

# Reader's Guide: 2012 Central Valley Flood Protection Plan Attachments

The 2012 Central Valley Flood Protection Plan (CVFPP) includes 29 attachments, divided into 5 volumes. These attachments describe the data, analyses, findings, and technical studies that were developed to support the 2012 CVFPP. This Reader's Guide summarizes information on each attachment (purpose and contents, how the attachment contributes to the 2012 CVFPP, and the intended audience).

## VOLUME I

Volume I contains six attachments that support the 2012 CVFPP.

### Attachment 1 – Legislative Reference

The purpose of this attachment is to demonstrate how the 2012 CVFPP meets State of California (State) legislative requirements and direction. Included in this attachment is text from each California Water Code section pertaining to the development and required content of the 2012 CVFPP, along with a brief summary of how the California Department of Water Resources (DWR) has responded to each legislated provision as part of 2012 CVFPP development. This attachment is directed toward legislative and Central Valley Flood Protection Board staff, and the public.

### Attachment 2 – Conservation Framework

This attachment serves two purposes. The first purpose of the Conservation Framework is to be an environmental guide for flood project planning in the 2012 CVFPP. The second purpose is to present a broad outline and preview of a longer term Central Valley Flood System Conservation Strategy (Conservation Strategy) to be completed by 2017. The Conservation Framework describes how environmental stewardship is integrated into flood management activities, directs the reader to relevant environmental elements in the CVFPP, and gives additional detail on environmental planning elements, including regulatory compliance. Additional supporting analyses are documented in Volume V. This attachment is directed toward all readers of the 2012 CVFPP.

### Attachment 3 – Documents Incorporated by Reference

The purpose of this attachment is to demonstrate how legislative requirements were met through documents prepared in parallel with the 2012 CVFPP. These documents are referenced in numerous locations throughout the 2012 CVFPP. The 2012 CVFPP incorporates information by reference from several documents that are either linked with the 2012 CVFPP through legislative requirements, or related management policies that adoption of the 2012 CVFPP will trigger. These documents include the *State Plan of Flood Control Descriptive Document* (DWR, 2010), *Flood Control System Status Report* (DWR, 2011), and *Urban Levee Design Criteria* (DWR, expected 2012). Each document is summarized in this attachment to provide a stronger link

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between these parallel efforts and the 2012 CVFPP. This attachment is directed toward legislative and Central Valley Flood Protection Board staff, and the public.

### **Attachment 4 – Glossary**

The purpose of this attachment is to define and clarify key terms used in the 2012 CVFPP main body or attachments. Definitions of some terms used in the 2012 CVFPP are referenced directly to government codes or other preexisting sources, while others were developed collaboratively with stakeholders. The glossary defines terms used in the context of the 2012 CVFPP that may have different meanings in other disciplines. This attachment is directed toward all readers of the 2012 CVFPP.

### **Attachment 5 – Engagement Record**

The purpose of this attachment is to demonstrate the comprehensive and earnest stakeholder engagement efforts that contributed to development of the 2012 CVFPP and related documents. This attachment documents efforts to engage partners, stakeholders, and the public in the development of the 2012 CVFPP and related documents. Various engagement venues used to solicit input are described, such as work groups (regional and topic), forums, interest group briefings, local jurisdiction briefings, and partner meetings. The use of communication tools and media are also described, including newsletters, Web site, mailings, news releases, and videos. This attachment is directed toward partners, stakeholders, and the public.

### **Attachment 6 – Contributing Authors and Work Group Members List**

The purpose of this attachment is to catalogue the involvement of authors, contributors, key reviewers, and work group members throughout 2012 CVFPP development. Authors and work group members are not specifically referenced in the main body of the 2012 CVFPP. This attachment presents the names and affiliations of all significant contributors to the 2012 CVFPP. It is directed toward partners, stakeholders, and the public.

## **VOLUME II**

Volume II contains two attachments that describe the plan formulation process and provide local and regional project summaries, respectively.

### **Attachment 7 – Plan Formulation Report**

The purpose of this attachment is to describe of the plan formulation process, intermediate products, and findings that resulted in the State Systemwide Investment Approach (SSIA). This attachment provides an overview of the background and legislative requirements for the CVFPP and discusses current conditions and identified problems that led to the need for a systemwide approach to flood management. It also describes the process and methodology for developing three preliminary approaches (Achieve State Plan of Flood Control Design Flow Capacity, Protect High Risk Communities, and Enhance Flood System Capacity) and the SSIA. This attachment is directed toward technical experts, partners, and stakeholders.

### **Attachment 7A – Local and Regional Project Summaries**

The purpose of this attachment is to collect and display information used to inform plan formulation activities, but is not directly referenced in the 2012 CVFPP. It also provides recognizes the wide range of local flood planning activities and projects that are not large enough in scale to directly include in the SSIA, but may be considered in follow-on regional planning efforts. This attachment summarizes publicly available information on a wide array of local and regional projects proposed by partners, stakeholders, and other interested parties through the CVFPP communication and engagement process. Also, both active and proposed local projects that could potentially have systemwide effects on flood planning activities throughout the Central Valley are identified. This attachment is directed toward technical experts.

## **VOLUME III**

Thirteen technical attachments support the 2012 CVFPP. Because of the total length of these attachments, they are separated into two volumes. Volume III contains the first six technical attachments.

### **Attachment 8 – Technical Analysis Summary Report**

The purpose of this attachment is to briefly summarize analyses that supported formulation of the CVFPP and to direct readers to specific technical attachments for more information. The Technical Analysis Summary Report contains no results (these are found in individual attachments 8A through 8L), and it is not directly referenced in the 2012 CVFPP. In addition, this attachment provides an overview of the technical analysis approach, tools, and data supporting development of the 2012 CVFPP, describes the information flow and linkages between the various analyses, and provides an overview of the tools and information under development to support the 2017 CVFPP. This attachment is directed toward technical experts.

### **Attachment 8A – Hydrology**

The purpose of this attachment is to document the synthetic hydrology used to develop the 2012 CVFPP. Based on the “composite floodplain” concept, this hydrology recognizes that a frequency-based floodplain is not created by a single flood event, but by a combination of several events, each of which shapes the floodplain at different locations. A series of storm centerings (i.e., a set of storms with different return periods or annual exceedence probabilities, assigned to a set of tributaries) was developed to characterize flooding in different parts of the Sacramento and San Joaquin river basins. This synthetic flood hydrology generated unregulated flow hydrographs into reservoirs and streams throughout the planning area. No changes were made to the synthetic hydrology, which was originally developed by the U.S. Army Corps of Engineers for the *Sacramento and San Joaquin River Basins Comprehensive Study* (USACE, 2002). This attachment is directed toward technical experts.

### **Attachment 8B – Reservoir Analysis**

The purpose of this attachment is to document the reservoir analysis performed to establish a No Project baseline for reservoir operations, and to provide reservoir releases as input to riverine hydraulic models. The potential operational scenarios identified through the reservoir assessment are included as storage elements of the Enhance Flood System Capacity Approach. These operational scenarios were not carried into the SSIA. The 2012 CVFPP reservoir analysis used the USACE Hydrologic Engineering Center 5 (HEC-5) reservoir models, developed originally for the *Sacramento and San Joaquin River Basins Comprehensive Study* (USACE, 2002). HEC-5 models were updated to represent current operations. In addition, the HEC Reservoir Simulation (HEC-ResSim) model for Folsom Lake was used to simulate modified releases from Folsom Dam under the Joint Federal Project. Reconnaissance-level analysis for the 2012 CVFPP assessed the sensitivity of peak floodflows in the Sacramento and San Joaquin river basins to modified reservoir operational criteria (e.g., storage allocation, objective release), for the purpose of identifying operational scenarios with the potential to reduce flood risks. This attachment is directed toward technical experts.

### **Attachment 8C – Riverine Channel Evaluations**

The purpose of this attachment is to document estimates of stage and flow data under current conditions, the three preliminary approaches, and the SSIA, as indicators of flood risk reduction benefits. The estimates also provided input for use in the flood damage assessment analysis (economic damages), and upstream boundary conditions for the Sacramento-San Joaquin Delta (Delta) channel evaluations model. In addition, the attachment documents hydraulic modeling performed for channels within the Sacramento and San Joaquin river basins to support flood management system

evaluations for the three preliminary approaches and the SSIA. The 2012 CVFPP riverine channel evaluations used the USACE UNET models developed originally for the *Sacramento and San Joaquin River Basins Comprehensive Study* (USACE, 2002) as a base. These UNET models were updated to represent current conditions and operations. Reservoir analysis results from HEC-5 and HEC-ResSim models (Attachment 8B) provided input to the CVFPP UNET models. Outputs from the CVFPP UNET models were used as input to the estuary hydraulic models (Attachment 8D), flood damage evaluation models to estimate economic damages (Attachment 8F), and life risk analysis (Attachment 8G). The CVFPP models were modified to simulate potential changes to levees, bypasses, weirs, and other system operations to support evaluation of No Project conditions, the three preliminary approaches, and the SSIA. This attachment is directed toward technical experts.

#### **Attachment 8D – Estuary Channel Evaluations**

The purpose of this attachment is to show how changes in Delta stage between the No Project condition and the four CVFPP approaches was used as an indicator of potential hydraulic effects of the preliminary approaches and SSIA in the Delta, and were considered in plan formulation. Output was also used to estimate potential economic damages for selected areas. In addition, this attachment documents hydraulic modeling performed within the Delta to support flood management system evaluations for the three preliminary approaches and the SSIA. The RMA Delta Model was used to evaluate channel stages, as well as out-of-system volume leaving Delta channels and entering islands through levee breaches/overtopping. Riverine channel hydraulic modeling results from UNET (Attachment 8C) provided the upstream boundary conditions for the RMA Delta Model. Levee elevation assumptions in the RMA Delta Model were modified to simulate each CVFPP approach. Outputs from the RMA Delta Model were used as input to flood damage evaluation models to estimate economic damages for some Delta islands (Attachments 8E and 8F). This attachment directed toward technical experts.

#### **Attachment 8E – Levee Performance Curves**

The purpose of this attachment is to document development and use of updated levee performance curves to reflect current performance of the State Plan of Flood Control levee system in the Sacramento and San Joaquin river basins, using information generated by the Urban Levee Evaluations (ULE) Project and Non-Urban Levee Evaluations (NULE) Project, part of DWR's Levee Evaluations Program. Levee performance curves describe the probability of failure of a levee segment and are key inputs to the hydraulic, flood damage analysis, and life risk models. Levee performance curves provide geotechnical relationships between river stage and the probability that a levee segment will breach (water from the water side of the levee flows in an uncontrolled manner to the landside of the levee) at that stage. The new levee performance curves were developed by an expert panel that included USACE, DWR, ULE/NULE contractors, and other industry experts. The levee performance curves were key inputs to the hydraulic models (Attachment 8C), economic models (Attachment 8F), and life risk models (Attachment 8G), where they were used to describe geotechnical probability of levee failure. This attachment is directed toward technical experts.

### **VOLUME IV**

Thirteen technical attachments support the 2012 CVFPP. Because of the total length of these attachments, they are separated into two volumes. Volume IV contains the remaining eight technical attachments.

### **Attachment 8F – Flood Damage Analysis**

The purpose of this attachment is to document the risk-based analysis of the potential economic consequences of flood inundation. Analysis used the USACE Hydrologic Engineer Center Flood Damage Analysis (HEC-FDA) model to estimate expected annual damages (EAD). EAD due to flooding is the primary decision making criterion used to determine the economic feasibility of flood damage reduction projects. EAD estimates were performed for structure and content damages, crop damages, and business income and production losses. To describe the hydrologic, hydraulic, and geotechnical performance and uncertainties of the system, the flood damage analysis used levee performance curves (Attachment 8E), stage-frequency curves from riverine and estuary hydraulic models (Attachments 8C and 8D), and flood depth information from prior floodplain hydraulic analysis. To describe the economic consequences of flood inundation, the analysis used information from a 2010 reconnaissance-level structural inventory, 2010 spatial cropping patterns, and contents-structure ratios and depth-damage functions. The HEC-FDA model applies a Monte-Carlo simulation to compute the expected value of damages considering a full range of potential floods, calculated within numerous impact areas throughout the Systemwide Planning Area. EAD is reported in the CVFPP for the No Project condition, three preliminary approaches, and the SSIA. Comparison of approach EAD with No Project EAD is the primary indicator of flood damage benefits. This attachment is directed toward technical experts and decision makers.

### **Attachment 8G – Life Risk Analysis**

The purpose of this attachment is to document the risk-based analysis of the potential public safety consequences of flood inundation, and the attachment includes estimates of expected annual life risk similar to the flood damage analysis (Attachment 8F). The life safety analysis used USACE HEC-FDA models developed for the economic damages analysis to generate annual expected life risk. For population exposure and inundation consequences, the analysis used 2000 U.S. Census population data, the best available information at the time the analysis was conducted, and mortality-depth curves from work done by S.N. Jonkman in New Orleans after Hurricane Katrina. Just as EAD is used to assess the potential economic benefits of a plan, life risk analysis is used to assess the potential life safety benefits (reduction in injuries and loss of life). The percent reduction in life risk is shown for the SSIA compared with the No Project condition. Similar results are available for each of the three preliminary approaches in this attachment. This attachment is directed toward technical experts.

### **Attachment 8H – Regional Economic Analysis for the State Systemwide Investment Approach**

The purpose of this attachment is to document the regional economic impact analysis supporting the evaluation of the SSIA. The regional economic analysis used IMPLAN to estimate the effects of the proposed flood management improvements on regional economic activity, specifically employment and industry output. Annual employment and industry output effects of SSIA project construction and avoided business losses from flooding are also estimated. SSIA cost estimates were used as input for the construction-related aspects of the analysis, and avoided business losses from the flood damage analysis (Attachment 8F) were used as input to the industry/business-related aspects of the analysis. Annual regional economic impacts due to implementation of the SSIA help to describe the economic benefits associated with proposed flood management improvements. Regional economic analysis was only performed for the SSIA in the 2012 CVFPP (not for the three preliminary approaches). This attachment is directed toward technical experts.

### **Attachment 8I – Framework for Benefit Assessment**

The purpose of this attachment is to document benefit assessments conducted for the three preliminary approaches and the SSIA. This attachment highlights potential ways of assessing a broad range of economic benefits, and describes the benefit assessments conducted for the 2012 CVFPP. It summarizes the quantitative economic evaluations for the 2012 CVFPP that are documented in detail in other attachments, including flood damage analysis (Attachment 8F), life risk

analysis (Attachment 8G), and regional economic analysis (Attachment 8H). It also summarizes of various other benefits that were qualitatively assessed for the SSIA. This attachment is directed toward technical experts and decision makers.

### **Attachment 8J – Cost Estimates**

The purpose of this attachment is to describe and present the basis for development of pre-appraisal-level capital cost estimates for the three preliminary approaches and the SSIA. Included in this attachment are cost assumptions and conceptual level engineering associated with different aspects of the cost estimates. Also included are various supporting Technical Memorandums and other data/information. This attachment is directed toward technical experts and decision makers.

### **Attachment 8K – Climate Change Analysis**

The purpose of this attachment is to provide a broad overview of possible impacts resulting from climate change and a methodology/approach for continuing studies. As part of 2012 CVFPP development, two topic work groups comprising climate change experts were formed to develop, recommend, and describe a unique threshold approach for analyzing climate change in the context of flood management. The Threshold Analysis Approach is a bottom-up approach focusing on vulnerability and associated prudent investments, aimed at broadening the chance of adaptation regardless of which climate change scenarios may be realized (rather than focusing on maximizing benefits under selected scenarios). The thresholds or vulnerabilities can be assessed at system, regional, and community levels. For the 2012 CVFPP, a pilot study was conducted using the draft Feather-Yuba coordinated operation model developed under the DWR Central Valley Hydrology Program. The vulnerability of exceeding release capacity and downstream flow objectives was assessed in the context of a surrogate index of Atmospheric Rivers. Results show promise for the proposed methodology; however, much work and research are needed for a full application, which is anticipated in support of the 2017 CVFPP update. This attachment is directed toward technical experts.

### **Attachment 8L – Groundwater Recharge Opportunities Analysis**

The purpose of this attachment is to describe how groundwater recharge may be integrated with flood management projects. The attachment contains information on different groundwater recharge mechanisms and a high-level description of where groundwater recharge might be most effective in the Central Valley. Authorizing legislation required the 2012 CVFPP to consider potential groundwater flood storage and recharge. Results from this attachment informed development of the Enhanced Flood System Capacity Approach and SSIA. This attachment is directed toward technical experts and local water entities interested in groundwater storage projects.

## **VOLUME V**

Volume V contains eight attachments that support the 2012 CVFPP.

### **Attachment 9 – Supporting Documentation for Conservation Framework**

The purpose of this attachment is to briefly summarize analyses that supported formulation of the Conservation Framework and direct readers to individual technical attachments for more information. The Technical Analysis Summary contains no results; these are found in individual attachments (9A through 9G), and is not directly referenced in the 2012 CVFPP. In addition, this attachment provides a brief overview of the technical analysis approach, tools, and data supporting development of the Conservation Framework. This attachment is directed toward technical experts.

### **Attachment 9A – Regional Advance Mitigation Planning**

The purpose of this attachment is to provide an overview document that describes the concepts behind Regional Advance Mitigation Planning (RAMP) and the framework under which it will be implemented. This framework helps the regulatory agencies understand how DWR could be locating and securing its mitigation for proposed infrastructure projects or improvements. This attachment forecasts how future RAMP-sponsored mitigation sites in strategic locations throughout the Systemwide Planning Area could speed approvals for the State's infrastructure agencies when the agencies seek permits for "take" of endangered species, fill of wetlands, or disturbance to streambeds and their banks. This attachment describes the steps taken to develop a statewide mitigation process that integrates project-specific mitigation with regional and statewide conservation priorities, and that offsets unavoidable impacts of planned infrastructure projects before the prospects are constructed. Release of the RAMP document as part of CVFPP shows that DWR has embraced a strategic, forward-looking, and regional approach to mitigation, and that there is reasonable expectation that DWR can provide solutions that address conservation priorities in ways that are coordinated and take into account agricultural communities and land uses. This attachment is directed toward environmental groups, regulatory agencies, and decision makers.

### **Attachment 9B – Status and Trends of the Riverine Ecosystems of the Systemwide Planning Area**

The purpose of this attachment is to summarize the current status and historical trends of riparian and riverine ecosystems in the Systemwide Planning Area for the CVFPP. The summary of status and trends in this report is intended to document the need for and support the development of the Conservation Framework and that will be a component of the 2012 CVFPP and the Conservation Strategy. This attachment describes ecological history and relevance of riparian and riverine ecosystems in the Sacramento and San Joaquin valleys, assesses the status and trends hydrologic and geomorphic processes, and summarizes data gaps. This attachment is directed toward technical experts and decision makers.

### **Attachment 9C – Fish Passage Assessment**

The purpose of this attachment is to identify physical barriers to anadromous fish passage and recommend actions for modifying the Central Valley flood management system that could contribute to the recovery of native anadromous fish in the Central Valley. Recommended actions include identifying barriers, evaluating the extent to which each barrier impedes migration, and modifying barriers to allow unimpeded migration. These actions will improve habitat connectivity and promote the recovery of anadromous fish populations in the Sacramento-San Joaquin River Flood Management System. The attachment provides information that will be used to manage flood protection in a manner that improves anadromous fish passage and fish habitat while maintaining adequate levels of flood protection within the Systemwide Planning Area. This information will be used to guide the allocation of limited funding resources for fish passage improvement actions and the operation of the flood system in specific locations. This attachment is directed toward technical experts and decision makers.

### **Attachment 9D – Improving Vegetation Data**

The purpose of this attachment is to describe the importance of high quality vegetation data for improving flood management and ecosystem conditions in the Central Valley, summarize other related mapping efforts, and describe DWR's approach, progress, and future steps for improving the quality of vegetation data. The attachment documents how DWR is improving vegetation data to support informed decisions for flood management. It informs readers that DWR is working collaboratively with others to follow tested and standardized approaches to produce high quality data. The attachment also justifies the need and benefits for developing finer scale data to support project-level planning. This attachment is directed toward technical experts and decision makers.

### **Attachment 9E – Existing Conservation Objectives from Other Plans**

The purpose of this attachment is to provide information on other conservation planning efforts (both completed and ongoing) with regional, geographically based, and/or quantifiable conservation measures potentially relevant to the Conservation Strategy. The Conservation Strategy, in conjunction with the CVFPP, will overlap with multiple regional and collaborative conservation plans that have either been previously implemented or are planned for the Sacramento and San Joaquin valleys. Regional planning is most effective when coordinated with similar programs and plans to the maximum extent possible. Coordination among the Conservation Strategy and similar, related conservation and collaborative planning efforts is essential to determine if the Conservation Strategy can contribute to the shared conservation objectives of other plans or programs while meeting its own conservation objectives. Plans and programs were selected for inclusion that overlapped at least partially with the State Plan of Flood Control Planning Area or Systemwide Planning Area, and that included conservation objectives likely to be related to the Conservation Strategy. The list is not comprehensive, but includes examples of the types of efforts that should be considered in developing the Conservation Strategy. This attachment is directed toward technical experts and decision makers.

### **Attachment 9F – Floodplain Restoration Opportunity Analysis**

The purpose of this attachment is to support the identification, development, and implementation of specific restoration actions, and the attachment summarizes the results of a Floodplain Restoration Opportunity Analysis (FROA). The FROA identifies areas with greater and/or more extensive potential opportunities for ecological restoration of floodplains. It does so by considering physical suitability and opportunities and constraints related to existing land cover and land uses, locations and physical condition of levees, locations of other major infrastructure, conservation status of land, and locations that stakeholders are interested in restoring. This attachment provides the methodology used to determine acreages for the physical potential to inundate floodplains cited in the Conservation Framework. The analysis provides the foundation for evaluating the floodplain restoration potential of the Systemwide Planning Area. This attachment is directed toward technical experts and decision makers.

### **Attachment 9G – Regional Permitting Options**

The purpose of this attachment is to display programmatic approaches to permitting and other regulatory authorizations for flood management activities (e.g., regional permitting mechanisms), which are important parts of improving and integrating flood management and ecosystem conservation in the Central Valley. This attachment provides background information regarding programmatic permitting options and their requirements, which are an important consideration for the Conservation Framework and development of the Conservation Strategy. The attachment supports both the CVFPP and the linked Conservation Strategy by describing the benefits of programmatic authorizations (compared to project-by-project permitting); identifying the types of flood management activities that could potentially be covered by such programmatic authorizations; describing and evaluating several options for developing programmatic authorization mechanisms for the flood management system, and identifies other important environmental regulations that apply; and identifying potential overlaps and gaps with existing regulatory-based regional plans (e.g., Natural Community Conservation Plans, Habitat Conservation Plans, Regional General Permits, Routine Maintenance Agreements). This attachment is directed toward technical experts and decision makers.