Content

Subgroup: Improve Flood Management

Chapter [#] Floodflow Management

Floodflow management is one of two strategies included in California Water Plan Update 2009 specifically intended to improve flood management. It includes projects and programs that detain or divert floodwaters, improve the ability of channels to accommodate floodwaters, and improve the ability of floodplains to store and slowly release floodwaters. The other flood-specific management strategy is flood impact reduction (see Chapter _ in Volume 2). Additionally, other resource management strategies discussed in this plan may provide flood management benefits.

The selective application of these strategies provides an opportunity to engage in Integrated Flood Management, a process that promotes a comprehensive approach to flood management that considers land and water resources at a watershed scale within the context of Integrated Regional Water Management, which aims to maximize the benefits of floodplains and minimize the loss of life and damage to property from flooding.

Floodflow Management in California

Background

Traditionally, flood management has relied on physical improvements which divert or reduce floodwaters and avoids damage to lives and property. Often referred to as "flood control," this concept favored physical modification of stream channels, dams and surface impoundments, levees, and other structures that altered or confined natural watercourses. More recently, the emphasis has shifted to a more integrated approach with both structural and non-structural methods including land use practices that minimize development in flood prone areas (e.g., floodplains, alluvial fans, and low-lying coastal areas), and enhance the ability of undeveloped floodplains and other open spaces to absorb, store, and slowly release floodwaters during small and medium-sized events. The application of Integrated Flood Management extends the range of strategies that may be employed to include those that may be primarily focused on other water resource issues (such as water supply or water quality) but have the potential to provide ancillary flood management benefits. The strategies that may be implemented to improve flood management 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 risks (e.g,. riverine, alluvial fan, or coastal), and the areal extent of areas subject to these flood risks.

Description

Floodflow management includes the following types of projects and programs: 1) Dams and Reservoirs; 2) Levees, Floodwalls, and Flood Embankments; 3) Channelization Improvements; 4) High Flow Diversions and Bypasses, and 5) Floodplain Function Restoration.

Dams and their associated reservoirs provide an opportunity to collect floodflows and release the water downstream slowly, such that the downstream capacity of the river or channel is not exceeded. Following the storm event, the stored water is often released, to provide storage capacity for subsequent storms. Most California reservoirs with significant storage capacity are multi-purpose projects providing water supply, flood control, and recreation benefits. Examples include Shasta Dam and Reservoir on the Sacramento River, Oroville Dam and Reservoir on the

Feather River, and Folsom Dam and Reservoir on the American River, all located on the western slope of the Sierra Nevada. Smaller reservoirs throughout California typically provide some incidental flood benefits and could be re-operated to provide increased flood management benefits.

Levees, floodwalls, and flood embankments are a common form of flood protection, where an earthen or rock berm is constructed parallel to a stream (or around a lake) to provide protection from high water, typically during floods. Levees, floodwalls or flood embankments may be placed close to the stream edge, or further back (e.g., a setback levee), incorporating a portion of the floodplain. Although the use of levees for flood management is widespread, the potential for failure of old levees can be high, due to poor design and construction techniques Even modern levees can fail as a result of poor maintenance, or overtopping (where the water surface elevation exceeds the height of the levee). Floodwalls (or seawalls) are sometimes installed along low-lying coastal areas to protect those areas from high surf or storm surges. The Central Valley's state-federal flood control system includes approximately 1,600 miles of project levees that protect more than 500,000 people, approximately 200,000 structures, and two million acres of agricultural lands.

Channelization improvements are modifications to a river or stream to increase the channel capacity, thereby improving the ability of the channel to convey floodflows. This may result in channelization of the stream where the stream bed and banks are covered with concrete, rip rap, or other materials, to enhance the channel's drainage efficiency by reducing surface roughness. Although effective at conveying flows more quickly, channelization results in the loss of habitat, simplifies channel morphology (as channels are often straightened) and removes the potential for infiltration of flows to the underlying groundwater (and groundwater contributions to stream flow). Channel improvements are particularly common in urban areas where the high value and limited availability of land have limited opportunities for more integrated forms of flood management. In some regions, hydromodification of additional streams has recently been prohibited by regional water quality control boards, which limits the potential application of this type of flood management. An example of a high capacity concrete-lined channel located in an urbanized environment is the Los Angeles River system.

High flow diversions and bypasses are structural features which divert a portion of floodflows into adjacent lands which provide additional through-flow capacity and/or temporarily store the flows and slowly release and infiltrate the stored water. These diversions require careful design to assure that the high flows associated with flood events don't erode the diversion or adjacent banks, and require acquisition of lands, or easements to allow for occasional inundation of the lands in the bypass. An example is the Yolo Bypass north of Sacramento, which diverts high flows from the Sacramento River into lands adjacent to the river, some of which serve as habitat and some are used seasonally for agriculture.

Floodplain function restoration is a technique that recognizes that periodic flooding of undeveloped lands adjacent to rivers and streams is a natural function and may be a preferred alternative to restricting floodflows to the existing channel. To permit seasonal inundation of undeveloped floodplains, structural improvements (e.g., a weir) may 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. This may require purchase of the lands that could be subject to inundation, or the implementation of flood easements from willing land owners. The intent of floodplain function restoration is to preserve and/or restore the natural ability of undeveloped floodplains to absorb, hold, and slowly release floodwaters.

Connections to Other Resource Management Strategies

The concept of integrated flood management relies on the application of multiple strategies to achieve a comprehensive effect. In addition to the two flood-specific strategies, other resource management strategies included in the Water Plan also have the potential to provide flood management benefits and may be included as an element of integrated flood management. Potential flood management benefits from other resource management strategies include:

- Conjunctive Management and Groundwater Storage: Diversions of surface water for groundwater infiltration could enhance flood management by reducing flows.
- Conveyance: Improvements to regional water supply distribution systems could enhance the potential for floodflow conveyance.
- Ecosystem Restoration: Ecosystem restoration can enhance the ability of open spaces to absorb rainfall and runoff and reduce the potential for flood events, or enhance recovery after flood events.
- Forest Management: preservation of forest meadows, riparian vegetation along streams, and maintenance of forest canopy may reduce soil erosion and moderate the severity and frequency of some flood events and promote recovery after flood events.
- Land Use Planning and Management: Land use planning, in both urban and rural locations can affect the potential risk to lives and property on floodplains, alluvial fans, and coastal areas to flooding, and affect the intensity and duration of some flood events.
- Surface Storage: Reservoirs can be designed to provide storage for floodflows, thereby reducing downstream flood peaks or volumes.
- System Reoperation: Reoperation of reservoirs constructed for water supply purposes could provide opportunities to preserve and/or enhance flood management capabilities, by providing for the storage of floodflows.
- Urban Runoff Management: Management of urban runoff for purposes of improving water quality can preserve and/or enhance flood management by designing management practices to reduce or delay flood peaks.
- Watershed Management: Watershed management can promote the retention of open space and habitat which may reduce the severity and frequency of flood events and promote recovery after flood events.

Potential Benefits of Floodflow Management

The primary benefits of Floodflow Management are derived from the potential to reduce risks to lives and property from flood events, which reduces the social and economic disruption and flood recovery costs.

Periodic inundation of undeveloped floodplains can provide opportunities to store and slowly release floodwaters, thus reducing flood flow peaks and their subsequent impacts during small and frequent flood events. These areas act as sponges, soaking up floodwaters, filtering runoff and providing opportunities to enhance groundwater. The deposition of sediment and debris during inundation can improve the quality of habitat and enhance soil conditions in agricultural areas.

The potential benefits that would accrue to each hydrologic region depend on the potential need for additional flood protection within each region. The Regional Reports (included in Volume III) for each of the 10 hydrologic regions and 2 special interest areas describe some of the potential

benefits of integrated flood management, which could include structural modifications and restoration of floodplain functions. The Central Valley Flood Protection Plan, which includes the Sacramento and San Joaquin hydrologic regions, is intended to identify structural and non-structural improvements, including levee repairs and modifications to reduce potential for levee failure and increase flood protection to a 200-year level for urban areas in the Central Valley. When implemented, this would reduce potential damage associated with flood events in those watersheds.

Inter-regional benefits associated with Floodflow Management are limited, as the conveyance of floodflows does not occur between hydrologic regions. However, the implementation of Floodflow Management within the Mountain Counties special interest area has the potential to provide benefit to downstream areas in the Sacramento and San Joaquin regions. Similarly, improvements in the Sacramento and San Joaquin regions would provide benefit to the Sacramento-San Joaquin Delta Region. Statewide benefits from Floodflow Management would accrue from improvements to the State and Federal Flood Control System. Improvements to that system could reduce the State's liability for future flood events.

Other potential benefits from the implementation of Floodflow Management include:

- Water Supply and Drought Preparedness: Detention of floodwaters could provide benefits to the extent that structural improvements result in additional water storage or groundwater infiltration and increased protection of water supply conveyance systems.
- Reduce Groundwater Overdraft: The development of high-flow diversions and flood bypasses may have the greatest potential to enhance water supply and drought preparedness, and both typically result in the discharge of water into areas that retain water for long periods, which enhance the potential for groundwater recharge.
- Water Quality: Structural improvements may enhance water quality, to the extent that such improvements reduce sediment loads, although channelization of streams can eliminate the potential for assimilation of pollutants from plants and aquatic organisms.
- Energy: Implementation of Floodflow Management is unlikely to result in energy benefits, as floodwaters are typically released after storm events and are not available to increase hydroelectric power generation. Also, if groundwater levels are higher, less energy will be required to pump it out.
- Resource Stewardship: Implementation of floodplain function restoration and development of setback levees, incorporating a portion of the floodplain, have the potential to enhance terrestrial and aquatic habitat and provide ecosystem restoration benefits.

Potential Costs of Floodflow Management

The Department of Water Resources is currently working to identify the costs of improving flood management on a statewide basis. Included in this effort is the Central Valley Flood Protection Plan, a Statewide Flood Management Planning Project, and support for enhanced regional flood management through Integrated Regional Water Management (IRWM) plans. Collectively, these efforts will identify flood risks, propose feasible flood management improvements and quantify the cost of implementing the identified improvements. Some preliminary information may be available to inform Update 2009 of the Water Plan, but the bulk of this information may not be available until the subsequent (2013) update of the Water Plan.

Major Issues Facing Floodflow Management

Although Floodflow Management can reduce the intensity and frequency of flooding, man-made flood protection cannot completely eliminate risk of flooding, as the design capacity of structural measures can be exceeded by large storm events or individual elements of structural protection systems can be subject to failure. Thus some residual risk of flooding will remain in those areas protected by Floodflow Management projects and programs.

The liabilities associated with flood management and the ability to limit these liabilities poses a major challenge to the State of California. Major efforts to address these liabilities, such as the Central Valley Flood Protection Plan, are underway. The absence of a common standard, regarding what constitutes "reasonable" impacts on downstream drainage have created variable risks to local agencies from facilities constructed long ago. The potential liability discourages agencies from constructing flood management projects, which could delay needed improvements.

Global climate change may have a significant impact on the timing and magnitude of precipitation and runoff and contribute to a rise in sea levels. Increased air temperatures may reduce the extent of snowpack in mountainous areas, thereby increasing the portion of watersheds that are available to contribute to direct winter runoff. Decreased snowpack would also reduce spring runoff volumes. Rainfall intensity for individual storms could also increase. Sea level risk could increase the potential for high tides and storm surges to inundate low-lying coastal areas. These changes could change the magnitude and frequency of flood events, although specific effects may be difficult to reliably predict. However, the potential for increased flood frequencies and flood magnitudes and a rise in sea level suggests that the enhancement of both structural and non-structural flood management measures may be needed.

Integrated flood management suggests the application of a wide range of strategies to achieve a comprehensive result. However, the application of some of these strategies, such as those focused on water supply or land use planning, is beyond the control of local flood managers. Thus, integration creates challenges associates with the close coordination of activities by multiple agencies, both to achieve a coordinated result and avoid unintended consequences. Although IRWM has been proposed as a methodology to address water resource management, coordination of actions by multiple agencies is often complex, requiring memorandums or other legal agreements that address issues of liability and responsibility. The lack of clear mechanisms to implement coordinated actions may hamper the potential for integrated action.

Existing structural flood management systems, such as levees, were designed to separate river and stream channels from adjacent land uses. The installation of these features permitted occupation and development of adjacent lands, sometimes resulting in the placement of structures and homes in close proximity to levees and stream banks, which may limit future improvements, such as expansion, reconstruction, or the creation of setback levees.

Although the restoration of floodplain functions may result in flood management and habitat benefits, the integration of naturalized floodplains into structural flood management systems requires careful evaluation of geomorphologic and hydraulic factors and may require some form of management to assure the long term sustainability of these features.

Currently, the extent of flood management needs is not well documented for most portions of the state. Some local flood management plans (and multi-hazard mitigation plans prepared in response to the Stafford Act) describe local needs, but coverage of such plans is not statewide. The age, condition, and maintenance status of existing flood management facilities may not be well documented The affect of sea level rise on lands along the coast or in low-lying inland areas

(e.g., the Delta) or on the discharge of flood waters in river channels at coastal locations may not be well documented. Many regions lack current hydrologic information or hydraulic models that are needed to assess potential flood risks, suggesting that the state may need to consider investments in data collection and analysis to address data gaps and improve understanding of potential flood risks.

The costs of Floodflow Management can be substantial, competition for scarce local resources and legal requirements for approval of new funding (e.g., a two-thirds vote) may impede implementation of structural flood improvements. Population growth and development pressures may increase the population at risk, increasing demand for additional flood protection projects and programs. In some locations, federal participation could help provide additional funding, although the availability of federal funds is not assured, given competition from other regions and programs.

Implementation of Floodflow Management will not adversely affect drought preparedness, water quality or energy consumption. As an element of Integrated Flood Management, this strategy will enhance flood management. Promotion of this strategy as an element of integrated regional water management creates challenges, as the implementation of multi-purpose projects, or use of dams and reservoirs for both flood management and water supply typically requires close coordination between multiple agencies.

Recommendations to Facilitate Floodflow Management

To facilitate Floodflow Management, it is recommended:

- Flood control districts and other relevant jurisdictions should analyze potential flood risks and make this information publicly available, including residual risks in areas protected by structural flood protection systems. The public, businesses, and public agencies should be provided with sufficient information about potential flood risks to make informed decisions that safeguard their lives, property, and critical facilities.
- Flood control districts and other relevant jurisdictions should incorporate the potential affects of climate change into planning for future flood events. Until more refined projections are developed, DWR recommends a 20% higher peak flow reference for planning purposes.
- The Department of Water Resources should develop a comprehensive Central Valley Flood Protection Plan (as described in SB5) with extensive stakeholder input by January 1, 2012.
- The Department of Water Resources should identify opportunities and needs to improve integrated flood management statewide with extensive stakeholder input by January 1, 2012.
- The Department of Water Resources should develop a strategy to provide incentives and support for the creation and maintenance of IRWM plans that address regional flood management issues by January 1, 2012.
- The Department of Water Resources should develop a financing strategy to address statewide flood management needs and the creation and maintenance of IRWM plans by January 1, 2012.

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