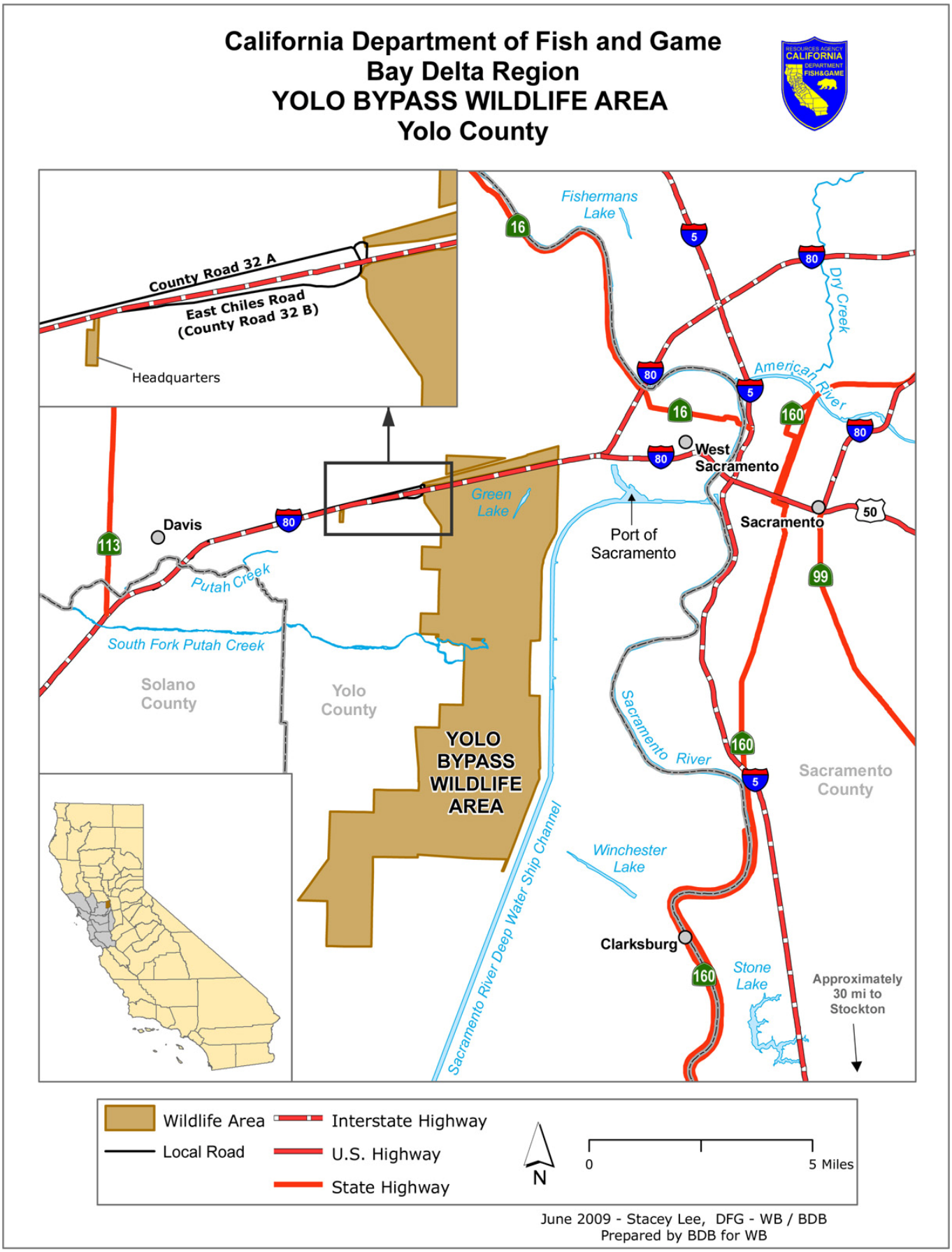


FIGURE 40: Yolo Bypass Wildlife Area.

Chapter 5. Conclusion

Completed November 2013

This document has from the outset been produced to create a conceptual foundation for designing an appropriate rehabilitative solution for Sherman Island. Although many of the proposed case ideas were initially rebuffed in theory by skeptical members on the design team, after review of working projects, many of such ideas became practical givens for development. An example of such a case was the floating solar array. Prior to literally witnessing Far Niente Winery's floating solar array, the concept of a buoyant electrical grid seemed near ridiculous to at least one of the researchers. After case review, the design team found that the cost, production value and applicability of this concept make for a near perfect fit for the Sherman Island Delta Project.

The fitting nature of many of the reviewed cases led the team to envision a greater number of applications for the project. In the following section, a series of *Cases of Future Interest* have been outlined based on an expanded view of what is possible on site. These cases include the Yolo Bypass as Integrated Flood, Agricultural & Wildlife Sanctuary; Hydroponics Floating Greenhouse; Floating Markets of Bangkok; Anaerobic Digestion Food Waste Processing Center; and the Floating Charter School of Lagos.

In the section immediately following the delineated *Cases of Future Interest*, an *Operations & Ownership Abstract* has been composed largely based on the relationships witnessed during the team's case study review. Since the inception of the Sherman Island Delta Project, the question of *who* and *how* will the project be executed has been of paramount concern for the specialist team. The in-depth review of each case has illuminated a full range of opportunities in execution that can be evaluated as the project reaches a status of appropriate design. Finally, a short *Future Work* section concludes the Report, outlining the immediate course of action necessary for the team in executing the Sherman Island Delta Project.

A. Cases of Future Interest

The following abstracts are "cases of future interest", in other words, projects that represent potentially fruitful design opportunities for the SIDP. These cases selected for future study were included due to the findings from past on-site visits by the team as previously enumerated. The following project inquiries include the Yolo Bypass Integrated Flood, Agricultural & Wildlife Sanctuary; a Hydroponics Floating Greenhouse Concept; the Floating Markets of Bangkok; an Anaerobic Digestion Food Waste Processing Center; and the Floating Charter School of Lagos.

CASE INTEREST V:
YOLO BYPASS AS INTEGRATED FLOOD, AGRICULTURAL & WILDLIFE SANTUARY

Location: Between the California cities of West Sacramento and Davis, the Yolo Bypass is north and south of Interstate 80 between Tule Jake Road (east side) and Levee Road (west side), of Yolo and Sacramento Counties.
Case Study of Interest Compiled by Bradley Angell

Although this case was covered briefly in the prior study description, an important aspect of current research and operations is important for development of the SIDP site. Recently, many of the farm plots within the Yolo Bypass – specifically rice fields – have been employed to raise and fatten salmon fries prior to release into the open waterways

of Northern California (*See* **Figure 1**). As fish conservation has become a defining aspect of the future development activities within the SSJD, these new methods of integrated farming and fish rearing could prove instrumental in the eventual design of a Sherman Island project.

CASE INTEREST W:
HYDROPONICS FLOATING GREENHOUSE CONCEPT

Location: Groundwork Hudson Valley maintains a Science Barge on the Hudson River in Yonkers, New York. The office address is at 22 Main Street, 2nd Floor, Yonkers, NY 10701.
Case Study of Interest Compiled by Richard Fisher

Current methods of terrestrial agriculture require large amounts of water, petrochemical fertilizers and pesticides, the majority of which are not absorbed by plants but leave the land via groundwater runoff. Water contamination and waste is greatly reduced in hydroponics systems since nutrients and water are recycled through a closed loop water recirculation system. The Science Barge on the Hudson River is a prototype sustainable urban farm developed by NY Sun Works and acquired by Groundwork Hudson Valley in October, 2008 to be operated as an environmental education center. The floating greenhouse grows fresh produce including tomatoes, melons, greens, and lettuce with zero net carbon emissions, zero pesticides, and zero runoff. All of the energy needed to power the Barge is generated by solar panels, wind turbines, and biofuels while the hydroponic greenhouse is irrigated solely by collected rainwater and purified river water (*See* **Figure 3**) This project demonstrates a unique opportunity for Sherman Island to grow crops while managing inputs and outputs to reduce environmental impacts and revive the once flourishing agricultural culture of the island.

CASE INTEREST X:
FLOATING MARKETS OF BANGKOK

Location: Scattered throughout Bangkok, Thailand. Major markets are at Amphawa, Bang Khu Wiang, Bang Nam Pheung, Damnoen Saduak, Khong Lat Mayom, Taling Chan, and Tha Kha Floating Markets.
Case Study of Interest Compiled by Bradley Angell

Many of the delta cities of the world have developed and thereafter relied upon waterways not only for providing water and transportation, but as places of market congregation. Most monumental in expressing this practice of "water as open marketplace" are the Thai of Bangkok. For generations, Bangkok residents have used the cannels of their bustling city to park and sell fresh produce, wares and seafood (*See* **Figure 4**). In our team's development of a potential central location for a California Delta-centric social and economic activity "place", these Bangkok floating markets exhibit the special dimensions, necessary conditions and opportunities for creating water-borne open markets for local resident and tourists alike.

CASE INTEREST Y:
ANAEROBIC DIGESTION FOOD WASTE PROCESSING CENTER

Location: At present, there are no direct examples of any barge-serviced

anaerobic digestion food waste processing center for case review. A terrestrial center that would be helpful in possible case study review is located at the Monterey Regional Waste Management District in Marina, California.
Case Study of Interest Compiled by Bradley Angell

Two movements in parallel have pushed anaerobic digestion to the forefront as an exploding niche of urban development (*See* **Figure 5**). The first movement is the Zero-Waste movement recently enacted into law in California. The second movement is the capture of biological waste for conversion into methane-based energy production. As food waste is a major component of landfill waste deposition, this category of refuse is a major target of future waste diversion activities by university campuses, municipalities, and regional governments. Further, as this food waste material can be used to harvest methane employing an anaerobic chemical process, it can prove lucrative for producing renewable energy direct to local power grids. Sherman Island is centrally located to both the San Francisco Bay Area as well as to Sacramento, therefore developing a processing center for food waste conversion is an option that requires further inquiry.

CASE INTEREST Z:
FLOATING CHARTER SCHOOL OF LAGOS

Location: Makoko Slum, Lagos, Nigeria.
Survey Participants: On-site s*urvey has not been conducted by team*
Case Study of Interest Compiled by Richard Fisher

Student disinterest, loss of critical thinking and problem solving abilities in the general public has led to education movements toward applied learning through hands-on science and exploration. A school with adjoining research lab within the Delta environment could provide unique opportunities for exploration and experimentation in the natural setting. The Makoko Floating School is a prototype floating structure, built for the historic water community of Makoko. Due to the innovative approach taken to address the community's social and physical needs while adapting to the impacts of climate change, this is a case study worth pursuing further. Its objective is to create a sustainable, ecological, alternative building system while promoting education for the teeming population of Lagos (*See* **Figure 6**).

FIGURE 1: Yolo Bypass Salmon Research Project.

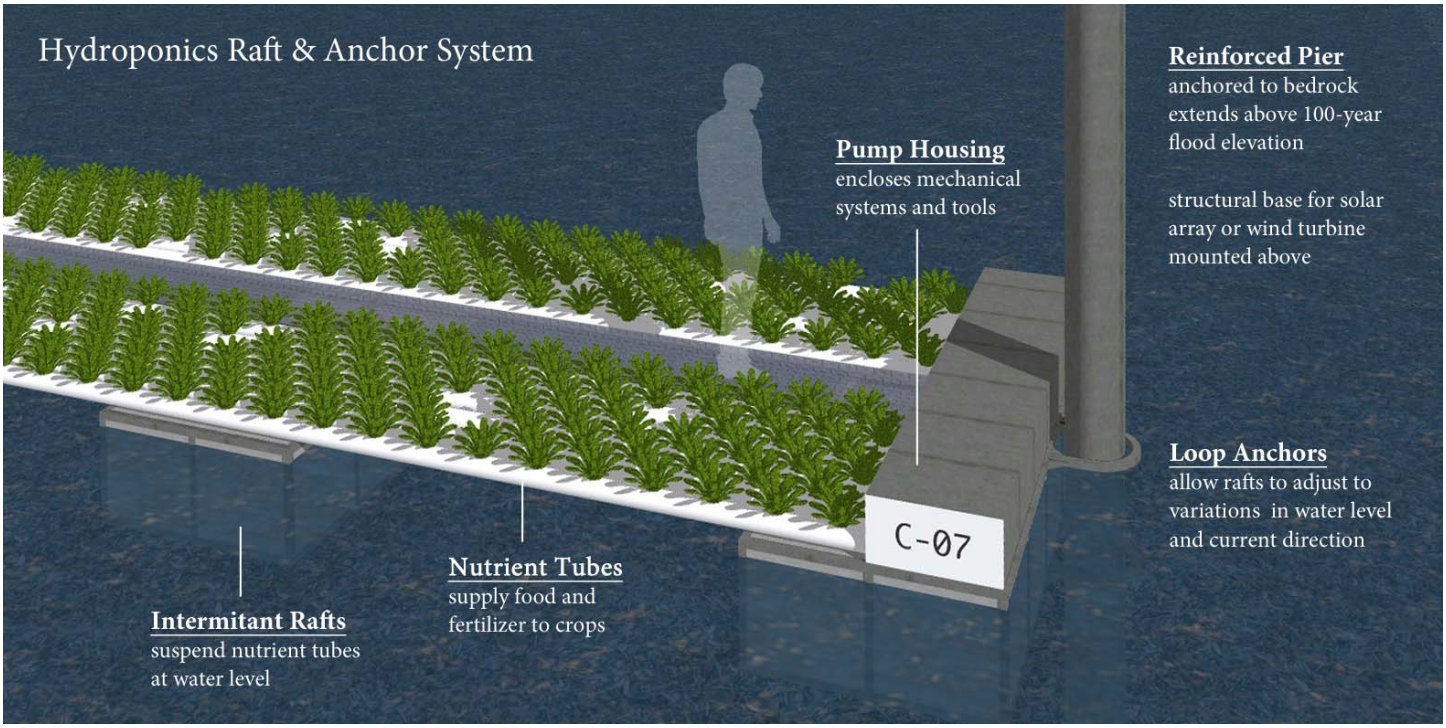


FIGURE 2: Conceptual Floating Hydroponic System for Sherman Island.

FIGURE 3: Science Barge on the Hudson River.

FIGURE 4: Famous Floating Markets of Bangkok.

FIGURE 5: Conceptual Anaerobic Digestion Facility Serviced by Delta Barge.

FIGURE 6: Makoko Floating School of Lagos, Designed by Kunle Adeyemi.

B. Operations & Ownership Abstract

Sherman Island, albeit neglected at this point in the evolution of the California Delta, is a special place. Due to its environmental settings and infrastructural importance in protecting the western United States' most precision resource, the island may require a special sort of operation and ownership scenario in balancing the necessity of large-scale water management, environmental remediation, and desperately needed economic development. Due to the demands of public oversight as well as the importance of private resource investment, a public-private partnership would be the typically assumed result for redeveloping Sherman Island in balance with stakeholder goals. In spite of this expectation, it is important in completing an adequate case study analysis to outline the full range of potential operation and ownership relationships, a series of scenarios that is discussed below and annotated in **Table 1**.

Operator	Owner	Applicable Case
Public Ca. Department of Fish & Wildlife	*Public* U.S. Bureau of Reclamation	Nimbus Hatchery & Visitor's Center
Private Sherman Lake Marina (Bob)	*Public* Ca. Department of Water Resources	Sherman Lake Marina
Private Far Niente Winery	*Private* Bank of America	Far Niente Winery Floating Solar Array
Public Ca. Department of Fish & Wildlife	*Private* Farmers/ Yolo Land Trust	Yolo Bypass Wildlife Area

TABLE 1. Operations & Ownership Demonstration Grid.

Generally, there are four operations-ownership relationships possible for the development of Sherman Island according to stakeholder goals. These four include a public operator-public owner relationship, a private operator-public owner relationship, a private operator – private owner relationship, and a public operator – private owner relationship. Fortunately, due to the depth of investigation undertaken in this case study report, all four relationships have been exhibited in prior case studies and can be summarized in reference to their previously discussed circumstances.

Public Operator – Public Owner

This first 'public operator – public owner' relationship type, the Nimbus Hatchery & Visitor's Center is demonstrative of the mechanisms of project development and maintenance. As mitigation for the detrimental impacts of both the Nimbus and Folsom Dams, the U.S. Bureau of Reclamation paid for both the capital improvements and annual operational budget for the Nimbus Hatchery. Due to their expertise and willingness to operate the facility, the California Department of Fish & Wildlife has since the opening of the facility solely operated the facility on behalf of the federal agency.

Private Operator – Public Owner

The less frequent, but still significant 'private operator – public owner' relationship is frequently used to maintain U.S. Bureau of Land Management and U.S. Forest Service properties throughout the western United States. As it pertains to the California Delta region, many of the islands are primarily owned by the California Department of Water Resources so as to assure full control in flood management. So as to superficially

maintain the agrarian, locally operated notion of these delta properties, where possible the DWR leases its property back to adjoining property owners for commercial, agricultural or recreational purposes. Of the cases profiled in this study, the Sherman Lake Marina is a telling example of this private operator –public owner relationship. Bob, the proprietor of the Sherman Lake Marina, personally owns thirty acres on the western edge of Sherman Island. Due to his ownership right on the island, the DWR has the right to lease adjoining lands as necessary for Bob's interest in the property. Even though much of the Sherman Lake Marina is owned outright by Bob, the area that hosts camper facilities, fishing and other outdoor activities is actually leased from the public state agency. As is common in such private operation – public ownership relationships, the private operator is responsible for installing services that improve the property's suitability for improved use. For example, the Sherman Lake Marina recently improved water services, extended electric meters and installed a new septic system on DWR properties so as to improve commercial opportunities on the publicly-owned land.

Private Operator – Private Owner

Perhaps the most common capitalist relationship of 'private operator - private owner' also has potential for the site, especially in the development of projects that require large-scale capital improvements which potentially provide long term, consistent returns on investment. As noted in the Far Niente Winery case study, electrical production projects like solar or wind turbine installation could allow for such a profit-oriented, yet environmentally progressive development.

Public Operator – Private Owner

Quite an uncommon but potentially fruitful operator-owner relationship is possible whereby public agents operate a project development over privately owned properties. The best example of this type of arrangement is at the Yolo Bypass just west of Sacramento, California. Farmers have sold their rights to intensely develop their property beyond an agricultural use to a local conservation trust, the Yolo Land Trust. As part of the development rights purchased by the Trust, the limited property rights holder has stipulated that extensive conservation efforts may be conducted on privately held properties, especially in the rainy season when farmland is regularly flooded. These conservation efforts are primarily spearheaded and managed by the California Department of Fish and Wildlife in conjunction with regional universities. During this flood season, migratory birds, ducks, and geese flock to the Yolo Bypass to eat and breed. As a bird and wetland habitat project, this arrangement has been dramatically successful. Currently, new studies are being conducted by the Department of Fish and Wildlife as to the success of future fish conservation projects that can occur during the farming season (*See* **Figure 1**). Employing the power of the conservation easement, private ownership could be promoted throughout Sherman Island all the while reserving the right of interested public agencies to manage for flood control, species conservation and other public interests.

C. Future Work

In conducing and documenting this case study report, the Sherman Island Delta Project team has discovered, verified, and dismissed a multitude of scenarios possible for the project site. Unwritten in this project paper is the importance of meeting and discussing the project with local residents, the commercial interests in the area, and public agency personnel that hold responsibility in providing for the safety, health and continued welfare of the state. In the Sacramento-San Joaquin River Delta region, this balance of the interests of flood control, a state-wide source of clean water, species conservation, and the Delta way of life necessitates uniquely original methods of project development and operation. Fortunately, the Sacramento-San Joaquin Delta is located in Northern California where uniquely original projects have become the norm for residents constantly shifting political resources to mitigate economic hardship, environmental challenges, and the difficulties of equitably distributing iterated bursts of good fortune.

Immediately after completing our reconnaissance in the field, new cases were identified for study. These new interests were outlined as *Cases of Future Interest*. Although the luxury of visiting each of these available sites is welcome, in truth, the project budget for this investigation will most likely require the design team to move forward with existing field knowledge and simply use traditional sources of research to reflect such indicated interests in upcoming documents as they are applicable. From this point, the SIDP team shall outline a suggested design for the project site according to the findings of the case. After such schematic design is complete, a feasibility study shall be undertaken to evaluate cost-benefit and environmental conditions of the selected course in proposed development.