
Napa River Flood Control Channel Design: Obstacles and Successes

Flood Control 2.0 - Flood Protection Project Case Study
San Francisco Bay Conservation and Development Commission
November 2016



Synopsis: Project Description (Project area and objectives)

The Napa River has 47 tributaries (FONR) covering a drainage area of 426 sq. miles from its headwaters near Calistoga down 55 miles into San Pablo Bay, an embayment of the San Francisco Bay. The Napa River watershed includes Huichia Creek, Carneros Creek, Browne Valley Creek, Redwood Creek, Dry Creek, Conn Creek, Rector Creek, Soda Creek, Sarco Creek, Tulluray Creek, Murphy Creek, Spencer Creek, Suscol Creek, Fagan Creek, American Canyon Creek, Lake Hennessey, and Rector Reservoir (Figure 2). The river is tidal up to about Trancas Street in the northern half of the city of Napa with the lower 17 miles of the river typically being estuarine. The tidal influence is greater in the summer due to limited freshwater flows from surrounding tributaries, however, large winter flows result in a more freshwater riverine environment over most of the river's area. The primary land use in Napa County is agriculture. Approximately 35% of the watershed is forest, 23% grassland/rangeland, and 19% is agriculture, and 8% of the watershed is developed land (residential, industrial, and commercial uses) (ABAG, 2000).

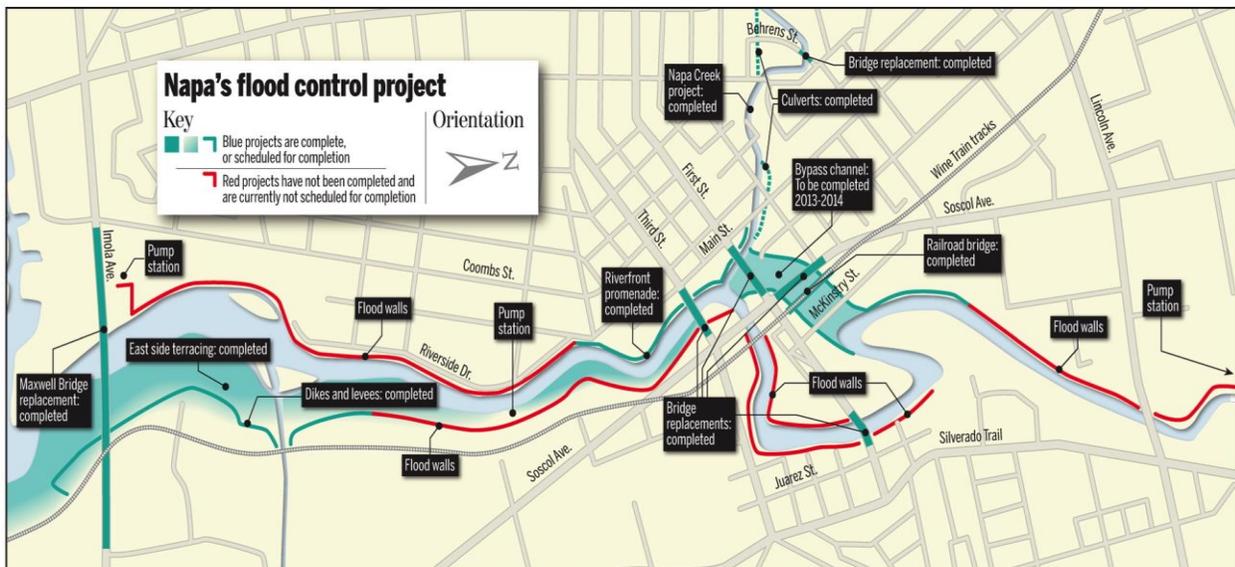
Urban development in Napa is concentrated along the Napa River within or near the river's natural floodplain. Winter storm events bring large volumes of rainwater rushing through the watershed. Often, the flash flood nature of the rain events occurs over a matter of hours, and provides little time for residents to take flood protection measures: resulting in large amounts of property damage and the need for federal recovery funds. In the area of the Napa River, major floods, such as a 35-year equivalent flood event, have caused an estimated \$100 million in damage (Stalker, 2013).

As a result of flood damage in the area, ideas began to surface in the 1970's about designing flood protection along the Napa River. The United States Army Corp of Engineers (USACE) created preliminary plans using traditional USACE flood control approaches: deepening the channel, straightening the channel, constructing a trapezoid channel, building levees and floodwalls to protect structures, and employing rip rap/concrete lined banks to enhance conveyance of water through the channel. Members of the local community (businesses, government, and residents) and Resource Agencies (The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), United States Department of Fish and Wildlife (USFWS), NOAA National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW)) formed a Community Coalition, which raised concerns about the preliminary plans for the Napa River and advocated for the inclusion of natural habitat features to the designs. After many negotiations between the Community Coalition and the USACE, the "Living River" design concept was adopted.

The Napa River and Creek Flood Protection (NRCFP) project "Living River" design provides flood protection to surrounding properties from a 100-year flood event through both built structures and the restoration of natural riverine habitats. The NRCFP project spans approximately seven miles of the Napa River from the Highway 29/121 Bridge to Trancas Street in the City of Napa and includes modifications to Napa Creek as well as areas other areas along the Napa River. The Environmental Impact Statement and Environmental

Impact Report (EIS/EIR) evaluated various project alternatives and the final approved project design was chosen based upon 100-year flood protection, geomorphic data, water quality objectives, incorporation of natural design elements, and enhancing/restoring habitat for wildlife. The “Living River” design accounted for differences in the estuarine and freshwater reaches of the River, an increased tidal prism, and utilized both built and natural solutions to provide 100-year flood protection and a multi-benefit project for Napa County. The first phase of construction began in 2000.

After 16 years of construction, the NRCFP is nearing the final stages of completion and has already proven to be a beneficial project. Not only has it provided necessary flood protection, but the project also enhanced the habitat value of the river while also improving public access and the aesthetics along the river. This model project illustrates the value of multi-benefit flood control projects that utilize both gray and green solutions to flood control.



Kelly Doren/Register

Figure 1. Napa River and Creek Flood Protection (NRCFP) project site plan illustrating project components in downtown Napa and the 2013 status of the project construction (Doren, 2013).

1. Site History and Project Motivation

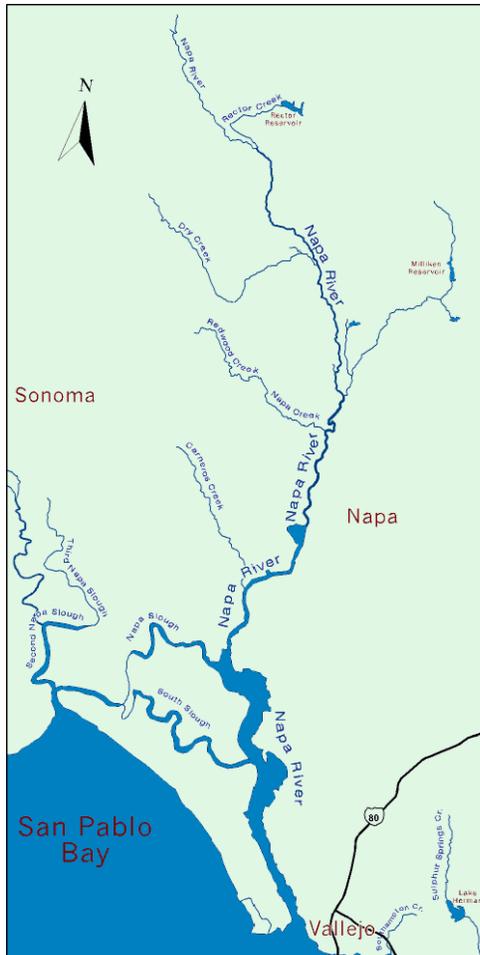


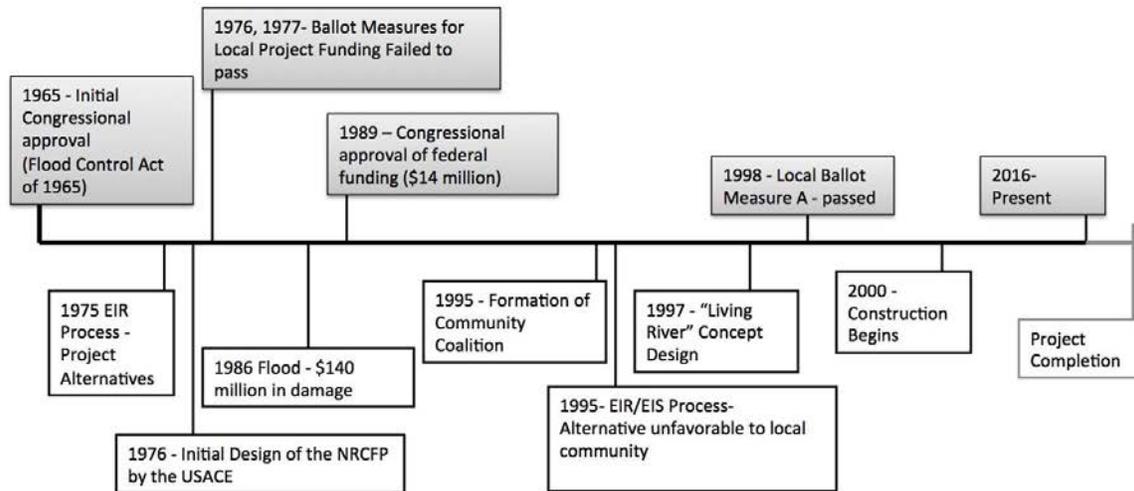
Figure 2, <http://museumca.org/creeks/1950-RescNapa.html>

Since 1862, twenty-two separate, serious, historic flood events on the Napa River have caused large amounts of property damage (Techel, 2011). About 19 of these floods occurred between 1961-1997, causing an estimated \$542 million in residential property damage (FEMA, 2006). This damage along with the lack of adequate flood protection was the primary impetus for the Napa River and Creek Flood Control Project (NRCFP). The United States Congress provided the initial authorization for a Napa River flood control project under the Flood Control Act of 1965 in the form of funds allocated for research and study of flooding along the Napa River.

After completing technical studies related to flooding of the Napa River, the Napa County Flood Control and Water Conservation District (NCFWCWD) worked with the Army Corps of Engineers (USACE) to begin designing a flood control system for the River around the City of Napa. The USACE (Sacramento Division) originally led the project planning and design phase with design elements resembling more traditional engineered flood control channel features, including: deepening of the channel through dredging; straightening the channel and eliminating the oxbow from the river; adding riprap to the banks of a trapezoidal channel; and included levees/flood walls as protective structures for armoring and protecting development along the riverbanks. This

initial design proposal went before voters in Napa County on the local ballot in 1976 and 1977 for approval of the local funding match, but the proposal was rejected both times.

Project Timeline



This major disaster helped rally local and federal support for planning and designing a flood control system for the City of Napa and the surrounding areas. In 1989, Congress authorized the NRCFP project for \$14,950,000 in federal funds for planning and design of a flood control system. In 1993, the NRCFP was revitalized and talks of flood control channel designs for the river were reinitiated. The scale of the 1986 disaster spurred the interest of many groups to participate in the planning process for flood control along the Napa River.

From this interest, a unique coalition - the Community Coalition for Napa Flood Management (Community Coalition) - formed to advocate for the inclusion of green design solutions to flood control through a community-based planning process. The Community Coalition consisted of over 40 agencies and 400 people which included: residents, businesses, more than 27 local/State/regional and federal government entities, the Napa Chamber of Commerce, Sierra Club, Friends of the Napa River (FONR), Napa Valley Economic Development Corporation, Farm Bureau, Land Trust, Conference and Visitors Bureau, and a number of other groups. The Community

In February of 1986, Napa Valley experienced one of the largest floods on record, which flooded many parts of downtown Napa and destroyed large amounts of property. The flood caused over \$140 million in damage, resulted in 7,000 residents being evacuated (Napa County Flood Protection and Watershed Improvement Authority Ordinance No. 1), and flooded about 60% of the City of Napa.

Coalition worked with USACE through many public meetings to come up with a new “Living River” General Design Memorandum (GDM) for the Napa River flood control.

The Community Coalition assisted in the passage of local Measure A in 1998, which provided funding for the local match to the federal funds for the project through a half-cent local sales tax collected over a 20-year period. Measure A specifically allocated funds for flood protection, drainage improvements, dam safety, and watershed management throughout incorporated and unincorporated portions of Napa County. The Napa County Flood Protection and Watershed Improvement Authority administers the local funding for particular project elements, and a majority of the project coordination and implementation for the NRCFP is performed by the Napa County Flood Control and Water Conservation District (NCFCWCD).

After approval of the “Living River” design and the approval of local funding, the NCFCWCD needed to purchase certain land/properties and obtain easements before construction of project design features occurred along the river. Acquisition of properties along the river within the floodplain was critical for the design of the project. Negotiations with property owners within the high-cost real estate area along the river required appropriate compensation to the residents and/or property owners, which added to the overall cost of the project. In the end there were 53 mobile homes, 16 residences and 28 commercial buildings purchased and removed from the floodplain of the river along with the replacement of nine bridges along the river to accommodate the project construction.

The multi-benefit aspects of this project helped garner support from many members of the community for the “Living River” design concept. Construction on the project began in 2000.

1.2 Project Objectives: (based upon geomorphic, water quality, and habitat considerations)- “Living River” design

- Convey variable flows and store water in the floodplain
- Balance sediment input with sediment transport
- Provide quality fish and wildlife habitat
- Maintain good water quality and water supply
- Provide recreational and aesthetic value to the surrounding areas
- Maintain natural slope, width and width/depth ratio for the river
- Restore connections between the river and the adjacent flood plain
- Allow the river to meander naturally as much as possible
- Maintain natural channel features: mudflats, shallows, sandbars, and uneven bottom to the extent possible
- Maintain riparian corridors along the river for fish species
- Restore habitat value of the river for wildlife
- Decrease water surface elevations during flooding through widening the river and creating terraces in the channel and restoration of wetlands south of the City of Napa

1.3 Major Project Elements:

- First Street, Third Street and Soscol Bridges were redesigned and reconstructed in downtown Napa;

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- Floodwalls incorporated into an amphitheater located at the Veterans Memorial Park, which functions as a catchment basin during flooding;
 - Floodwall/riverfront promenade along the river between Hatt and First Street to serve as a public access area;
 - Restoration of diked farmlands into tidal wetlands south of Imola Avenue and other natural areas along the river;
 - Cleanup of contaminated soil and debris sites on the eastern side of the river;
 - Flood control dry bypass for the oxbow, which functions as public space during the dry season and is closed during the wet season to allow some of the floodwaters to bypass the oxbow;
 - Revitalized Oxbow district;
 - Elevated Railroad bridges and relocated tracks in order to widen the river at particular sections;
 - Creek bank terracing and placement of redwood root wads for habitat and biotechnical bank stabilization;
 - Increased recreational opportunities and public access areas;
 - Stormwater detention basins with accompanying pump stations to convey floodwaters behind flood walls back into the Napa River; and
 - Floodwall construction in 2016-2018 pending future federal funding allocations.

The overall project was initially predicted to be completed in seven years, but some of the project and funding delays discussed in this case study extended that timeline and the project is currently anticipated to be complete in 2016.



Figure 3. Restored wetlands on formerly diked farmlands south of Imola Avenue

Project Impacts:

During the construction process, there were some minor, temporary, negative impacts. These disturbances included: impairment of views of the river during construction, and associated short-term noise impacts. The preferred “Living River” alternative design evaluated in the 1995 EIS/EIR did not eliminate but avoided and minimized the most significant impacts to hydrology, water quality, vegetation and wildlife. This preferred alternative also provided the most visually and aesthetically appealing elements to visitors and the citizens of the City of Napa, while also accomplishing the flood protection goals.

Project Benefits:

Some of the major benefits of this project included: improvements to six miles of the Napa River and one mile of Napa Creek; restoration of over 400 acres of emergent marsh and 150 acres of seasonal wetland habitat (South Wetlands Opportunity Area); protection for an estimated 3,000 properties from a 100-year flood event, estimated at \$1 billion in savings over the life of the project (Techel, 2011); improved aesthetics of public spaces in downtown Napa; return and support of a number of bird species to the wetland and riparian areas; and enhanced recreational opportunities for residents and visitors to Napa.

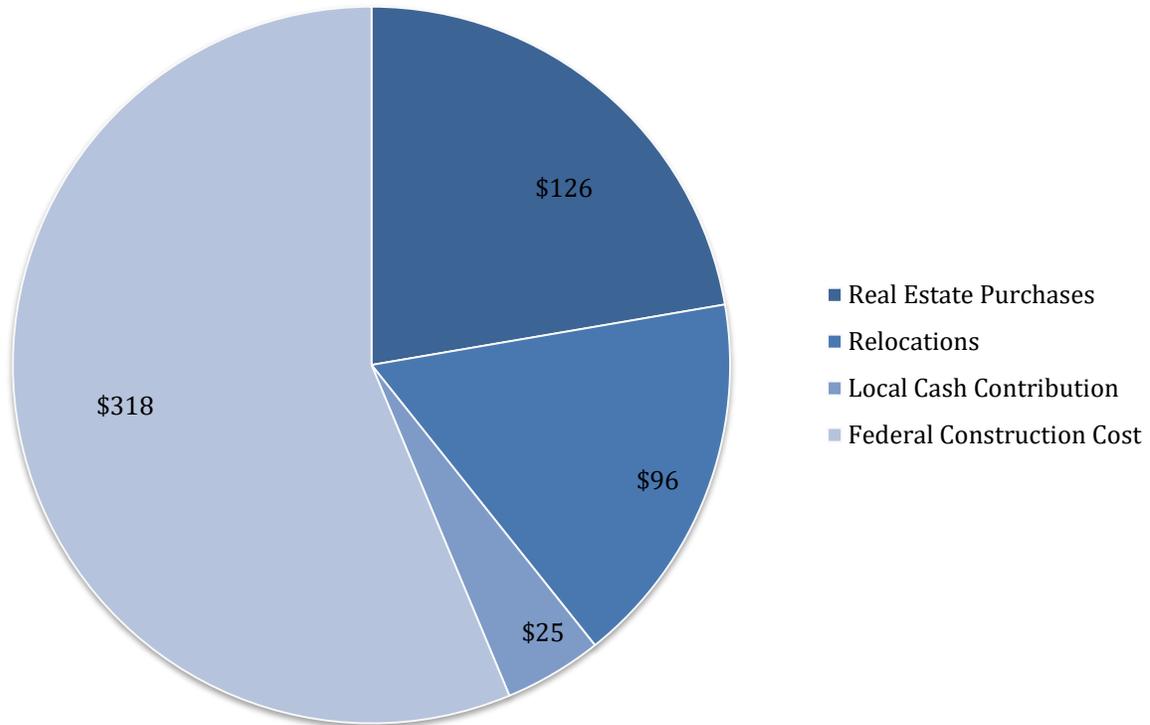
The first test of some of the new channel design features came in 2005 when the project was estimated to be 40% complete (FEMA, 2006). During a storm event, 10 inches of rain fell in a period of 24-hours. Through features of the NRCFP and community preparedness actions (sandbags, and evacuations), significant economic loss was avoided (FEMA, 2006). Since that time, the project features have continued to reduce flooding impacts on the surrounding community and provide ancillary economic and recreational benefits.

2. Exceptional Project Aspects

2.1 Project Cost. The total project cost is estimated at \$565 million, including \$126 million in real estate purchases, \$96 million in relocations and \$25M in cash contributions coming from the local funding. The State of California reimbursed the NCFCWCD for 75% of real estate costs and 90% of its relocations costs through the Department of Water Resources State Flood Control Subventions Program. The remaining \$318 million is the estimated federal construction cost for the project. The amount of local support for the project was extraordinary, with county residents and visitors providing over \$200 million through the 1998 countywide Measure A tax; however, this ½ cent sales tax will expire in 2018.

In addition to Measure A and USACE funding, additional support was provided through grants. Additional funding sources included: Flood Mitigation Assistance (FMA); Hazard Mitigation Grant Program (HMGP); Mitigation Planning; National Flood Insurance Program (NFIP); State sources; Other Federal Agencies (OFA); Other FEMA funds; Unites States Department of Homeland Security; Commercial and residential property owners; and the United States Small Business Administration (SBA).

Total Project Cost (millions)



2.2 Formation of the Community Coalition for Napa Flood Management (Community Coalition). The community around Napa River embraced the river as a major, unique component to the livelihood and aesthetic of the community and was concerned about how flood control designs may impact the river. A Community Coalition of over 400 people was formed and consisted of residents, interest groups, and Regulatory and Resource Agency staff. Through a public outreach and community meeting process (about eight town-hall meetings held over the course of 24 months), the Community Coalition championed efforts to maintain the oxbow as a contiguous part of the Napa River and did not support ideas to straighten the river and cutoff the oxbow. The Community Coalition realized early on that bypassing the oxbow would cause it to silt in and lose an important ecological and hydrological feature of the river. In response to these concerns, a dry bypass (Figure 4) was designed to be disconnected from the river for most of the year, except during periods of flooding when water would fill the area and be directed downstream to enhance water conveyance.

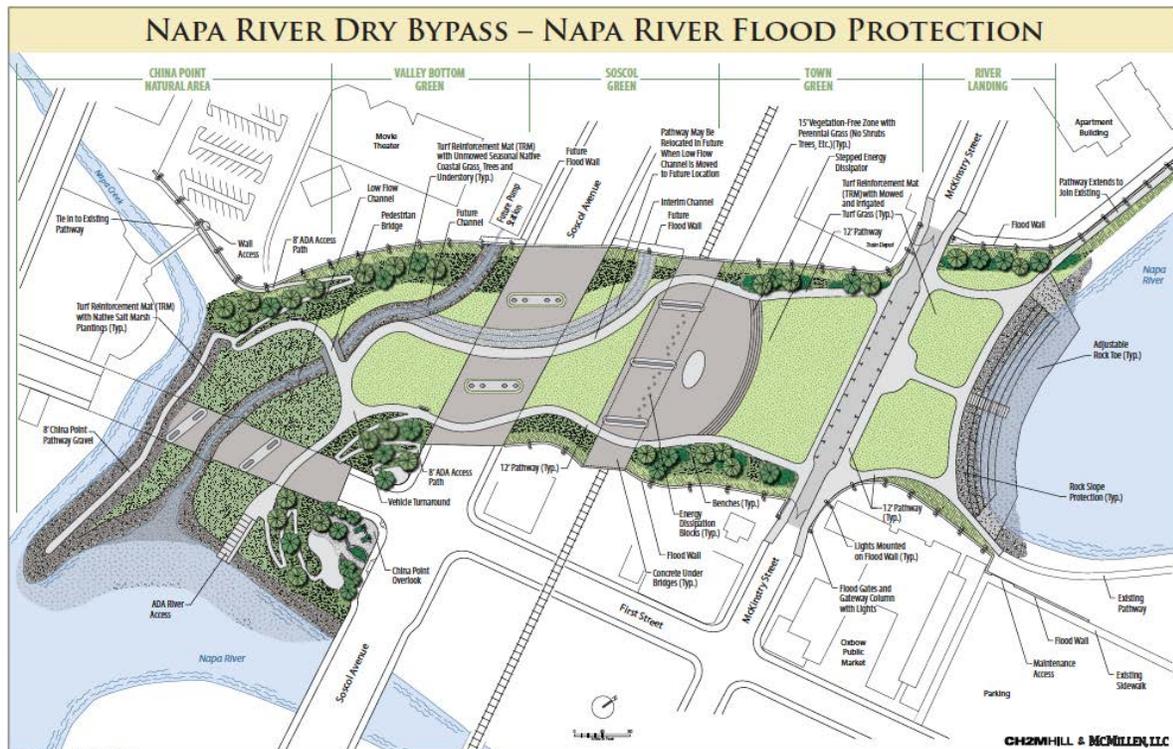


Figure 4. Design for the oxbow dry bypass. Consisting of parks and public access, recreational areas during the dry season and gates that are closed during flooding in the wet season to prevent public access during flooding

2.3 Restored Wetlands. Through this project over 900-acres of high-value tidal marsh habitat was restored, including 400-acres of previously diked farmlands south of Imola Avenue (Figure 3). The formerly diked off farmlands south of Imola Avenue were allowed to revegetate naturally once reconnected to the river and the NCFWCDC was surprised at the rapid recolonization of the formerly diked off farmlands by wetland species once tidal action was restored. It was not necessary to have active plantings in the tidal restoration areas because adjacent wetlands provided seeds to revegetate the area. Currently, extensive monitoring is ongoing to assess the success of the restoration.

2.4 Increased Tidal Prism and Catchment Basins. Opening up the formerly diked farmlands to tidal action allowed for an increased tidal prism south of the City of Napa. Increasing the tidal prism reduces the tidal flows further upstream, thereby reducing upstream floodwater elevations within the City during heavy run off, while also providing habitat for native species. Additionally, the project included the construction of three catchment basins that function to temporarily provide water capacity for the floodwaters of the river during storms.

2.5 Biotechnical Bank Stabilization. Rather than using riprap in many areas of the, the NRCFP included biotechnical engineering methods, such as (1) the redwood root wads for fish habitat and bank stabilization, and (2) burlap embedded with willow seedlings, which adds functional stability to the riverbanks similar to that of riprap once the willows have grown.

2.6 Resource Agency Support. The Resource Agencies provided support for the project throughout the planning and implementation process by assisting the Community Coalition in advocating for the “Living River” design with the USACE and including terms and conditions into their authorizations that required the project to incorporate natural design features and best management practices.

2.7 Infrastructure Relocation and Reconfiguration. This project involved the replacement of nine bridges along the river. It also included working with the Napa Valley Wine Train to realign and elevate portions of the railroad to accommodate widening of the creek and the construction of a new, elevated bridge over the river. This project required a number of local roads and utilities to be moved: resulting in a huge cost for the project.

3. Regulatory Aspects

Modifications to land, waterways and wetlands require permits from a host of Regulatory Agencies and consistency with local plans and zoning ordinances. For projects where habitats are modified, or species are impacted, additional review and permitting by appropriate Resource Agencies is likely required. In examining the project, the Regulatory and Resource Agencies often require alterations to the project to reduce impacts to resources within the project area, and ensure human safety.

3.1 Local/Specific Issues.

3.1.1 Local area plans.

The approval of the Napa River Flood Control Channel “Living River” design sparked many other planning efforts in both the City and County of Napa due to the scale of the project and the importance of the river to the communities surrounding it. The County performed a routine General Plan amendment and incorporated many of the “Living River” guidelines related to public access/use of the river (bird watching, fishing, boating, etc.) and enjoyment of the natural resources into its updated General Plan policies. The Napa County General Plan currently incorporates policies to:

- Protect agricultural uses of many areas of the County lands
- Maintain biodiversity
- Protect natural resources, water resources and improve the ecological health of the Napa River
- Provide areas of permanently protected public open space
- Encourages environmental stewardship
- Addresses climate change and ways to limit local contributions to the global problem.

The County General Plan update was developed after NRCFP was approved and the update incorporated policies related to the objectives of the “Living River” NRCFP design and the project was easily found to be consistent with the local area plan.

3.1.2 Local government ordinances & design guidelines.

During the early phases of the NRCFP, the City of Napa developed a temporary ordinance prior to the initiation of construction of the flood control project, which stipulated that private property owners within the project footprint were not allowed to develop their property in a way that would then increase the cost to the flood control project and cause an increased in the public funds necessary to purchase the property. In anticipation of the construction of NRCFP, the City of Napa also developed policies related to building aesthetics and public areas in downtown Napa, which would be consistent with design features of the NRCFP.

3.2 Regional Issues

3.2.1 State and Federal Permitting.

The NRCFP lies within a number of state and federal jurisdictions, including the USACE, the San Francisco Bay Regional Water Quality Control Board (Water Board), the California Department of Fish and Wildlife (CDFW), the US Fish and Wildlife Service (USFWS) and the NOAA National Marine Fisheries Service (NMFS), but is outside of the San Francisco Bay Conservation and Development Commission's (BCDC) jurisdiction. The USACE and the Water Board both regulate "fill" in the project area, as Waters of the US and Waters of the State, respectively. CDFW, USFWS and NMFS administer the state and federal Endangered Species Act, and NMFS administers the Magnuson Stevenson Fisheries Management Act.

3.2.2 Biological Resources.

The project location can have a major influence on the timing and approval of the project due to species inhabiting the project area and the presence of habitats of concern. In the case of Napa River, the main species of concern in the project area were the Central California steelhead, Sacramento splittail, California black rail, and Mason's lilaeopsis (an endangered plant) triggering review with CDFW, NMFS and the USFWS.

The early USACE project design proposed leaving the existing bridges intact; requiring channel deepening to achieve the proposed trapezoidal design with the appropriate side slopes. The Resource Agencies concerns with the initial project proposed by the USACE included: excess siltation and ongoing maintenance dredging over time; decreases in available oxygen as a result of increased channel depth; loss of wetland habitat during construction; the loss of steelhead habitat; and known contaminants in the riverbank sediments that the USACE proposed to leave in-place using sheet pile walls, which could lead to future contamination of the river.

When the "Living River" design concept was proposed, the resource agencies encouraged the idea because it provide several habitat and species benefits and address many of the issues above. As a result of this support, the "Living River" design was included as an alternative evaluated in the Final EIS/EIR and ultimately selected as the preferred alternative. The overall project improved habitat for

species of concern and included best management practices agreed upon in advance, thereby reducing potential conflicts with the laws and policies protecting special status species. This early engagement and agency support created a straightforward consultation process with few issues to resolve or mitigate for.

Table 1. Species of Concern in the NRCFP area and required monitoring during construction.

Species of Concern	Agencies	Monitoring Time
Central California steelhead	NMFS, CDFW	June 1 to October 15 work window and the use of silt curtains during construction
Sacramento splittail	USFWS, CDFW	June 1 to October 15 work window and the use of silt curtains during construction
Mason's lilaepsis	CDFW, USFWS	Surveys conducted through 2011, "take" permit required and plants were to be transplanted to another location when possible
California black rail	CDFW	Surveys conducted prior to construction near brackish and salt marsh environments. Work restricted from February 1 to August 1 when within 100 feet of marsh habitat.

3.2.3 Conformance with the Regional Water Board (Water Board) Basin Plan.

There were land use changes required by the Regional Water Quality Control Board’s San Francisco Bay Basin Plan, which prioritized modest, environmentally responsible development that supported the “Living River” design concept. The project also needed to address debris and contaminated sediments in portions of the flood control channel, which almost severely impacted the design of the flood control project because the USACE originally did not originally want to remove contaminated sediments due to the additional cost required for an offsite, upland disposal area rather than performing onsite containment. The Water Board and Resource Agencies advocated for complete removal of the contaminated areas to prevent further exposure for wildlife present in and around the project area in the future. After such discussions, large amounts of debris that had been historically added to the banks for riverbank stabilization and erosion control were removed from the river.

3.2.4 Mitigation and Monitoring. The addition of the restored baylands south of the City of Napa and other habitat restoration along the river made the project a self-mitigating project and all potential impacts to natural resources were reduced to a

less than significant level as determined in the Final EIS/EIR. These determinations were supported by extensive studies of the hydrology of the river, impacts to biological resources in the project area, the degree of inundation, types and extent of the restored habitat, etc. The restored baylands were allowed to revegetate naturally without the need for much intervention in the restoration area. The saltwater coming onto the restored former farmlands was concerning, but the saltwater successfully prevented terrestrial plants, including weeds, from establishing on the site and allowed the historic wetlands to be restored. Monitoring of the success of the restoration efforts began in 2000 and continues today (Table 2).

Table 2. Required mitigation and long-term monitoring of impacts related to the NRCFP project.

Impacted Area	Monitoring	Time	Mitigation
Woody Vegetation	Construction areas initially surveyed by an arborist	Annual qualitative surveys of planted trees, with vegetative cover surveys conducted every 5 years for up to 40 years	On-site replacement of impacted woody vegetation at a ratio of 5:1, followed by annual monitoring and watering until re-established
Wetland Vegetation	Monitor elevation and vegetation changes in the wetlands, with transect surveys conducted every five years	Annual qualitative monitoring, quantitative transect surveys conducted every 5 years for up to 40 years	Impact to 44.18 acres of jurisdictional wetland, but mitigating through the creation of 107 acres of tidal mudflats and wetlands
Salinity	Testing and monitoring of sediment salinity	Annual monitoring for up to 40 years	Saline soils around the restored wetland locations
Hydrology- changes to accretion rates in some locations along the project and areas of bed degradation following storm events	Monitoring program to collect hydrodynamic, sediment transport and morphological data to feed into and develop predictive models.	Annual monitoring, quantitative surveys every 5 years for up to 40 years	Performance based maintenance dredging program, to monitor areas and only dredge those that absolutely need it.
Habitat Impacts - smoother banks and	-	During Construction	Placement of rootwads and rock along the banks to

removal of overhead
vegetation in areas

provide bank stability and
suitable fish habitat

3.2.5 Personnel Changes and Project Timeline. Due to the extended construction period for this project, some disagreements regarding project designs surfaced between the local project manager and the regional USACE project manager during construction. Additionally, there were a number of changes in the USACE project coordinator and staff turnover during the life of the project that likely added to set backs in the project construction schedule; and revisiting and negotiating over particular design elements that had previously been agreed upon; and increased the overall project cost.

3.2.6 Levee Certification (FEMA). Flood protection levees were constructed as part of the NRCFP, but many have not yet gone through the process of being certified by an engineer at the time that this analysis was completed. For certification as flood protection structures, the levee design and construction must adhere to USACE guidelines and standards, which include strict construction specifications and requirements for removal of any vegetative growth within 15 feet of the toe of the levee. These federal standards conflict in some areas of the NRCFP with the innovative flood control designs that utilize more natural elements, such as riparian habitats, to enhance flood control along the river. These federal policies may also be in conflict with State Resource Agency policies related to wildlife habitat, especially in riparian areas. The levees built in the southern part of the NRCFP project did not run into the issues with levee certification because the levees were no longer needed because the buildings and residences were removed and thus the levees were no longer required as flood protection or in need of certification. However, when levees are built in upstream riparian areas (such as the streambanks along the Oxbow and north), there are likely going to be issues and conflicts over the designs and removal of riparian habitat in response to USACE requirements for compliance with USACE guidance and certification of the levees.

3.3 Resolution of Issues.

3.3.1 Negotiations over Design. Originally, there were conflicts over the project preferred alternative designs between USACE, the Resource Agencies and the local community. Conflicts were resolved through the creation of a local Community Coalition that addressed the areas of concern in the project designs and gathered community support for particular design aspects. The Community Coalition along with outside consultants, Resource Agency personnel and USACE developed the “Living River” major project concepts to meet the original goals/objective of the project (EIR) and the General Design Memorandum (GDM).

In restoring the Napa River, the “Living River” design attempts to set the levees back from the river/stream banks, but that was not always possible due to the presence of development and infrastructure adjacent to the river. In 2013 there were also conflicts between the NCFWCWD and USACE over the construction of floodwalls along the northern portions of the project. This conflict was somewhat resolved in early 2014 when the USACE verbally agreed to keep the floodwall and other project elements in the contract that was going out for bid for work on the bypass and floodwalls. However, there were some project elements, such as some of the recreational facilities and trails that NCFWCWD wanted to incorporate to make the project desirable to the County residents and visitors. For these types of design features, the County was solely responsible for funding these elements.

3.3.2 Minimizing Impacts and Mitigation. The permitting agencies required best management practices and specific conditions to minimize the impacts to listed species and their habitats. To offset any potential environmental impacts caused by the project that could not be fully minimized, the south Napa baylands restoration project was incorporated into the original project description as a means for a self-mitigating project; eliminating the need for extensive project mitigation. The Resource Agencies were happy to have this restoration element in the design. But, prior to the breaching of the former farm levees, there were extensive studies done on the hydrology of the area, the degree of inundation, and the impacts to the local organisms. Heavy monitoring of the restoration of the baylands was also required and is currently underway to evaluate the success of the restoration. The City and County of Napa also created freshwater seasonal wetlands on the Stanley Ranch as part of restoration/mitigation component of the project. A number of studies before and after wetland restoration were required as part of the permits/approvals from the Regulatory and Resource Agencies (Table 2). As of the time of this report, the restored wetlands have already provided enhanced habitats around the river and the NCFWCWD has documented the return of a number of bird species to these areas.

4. Funding Challenges

4.1 USACE Benefit: Cost Ratios (BCR). Another major challenge for the NRCFP was the economic benefit: cost ratio (BCR) analysis performed to calculate the federal funding for the project. Congress originally authorized studies on the flooding of the Napa River in 1965, but no funding for the construction at that time. In 1989, Congress authorized the Napa River project for \$14,950,000 in federal funds for planning and construction of a flood control system. Additionally, Congress approved federal funding for the flood control project in 1997 based on early designs of the project, which included the “Living River” design. One complication of this federal funding is that the annual project funding needs to be associated with specific budget items and be allocated through annual appropriations in the USACE budget, and thus funding for constructing certain project features in any particular year is not guaranteed. Due to the timing of the original project

planning and federal authorization in the late 1990's, the USACE calculations for the BCR did not allow the environmental benefits of the habitat restoration components to be considered as project benefits.

As the overall cost of the project increased, the USACE BCR analysis often resulted in the project being assigned a poor rating as a federal investment due to the cost of the project and exclusion of the environmental benefits. The high cost of the project was influenced by the high cost of particular project elements, such as moving the Wine Train railroad, construction of pump houses, purchasing of expensive real estate in the project area, etc. These high project cost and the resultant low BCR made it difficult at times for the project to secure federal funding in the annual USACE budget to move forward with construction.

In 2013, the NCFWCD asked USACE for a reevaluation of the BCR for the project, given that newer projects are authorized to incorporate environmental benefits in the BCR analysis. The USACE determined that the NRCFP's authorization was too old to qualify for reassessment of the BCR and declined to reevaluate the project; further reducing the potential for additional USACE funding to finish the project. The low BCR may have impacted and extended the timeline for this flood control project due to an inability to consistently secure federal funding during certain years and USACE prioritizing funding for other projects with higher BCRs.

4.2 Annual Federal Funding. Federal funds allocated annually for this project depended upon: whether the USACE included sufficient funds for the project in its proposed budget for any given year, which USACE must plan for and incorporate into its budget at least two years in advance of expenditures; support from USACE Headquarters; inclusion in the President's budget; and approval by Congress. Due to the nature of this funding process, in addition to the low benefit: cost ratio, there was difficulty at times securing annual federal funds for the project, which added to delays in construction.

In addition to the annual funding issue, federal funding for a project is generally limited by the total estimated cost of the project, with adjustments for inflation. When a project exceeds its estimated funding, which is the case for the NRCFP, there is a limit, known as the 902 limit (from Section 902 of the Water Resources Development Act (WRDA) of 1986 related to USACE Cost limits for civil works projects), to the additional funds that can be requested (USACE Memorandum, 2012). Once that 902 limit is reached, the project cannot receive additional federal funds unless Congress reauthorizes it. At the August 2013 meeting of the Napa County Technical Advisory Panel meeting, the USACE advised the group that after the completion of the dry bypass for the oxbow, there would be no additional federal funding for the project available, unless the County of Napa applied for a post authorization change report requesting the additional funding and it was approved (Napa County TAP Minutes, 2013). The remaining project costs would be the responsibility of the local project sponsors, which may further slow completion of the project if funding is not readily available.

4.3 Project Cost Sharing & Betterments. The estimated total project cost is \$565 million. As this project was part of the USACE flood control civil works program, the USACE was the federal project partner, contributing funds, design expertise and construction contracting.

The local project sponsor was the Napa County Flood Control and Water Conservation District (NCFCWCD). Under federal cost sharing rules, the project had a cost share ratio minimum of 75:25 and maximum of 50:50 between the federal and local sponsor, respectively.

Based upon USACE cost sharing guidelines, some aspects of the project required a greater local contribution if the design element was determined to be a “betterment” and beyond the federal flood protection requirements for the project and served other purposes, such as recreational benefits. Betterments that were still for flood protection purposes could be cost shared, but at a greater cost sharing rate for the NCFCWCD – up to 50% of the cost paid by the local sponsor, and elements deemed not necessary for flood protection required the local sponsor to contribute 100% of the funding.

These cost sharing requirements led to conflicts over inclusion of certain design elements, and disagreements over whether project elements were truly “betterments” or necessary elements for flood protection. The USACE considered many of the trails or recreational facilities betterments and did not provide funding for these design elements. NCFCWCD is now paying 100% of the cost for project elements determined by the USACE to be “betterments.”

4.4 Local Funding. Measure A, became effective in 1998 and included a number of requirements limiting the use of tax funds. The tax collection period was 20 years and ends in 2018. The life of the tax was calculated based upon the original seven-year projected construction timeline, which has so far taken about sixteen years due to funding and construction delays, and was about 80% complete at the completion of this analysis. The longer the construction window extended; the higher the associated project cost. This caused concern for the NCFCWCD because Measure A allocated a finite amount of money available for the capital investment portion of the project and ceases to acquire new funds after the measure expires in 2018.

Measure A also included a provision that provided \$10 million dollars toward future maintenance. Some project elements were designed to need minimal maintenance and were meant to provide a more natural design solution to typical maintenance methods and also help the maintenance funds be available longer. The maintenance plan developed for the project included invasive species removal in the wetlands south of the City of Napa and less frequent maintenance dredging of the river than was necessary in the past.

5. Lessons Learned

1. Community support is extremely helpful in moving a project forward and authorizing the funding necessary to accomplish the project. The voters and citizens of Napa County were major advocates for the innovative and natural designs that were incorporated into this project. The extensive community involvement in the planning process garnered local support for the overall project. The public has been supportive throughout the project with only minor complaints about construction nuisances.

2. Involving the Regulatory Agencies early in the planning process and having buy-in early in the project is critical. For the NRCFP project, the Regulatory Agencies liked the “Living River” design and the habitat restoration elements incorporated into the project. In the case of the NRCFP, as a result of early buy-in by the Regulatory Agencies, the project moved through permitting rather quickly. Additionally, during the implementation and construction of the project, the Regulatory Agencies’ permit requirements, were instrumental in holding USACE to the original design objectives in the General Design Memorandum. However, there were at times conflicting ideas between the USACE design guidelines and the Resource Agencies policies, such as including more natural habitat features, which were slowly resolved and thus impacted the project timeline somewhat.

3. The federal authorization for funding can often delay the project until annual funding can be secured. Federal funding from the USACE can be a great asset for a flood control capital infrastructure project, but this funding comes with some drawbacks. A project may experience difficulties securing annual federal funding as a result of USACE staff that are unfamiliar with the project, the project not being cast as an urgent project with a high benefit: cost ratio, or the project not being prioritized in the USACE budget for any given year. Lack of a priority project can lead to delays in design approval for project elements and construction as the USACE awaits funding approval from Congress. If a project experiences multiple delays in annual funding, the project may easily exceed the overall construction timeline. In the case of the NRCFP, the project was initially anticipated to be complete in seven years. However, the initially expected long period of construction, and annual funding delays also accompanied USACE project manager and staff turnover, which impacted the coordination between the USACE and the NCFWCD, and led to difficulties in construction of particular projects elements and further extended the project timeline. Projects with shorter term initial construction timelines may experience less delays related to annual federal funding and may not experience the same staff turnover, which may streamline the project completion. Flood control project managers that have federal funding and support should be prepared for such a delays.

4. Inclusion of habitat features in the project design can help improve the benefit/cost ratio of the project. The NRCFP was unable to incorporate and count many of the habitat restoration areas as project benefits. The addition of restored habitats and environmental benefits to the project design can help current and future projects achieve a better benefit: cost ratio to secure annual federal funding for implementation and construction.

5. Garnering and maintaining public support is critical for local project funding, especially when construction surpasses the originally intended timeline. Expected to take seven years to complete, the NRCFP is still nearing completion after 16 years of construction. The successful passage of Measure A required extensive outreach to various communities within Napa County as well as the incorporation of flood control improvements throughout the County that would not only enhance protection for those living in the City of Napa but for all residents. It was noted that community participation in the design phase of the project largely helped gain support for the project. The local support for the project helped ensure that the project moved forward and today, the NRCFP currently protects over 3,000 homes/businesses from flooding (FEMA, 2006). Yet the Measure A tax is set to expire in 2018 and in the future,

NCFWCD may need to obtain additional funds for maintenance activities after Measure A funding is spent. If it is necessary, having a favorable project that is a highlight of the community will likely help secure future funding.

6. Allowing the river space to meander where it can and allowing space/room for the river to expand may make permitting the project easier. Although, there were some difficulties in obtaining the necessary land for the project through the purchasing of properties along the river, allowing the river to take a more natural course, incorporating natural features, and restoring natural processes in the flood control channel makes it easier for the Regulatory Agencies to permit the project.

6. Conclusions - Looking forward

The innovative “Living River” design approach for the Napa River and Creek flood control project was successful in garnering community support for the project and restoring natural watershed features that work alongside built flood control structures to enhance the flood control capacity of the River.

The region around the Napa River has benefited from increased economic growth as a result of the flood control project and enhancements to developments along the river, enhanced flood protection, increased public access to the River, and improved aesthetics of the River mainly through habitat restoration and the return of various species to the area. The design for the Napa River through downtown has reinvigorated the city center and there has been an increase in the amount of ecotourism related to migratory birds now using the restored wetland as habitat as part of the Pacific Flyway. An estimated \$1 billion (Techel, 2011) in saving is anticipated over the life of the flood control project.

This project was extremely unique in terms of the cost of the project and the amount of financial investment, both federally and locally. The project area and adjacent land uses provided flexibility in planning the course of the flood control channel and designing the footprint of the actual project, but this may not necessarily be available in other highly urbanized areas around San Francisco Bay. This project was also very unique in terms of the project mitigation. Through the incorporation of the restored wetland/marsh areas south of the City of Napa, the project increased the tidal prism south of the city thus enhancing flood protection and providing some cost savings on mitigation as a result of the project’s classification as self-mitigating.

Although the project is still ongoing and nearing completion, the project has already proven to be successful in protecting the City of Napa and surrounding areas as demonstrated from major flood events in 2006 and recent winter storms in 2014. This project also created a beautiful downtown aesthetic and reconnected the public to the River through enhanced River vistas, access to public amphitheaters (dually functioning as catchment basins), and restored natural riverine habitats. In addition, this project is considered a model both regionally and internationally on how flood protection projects can provide multiple benefits, enhance community resilience and become a source of pride to its citizens.

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Water Quality/Fish Habitat Design Review Workgroup co-chaired by Leslie Ferguson (SFRWCB) and Jim Swanson (CDFW)

8. Who We are

This case study was developed through Flood Control 2.0: Rebuilding Habitat and Shoreline Resilience through a New Generation of Flood Control Channel Design and Management, an EPA-funded partnership of the San Francisco Bay Conservation and Development Commission (BCDC), the San Francisco Estuary Partnership (SFEP), the San Francisco Bay Joint Venture (SFBJV), and the San Francisco Estuary Institute (SFEI). This case study was only possible through the cooperation of the Napa River Flood Control and Water Conservation District. The four agencies mentioned above are working together to provide information resources and technical assistance to support flood control agencies in the design and evaluation of flood control projects for improved control function, sediment transmission, and Bay connectivity.

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