California's Flood Future

Recommendations for Managing
the State's Flood Risk

Attachment H:
Practicing Flood Management Using an Integrated Water Management Approach

FINAL November 2013

California's Flood Future is provided to help inform local, State, and Federal decisions about policies and financial investments to improve public safety, foster environmental stewardship, and support economic stability

FloodSAFE CALIFORNIA

PUBLIC SAFETY ENVIRONMENTAL STEWARDSHIP ECONOMIC STABILITY

US Army Corps of Engineers ®

STATEWIDE FLOOD MANAGEMENT PLANNING PROGRAM

FloodSAFE CALIFORNIA

FINAL

Attachment H: Practicing Flood Management Using an Integrated Water Management Approach

November 2013

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

UNITED STATES ARMY CORPS OF ENGINEERS
FLOOD PLAIN MANAGEMENT SERVICES PROGRAM

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Table of Contents

Table of Contents

Appendices

List of Tables

List of Figures

Acronyms and Abbreviations

BMP	best management practice
Caltrans	California Department of Transportation
CDFW	California Department of Fish and Wildlife (formerly Department of Fish and Game)
CEAC	County Engineers Association of California
CVFPP	Central Valley Flood Protection Plan
Delta	Sacramento – San Joaquin River Delta
DWR	California Department of Water Resources
FEMA	Federal Emergency Management Agency
Flood Future Report	*California's Flood Future: Recommendations for Managing the State's Flood Risk*
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan
IWM	Integrated Water Management
IWRM	Integrated Water Resources Management
IWRP	Integrated Water Resources Planning
NFIP	National Flood Insurance Program
O&M	operation and maintenance
OMRR&R	operation, maintenance, repair, rehabilitation, and replacement
RWMG	Regional Water Management Group
SCVWD	Santa Clara Valley Water District
SFMP	Statewide Flood Management Planning
SPFC	State Plan of Flood Control
SSIA	State Systemwide Investment Approach
TM	technical memorandum
USACE	United States Army Corps of Engineers
WRMP	Water Resources Management Plan

Acronyms and Abbreviations

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1.0 Introduction

1.1 Background

California is at risk for catastrophic flooding. All 58 California counties have experienced at least one flood event with significant consequences in the last 20 years, resulting in loss of life, and billions of dollars in damages. This report, *California's Flood Future: Recommendations for Managing the State's Flood Risk* (Flood Future Report), is the first product of the Statewide Flood Management Planning (SFMP) Program. The Program was developed under the FloodSAFE Initiative to expand California's flood management planning statewide. Specifically, the purpose of the SFMP Program is to make recommendations to inform flood management policies and investments in the coming decades by:

- Promoting a clear understanding of flood risks in California
- Garnering active support for partnerships at the local, tribal, State, and Federal levels[1]
- Coordinating with other California Department of Water Resources (DWR) planning efforts
- Identifying strategies and feasible next steps to better incorporate flood management into Integrated Water Management (IWM)
- Promoting an IWM approach for flood management solutions

The initial work of the SFMP Program was to collect information in support of the Flood Future Report, as well as to build unique partnerships with local flood management agencies, the County Engineers Association of California (CEAC), Federal Emergency Management Agency (FEMA), and the United States Army Corps of Engineers (USACE). Throughout the Flood Future Report, determinations about specific flood terms were made that may not represent the specific terms used by partner agencies. These are described in Textbox 1-1. A description of the Flood Future Report components, organization, and layout is provided in Appendix A.

1.2 Purpose

The purpose of this technical memorandum (TM), presented as Attachment H to the Flood Future Report, is to provide an overview of flood management in California using an IWM approach. This TM is focused on illustrating how flood management has evolved over time and is moving toward an IWM approach. Using an IWM approach to flood management will help flood management and other resource agencies address the complex set of demands and challenges such as multiple regulatory processes and permits, coordination with multiple agencies and stakeholders, and increased environmental awareness, all of which complicate project implementation.

[1]Hereafter in this document, the mention of governmental agencies is implicit to include tribal entities.

In this TM, when an IWM approach is referenced, it is considered to include a flood management aspect. An IWM approach does not always require a flood component; however, the focus of the Flood Future Report is flood management, so this consideration is appropriate. It is also important to note that not every flood management project can be developed using an IWM approach due to the need to prioritize public safety and property protection, especially during and immediately following a flood emergency.

1.3 Organization

This TM is organized to provide a description of traditional flood management, demonstrate how agencies at all levels are evolving to an IWM approach, provide an overview of IWM approaches that includes benefits and challenges to implementation, and findings and recommended actions for successfully implementing this approach. Throughout the document, nine brief case studies are used to illustrate a successful IWM approach. Detailed information about each of these case studies is provided in Appendix E. In some instances, these case studies represent portions of larger projects, thus costs and other information presented for the case studies are not consistent with all projects listed in Appendix E. Some of the case studies represent projects that have been completed in the past but are provided as good examples of an IWM approach.

Specifically, this TM is organized in the following sections and appendices.

- Section 1 – Introduction
- Section 2 – Traditional Flood Management
- Section 3 – An IWM Approach
- Section 4 – Strategies and Management Actions for Practicing Flood Management with an IWM Approach
- Section 5 – Benefits of an IWM Approach to Flood Management
- Section 6 – Currently Planned IWM Projects
- Section 7 – Findings and Recommended Actions
- Section 8 – References
- Appendix A: Flood Future Report Components
- Appendix B: Management Action Description
- Appendix C: Planned IWM Projects in California
- Appendix D: USACE IWM Projects in California
- Appendix E: Detailed IWM Case Studies
- Appendix F: Glossary

Textbox 1-1: Agencies Differ in Flood Terminology

One of the challenges in a multi-agency effort is resolving language and culture differences between agencies. Staff from both USACE and DWR who are responsible for developing this report have made a conscious choice to adopt certain terminology throughout the documents.

As an example, USACE has adopted ***flood risk management*** as the term to describe a broad flood program that encompasses planning, construction, and operation, maintenance, repair, rehabilitation, and replacement (***OMRR&R***). DWR executes a similar broad program, largely through its Flood Management Division. As a result, DWR uses the term ***flood management*** in much the same way USACE uses *flood risk management*.

Another term used throughout this document is ***100-year flood*** (or some other *x*-year flood). Although these terms are commonly used, both USACE and DWR prefer using ***1 percent chance flood*** (or a 1-in-100 chance event) to describe a flood that has a 1 percent chance of occurring in any given year. However, legislative language from 2007 directing DWR to undertake new planning using bond proceeds uses 100-year flood.

For Federally funded projects, the definition of operation and maintenance (***O&M)*** includes the local entity's financial obligation for OMRR&R of the implemented project. OMRR&R is a non-Federal responsibility when local, regional and/or State entities partner on a Federal project. DWR typically uses O&M to refer simply to operation and maintenance, although repair and rehabilitation are sometimes included depending on project specifics. References to O&M provided in this report include OMRR&R responsibilities when the project is a Federal/non-Federal partnership.

For this report, both agencies agreed that, although language and cultural differences remain, it is more important to focus on the shared responsibility of performing our flood risk management or flood management missions rather than the use of specific phrases not in each agency's respective culture. A glossary is included to help the reader understand specific terms used by flood professionals and those terms that are used to define specific agency missions.

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2.0 Traditional Flood Management

2.1 History of Flood Management

Floods are naturally occurring phenomena in California, which can be beneficial to natural systems. Floods can keep erosion and sedimentation in natural equilibrium, replenish soils, recharge groundwater, filter impurities, and support a variety of riverine and coastal floodplain habitats for some of California's most sensitive species. However, when floods occur where people live and work, the results can be tragic, including loss of lives and devastating economic impacts caused by damaged critical infrastructure, valuable agricultural land taken out of production, damaged habitats, and disruptions to California's water supply system. Flood management, in this report, includes policies and practices related to educating the public and preparing for, mitigating damages of, responding to, and recovering from flooding that creates risk for people and valued resources, as well as protecting the natural and beneficial functions of floodplains to the maximum extent practicable.

Floodplains are flat or nearly flat lands adjacent to streams or other bodies of water that are periodically inundated. By definition, floodplains also include lands adjacent to and behind levees or other flood management structures.

In the 1800s, flood management was the responsibility of individual landowners (Kelley, 1998). This attitude changed when catastrophic floods occurred in the late 1800s and early 1900s, resulting in a series of flood control statutes that increased State and Federal government's responsibility for flood management. These statutes were the impetus for construction of numerous flood management structures including dams, levees, reservoirs, and floodwalls.

In the 1960s, studies found that damage due to floods was increasing and that continued urban development in floodplains was increasing flood risk. As a result, local, State, and Federal agencies began developing policies and programs that managed floodplains in addition to implementing structural solutions for controlling floodwater (FEMA, 2010).

Residual Risk is the likelihood of damage or other adverse consequences remaining after flood management actions are taken. Flood risk can never be 100 percent eliminated.

Historically, flood management focused on developing narrowly focused flood infrastructure projects to reduce the chance of flooding in a specific geographic area. This infrastructure works effectively to reduce the chance of flooding and avoid damage to lives and property, but certain infrastructure can also alter and confine natural watercourses. These alterations can lead to unintended consequences, such as loss of ecological function and redirection of flood risks upstream or downstream of projects. Also, traditional approaches to flood management have resulted in enabling urban and agricultural development within floodplains, placing property and people at risk of flooding, many of whom have inadequate awareness regarding residual flood risk.

Today, flood managers face an increasingly complex world of resource management issues, regulatory constraints, and diverse stakeholder demands. Many of these challenges did not exist when some of the original infrastructure

solutions were conceived and implemented. These challenges include increased environmental awareness, multiple agency jurisdictions, inadequate financing, and conflicting regulations and permitting requirements. The path forward for successful implementation of projects calls for a shift to IWM solutions as opposed to the narrowly focused projects of the past.

2.2 Issues Facing Flood Management Projects

Project development, implementation, and operation constraints have changed as societal values have evolved. Today, all projects, including flood management projects, face increased stakeholder involvement, land use constraints, changing regulatory requirements, and new environmental considerations.

Local, State, and Federal flood management agencies identified a number of issues facing project development and operation as part of the research used to develop the Flood Future Report. More than 140 public agencies responsible for flood management provided information. This effort is summarized in *Attachment E: Existing Conditions of Flood Management in California (Information Gathering Findings)*.

Specific issues impacting flood management projects include the following:

- **Projects require extensive stakeholder involvement, which increases project planning costs.** Stakeholders have become more educated about project development and environmental requirements. Successful projects require proper engagement of a diverse set of stakeholders. The cost associated with stakeholder engagement activities must be included in planning and implementation costs.
- **Flood management responsibility is fragmented**. Responsibilities for planning, administering, financing, and maintaining flood management facilities and emergency response programs are usually spread among several agencies or between departments within a large agency. More than 1,300 agencies have some responsibility for flood management in the state. Flood management responsibilities are often spread out within and between these agencies.
- **Different methodologies and inadequate data make risk assessment complex and costly to complete.**
- **Land use decisions may not adequately prioritize public safety.** Uninformed residents and policymakers can make decisions that inadvertently put people and property at increased risk. In some cases, providing adequate space for flood management facilities to meet existing and future needs during the development approval process would reduce flooding impacts. Internal and intra-agency coordination is important when local agencies make development decisions. Improving coordination within and between agencies could inform the potential land use decisions to avoid adverse flood impacts. Even with new requirements that call for flood

considerations in General Plans, flood managers are not always included in land use discussions.

- **Delayed permit approvals and complex permit requirements are obstacles to flood risk reduction.** Many agencies wait years for permits, resulting in poorly maintained projects and missed funding opportunities for new projects. Often, agencies face conflicting or confusing requirements regarding project permits. Also, regulatory requirements to renew existing permits or obtain new permits frequently require extensive mitigation. This mitigation can greatly increase project costs and cause project delays.
- **Flood management projects are not prioritized from a systemwide or multibenefit perspective.** State and Federal flood management funding has traditionally been provided to local projects by analyzing a narrowly focused and localized set of benefits. In addition, funding levels for flood management are often set without regard to a systemwide prioritization of needs.
- **Lack of reliable, sustained funding puts California at significant risk.** Inadequate funding for flood management maintenance, operations, and improvements makes flood risk reduction difficult or impossible for many local agencies. Agencies at all levels are facing funding constraints. Local agency funding is often based on county general funds, which have been impacted by the economic downturn and limited by restrictions from Proposition 218 (1996 Right to Vote on Taxes Act). State funding for flood management has been tied to bond funding, much of which will be depleted by 2017. Reductions in Federal funding have occurred, resulting in potential reductions in funding levels for flood risk studies and projects.
- **Flood risk funding.** Funding for flood projects is based upon the potential that a significant flood will occur, rather than providing for day-to-day flood management needs.

These issues have led to an increase in the cost of flood management. Addressing these issues will require a move away from the traditional approach to developing flood management projects. The mitigation components of many projects are already moving flood management toward using an IWM approach. However, a true IWM approach requires coordination, collaboration, and inclusion of diverse objectives from the initiation of the project development process, rather than as a mitigation measure.

Thousand Palms, 2005

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3.0 An IWM Approach

In traditional flood management, the overarching purpose is to separate floodwaters from people and property that could be harmed. In contrast, IWM seeks a balance among exposure of people and property to flooding, the quality and functioning of ecosystems, the reliability of water supply and water quality, and economic stability (including both economic and cultural considerations). This shift changes the focus of flood management from a local context to a systemwide context.

3.1 What is an IWM Approach?

IWM is a strategic approach that combines specific flood management, water supply, and ecosystem actions to deliver multiple benefits. This approach relies on blending knowledge from a variety of disciplines, including engineering, economics, environmental science, public policy, and public relations. An IWM approach also promotes system flexibility and resiliency to accommodate changing conditions such as regional requirements, local preferences, ecosystem needs, climate change, flood or drought events, and financing capabilities.

Using an IWM approach is not a one-time activity. Long-term commitments and alignment among the responsible public agencies are necessary to create sustainable, affordable water resource systems. Achieving agency alignment and regional collaboration can be a challenge because an IWM approach requires striking a balance between objectives that are sometimes competing. However, using an IWM approach builds on broad stakeholder support and can lead to faster project completion, as well as access to additional funding sources.

IWM is an evolving approach embraced by many public and private entities around the nation and the world. As a result, nuanced differences exist in definitions of IWM, such as:

- Integrated Regional Water Management (IRWM), which is the application of IWM principles on a regional basis
- Integrated Water Resources Management (IWRM), which is another term used to describe IWM

Some of the different definitions of IWM are provided in the samples below.

IWM Project along Guadalupe River

United Nations

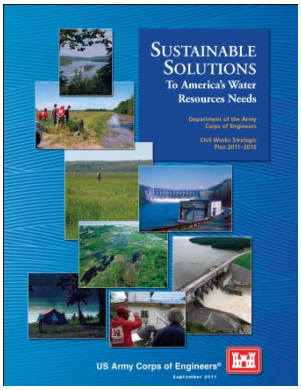
The United Nations uses the widely accepted definition of IWRM developed by the Global Water Partnership. The Global Water Partnership was founded in 1996 by the World Bank, the United Nations Development Programme, and the Swedish International Development Cooperation Agency to foster IWRM. The Global Water Partnership's definition of IWRM states (GWP, 2012):

> *IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.*

Republic of South Africa, Department of Water Affairs

The Republic of South Africa, Department of Water Affairs uses the widely accepted definition of IWRM from the Global Water Partnership, as well as the following (RSA, 2013):

> *Integrated Water Resource Management (IWRM) is simultaneously a philosophy, a process, and an implementation strategy to achieve equitable access to, and sustainable use of, water resources by all stakeholders at catchment (watershed), regional, national, and international levels, while maintaining the characteristics and integrity of water resources at the catchment (watershed) scale within agreed limits.*



U.S. Army Corps of Engineers

As part of the *USACE Civil Works Strategic Plan 2011- 2015*, the USACE has developed an overarching strategy that embraces IWRM. IWRM is defined as a holistic focus on water resource challenges and opportunities that reflects coordinated development and management of water, land, and related resources while maximizing economic services and environmental quality, and ensuring public safety while providing for the sustainability of vital ecosystems (USACE, 2012).

Department of Water Resources, IRWM Strategic Planning Team

IRWM, in its broadest sense, is a philosophy and practice of coordinating the management of water and related resources for the purpose of maximizing economic and societal benefits while maintaining the sustainability of vital ecosystems.

Santa Clara Valley Water District

The Santa Clara Valley Water Distract (SCVWD) implements the concept of IWM through a comprehensive Water Resources Management Plan (WRMP) (SCVWD, 2013). The SCVWD comprehensive WRMP outlines key issues and provides a framework for community understanding of policies related to water supply, natural flood protection, and water resource stewardship within the agency's boundaries. SCVWD's mission statement also encompasses the concept of an IWM approach (SCVWD, 2012).

As stated, the mission is to:

> *. . . provide for a healthy, safe, and enhanced quality of living in Santa Clara County through watershed stewardship and comprehensive management of water resources in a practical, cost-effective, and environmentally sensitive manner for current and future generations.*

Los Angeles County Department of Public Works

The Los Angeles County Department of Public Works is adopting a sustainable business approach that embraces the concepts of IWM in its 2012 Strategic Plan (LACDPW, 2012). This approach involves using a more holistic, creative, and collaborative method to solving problems, and it requires a balanced approach to deliver projects, programs, and services in an environmentally and socially responsible way that ensures the long-term health and well-being of the environment and the local community.

3.2 Evolution of Flood Management Toward an IWM Approach

Although different agencies may have different characterizations or use different acronyms to describe IWM, agencies around the state are moving toward using this approach. This section will describe how the approaches to flood management that are used by local, State, and Federal agencies are evolving.

3.2.1 USACE's IWM Approach

The Flood Control Act of 1936 declared that flood risk management (formerly flood control) was a national priority because floods constituted a potential menace to national welfare. This act established an enormous commitment by the Federal government to reduce the risk of flooding to people and property. Congress has authorized the USACE to plan, engineer, and construct hundreds of flood risk management projects consisting of hundreds of miles of levees, flood walls, and channel improvements, as well as approximately 375 major dams and reservoirs nationwide (USACE, 1988). These efforts have saved billions of dollars in property damage and protected millions of people from death, injury, and other related health issues.

Since 1977, Federal agencies have included IWM principles in flood management. Today, USACE incorporates IWM principles in its definition of floodplain management (see sidebar). As part of the USACE Civil Works Strategic Plan 2011-2015, the USACE

Floodplain Management is a continuing process, involving both Federal and non-Federal actions that seek a balance between use and environmental quality in the management of the inland and coastal floodplains as components of the larger human communities. The flood damage reduction aspects of floodplain management involve modifying floods and modifying the susceptibility of property to flood damages. The former embraces the physical measures commonly called "flood control;" the latter includes regulatory and other measures intended to reduce damages by means other than modifying flood waters. By guiding floodplain land use and development, floodplain regulations seek to reduce future susceptibility to flood hazards and damages consistent with the risk involved and serve in many cases to preserve and protect natural floodplain values.

USACE EP 1165-2-1

is embracing an overarching strategy that advocates an IWRM approach for projects. This plan identifies six cross-cutting strategies to assist with implementing an IWRM approach; these strategies are as follows:

- **Systems Approach** – Develop water resources planning and management on a watershed scale, using systemwide analysis methods and tools to understand, assess, and model the interconnected nature of hydrologic systems (e.g., watersheds) and the economic and ecologic systems they support, and to identify and evaluate management alternatives from both time (life-cycle) and function (multipurpose) perspectives.
- **Collaboration and Partnering** – Build and sustain collaboration and partnerships at all levels to leverage funding, talent, data, and research from multiple agencies and organizations.
- **Risk-Informed Decision Making and Communication** –Develop and employ risk- and reliability-based approaches that incorporate consequence analysis, especially risks to humans; identify, evaluate, and forestall possible failure mechanisms; and quantify and communicate residual risk.
- **Innovative Financing** – Think beyond traditional government appropriations and seek innovative arrangements such as public-private partnerships, revised funding prioritizations, and other appropriate funding mechanisms to develop and sustain the infrastructure for the nation's water resources.
- **Adaptive Management** – Promote and employ adaptive management, a process that promotes flexible decision making that can be adjusted in the face of risks and uncertainties (such as those presented by climate change) as outcomes from management actions and other events become better understood through monitoring and improved knowledge.
- **State-of-the-Art Technology** – Embrace new and emerging technology to its fullest advantage. Invest in research that improves the resiliency of structures, assists in updating design criteria, and improves approaches toward planning and design (USACE, 2011).

Currently, USACE faces challenges to implementation of an IWM approach, including program and funding policies and procedures, cost-sharing requirements of non-Federal sponsors, and the need to clearly define the USACE roles in flood risk management and ecosystem restoration.

An IWM approach to a project is exemplified in the South San Francisco Bay Shoreline Project, briefly described in Case Study 1. For this project, the USACE has partnered with the California State Coastal Conservancy, U.S. Fish and Wildlife Service, and the SCVWD (for more information, see Case Study 1).

Case Study 1	
Project Name:	South San Francisco Bay Shoreline Study

Project Description:

The South San Francisco Bay Shoreline Study is located in the southern San Francisco Bay Area and covers approximately 26,000 acres of former tidal marsh. This study is investigating the feasibility of a combined flood risk management and ecosystem restoration project, as well as public access opportunities. Tidal flooding in the area is due to historic subsidence (up to 13 feet in some areas), which is projected to increase due to sea level rise.

In the San Francisco Bay- Delta Estuary, an estimated 85 percent of the historical tidal marshes have been filled or significantly altered during the past two centuries. These wetland habitats, including the salt ponds, tidal marshes, sloughs, mudflats, and open bay, are used by large populations of waterfowl and shorebirds, harbor seals, and a number of threatened and endangered species. The project is being developed in phases.

San Francisco Bay Hydrologic Region

Multiple Benefits and Success Factors

Benefits: Project benefits include:

- Reduced potential economic damages due to tidal flooding.
- Reduced risk to public health, human safety, and the environment due to tidal flooding.
- Increased contiguous marsh area to restore ecological function and habitat quantity, quality, and connectivity.

Success Factors: Diverse funding sources, phased approach.

Project Status

The total cost of the study is approximately $19 million, and the estimated project cost is on the order of $500 million. Feasibility studies and early implementation stages are funded and underway, although design and construction phases are currently unfunded.

Typical Natural Tidal Marshland in San Francisco Bay Area

3.2.2 DWR's IWM Approach

In 1956, the California Legislature passed a bill creating the Department of Water Resources. DWR was created to plan, design, construct, and oversee the building of the nation's largest State-built water development and conveyance system. Today, DWR protects, conserves, develops, and manages much of California's water supply, including the State Water Project, which provides water for 25 million residents, farms, and businesses. DWR also works to prevent and respond to floods, droughts, and catastrophic events that would threaten public safety, water resources and management systems, the environment, and property.

Today, even as the concept of IWM is evolving, DWR is actively promoting IWM approaches through many of its ongoing programs. These programs include:

- FloodSAFE California Initiative, which uses an IWM approach to improve public safety
- The California Water Plan, which develops an IWM Strategic Plan for the state

DWR IRWM Planning

DWR has supported IRWM with grants and technical services to regional water management groups (RWMGs) statewide. Forty-eight RWMGs now cover 87 percent of the state's geographic area and 99 percent of the population. The individual IRWM regions and RWMGs can be found at http://www.water.ca.gov/irwm/grants/index.cfm.

- IRWM planning, which has provided technical assistance and grants to support implementation of an IWM approach at a regional level

For example, DWR and other State agencies have recently developed IWM solutions in the following plans:

- Central Valley Flood Protection Plan
- Bay-Delta Conservation Plan
- Climate Change Initiative
- The Delta Stewardship Council's Delta Plan
- Strategic Plan for the Future of Integrated Regional Water Management

The Vic Fazio Wildlife Area Project demonstrates a long-term, State-funded, flood management project that is evolving to acknowledge and expand multiple benefits, including flood management, agricultural land use, and habitat restoration (see Case Study 2 for additional information).

Case Study 2

Project Name: Vic Fazio Wildlife Area

Project Description:

The Yolo Bypass near the project area is used to carry floodwater from major northern California rivers, diverting flows around low-lying communities in the Sacramento-San Joaquin River-Delta (Delta) and the City of Sacramento. The project area serves many functions, including agriculture, wildlife habitat, fish spawning habitat, and flood control.

The Vic Fazio Wildlife Area project consists of integrated management actions to:

- Provide a 41-mile-long swath of agricultural land that conveys floodwater to the Delta during times of heavy flows
- Provide for multiple uses along the bypass that supports a variety of land uses and resources, including agricultural production
- Provide regional recreational public access
- Provide an extensive levee system of flood control for the surrounding area
- Provide ecosystem benefits for rare and endangered species

Sacramento River Hydrologic Region

Multiple Benefits and Success Factors

Benefits:

This project provides multiple benefits, including:

- Provides flood protection for downstream communities
- Provides agricultural and recreational uses
- Improves ecosystem health and connectivity, including wetland, upland, grassland, and riparian habitats

Success Factors: Transparency, facilitation of permitting approach, multiple benefits, agency alignment.

Project Status

The project was designed to divert water during times of large flows through a series of weirs and channels and has been functioning since it was originally constructed following the adoption of the Sacramento River Flood Control Project by Congress in 1917. The project has continued to be adapted and expanded, based on the changing needs of the region. The California Department of Fish and Wildlife (CDFW) began acquiring property in the area in 1992, and CDFW continues to expand this area.

Geese Enjoy the Vic Fazio Wildlife Area

3.2.3 Local Agencies' Use of an IWM Approach

More than 1,300 flood management agencies[2] throughout the state are responsible for operation and maintenance (O&M), as well as repair, rehabilitation, and replacement (OMRR&R) of nearly 20,000 miles of levees, more than 2,000 dams, more than 1,000 debris basins, more than 100 major reservoirs, and many other facilities. These facilities have been developed over time using not only traditional flood management but also some IWM approaches. Initially, most flood management agencies were established by landowners in the region to address an ongoing flooding problem. These agencies either developed infrastructure alone or partnered with State and Federal agencies to build facilities.

Responsibilities of these agencies have evolved, and the types of agencies involved in flood management have expanded. Agencies with flood management responsibilities now include special districts, cities, counties, levee districts, reclamation districts, and tribes. This complex network of agencies has resulted in agency roles and responsibilities that sometimes overlap and occasionally have conflicting mandates.

Today, these agencies face a number of challenges with implementing flood management projects. The information gathering effort for the Flood Future Report (see *Attachment E: Existing Conditions of Flood Management in CA (Information Gathering Findings*) revealed the following conditions:

- Many projects are moving toward an IWM approach due to the mitigation requirements for permitting.
- Some agencies have fully embraced an IWM approach and include IWM principles in agency mission statements.
- Although most agencies are aware of IWM approaches and have considered an IWM project, the larger-sized urban agencies are generally the most active in planning and implementing IWM projects. Santa Clara Valley Water District, Sacramento Area Flood Control Agency, and Santa Ana Watershed Protection Authority are examples of large, urban agencies that have implemented projects using an IWM approach.
- Smaller or more rural agencies often struggle with developing projects using the IWM approach.

An example of a local agency-sponsored project using an IWM approach is the Sun Valley Watershed Management Plan presented in Case Study 3.

[2] See *Attachment G: Risk Information Inventory* for a complete list of flood management agencies.

Case Study 3

Project Name: Sun Valley Watershed Management Plan

Project Description:

The Sun Valley watershed is located in the San Fernando Valley in the city of Los Angeles, approximately 14 miles northwest of downtown Los Angeles. It is a densely urbanized area, approximately 60 percent of which is dedicated to industrial and commercial use. This plan is being implemented using a phased approach with the following components:

- Construct debris basins, including the use of large-scale stormwater separation devices.
- Manage runoff through watershed management by increased vegetative cover and infiltration basins, minimizing impermeable surfaces.
- Improve the quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitat communities.
- Manage municipal stormwater to provide regional or systemwide flood benefits.
- Increase local agency awareness of flood mitigation compliance, floodplain function, and grant application assistance through the Stakeholder Group.

Multiple Benefits and Success Factors

Benefits: This project has the following benefits:

- Improves stormwater management and reduces localized flooding
- Improves water quality of downstream receiving streams
- Increases water supply by capturing runoff
- Increases recreational opportunities via parks, trails, sporting facilities
- Improves wildlife habitat by restoring and connecting habitat corridors

Success Factors: Agency collaboration

Chronic Street Flooding – Sun Valley Watershed

Project Status

The Sun Valley Watershed Management Plan projects are being implemented in phases and are in various stages of securing funding. Completed phases of the project have costs totaling greater than $10 million. Additional projects are still pending, seeking final approvals and funding.

4.0 Strategies and Management Actions for Practicing Flood Management with an IWM Approach

Projects developed using an IWM approach have different components based on the type of flooding addressed, regional preferences, agencies involved, stakeholders involved, and funding available. An IWM approach to the practice of flood management is implemented by bundling different components or management actions together to achieve multiple project objectives.

Key elements to implementing an IWM approach apply to flood management, as well as to other water resource management practices.

4.1 Practicing an IWM Approach

One benefit of using IWM is that it encourages a systemwide perspective to solving flood issues along with an increased understanding of the cause and effect of different management actions. This moves solutions beyond simply reducing flood risk resulting from the 100-year flood event in compliance with NFIP requirements to an integrated approach that reduces flood risk and supports other objectives over a multitude of flood events. (A 100-year flood has a 1-in-100, or 1 percent, probability of occurring in any given year.) Traditional flood management approaches inadvertently allowed development in floodplains, putting people and property at risk. An IWM approach is balanced and leads to addressing a wide variety of needs. For example, projects are assessed based on the following attributes:

- Potential velocities and timing of flood flows, as well as resources that could be disturbed or damaged by those velocities and timings
- Depth and duration of floodwaters both during the event and after the event
- Ecosystem processes that could be either enhanced or diminished by projected flows
- Stability of floodways, including potential for scour, erosion, and sediment transport and deposition
- Opportunities for community and private access to and use of lands dedicated to the flood path
- Alternative or combined uses of the lands that make up the flood path
- Risks to the community should a flood occur, and recovery capabilities following a flood
- Water supply implications from the flood management system and operating conditions before, during, and after flood events

Flood Management as part of an Integrated Water Management Approach

IWM is an approach that combines specific flood management, water supply, and ecosystem actions to deliver multiple benefits. An IWM approach uses a collection of tools, plans, and actions to achieve efficient and sustainable solutions for the beneficial uses of water. An IWM approach reinforces the interrelation of different water management components—such as water supply reliability, flood management, and environmental stewardship—with the understanding that changes in the management of one component will affect the others. This approach applied to flood management looks at the benefits of flooding to natural systems. IWM acknowledges the importance and function of flooding as a natural part of the ecosystem and helps people to learn to live with and better understand the benefits of flooding. This approach promotes system flexibility and resiliency to accommodate changing conditions such as regional preferences, ecosystem needs, climate change, flood or drought events or financing capabilities.

An IWM approach requires unprecedented alignment and cooperation among public agencies, tribal entities, land owners, interest-based groups, and other stakeholders. It is not a one-time activity but rather an ongoing process. Also, this approach relies on blending knowledge from a variety of disciplines, including engineering, planning, economics, environmental science, public policy, and public information.

An IWM approach represents the future of flood management in California, with the goal to improve public safety, foster environmental stewardship, and support economic stability.

Today, flood management is evolving from narrowly focused traditional approaches toward an IWM approach. The flood management emphasis has shifted to this more integrated approach that includes a mix of multiple measures, including structural and nonstructural approaches. This more integrated approach enhances the ability of undeveloped floodplains and other open spaces to behave more naturally and absorb, store, and slowly release floodwaters during small and medium-sized events. Flood management as part of an IWM approach considers land and water resources on a watershed scale, employing both structural and nonstructural measures to maximize the benefits of floodplains and minimize loss of life and damage to property from flooding, and recognizing the benefits to ecosystems from periodic flooding. Flood management utilizes best management practices (BMPs), which are methods or techniques that are used in a variety of circumstances and fields, from stormwater management to land use planning, to yield superior results. The application of flood management approaches within the context of an IWM approach extends the range of strategies that could be employed beyond the traditional approach. Additionally, the approaches that could be implemented to manage flood risk within a hydrologic region or watershed will vary, depending on the physical attributes of the area, the presence of undeveloped floodplains, the type of flood hazards (e.g., riverine, alluvial fan, coastal), and the areal extent of flooding.

Although the primary purpose of flood management is public safety (i.e., reduce flood risk and reduce the impacts of flooding on lives and property), approaches to flood management can serve many purposes, and flood management is a key component of an IWM approach.

4.2 Management Actions

Flood management includes a wide range of management actions and can be grouped into four general approaches—Nonstructural Approaches, Restoration of Natural Floodplain Functions, Structural Approaches, Emergency Management, and Crosscutting Approaches. These approaches and the management actions within them serve as a toolkit of potential actions that local, State, and Federal agencies can use to address flood-related issues, and advance IWM.

These actions range from policy or institutional changes to operational and physical changes to flood infrastructure. Such

actions are not specific recommendations for implementation; rather, they serve as a suite of generic management tools that can be used individually or combined for specific application situations. A variety of management actions can be bundled together as part of a single flood management project (see accompanying project case studies in Appendix E: Detailed IWM Case Studies). Management actions also can be integrated with other resource management strategies under other objectives (e.g., water supply, water quality, ecosystem restoration, and recreation) to create multibenefit projects.

More than 100 flood management actions were identified by the Flood Future Report. The Flood Future Report used as a basis the Central Valley Flood Protection Plan (CVFPP) management actions that were applicable to the Central Valley. These were then broadened to apply to other regions of the state and to different types of flood hazards. The four general categories of management actions are summarized in this section. A detailed list of management actions and their descriptions is in Appendix B.

4.2.1 Nonstructural Approaches

Nonstructural approaches to flood management include land use planning and floodplain management.

Land Use Planning

Land use planning employs policies, ordinances and regulations to limit development in flood-prone areas and encourages land uses that are compatible with floodplain functions. This can include policies and regulations that restrict or prohibit development within floodplains, restrict size and placement of structures, prevent new development from providing adverse flood impacts to existing structures, encourage reduction of impervious areas, require floodproofing of buildings, and encourage long-term restoration of streams and floodplains.

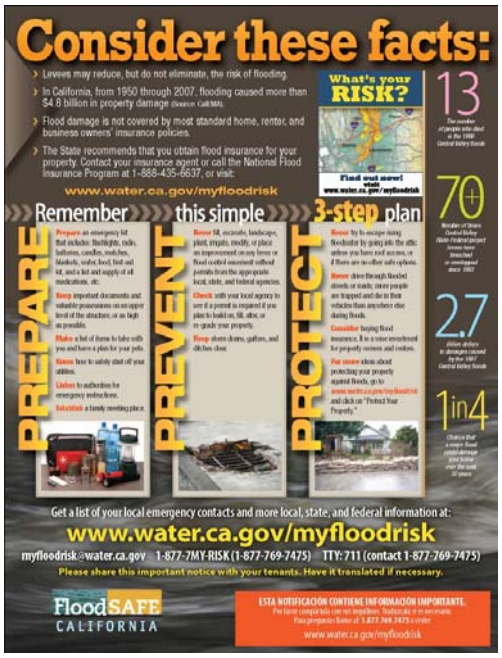
Construction within the Floodplain (survey pole denotes elevation of 100-year flood event)

Floodplain Management

Floodplain management generally refers to nonstructural actions in floodplains to reduce flood damages and losses. Floodplain management actions include:

- **Floodplain Mapping and Risk Assessment –** Floodplain mapping and risk assessment serve a crucial role in identifying properties that are at a high risk to flooding. Accurate, detailed maps are required to prepare risk assessments, guide development, prepare plans for community economic growth and infrastructure, utilize the natural and beneficial function of floodplains, and protect private and public investments. Development of needed technical information includes topographic data, hydrology, and hydraulics of streams and rivers, delineation of areas subject to inundation, assessment of properties at risk, and calculation of probabilities of various levels of loss from floods.

- **Land Acquisitions and Easements –** Land acquisitions and easements can be used to restore or preserve natural floodplain lands and to reduce the damages from flooding by preventing urban development. Land acquisition involves acquiring full-fee title ownership of lands from a willing buyer and seller. Easements provide limited-use rights to property owned by others. Flood easements, for example, are purchased from a landowner in exchange for perpetual rights to periodically flood the property when necessary or to prohibit planting certain crops that would impede flood flows. Conservation easements can be used to protect agricultural or wildlife habitat lands from urban development. Both land acquisitions and easements generally involve cooperation with willing landowners. Although acquisition of lands or easements can be expensive, they can reduce the need for structural flood improvements that would otherwise be needed to reduce flood risk. Maintaining agricultural uses and/or adding recreational opportunities where appropriate provide long-term economic benefits to communities and the State.



DWR Flood Risk Notification Program Flyer, 2012

- **Building Codes and Floodproofing –** Building codes and floodproofing include specific measures that reduce flood damage and preserve egress routes during high-water events. Building codes are not uniform; they vary across the state based on a variety of factors. Example codes could require floodproofing measures that increase the resilience of buildings through structural changes, elevation, or relocation and the use of flood resistant materials.
- **Retreat –** Retreat is the permanent relocation, abandonment, or demolition of buildings and other structures. Retreat can be used in a variety of settings from floodplains to coastal areas. In coastal regions, this action would allow the shoreline to advance inward, unimpeded in areas subject to high coastal flooding risks, high erosion rates, or future sea level rise. Integrating recreation uses into retreat areas along the shoreline provides economic uses for these buffer lands.
- **Flood Insurance –** Flood insurance is provided by the Federal government via the NFIP to communities that adopt and enforce an approved floodplain management ordinance to reduce future flood risk. The NFIP enables property owners in participating communities to purchase subsidized insurance as a protection against flood losses. If a community participates in the voluntary Community Rating System and implements certain floodplain management activities, the flood insurance premium rates are discounted to reflect the reduced flood risks.

- **Flood Risk Awareness (Information and Education) –** Flood risk awareness is critical because it encourages prudent floodplain management. Flood hazard information is a prerequisite for sound education in understanding potential flood risks. If the public and decision makers understand the potential risks, they can make decisions to reduce risk, increase personal safety, and expedite recovery after floods. Effective risk awareness programs are critical to building support for funding initiatives and to building a connection to the watershed.

Restoration of Natural Floodplain Functions

This strategy recognizes that periodic flooding of undeveloped lands adjacent to rivers and streams is a natural function and can be a preferred alternative to restricting flood flows to an existing channel. The intent of natural floodplain function restoration is to preserve and/or restore the natural ability of undeveloped floodplains to absorb, hold, and slowly release floodwaters, to enhance ecosystem, and to protect flora and fauna communities. Natural floodplain function conservation and restoration actions can include both structural and nonstructural measures. To permit seasonal inundation of undeveloped floodplains, some structural improvements (e.g., weirs) might be needed to constrain flooding within a defined area along with nonstructural measures to limit development and permitted uses within those areas subject to periodic inundation. Actions that support natural floodplain and ecosystem functions include:

- **Promoting Natural Hydrologic, Geomorphic, and Ecological Processes –** Natural hydrologic, geomorphic, and ecological processes are key components of promoting natural floodplain and ecosystem functions**.** Human activities (including infrastructure such as dams, levees, channel stabilization, and bank protection) have modified natural hydrological processes by changing the extent, frequency, and duration of natural floodplain inundation. These changes disrupt natural geomorphic processes such as sediment erosion, transport, and deposition, which normally cause channels to migrate, split, and rejoin downstream. These natural geomorphic processes are important drivers in creating diverse riverine, riparian, and floodplain habitat to support fish and wildlife, and in providing natural storage during flood events. Restoration of these processes might be achieved through setting back levees, restoring channel alignment, removing unnatural hard points within channels, or purchasing lands or easements that are subject to inundation.
- **Protecting and Restoring Quantity, Quality, and Connectivity of Native Floodplain Habitats –** Quantity, quality, and connectivity of native floodplain habitats are critical to promote natural floodplain and ecosystem functions**.** In some areas, native habitat types and their associated floodplain have been lost, fragmented, and degraded. Lack of linear continuity of riverine, riparian habitats, or wildlife corridors, impacts the movement of wildlife species among habitat patches and results in a lack of

diversity, population complexity, and viability. This can lead to native fish and wildlife becoming rare, threatened, or endangered. Creation or enhancement of floodplain habitats can be accomplished through setting back levees and expanding channels or bypasses, or through removal of infrastructure that prevents flood flows from entering floodplains. Coastal wetlands have been severely reduced, resulting in a loss of habitat for freshwater, terrestrial, and marine plant species. Restoration of these habitats could provide a buffer against storm surges and sea level rise.

- **Invasive Species Reduction –** Minimizing invasive species can help address problems for both flood management and ecosystems. Invasive species can reduce the effectiveness of flood management facilities by decreasing channel capacity, increasing rate of sedimentation, and increasing maintenance costs. Non-native, invasive plant and animal species often can out-compete native plants and animals for light, space, and nutrients, further degrading habitat quality for native fish and wildlife. These changes can supersede natural plant cover, eliminate, or reduce the quality of food sources and shelter for indigenous animal species, and disrupt the food chain. Reductions in the incidence of invasive species can be achieved by defining and prioritizing invasive species of concern, mapping their occurrence, using BMPs for control of invasive species, and using native species for restoration projects.

4.2.2 Structural Approaches

Structural approaches to flood management include flood infrastructure, reservoir and floodplain storage and operations, and O&M.

Colusa Weir and Bypass – normal flow (above) and 1997 flood (below)

Flood Infrastructure

Flood infrastructure varies significantly based on the type of flooding. Flood infrastructure can include:

- **Levees and Floodwalls –** Levees and floodwalls are designed to confine flood flows by containing waters of a stream or lake. Levees are an earthen or rock berm constructed parallel to a stream or shore (or around a lake) to reduce risk from all types of flooding. Levees could be placed close to stream edges, or farther back (e.g., a setback levee). Ring levees could be constructed around a protected area, isolating the area from potential floodwaters. A floodwall is a structural reinforced-concrete wall designed and constructed to hold back floodwaters. Floodwalls have shallow foundations or deep foundations, depending on flood heights and soil conditions.

- **Channels and Bypasses –** Channels and bypasses convey floodwaters to reduce the risk of slow rise, flash, and debris-flow flooding. Channels can be modified by deepening and excavating the channel to increase its capacity, or lining the streambed and/or banks with concrete, riprap, or other materials, to increase drainage efficiency. Channel modifications can result in increased erosion downstream and degradation of adjacent wildlife habitat, and often the modifications require extensive permitting. Bypasses are structural features that divert a portion of flood flows onto adjacent lands (or into underground culverts) to provide additional flow-through capacity and/or to store the flows temporarily and slowly release the stored water.
- **Retention and Detention Basins –** Retention and detention basins are used to collect stormwater runoff and slowly release it at a controlled rate so that downstream areas are not flooded or eroded**.** A detention basin eventually drains all of its water and remains dry between storms. Retention basins have a permanent pool of water and can improve water quality by settling sediments and attached pollutants.
- **Culverts and Pipes –** Culverts and pipes are closed conduits used to drain stormwater runoff. Culverts are used to convey streamflow through a road embankment or some other type of flow obstruction. Culverts and pipes allow stormwater to drain underground instead of through open channels and bypasses.
- **Coastal Armoring Structures, Shoreline Stabilization, and Streambank Stabilization –** Coastal armoring structures and shoreline stabilization reduce risk to low-lying coastal areas from flooding**.** Coastal armoring structures are typically massive concrete or earthen structures that keep elevated water levels from flooding interior lowlands and prevent soil from sliding seaward. Shoreline stabilization reduces the amount of wave energy reaching a shore or restricts the loss of beach material to reduce shoreline erosion rates. Types of shoreline stabilization include breakwaters, groins, and natural or artificial reefs. Streambank stabilization protects the banks of streams from erosion by installing riprap, matting, vegetation or other materials to reduce erosion.

Crescent City Breakwall, 2012

- **Debris Mitigation Structures –** For debris and alluvial flooding, Sabo dams, debris fences, and debris basins separate large debris material from debris flows, or the structures contain debris flows above a protected area. These structures require regular maintenance to periodically remove and dispose of debris after a flood. Deflection berms (or training berms) can be used to deflect a debris flow or debris flood away from a development area, allowing debris to be deposited in an area where it would cause minimal damage.

Reservoir and Floodplain Storage and Operations

Reservoir and floodplain storage and operations consist of:

- **Reservoir and Floodplain Storage –** Reservoir and floodplain storage provide an opportunity to regulate flood flows by reducing the magnitude of flood peaks occurring downstream. Many reservoirs are multipurpose and serve a variety of functions, including water supply, irrigation, habitat, and flood control. Reservoirs collect and store water behind a dam and release it after the storm event. Floodplain storage occurs when peak flows in a river are diverted to adjacent off-stream areas. Floodplain storage can occur naturally when floodwaters overtop a bank and flow into adjacent lands, or storage can be engineered using weirs, berms, or bypasses to direct flows onto adjacent lands.

Dominguez Gap Detention Basin and Wetlands

- **Storage Operations –** Storage operations optimize the magnitude and timing of reservoir releases. Storage operations can reduce downstream flooding by optimizing the magnitude or timing of reservoir releases, or through greater coordination of storage operations. Coordination can take the form of formal agreements among separate jurisdictions to revise reservoir release operations based on advanced weather and hydrology forecasts, or it can simply involve participation in coordination meetings during flood emergencies.

Operation and Maintenance

Flood Operations Center, 2006

Operation and maintenance is a crucial component of flood management. For Federally funded projects, the definition of O&M includes the local entity's financial obligation for OMRR&R of the implemented project. OMRR&R is a non-Federal responsibility when local, regional, and/or State entities partner on a Federal project. References to O&M provided in this report include OMRR&R responsibilities when the project is a Federal/non-Federal partnership. O&M activities can include inspection, vegetation management, sediment removal, management of encroachments and penetrations, repair or rehabilitation of structures, or erosion repairs. Because significant flood infrastructure constructed in the early to mid-twentieth century are near or have exceeded the end of their expected service lives, adequate maintenance is critical for this flood infrastructure to continue functioning properly.

4.2.3 Flood Emergency Management

Flood emergency management includes the following preparedness, response, and recovery activities:

- **Flood Preparedness** – Flood preparedness consists of the development of plans and procedures on how to respond to a flood in advance of a flood emergency, including preparing emergency response plans, training local response personnel, designating evacuation procedures, conducting exercises to assess readiness, and developing emergency response agreements that address issues of liability and responsibility.
- **Emergency Response –** Emergency response is the aggregate of all those actions taken by responsible parties at the time of a flood emergency. Early warning of flood events through flood forecasting allows timely notification of responsible authorities so that plans for evacuation of people and property can be implemented. Emergency response includes flood fighting, emergency evacuation, and sheltering. Response begins with, and might be confined to, affected local agencies or operational areas (counties). Depending upon the intensity of the event and the resources of the responders, response from regional, State, and Federal agencies might be required.

Flood Fighting, 2006

- **Post-Flood Recovery** – Recovery programs and actions include restoring utility services and public facilities, repairing flood facilities, draining flooded areas, removing debris, and assisting individuals, businesses, and communities to protect lives and property. Recovery planning could include development of long-term floodplain reconstruction strategies to determine if reconstruction would be allowed in flood-prone areas, or if any existing structures could be removed feasibly. Such planning should review what building standards would be required, how the permit process for planned reconstruction could be improved, funding sources to remove existing structures, natural habitat restoration, and how natural floodplains and ecosystem functions could be incorporated.

4.2.4 Cross-cutting Approaches

Several management actions within Flood Management are considered to be cross-cutting (i.e., they would be a part of all management actions). These cross-cutting actions are permitting, policy and regulations, and finance and revenue.

Permitting

Regional and programmatic permitting methods can provide faster and better delivery of flood management activities, including O&M, repair, habitat

enhancement and restoration, and minor infrastructure improvement or construction projects. Regional and programmatic permitting methods can be used to collectively manage permitting needs for multiple projects, over longer planning horizons, while consolidating mitigation and conservation efforts into larger, more viable conservation areas. This can accelerate permitting of flood system projects and lower per-unit costs versus project-by-project mitigation. Regional and programmatic permitting methods include regional Habitat Conservation Plans, Natural Community Conservation Plans, programmatic Endangered Species Act Section 7 consultations, and Regional General Permits.

Policy and Regulations

Policies and regulations that clarify flood management roles and responsibilities for local, regional, State, and Federal agencies can help improve coordination across the large number of agencies and entities involved in Flood Management. Multiple jurisdictional and regional partnerships can be encouraged for flood planning and flood management activities, including permitting, financing, O&M, repair, and restoration.

Finance and Revenue

Several finance and revenue strategies can increase the ability to fund flood management projects. Aligning flood management projects with other existing or planned projects (such as roads or highways) leverages funding from different agencies and jurisdictions to help accomplish objectives. Consolidating projects on a regional or watershed level can also improve cost effectiveness and financial feasibility by pooling resources.

Agency Coordination on Jones Tract Flood Fight, 2004

5.0 Benefits of an IWM Approach to Flood Management

DWR and USACE are committed to the IWM approach and have started to implement flood management programs to support multibenefit projects. As stated earlier, an IWM approach combines flood management, water supply, and ecosystem actions to deliver multiple benefits. It relies on blending knowledge from a variety of disciplines, including engineering, economics, environmental sciences, public policy, and public information. Successful implementation of an IWM approach requires agencies at all levels to work together to deliver projects that improve public safety, foster environmental stewardship, and support economic stability. Three benefits of implementing an IWM approach include identification of high-value multibenefit projects, regional collaboration and cooperation among agencies, and funding from a range of sources.

5.1 High-Value Multibenefit Projects

The value of using an IWM approach is in the results—improved public safety, enhanced environmental stewardship, and statewide economic stability. Localized, narrowly focused projects are not the best use of public resources and might have negative unintended consequences in nearby regions. The IWM approach can help deliver more benefits at a faster pace using fewer resources than what is possible from single-benefit projects. Examples of high-value multibenefit projects include the Salt River Ecosystem Restoration Project and the San Bernardino County Flood Control District Groundwater Recharge Program – Cactus Basins 3, 4, and 5 (see Case Studies 4 and 5).

Case Study 4

Project Name: Salt River Ecosystem Restoration Project

Project Description

The Salt River estuary is part of the Humboldt Bay/Eel River estuary complex encompassing three critical habitats: salmon and steelhead, shorebird wintering and migration, and riparian birds. The project is focused on:

- Restoring the Salt River channel and riparian floodplain to optimize fish passage, riparian habitat, and sediment transport
- Restoring tidal wetland and upland areas near confluence of the Salt and Eel rivers
- Reducing upslope sediment and control erosion in the sub-watersheds

This project is using an adaptive management plan to maintain overall project performance.

North Coast Hydrologic Region

Multiple Benefits and Success Factors

Benefits: The benefits of this project include:

- Reconnecting Eel River estuary with the Salt River channel and upslope watersheds
- Restoring 7.7 miles of riparian corridor and 444 acres of tidal wetland habitat
- Reducing chronic flooding
- Improving water quality and providing carbon sequestration

Success Factors: Multiple benefits, permitting approach, agency alignment.

Salt River Flooding near Ferndale

Project Status

The project has approximately $15.7 million (current and pending) in funding and is proceeding in two major phases. Phase 1 consists of wetland and upland restoration, as well as excavation and reconfiguration of 1.5 miles of Salt River channel. Phase 2 consists of an additional 5.5 miles of channel excavation and reconfiguration.

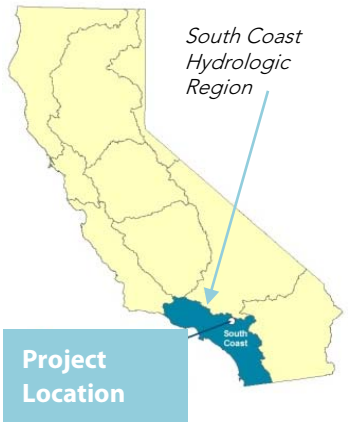
Case Study 5

Project Name: San Bernardino County Flood Control District Groundwater Recharge Program – Cactus Basins 3, 4, and 5

Description

The project is situated in a developed, highly urbanized area in the north-central portion of the City of Rialto. The project site is an undeveloped field of approximately 140 acres that would be used to capture floodwater for water supply via groundwater recharge. This project has the following components:

- New storage or updating, modifying, or replacing existing flood storage facilities to increase on-stream flood storage capacity.
- Reducing flow constrictions to improve conveyance.
- Providing groundwater recharge to improve water supply at flood basins.
- Improving the quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitat communities.



Multiple Benefits and Success Factors

Benefits: Benefits include the following:

- Reduced risk of flooding in and around the Rialto Channel by addressing flow constrictions
- Increased groundwater recharge
- Improved quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitats

Success Factors: Flood risk reduction, habitat restoration.

Cactus Basins, San Bernardino, 2012

Project Status

In 2011, technical studies were performed related to this project and downstream Rialto Channel. The project was awarded $1,000,000 in Proposition 84 (2006) Stormwater Grant funds from DWR through the Santa Ana Watershed Project Authority. Total project costs are estimated to be $31.6 million.

5.2 Large Range of Solutions

An IWM approach relies on bundling solutions from a variety of disciplines including engineering, economics, environmental science, public policy, and public outreach. These disciplines bring different perspectives in creative problem solving to bear, widening the potential alternative solutions for a project. This allows the different management actions discussed in Section 4 to be bundled together based on regional or project-specific needs. These new project aspects can bring resource agencies and other stakeholders to the table earlier in the planning process, potentially leading to an improved regulatory process with removal of obstacles. Broader solutions can lead to a wider range of funding sources, as described in Section 5.5.

5.3 Regional Collaboration and Cooperation

A benefit of regional collaboration and cooperation is it allows Californians to think holistically to develop long-term integrated approaches to flood management. Using an IWM approach is a process which allows stakeholders to develop long-term working partnerships. Efforts to reduce flood risk and create sustainable, affordable water resources systems will require long-term commitments, alignment, and cooperation among public agencies, tribal entities, landowners, interest-based groups, and other stakeholders. Collaboration must address diverse needs and information gathering, and must deploy other tools, policies, planning, regulations, and investments. The Lower Carmel River Floodplain Protection and Enhancement Project (Case Study 6) and the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project (Case Study 7) are examples of successful projects developed through agency collaboration and cooperation.

Case Study 6

Project Name: Lower Carmel River Floodplain Restoration and Flood Control Project

Project Description:

The Carmel River Project is within the lower reaches of the Carmel River watershed. The project area is located at a dynamic interface between marine and freshwater systems and serves as a refuge for sensitive species. The agencies involved in this project are the Big Sur Land Trust, Monterey County Water Resources Agency, Monterey County Public Works Department, and California State Parks. The project was developed to:

- Improve hydrologic functions by reconnecting floodplains through levee setback or removal and land restoration
- Integrate storage and filtration basins into restored floodplains to increase flood flow retention, promote sediment and nutrient removal, and increase groundwater recharge
- Conduct geotechnical engineering analysis and hydraulic modeling needed to support design of flood control improvements
- Modify placement and/or size of existing levees and/or floodwalls, add new levees or floodwalls, construct new bypasses, and restore channel form and function to improve flood protection
- Develop local flood management plan updates
- Establish and preserve agricultural operations adjacent to, but hydrologically disconnected from, the floodplains

Central Coast Hydrologic Region

Multiple Benefits and Success Factors

Benefits: Project benefits include:

- Reduced damages to residences, commercial businesses, and local and State of California infrastructure
- Improved connectivity between the main channel and overbank areas to reduce flooding hazards
- Installation of a protective buffer against sea level changes.
- Restored riparian and wetland habitat within the historical floodplain.

Success Factors: Agency coordination and collaboration

Project Status

Currently, Big Sur Land Trust has secured approximately $17 million in grant funding necessary for project implementation. The California State Parks implemented the Carmel River Lagoon Enhancement Project, and the California State Coastal Conservancy funded $4 million to the California State Parks to lead this effort. Monterey County Water Resources Agency received $500,000 from the U.S. Environmental Protection Agency.

Highway 1 Bridge over the Carmel River during the March 1995 Flood

Case Study 7

Project Name: Middle Creek Flood Damage Reduction and Ecosystem Restoration Project

Project Description:

The Middle Creek Restoration Project is located at the north end of Clear Lake. Major issues in the area over the last 20 to 30 years include flooding and degradation of water quality and habitat. Agencies involved in this project include the Lake County Watershed Protection District, USACE, Central Valley Flood Protection Board, DWR, CDFW, Central Valley Regional Water Quality Control Board, California Bay-Delta Authority, as well as local tribes and other stakeholder groups.

The project consists of:

- Acquiring properties and removing structures within the 100-year floodplain to reduce damage and remove barriers to flow
- Breaching levees to return the natural hydrology to the area
- Improving slope protection, including rock and natural vegetation, to minimize erosion
- Replanting native wetland, riparian, and woody vegetation to stabilize slopes and provide habitat
- Creating channels, sloughs, and ponds similar to those that existed prior to 1920

Sacramento River Hydrologic Region

Multiple Benefits and Success Factors

Benefits: The benefits of the project include:

- Reducing flood risk by removing structures and property at risk of severe flooding
- Removing approximately 3 miles of substandard levees, as well as one pumping station and one weir structure associated with these existing facilities
- Protecting more than 3 miles of public roads and a major high-voltage electric transmission line
- Improving water quality

Success Factors: Multiple watershed-wide benefits, agency collaboration.

View Looking Downstream Rodman Slough. Photographer standing on the substandard levee proposed to be breached.

Project Status

Construction of the Middle Creek Restoration Project was planned for 2012 through 2015 but has been delayed. The most recent project costs are estimated by the USACE at $48 million (2006 pricing).

5.4 Regional and Systemwide Approach

The benefit of using a regional and systemwide approach is that it takes into account a wide range of causes and effects, reducing potential negative unintended consequences in nearby regions. Regional approaches allow for the best use of public resources by increasing the number of issues considered. This also promotes system flexibility and resiliency by developing solutions that provide the best benefit to the overall system or region. In contrast, localized and narrowly focused projects may solve an issue or problem while transferring the problem up or downstream.

5.5 Access to Multiple Funding Sources

One of the benefits of using an IWM approach is the potential to access funding sources that might not have been available to single-benefit projects. This can lead to achieving sufficient and stable funding for long-term flood management. An example of securing funding from diverse sources is the Flood Management, Habitat Restoration, and Recharge on the San Diego River Project (Case Study 8). Phase II of the project was made possible by working with the California Department of Transportation (Caltrans) to perform crucial elements of the project that benefited all project partners. Another example, the Red Clover Creek Restoration Project (Case Study 9), consists of a group of projects that have been funded through a variety of sources, including local (agencies, landowners, and stakeholder groups), State (bond funding), and Federal (USACE, U.S. Forest Service, and National Resource Conservation Service) sources.

Case Study 8

Project Name: Flood Management, Habitat Restoration and Recharge on the San Diego River

Project Description:

The project is located in the community of Lakeside in San Diego County and is within a 580-acre area known as the Upper San Diego River Improvement Project. Improvements to the San Diego River and adjacent lands are focused on flood management, environmental habitat restoration, recreation, and water supply.

This project consists of project components that:

- Improve flood management and water quality as a result of restoration efforts designed to increase the wetlands, improve circulation in the pond, and improve sediment transport
- Acquire ownership or land tenure on property for preservation or restoration purposes
- Restore riparian habitat types for several threatened and endangered species
- Restore the channel, including work to improve flood management, restore natural meanders, and lower the 100-year flood level by widening the floodway
- Implement low-impact development techniques, including the use of bioswales to capture and treat urban runoff and improve water quality
- Capture flood flows for habitat (wetland) enhancement and for groundwater recharge

South Coast Hydrologic Region

Multiple Benefits and Success Factors

Benefits: Benefits of the project include:

- Reduced flood levels
- Prevention of urban development in a floodplain, currently subject to development pressure
- Improved sediment balance
- Protection of downstream bridges and water pipeline
- Improved water quality via constructed wetlands to treat urban runoff
- Increased water supply through groundwater recharge of the aquifer
- Increased recreation and public access opportunities, including camping areas, trails, and a boardwalk in the pond with access for the disabled

Success Factors: Tenacity for the project, collaborative project partners, phased approach, regional compatibility.

Pre-project Development Sediment Flows

Project Status

The project was initiated in 2004 and completed in 2010. Lakeside's River Park Conservancy received funding from various sources for the project, which totaled approximately $20.5 million in funding.

Case Study 9

Project Name: Red Clover Creek Restoration Project

Project Description:

The upper Feather River watershed straddles the northern Sierra Nevada Range between the Great Basin Desert and the Central Valley of California. Water originating from its drainages represents a significant component of the State Water Project and provides high-quality water for hydropower generation, agriculture, industry, and cities. Historical mining activities have created sediment issues in the region. The multi-year, large public-private partnership project consists of integrated management actions to:

- Stabilize stream channels to address erosion and improve water quality
- Increase summer base flows for priority species and beneficial uses
- Restore floodplain habitat for sensitive species

Agencies participating or providing funding to this project include a consortium of 24 public and private sector groups.

Sacramento River Hydrologic Region

Multiple Benefits and Success Factors

Benefits: Benefits from this project include:

- Improved stream conditions
- Reduced sediment loads
- Restored floodplain function and habitat, waterfowl and wetland enhancement
- Improved water quality and reduced turbidity
- Reduced impacts to downstream water supply users and flood risk reduction to downstream communities

Success Factors: Broad Funding Sources; Stakeholder collaboration, adaptive management.

Project Status

The project is in development and construction, with funding for individual stages coming from different public and private sources.

Red Clover Creek – Before Restoration

Red Clover Creek – Restored

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6.0 Currently Planned IWM Projects

A number of agencies throughout California are successfully implementing the IWM approach and using a variety of management actions to address different types of flood hazards. Flood management agencies throughout the state have cumulatively invested more than $11 billion in flood management in the last decade, including financing from bond funds generated by California's Propositions 1E and 84 of 2006. Although IWM projects are among this investment, increased project incentives, as well as technical assistance, are required to expand the number of these projects.

As part of the information gathering effort, more than 140 local agencies were contacted to assist the SFMP team in identifying both planned flood management and IWM projects in California. To distinguish IWM projects from projects for flood management only, flood management projects that sought to integrate other benefits (e.g., ecosystem restoration, water supply, groundwater recharge, recreation, hydropower) were identified as IWM projects.

Furthermore, the most recent plans from each of the 48 IRWM regions were collected and reviewed for additional IWM project information. Each of the IRWM regions was contacted to verify the information compiled. More projects can be added to the list in the future when new projects are identified during development or update of their IRWM plans.

More than 900 projects and improvements totaling more than $50 billion in planned projects were identified from local agencies in all regions, including State efforts such as the CVFPP and Sacramento – San Joaquin River Delta (Delta) improvements, and Federal agencies (USACE). However, this does not represent the total cost of the planned projects because approximately 20 percent of the projects listed do not have associated cost estimates at this time. Section 6 outlines the specific IWM cost information available for each source of proposed/planned projects. For CVFPP and Delta improvements, specific project information was not available so total IWM project cost estimates represent local and USACE planned/proposed projects. Section 6 provides a breakdown of the number and costs associated with planned projects that use an IWM approach.

6.1 Local Planned Projects

As shown in Table H-1, 287 locally planned flood management projects statewide use an IWM approach. Information for these planned projects is presented in Appendix C.

Table H-1. Summary of Local Planned Flood-Related IWM Projects

Hydrologic Region	Total Number of Local Planned Projects	Number of IWM Projects	Number of IWM Projects with Cost	Number of IWM Projects without Cost	Total Value of IWM Projects with Cost ($ million)
Central Coast	42	29	19	10	110
Colorado River	24	1	1	0	2
North Coast	26	15	11	4	100
North Lahontan	14	5	4	1	20
Sacramento River	159	66	36	30	240
San Francisco Bay	118	43	32	11	950
San Joaquin River	55	25	19	6	580
South Coast	335	63	56	7	1,030
South Lahontan	33	21	19	2	130
Tulare Lake	30	18	18	0	220
Total	**836**	**286**	**215**	**71**	**3,382**

Note: All projects were identified as of January 2012.

6.2 Central Valley Flood Protection Plan

The CVFPP has identified additional flood improvements as part of its State Systemwide Investment Approach (SSIA) that would include additional projects with an IWM approach. The SSIA is the State's preferred approach for modernizing the State Plan of Flood Control (SPFC) to address current challenges to achieve the CVFPP goals of improving flood management, improving O&M, promoting ecosystem functions, improving institutional support, and promoting multibenefit projects.

Future project needs of $14 to $17 billion have been identified in the CVFPP. These projects represent the proposed improvements to SPFC facilities and complementary actions for flood management in the areas protected by the SPFC. It does not include all remedies for the complete list of flood infrastructure needs.

Table H-2 presents a summary of the potential for incorporating an IWM approach for each element and provides a preliminary cost estimate for the SSIA. All costs are planning-level estimates; they are based on 2011 price levels and will differ in the future. Actual costs will vary from those in Table H-2 because of a wide range of factors, including project justification by feasibility studies, project configuration, implementation time, future economic and contractor bidding conditions, as well as a number of other factors.

Table H-2. Estimated Costs of SSIA Proposed Projects in CVFPP and Projects with Potential for an IWM Approach

Element	Potential for IWM Approach	Estimated Costs ($ million)
Urban Improvements	Low	5,500 to 6,670
Small Community Improvements	Medium	690 (approximately)
Rural-Agricultural Improvements	High	1,080 to 1,190
System Improvements	High	5,150 to 6,500
Residual Risk Management	Low-None	1,520 to 1,870
Total Cost		**$13,940 to 16,920**

Notes:

The cost estimates include SPFC flood management investments that have already been expended or committed during 2007 to 2011.

Some elements of locally identified projects included in the IWM Project List might be included in the CVFPP overall cost estimates.

All costs are planning-level estimates are based on 2011 price levels and will differ in the future. Actual costs will vary because of a wide range of factors, including project justification by feasibility studies, project configuration, implementation time, future economic and contractor bidding conditions, and many others.

Source: DWR, 2012

6.3 Delta Improvements

Currently, no comprehensive flood risk reduction plan exists for the Delta, and no associated cost estimates are available. Costs for future levee improvements will depend on what level of protection is shown to be cost effective for individual islands/tracts and for the network of islands/tracts. Levees for individual islands/tracts not only provide direct benefit to the areas they protect but also provide benefit as part of the network of levees that define the water channels and the configuration of the Delta. As a result, the level of protection provided by levees will vary. Due to the complex nature of the Delta and the number of agencies and stakeholders involved, most Delta improvements will likely be developed using an IWM approach.

Ongoing programs and investigations will influence future plans for the Delta, but no current cost estimates are available from these efforts as yet. Therefore, past studies were used to show a range of potential costs to improve Delta levees to achieve different levels of flood protection. The past study estimates show a wide range of potential improvements, with estimated costs ranging from $0.1 billion to over $17 billion. The wide range in cost estimates is due to variability in existing reports and available information. With the lower estimate that accepts more levee failures, responsible agencies will need to place more effort on future recovery from flooded islands/tracts, or make decisions not to recover certain areas after flooding. Costs for Delta improvements also will vary based upon the number of projects developed using an IWM approach.

6.4 USACE Planned Projects

For the 2012 fiscal year, 33 USACE-proposed flood management projects using an IWM approach were identified in California, with an aggregate total of approximately $2 billion. These projects comprise new and ongoing flood risk studies and authorized construction projects. Of these 33 projects, 9 projects were funded for fiscal year 2012. Table H-3 presents a summary of the planned USACE projects using IWM approaches, categorized by hydrologic region. The costs listed in Table H-3 include local and Federal costs for the full project. Projects from other programs, including the Flood Plain Management Services and the Planning Assistance to States, are not captured here. Such projects are USACE recommendations for funding appropriations in California to be included in the President's budget; however, this recommendation does not imply that any project will receive appropriations. Each funding request may or may not be included in the Energy and Water Appropriations for any given year.

Thirty-three of the 60 identified USACE proposed projects use an IWM approach, with an estimated total cost of $4.8 billion. This illustrates progression toward integrated approaches to flood management practices. A complete list of USACE potential and ongoing flood projects identified as using an IWM approach is included in Appendix D.

Table H-3. Summary of USACE Planned Flood-Related IWM Projects

Hydrologic Region	Number of IWM Projects	USACE Project Cost Share for IWM Projects (millions)	Number of Projects Funded in FY 2012	Funding Appropriated in FY 2012 (millions)
Central Coast	2	310	0	-
Colorado River	0	-	0	-
North Coast	2	150	0	-
North Lahontan	0	20	0	-
Sacramento River	2	230	0	-
San Francisco Bay	10	450	4	3
San Joaquin River	0	10	0	-
South Coast	13	420	4	29
Tulare Lake	4	500	1	13
TOTAL	33	$2,090	9	$45

FY Fiscal Year
Source: USACE, 2012 and USACE, 2013

6.5 Statewide IWM Projects

Statewide, there were 320 planned/proposed projects identified as using an IWM approach to the practice of flood management. This number reflects local and USACE projects only because no specific projects have been identified for CVFPP and Delta improvements (as described above). As shown in Table H-4, projects using an IWM approach account for over 35 percent of the total number of identified planned/proposed projects. Table H-4 also presents a summary of the

estimated costs of the planned local and USACE projects using IWM approaches categorized by hydrologic region. Although not all projects have cost estimates, the list of projects illustrates the wide variety of flood projects using an IWM approach undertaken by agencies in each hydrologic region.

Projects using an IWM approach that have a flood management component are most commonly combined with ecosystem restoration (approximately half of the projects using an IWM approach) or water supply components (as addressed by about a quarter of the projects). The Sacramento River and South Coast hydrologic regions have the most proposed/planned projects that use an IWM approach.

Figure H-1 presents a summary of the number of planned projects, both local and USACE, using an IWM approach in each hydrologic region of California. Most of these projects are planned in the urban areas of the state, such as in the counties of Los Angeles, Orange, Santa Clara, and San Diego.

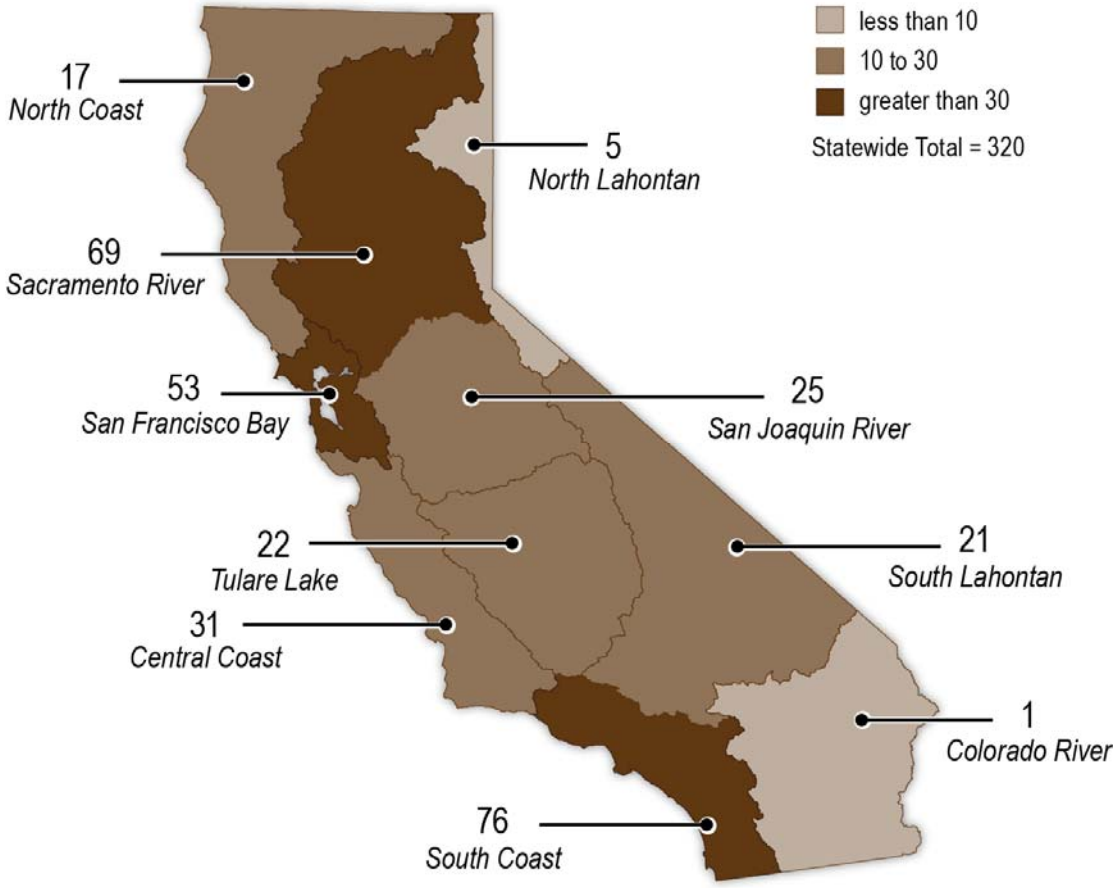

Figure H-1. Map of Local and USACE Planned Flood Management Projects Using an IWM Approach

Table H-4. Summary of Local and USACE Planned/Ongoing Flood-Related IWM Projects

Hydrologic Region	Total Estimated Cost of Projects ($ million)	Total Estimated Cost of IWM Projects ($ million)	Total Number of Projects (Local and USACE)	Total Number of IWM Projects	Flood-Related IWM Project Type					
					Agriculture	Ecosystem	Water Supply	Recreation	Water Quality	Transportation
Central Coast	780	420	48	31	1	15	2	1	11	1
Colorado River	70	2	25	1	0	0	1	0	0	0
North Coast	260	250	28	17	1	6	4	1	4	1
North Lahontan	40	40	14	5	0	3	1	1	0	0
Sacramento River	2,550	470	163	69	1	40	14	3	9	2
San Francisco Bay	3,370	1,400	135	53	0	40	2	5	4	2
San Joaquin River	780	590	59	25	0	10	13	0	2	0
South Coast	8,400	1,450	354	76	0	35	18	5	14	4
South Lahontan	170	130	33	21	0	6	10	2	3	0
Tulare Lake	1,270	720	37	22	1	7	11	1	2	0
SUMMARY	17,690	5,472	896	320	4	162	76	19	49	10
Percent of Total	N/A	N/A	N/A	N/A	1%	51%	24%	6%	15%	3%

Note: All IWM projects listed in this table include a flood management component in addition to other components explicitly identified here. All projects were identified as of January 2012.

Source: USACE, 2012 and USACE, 2013

7.0 Findings and Recommended Actions

7.1 Findings on the IWM Approach

Flood management practices have evolved from single-purpose projects to a more holistic IWM approach. A number of challenges and opportunities exist for project implementation using an IWM approach (as shown in Table H-5), most significantly with agency alignment and cooperation, as well as with competing needs and objectives between agencies. Using an IWM approach provides significant benefits, including high-value multibenefit projects with broader access to funding. Other key findings on the IWM approach include the following:

- The current economic and ecosystem conditions make it more important than ever for all public agencies to use an IWM approach for near-term and long-term planning.
- An IWM approach that combines flood management, water supply, and ecosystem actions to deliver multiple benefits is the best use of public resources.
- IWM is complex and requires long-term commitments among the responsible public agencies to align their sometimes conflicting missions and objectives.
- Involvement of a broad spectrum of agencies and stakeholders in project development builds advocacy and support for multibenefit programs and projects, addresses institutional conflicts, and helps expand the range and diversity of funding sources.
- Collaboration and alignment among diverse agencies and stakeholders is the single most-cited success factor in the case studies illustrated in this document.

Table H-5. Challenges and Opportunities to Implementing an IWM Approach

Types of Implementation Hurdles	Challenges	Opportunities
Increased Coordination	An IWM approach requires involving a large number of agencies with complex jurisdictional roles and responsibilities, and multiple management goals. Coordinating activities across geographic and agency boundaries from a system perspective can require large investments of time and funds, which can be particularly difficult for smaller local agencies. The sheer number and types of agencies can also create difficulties in establishing a collaborative approach or even in determining who should be involved in IRWM and IWM projects. Some stakeholders might object to a portion of a project for which the flood agency does not have a direct interest, thereby complicating IWM implementation.	Coordination among diverse agencies and entities can be effective in addressing the multitude of jurisdictional and facility ownership issues and restrictions commonly encountered in complex flood and water management projects. Coordination can address potential areas of conflict in project goals before they occur and reduce unintended consequences. Similarly, multipurpose projects are more likely to engage stakeholders that a flood agency does not typically work with. By engaging stakeholders and participation from a system perspective, the opportunity to build advocacy, accelerate project implementation, and become aware of potential pitfalls before they occur are greatly improved.

Table H-5. Challenges and Opportunities to Implementing an IWM Approach

Types of Implementation Hurdles	Challenges	Opportunities
Competing Land Uses on Floodplains	Many floodplains are already urbanized or have other competing land uses, restricting opportunities for IWM approaches to projects. The public is often unaware of their flood risk or the beneficial functions of floodplains.	Floodplains can provide excellent land for agriculture, groundwater recharge, and desirable access to water and recreation. Education of the public and decision makers about the land-water interaction can yield positive results for all elements of water management.
Long-Term Planning Horizons	An IWM approach requires long-term planning and investment, which are difficult to promote when the public is often focused on short-term issues.	Long-term approaches are often more likely to yield sustainable results, which ultimately are better investments.
Funding	Some funding sources have strict requirements that tie funding to specific, authorized program purposes. These restrictions, while important for accountability, can inhibit funding opportunities for multibenefit projects.	IWM solutions promote projects with multiple objectives and increase access to more funding sources. Several State and Federal agencies (such as USACE and DWR) promote the IWM approach and have structured their flood management programs to support multibenefit IWM-approach projects. Coordination across geographic and agency boundaries can help multiple agencies pool and leverage their funding to achieve multiple objectives. A multipurpose IWM project approach can often achieve benefits with less cost and a smaller footprint than multiple single-purpose projects.
Regulation, Permitting, and O&M	Projects with an IWM approach often must comply with increased permitting and regulatory requirements because of the multiple purposes they serve. This typically increases project complexity and planning costs.	Environmental enhancements designed to accommodate routine O&M can help reduce mitigation requirements and reduce long-term O&M costs. In some locations, permitting agencies have started to collaborate through regional permitting to find ways to streamline permitting that balances competing needs.
Climate Change	Climate change might lead to sea level rise and alter precipitation and runoff patterns, creating uncertainty for several resource management areas related to projects using an IWM approach.	Because IWM project approaches are more integrated with natural systems, these projects offer more options to address the uncertainty presented by climate change and other variables. The flexibility of using an IWM approach lends itself well to adaptive management.

7.2 Recommended Actions

Based on the findings, the following actions are recommended to bolster the IWM approach statewide while developing flood management solutions:

- Improve sharing of data and other information between public agencies to foster collaboration and cooperation between agencies.
- Facilitate regular coordination between land use planners, resource managers, and floodplain managers to improve working relationships and protect public safety.
- Link funding for flood management and other project types to the use of practices that support an IWM approach to land and to project development.
- Implement flood management from regional, systemwide, and statewide perspectives to provide multiple benefits by:
  - Creating Regional Flood Planning Areas that address region specific flood management issues, opportunities, and solutions
  - Developing a bottom–up approach for prioritizing flood projects that value multiple benefits
  - Improving consistency of terminology related to IWM approaches and projects, and consistency of processes for funding and securing project support from State and Federal agencies
  - Incentivizing an IWM approach by linking funding requirements to using an IWM approach
- Increase collaboration among public agencies to improve flood management planning, policies, and investments, which will increase effectiveness of flood management by:
  - Utilizing existing planning groups and other forums to improve coordination of water management for multi-objective projects
  - Facilitating programmatic permitting for multiple projects over longer planning horizons by showing a full range of project benefits to regulatory agencies
  - Fostering interagency coordination and collaboration in planning, project development, and emergency management by providing in-kind credits and other funding linked to using an IWM approach
  - Establishing consistent methods to evaluate project priorities statewide based on an IWM approach

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STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

UNITED STATES ARMY CORPS OF ENGINEERS
FLOOD PLAIN MANAGEMENT SERVICES PROGRAM

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The complete report, *California's Flood Future: Recommendations for Managing the State's Flood Risk*, including technical attachments and other supporting information is available for review at:

http://www.water.ca.gov/SFMP