CHAPTER 8.
ANALYSIS OF FLOOD MITIGATION ALTERNATIVES

During the CFHMP planning process, Advisory Committee members identified a variety of flooding issues and concerns and proposed a range of potential solutions. This chapter presents identified flooding issues, analysis of potential mitigating alternatives, preferred alternatives and recommended actions.

The CFHMP is a policy document which contains recommended actions or policy changes to reduce flood hazard in a comprehensive fashion. Recommendations in the CFHMP Amendment include studies related to those actions or policy changes. These recommended studies are either of a general nature (i.e. study the available sediment supply in this reach) or specific, such as the recommendation for further study of the effects of levee relocation on adjacent infrastructure. For instance, such studies and environmental analysis will include assessing impacts to the City of Yakima Wastewater Treatment Plant (WWTP) outfall, mixing zone, and resultant water quality of the Yakima River, including identification and evaluation of mitigation measures to reduce or eliminate potentially significant adverse impacts caused by levee relocation or alteration of other infrastructure adjacent to the WWTP outfall.

Each flooding issue is presented as either region-wide, specific to a river reach, or affecting areas outside the CFHMP study area. Region-wide issues apply throughout the study area and include regulatory issues, general trends in flood patterns, issues associated with operation and maintenance of flood control facilities, and land use issues. River reach issues identify specific areas within a river reach that have repeatedly experienced flood damage or that have been identified as a flooding concern. Flooding issues outside the CFHMP study area are additional concerns.

Each flooding issue was given a label indicating geographic area and issue number, and those with specific locations were plotted on Figure 8-1. For example, label RW1 refers to region-wide issue number one, UR1 refers to issue one in the upper reach (Yakima Canyon to Selah Gap), MR2 refers to issue two in the middle reach (Selah Gap to SR 24 bridge), and LR1 refers to issue one in the lower reach (SR 24 bridge to Union Gap). Issues outside the study areas are identified as OSA.

Through the 1998 CFHMP ranking process, Advisory Committee members assigned each flooding issue a priority. Related issues were combined and discussed as a single issue in 1998. In the 2007 update, flooding issues are consistent with the 1998 plan. The actions were prioritized based on the likelihood of near term projects (such as SR 24 bridge replacement), changed conditions since the original plan was drafted (such as the purchase of large areas of floodplain by the US Bureau of Reclamation), or additional information or studies which were not available to the original advisory committee [such as LIDAR data, the Stanford *et al*. studies (2002), the analysis by Lorang (in Stanford *et al.* 2002), or the Floodplain Consistency Report for SR 24 (WSDOT 2003)]. The amended list is presented in Table 8-1. Several issues have been eliminated entirely from consideration in this flood plan due to their resolution during the multi-jurisdictional 1998 – 1999 GMA comprehensive planning process, changes in land ownership, or other reasons. For a list of reasons for issue-specific changes or deletions from the 1998 to 2007 versions, see Appendix B.

TABLE 8-1.
AMENDED ADVISORY COMMITTEE RANKING OF FLOODING ISSUES

ID	Flooding Issue	Rank
LR5	Aggradation/Reduced Flood Capacity Upstream of SR 24 Bridge; Flood Damage to SR 24 Bridge, Yakima Regional Wastewater Treatment Plant Levee, and DID #1 Levee	1
MR2	Yakima Beech Street Gravel Pit Levee	2
LR3	Increased Flood Elevation near Union Gap	3
LR7	Capture of Edler Ponds	4
RW1	Floodplain Mapping	5
RW20	Loss of Channel Capacity due to Sediment Accumulation	6
NA1	Bedload Movement and Channel Instability of Naches River	7
RW13	Funding for Flood Control Work and Restoration Proj.	8
RW6	Public Disclosure of Floodplain Status	9
RW12	Protection of State and County Roads	10
RW3	Channel Migration	11
RW9	Diversity of Opinions Relating to River Management	12
RW4	Flood Hazard Ordinance	13
RW2	Loss of Fisheries Habitat and Riparian Areas	14
LR1	Erosion of Agricultural Land	15
RW17	Existing Structures in the Floodplain	16
RW8	County Policy on Flood Hazard Management	17
RW16	Operation and Maintenance of Flood Control Facilities	18
RW10	Acquisition/Preservation of Floodplain Open Space	19
RW19	Flood Warning and Emergency Response	20
RW18	Community Rating System	21
UR1	Erosion of Agricultural Land	22
RW15	Use of GIS Data	23
UR5	East Selah Gravel Pit Levee	24
RW5	Revision and Consistency of Critical Areas Ordinance	25
OSA1	Continued Flood Damage Outside CFHMP Area	26
RW7	Flood Insurance and Public Education	27
LR6	Spring Creek Backwater Flooding	28
MR7	Flood Damage to Robertson Landing	29
MR8	Borrow Pit Levee Upstream of Terrace Heights Bridge[a]	30
MR6	Flood Damage to Greenway Path near Boise Cascade	31
UR3	Flood Damage to Harlan Landing	32
UR4	Inundation of Elks Golf Course	33

a. Recent research had indicated that borrow pits are not suitable fish habitat. This issue is resolved.

This chapter is organized according to the severity of the flood hazard or risk associated with each issue, as ranked above, and the actions to address those risks are ordered based on their effectiveness and the status of those actions – i.e. actions already being implemented appear first in the sequence under each issue. This organization should provide a rough level of priority for the actions, and provide a means of focusing effort on the sequence of actions that should occur during plan implementation.

Actions Necessary to Meet SEPA Requirements

All chapters of the plan have been updated to reflect current situations and a new action has been added to the plan herein to perform additional environmental review that comprehensively assesses the environmental impacts to public infrastructure resulting from actions proposed in the plan:

1) If the assessment indicates that impacts from plan projects are likely, then the FCZD shall work with affected agencies to secure funding to conduct further project-related environmental review. The lead agency would be determined when the project is proposed by the proponent.

2) The FCZD shall work closely with affected agencies to propose mitigation projects that specifically address impacts; and, ensure that mitigation for project impacts is funded and constructed as an integral part of the projects(s). The FCZD shall endeavor to secure state and federal funding for all project related needs, including mitigation.

3) Flood hazard reduction projects shall not proceed unless associated mitigation projects are also funded and constructed on a timeline that ensures that the concerns about the WWTP compliance and other public infrastructure related to said projects(s) are eliminated.

4) Flood hazard projects shall be subject to all applicable state and federal environmental laws, including project specific reviews under SEPA and NEPA.

LR5—Aggradation/Reduced Flood Capacity Upstream of SR 24 Bridge; Flood Damage t o SR 24 Bridge, Yakima Regional Wastewater Treatment Plant Levee, and DID #1 Levee (1)

Problem Definition

Overview of General Conditions

The configuration of the levees and the old SR 24 bridge has resulted in a constriction in the area of the bridge itself. This configuration has effects on stream power upstream and downstream of the old SR 24 bridge, resulting in aggradation upstream of the bridge, and erosion of levees and the river channel downstream of the bridge. Streampower is a measure of available energy to transport and erode sediment in the bed and banks. Upstream of the constriction, channel and floodplain elevations in places interior to the levee system are 6 feet higher than the natural floodplain elevations outside the levees as illustrated in Figures 8-2 and 8-3 at Sportsman State Park. The cross section is derived from LIDAR data and shows the floodplain elevation in the State Park, outside of the levees on the left (east) side of the graph. This is the level of the floodplain prior to construction of the levees in 1947. As gravel

accumulates in the reduced available floodplain, the active channel is forced against the levee, increasing stream power and erosion of the levee face. As aggradation proceeds, the levees are in danger from either over topping due to loss of conveyance or erosion and undercutting from confinement of the stream against the levee face.

A recent analysis of stream power (Lorang in Stanford *et al*. 2002) shows that the combination of areas of gravel accumulation, increased gradient, and the narrow channel through the bridge opening, have resulted in high levels of available energy to transport sediment (Figure 8-4) in the Gap to Gap River reach . This reach was modeled to estimate stream power during a 15,000 cubic feet per second (cfs) flood (approximate 2-year return frequency). Red indicates higher stream power and is associated with areas of levee erosion, bridge scour, and downcutting of the channel. White and blue areas indicate lower energy areas corresponding with areas of channel aggradation (sediment accumulation). The areas of high energy are relatively small and are concentrated along the levee and at the bridge opening. These areas of high energy identified in the report correspond well with repeated (8 times since the 1972 flood) levee erosion at the Yakima Regional Wastewater Treatment Plant, downcutting of the channel adjacent to the WWTP, and erosion of the DID#1 levee downstream of the WWTP. Further aggradation upstream of the bridge will aggravate existing erosion problems, as well as associated problems such as raising of the local water table, channel instability, and reduced capacity of the levee system to control the base flood upstream of the constriction. Downstream of the constriction, downcutting of the riverbed and associated erosion of the Yakima Regional Wastewater Treatment Plant levee and the DID #1 levee will also continue.

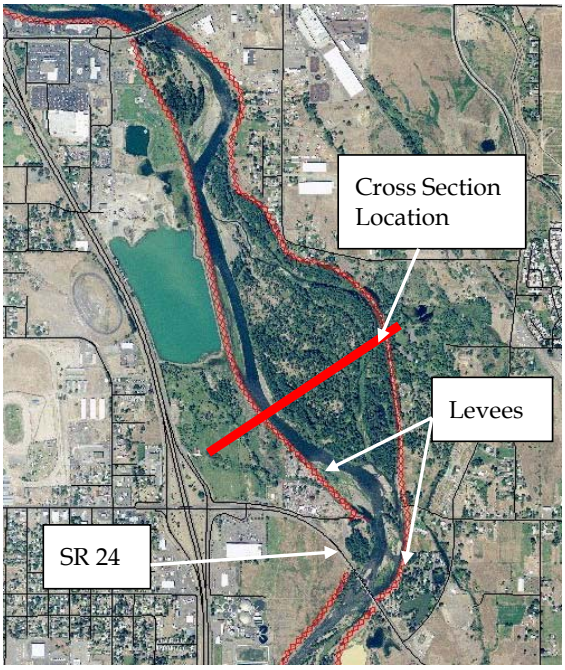


Figure 8-2. Aerial Photograph of Sportsman's State Park and Vicinity Cross Section Location.

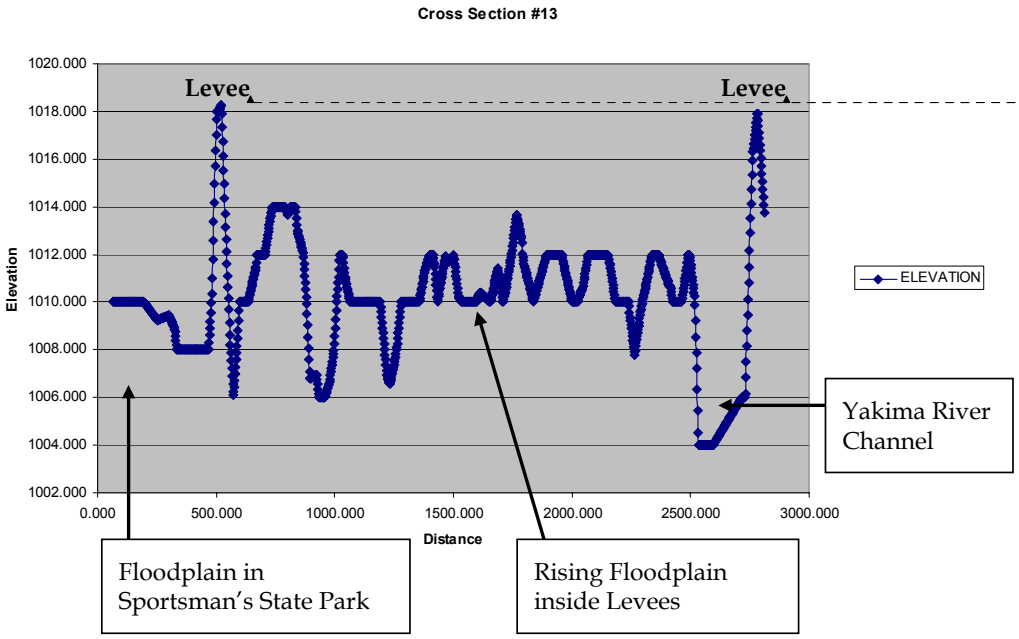


Figure 8-3. Aggradation (Stream Bed and Floodplain Rise) at Sportsman's State Park.

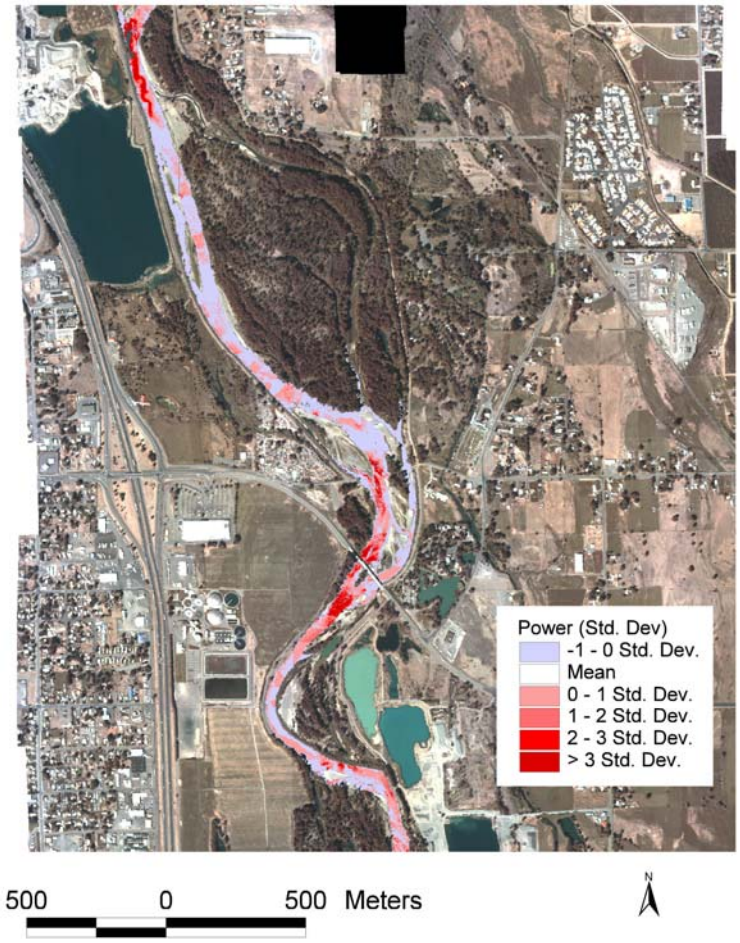


Figure 8-4. Stream Power Graphic. From Stanford *et al*. 2002.

Figure 8-5 is a Yakima River Profile from LIDAR data that shows the relative elevations of the water surface of the river at lower flow, the floodplain inside the levee system, and the floodplain outside of the levee system. The SR 24 bridge is in the middle of the graph at the location of the blue spike. Note how the elevation of the cyan line (water surface elevation) relative to the blue line (floodplain outside the levees) changes as the river moves through the bridge. The channel is rising in relation to the floodplain upstream, and lowering downstream.

Upstream of SR 24, the water surface elevation is above the elevation of the floodplain surface outside the levees in several locations. Analysis of aerial photos and conversation with personnel at the Arboretum and Sportsman's State Park indicate that the water table associated with the river has also risen. On the Arboretum (west) side of the river, this has resulted in vegetative change (die off of trees) in a wetland that is located in an old river meander, and a similar die off of some trees on the State Park side. On both sides of the river, there are "floodgates" through the levee system which are designed to be opened when floodwaters

accumulate outside of the levee system, and need to be drained toward the river. On the Arboretum side of the river, these "floodgates" also serve as the outlet of Buchanan Lake (which is the water table exposed to the surface) during most of the year, and the "floodgates" are closed during flood events to prevent floodwaters from backflowing during the event.

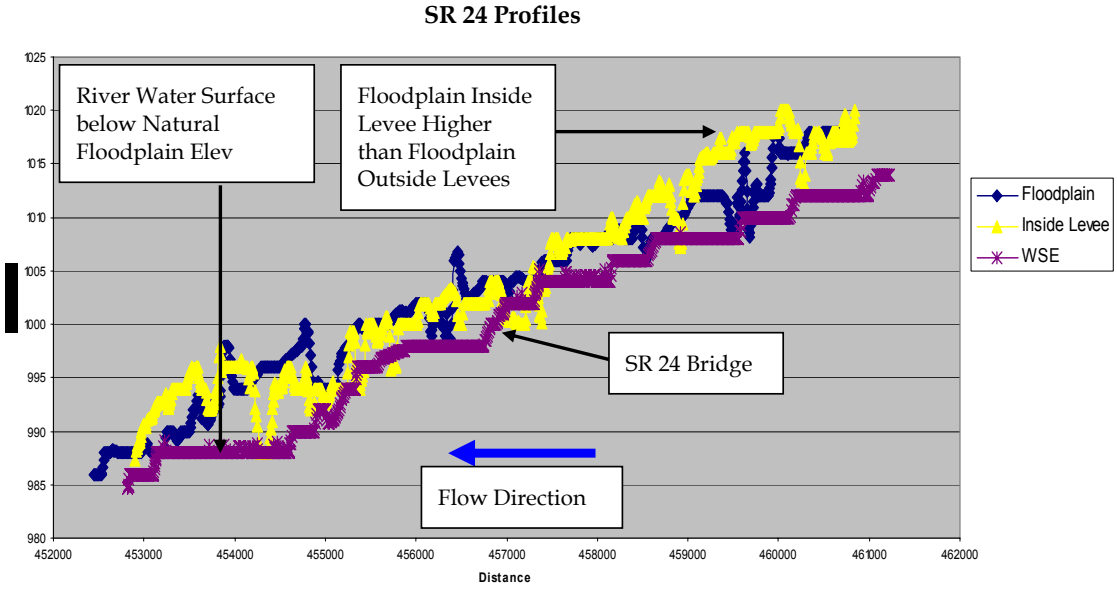


Figure 8-5. Change in Bed Elevation Upstream and Downstream of SR 24.

The rise of the riverbed and water table are problematic for several reasons. Currently, the Buchanan Lake/Beech Street Pit drain must be annually maintained and deepened because the river bed plugs the outlet (i.e., the river surface is now above the elevation of the floodgate), and as a result, the gate is not very effective as a drain. Buchanan Lake rose during the 1996 flood, but it could not drain to the river. Instead, the lake drained through the Arboretum and into the Nob Hill Auto Wrecking Yard, which was flooded for several days. If the river bed and water table continue to rise in this area, this type of flooding (i.e., flooding outside of the levees which cannot be controlled) will become more frequent, the efficiency of the Buchanan Lake drain will continue to be reduced and the lake and water table elevation will rise (which effects I-82, Central Pre-Mix, the Arboretum and other properties west of I-82), and Sportsman's State Park and the Arboretum will continue to lose large trees which are of high recreational and public value.

Downstream of SR 24, lowering of the water table was initially associated with the gravel mining operations at the Newland Pit on the east side of the river. Groundwater was pumped out of the pits during mining operations (usually during summer and fall), which resulted in a localized lowering of the water table in the vicinity of the pit. Due to the near surface geology of the area (for a good description see the Central Pre-Mix EIS for the proposed East Valley

mine; Brown, 2002), this resulted in a loss of water to the root zone of adjacent cottonwood trees, and their death. Although mining has ceased, the water table has not recovered and remains at the same elevation as the surface of the river (see Figures 8-6 and 8-7). Recovery of the natural riparian zone in this area will probably not occur unless the water table rises to its pre-mining and pre-river downcutting elevations. Based on the soils exposed in the pit walls of the mining area, the current water table is now approximately five feet lower in the spring than under natural conditions, and can be expected to continue to lower if the hydraulic/sediment routing conditions in this reach remain similar to their current condition.

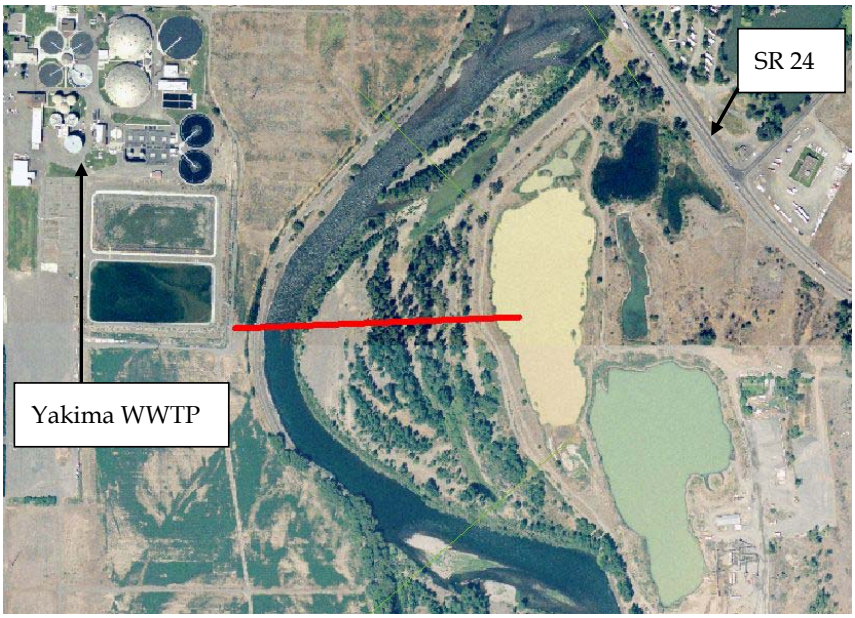


Figure 8-6. Cross-Section Location at the Newland Pit.

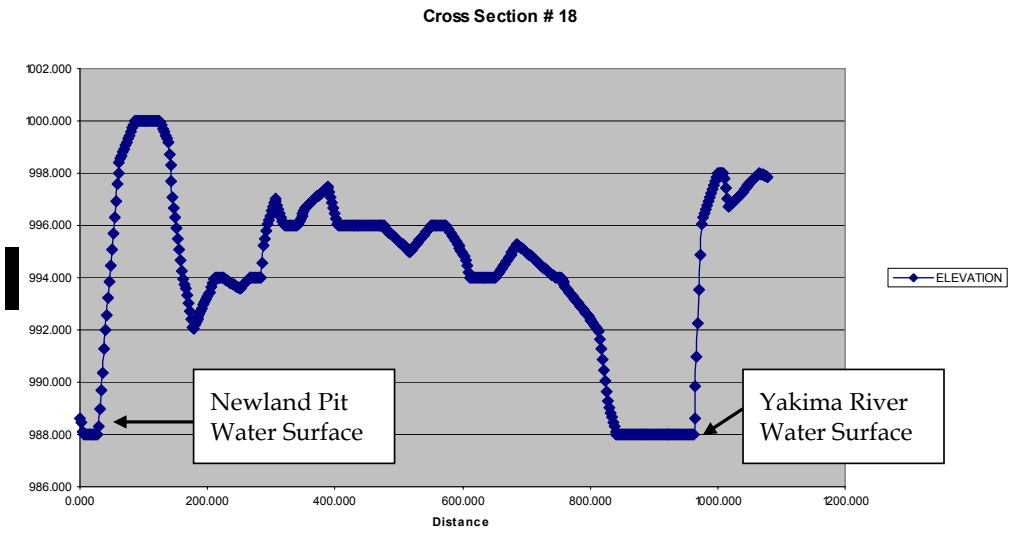


Figure 8-7. LIDAR Generated Cross Section. (Note the similarity in elevation between the water surface elevation of the river and of the water level in the pit.)

Associated with the aggradation and configuration of the levees is a scour problem at the old SR 24 bridge. Several of the bridge piers were constructed on relatively shallow footings. With channel movement, downcutting of the channel, and increased energy through the bridge opening, several of the old SR 24 bridge piers are in danger of failure during fairly small and frequent flood events. Currently, the old SR 24 bridge is listed as "Scour Critical" by the Washington State Department of Transportation (WSDOT) and is monitored during and after all flood events for scour at the piers. On five separate occasions, the WSDOT has had to perform emergency (i.e., outside normal hydraulic season work window) stabilization of the bridge piers by installing riprap and grouting to support the footings of these piers. The WSDOT is currently replacing the old SR 24 bridge with a new and longer structure. This structure is supported by drilled-shaft piers, which will withstand scour from flood events well beyond the 100-year flood. The longer bridge length does not resolve the constriction that currently exists at this location, as the configuration of the levees upstream and downstream of the bridge location will remain unchanged.

As stated above, the configuration of the levees and existing SR 24 bridge concentrates the flow of the river in a relatively small area, which leads to aggradation upstream of the bridge, high scour and energy at the bridge itself, and erosion downstream of the bridge. The concentration of flow means that the main flow of the river downstream of the bridge is always located at the WWTP outfall, and the relatively high velocities and high turbulence of this steep and confined section ensure that the WWTP effluent is rapidly and efficiently diffused into the river. The standard the WWTP effluent must meet is based on State water quality standards, and a statistical low flow (the 7-day low flow which occurs with a frequency of 10 years), to ensure that even at very low flows the water quality standards are not violated. Changes to the configuration of the bridge and levee system upstream can be expected to change the hydraulic

conditions at the outfall, with a very high probability that the river channel will begin to move/migrate if the levees are relocated. This would potentially result in the outfall no longer being located in the river, the outfall being buried as the river recovers to a more natural elevation, or reduced flow and turbulence at the outfall, any of which would result in violation of water quality standards and/or the City's NPDES permit from the Department of Ecology, which allows the WWTP to discharge to the river.

The WWTP serves the entire urbanized area of Yakima, including the City of Yakima, the City of Union Gap, and the Terrace Heights area. It is critical that this facility continue to function into the future in conformance with state water quality standards, and that the WWTP be given a high degree of flood protection given the consequences of losses or compromised function of the WWTP to the economy of the region, public health, and environment of the Yakima Urban Area and areas further downstream.

Ongoing Projects

Replacement of SR 24 Bridge

The WSDOT is replacing the SR 24 bridge to improve traffic capacity of the bridge and adjacent portions of SR 24 in the Yakima Urban Growth Area and to reduce the scour potential of the bridge piers, which occurs at flood discharges at and above the one-year flood (WSDOT, 2003). The new bridge is a four-lane structure with an overall span of approximately 1,600 feet. The bridge will extend from approximately Keys Road to 150 feet west of the existing SR 24 abutment.

An Environmental Assessment was prepared for the project by WSDOT, along with an analysis of the current floodplain conditions upstream and downstream of SR 24 (Park, 2003). The basis for the longer bridge alternative is that the current configuration of the levees upstream and downstream of the bridge, inclusive of the bridge itself, is leading to aggradation upstream of the bridge, and degradation downstream. The aggradation upstream of the bridge has resulted in lessening of the conveyance capacity upstream of the bridge. The levee system was originally constructed to control the 200-year flood. It now controls the 100-year flood despite having been raised twice (in 1971 and 1982) to bring it into conformance with COE requirements. Had the current SR 24 bridge been replaced with a similar structure, aggradation would likely continue into the future, resulting in increased operational costs for maintenance of the levee and:

- Increased stream power and erosion of the levees upstream and downstream of SR 24, and erosion of the bridge abutments themselves, due to increase in local slopes and confinement of the stream channel
- Further increases in the elevation of the water table upstream of the bridge, and lowering of the water table downstream of the bridge
- Sediment starvation of the downstream reach, resulting in hazard to infrastructure downstream.

The new bridge effectively resolves a major flood hazard issue, the stability of the SR 24 bridge, but does not address the underlying problem of a constriction at the bridge opening, and the sediment transport and erosion problems related to that constriction. The WSDOT is not reconfiguring the levee system that is connected to the existing SR 24 bridge, so the constriction

remains in place. The length of the new bridge does allow and facilitate reconfiguration of the levee system to reduce or eliminate the effect of this constriction.

Public Agency Floodplain Purchases

Since 1999, the US Bureau of Reclamation (BOR) has been acquiring property in the floodplain below the SR 24 bridge through implementation of the Yakima River Basin Water Enhancement Project (YRBWEP). Figure 8-8 shows the location of these BOR purchases, as well as purchases by the Yakama Nation, which were for similar purposes. The BOR's goals are to protect and restore valuable habitat for salmonids as well as acquire the water rights associated with these parcels. Based on BOR funded research in the Yakima River Basin (Stanford and Snyder 2001, Stanford *et al*. 2002), the "Union Gap Reach" between Selah Gap and Union Gap was selected as the mainstem reach that is best suited for restoration of salmonid habitat.

The most valuable habitats in this reach are in the lower portions below SR 24. Given the effect that the design and location of a replacement SR 24 bridge would have on the BOR's goals for restoration and protection of habitat in the lower Union Gap Reach, the BOR has been active in advocating a longer span to allow for more floodplain restoration at and downstream of SR 24. Depending on the configuration of the new bridge, the BOR is willing to actively pursue more property acquisition in this area to maximize floodplain restoration.

Much of the economic and land use analysis, which was in the original Upper Yakima CFHMP and considered as the economic benefits of construction of a new 100-year levee near Blue Slough, has been superseded by public agency acquisition of most of the property likely to be affected by levee removal and setback. Much of the property that would be subjected to increased flooding is now in public ownership, and increasing the flood frequency, floodplain function, and habitat attributes of these lands will actually have positive economic impacts for the current owners and the public at large.

The BOR has options on additional properties in the action area of the CFHMP and their purchase is dependent on the outcomes of the Central Pre-Mix proposal (discussed below) and actions that result from this CFHMP.

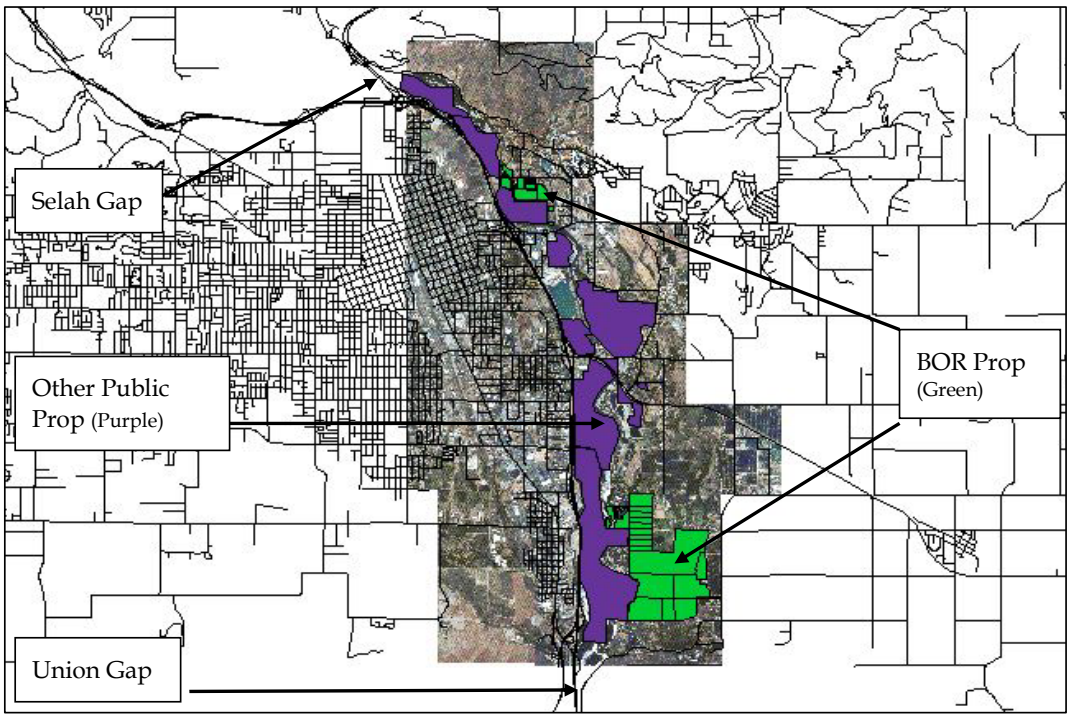


Figure 8-8. Bureau of Reclamation and other Public Ownership in the Gap-to-Gap Reach.

Central Pre-Mix Mining Proposal

Central Pre-Mix (CPM) has received zoning approval from the County for a new gravel mine and processing facility on property CPM owns on Riverside Road, east of the Yakima River. The proposed mine pits will be over 1,200 feet from the Yakima River. As additional mitigation, CPM has committed to setback of a portion of the DID #1 levee on their property, and to dedicate a 197 acre area west of the proposed setback levee as a floodplain and wildlife "enhancement area" (see Figures 8-9 and 8-10). Any levee setback or reconfiguration implemented as a result of this CFHMP should take advantage of the CPM proposal. There is also the potential for conflict between the levee pullback proposed by CPM and the goals of the BOR for its purchased properties in this location and further downstream. These largely complementary projects and goals should be resolved in the near future.

In addition, the Newland Pit, which was active during the formulation of the original CFHMP, has ceased operation, and is in the process of being reclaimed by CPM. The configuration and depth of these pits make them good candidates for incorporation back in to the floodplain of the Yakima River.

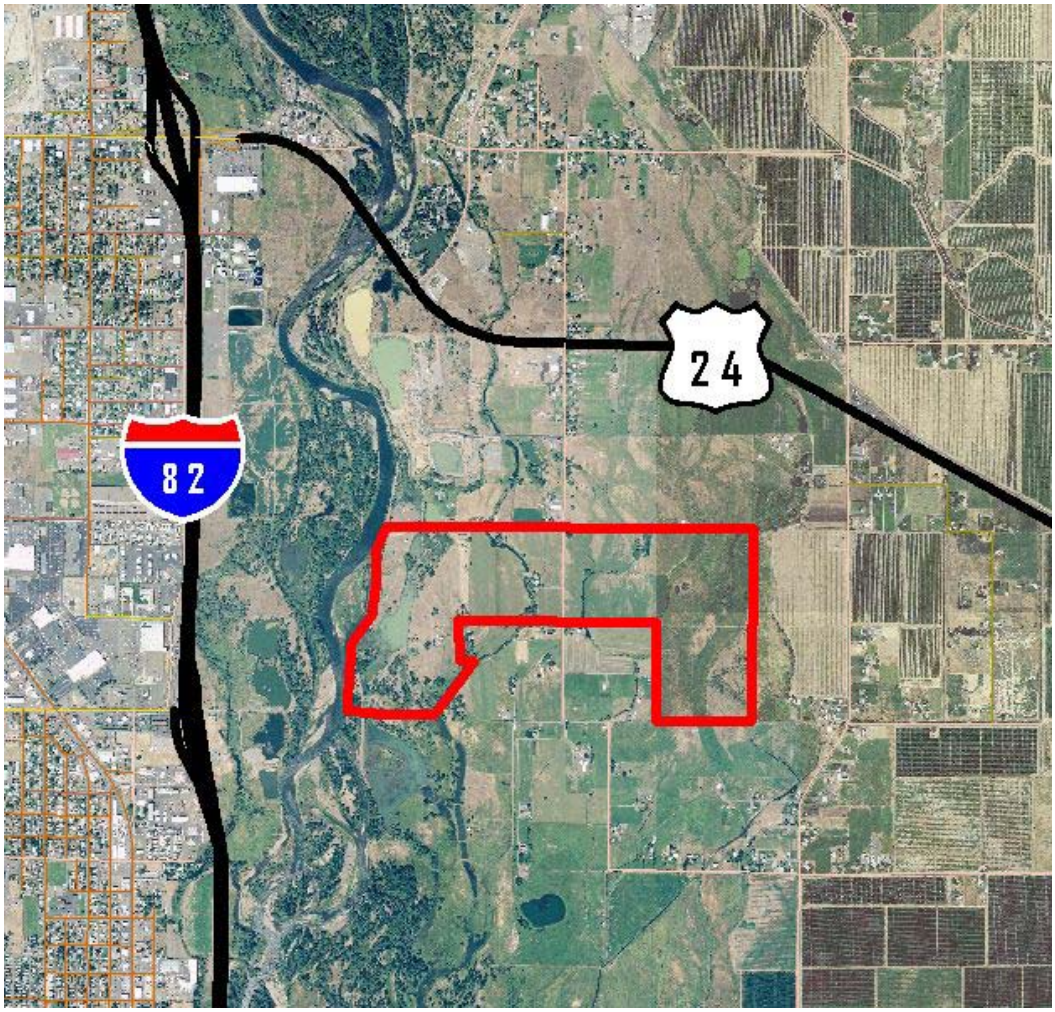


Figure 8-9. Proposed Central Pre-Mix East Valley Gravel Mine and Associated Properties.

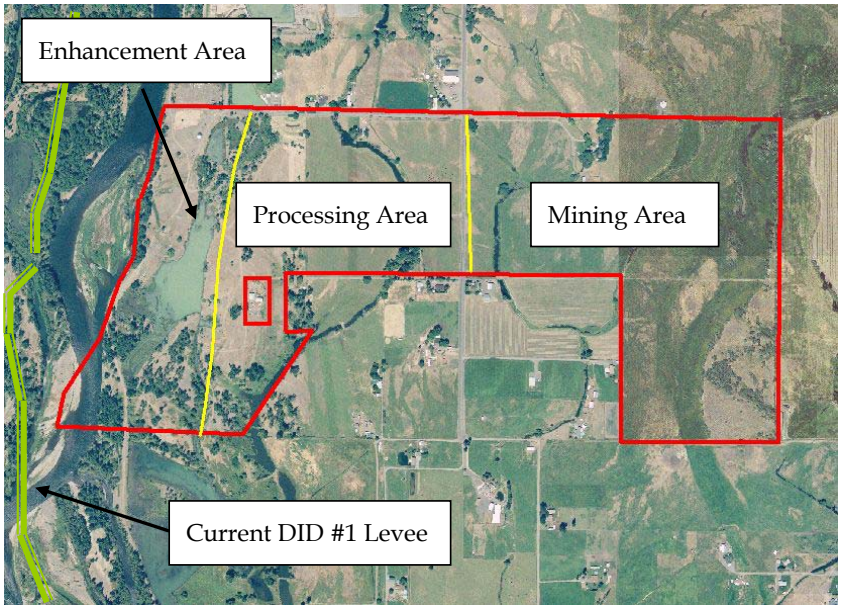


Figure 8-10. Proposed Enhancement Area and Current Location of Diking Improvement District #1 Levee, Proposed Central Pre-Mix East Valley Mine.

Alternatives to correct flood hazards will involve consideration of levee reconfiguration, raising, setting back, or increasing the amount of armor on the levees, and the SR 24 bridge.

The DID #1 levee is approximately 11,000 feet in length and located on the eastern bank of the Yakima River downstream of the SR 24 bridge. It is not certified as a 100-year levee due to the materials, method of construction and insufficient freeboard (3 feet) required above the 100-year flood. Alternatives for reconfiguration of this structure should include an analysis of the ability of a reconifigured levee to provide 100-year flood protection to areas east of the river.

Level of Protection for Existing DID#1 Levee

Examination of the computer analysis completed in 1995 revealed that the DID#1 levee existing on the left bank at that time should provide approximately a 25-year level of protection with no freeboard. However the levees were not overtopped in 1996 when Emergency modifications to the levee were made in response to the February 9, 1996 flood (peak flow reached approximately 56,000 cfs) and the concerns that the levee would overtop and possibly fail..

The model indicates that flows greater than 35,000 cfs, a 25-year event, the existing left riverbank levee would be close to overtopping. This would begin at a low point approximately 2,000 feet downstream of SR 24. For flows significantly greater than 35,000 cfs, the area behind the levee (i.e., the left overbank) would be used to convey floodwaters.

For a 100-year flood event (56,300 cfs at Parker), an additional 21,300 cfs must be conveyed in the channel and behind existing levees. To confine the 100-year flood flow and provide 3 feet of

freeboard within the left bank levee, the levee would need to be raised between 1.5 and 6.0 feet to (specific increases in elevation depend on the location along the levee).

The 1996 emergency work allowed the structure to provide greater protection than predicted in the hydraulic analysis.

Discussion of Alternatives

The concern is to reduce flood hazards associated with the following: aggradation/reduced flood capacity upstream of SR 24 bridge; flood damage to SR 24 bridge, erosion at the Yakima Regional Wastewater Treatment Plan levee, and potential failure of DID #1 levee.

Reconfiguration of DID #1 levee

To evaluate the potential for flood hazard reduction below SR 24 bridge, the following alternatives for the DID #1 levee were examined in the 1998 report.

- Strengthen the existing levee but maintain its current elevation.
- Raise the existing riverbank levee to provide 100-year protection, extending 2,000 feet downstream of SR 24 bridge.
- Raise the existing riverbank levee to provide 100-year protection, extending approximately 10,000 feet downstream of SR 24 bridge.
- Construct a 100-year setback levee along Blue Slough, extending approximately 2,500 feet downstream of SR 24 with no modification to the existing levee.
- No modifications to the existing levee (No Action).

Levee alternatives were evaluated using a hydraulic computer model (HEC-2), the computer model used by FEMA, to define the regulatory floodplain. FEMA HEC-2 data files were obtained from the US Army Corps of Engineers (COE) and modified to reflect changes in river hydraulics caused by levee modifications. Several scenarios were simulated to determine the impact on flood elevations and floodplain boundaries. Objectives of the computer simulations were as follows:

- Determine how high the existing riverbank levee must be raised to provide 100-year protection
- Determine the extent of protection provided by the existing levee
- Determine amount of flow, depth of flooding, and floodplain boundaries east of the existing levee if the levee was overtopped.
- Examine changes in floodplain boundaries and flood elevations if a 100-year levee extended 2,000 feet downstream of SR 24 bridge (this was previously evaluated by the COE).
- Examine changes in floodplain boundaries and flood elevations if a 100-year levee extended 10,000 feet downstream of SR 24 bridge.
- Examine changes in floodplain boundaries and flood elevations if a 100-year setback levee was constructed along Blue Slough.

Review of Existing Hydraulic Conditions

Yakima River hydraulic conditions were reviewed in 1998 to assess the accuracy of existing floodplain boundaries. This involved reviewing the hydraulic model FEMA used to determine the revised preliminary regulatory floodplain (FEMA 1995).

Reviewing FEMA's computer model revealed that the existing left bank levee below SR 24 bridge was not represented in the data. This is standard practice if the levee does not meet FEMA elevation requirements to confine the 100-year flood flow with 3 feet of freeboard. Therefore, FEMA floodplain boundaries were determined as if the levee did not exist. To examine if this overestimated the extent of floodplain boundaries, computer model runs were performed with the left riverbank levee in place. The analysis used surveyed levee elevations collected prior to the February 1996 flood. The following scenarios were simulated:

- Allow the levee to overtop without any structural failure
- Allow a 1,000 foot levee failure at the lowest elevation location without a permanent channel change as a result of the failure.

Allowing the existing left bank levee to overtop or fail during a 100-year event results in floodwaters being conveyed within the left overbank, east of the levee. Water surface elevations and floodplain boundaries were estimated using these predicted overbank flows If the levee were overtopped with no structural failure, an estimated 8,500 cfs would be conveyed within the left overbank. If the levee failed at its lowest elevation, an estimated 12,000 cfs would be conveyed within the left overbank. Both scenarios convey considerably less flow than predicted by FEMA's model.

The existing levee incorporated in the computer model produces higher water surface elevations in the river channel and the floodplain on the western side of the river, but lower flood elevations within the left overbank, compared to FEMA's flood elevations. Table 8-2 displays predicted water surface elevations for estimated flow rates conveyed in the left overbank and channel. For the existing 25-year levee overtopped without failure during a 100-year event, the left overbank water surface elevations are estimated to be 0.9 to 2.4 feet lower than those predicted by FEMA and water surface elevations in the main channel to be 0.6 to 2.0 feet higher. The increase in estimated channel water surface elevations represents less flooding in the left overbank than FEMA estimated, but more flooding on the right overbank than shown by FEMA.

Similarly, if the left bank levee failed, left overbank water surface elevations are predicted to be 0.2 to 1.9 feet lower than those predicted by FEMA and water surface elevations in the main channel would be 0.2 to 1.7 feet higher. Compared to FEMA flood predictions, the levee failure scenario also represents a decrease in flood elevations in the left overbank and higher flood elevations in the right overbank.

Therefore, representing hydraulic conditions with the existing 25-year levee generally displays a decrease in flood hazard within the left overbank in comparison to hydraulic conditions without the levee as modeled by FEMA (i.e., areas adjacent to and downstream of the City of Yakima WWTP).

Levee Alternatives

Hydraulic conditions were modified in the computer model to represent the various levee alternatives listed below. The predicted changes in water surface elevations, floodplain

boundaries, and assessed value protected relative to the preliminary revised FEMA floodplain conditions are shown in Figure 8-11.

TABLE 8-2
PREDICTED 100 YEAR WATER SURFACE ELEVATIONS

Cross-section	Levee Overtops[a]		Levee Failure[b]		FEMA 100-year	
Location (river mile)	Channel[c]	Behind levee[d]	Channel[c]	Behind levee[d]	Flood Elevation	Comments
111.27	1003.0	–	1003.0	–	1000.8	SR24 Bridge
111.07	1000.7	–	1000.8	–	997.4	Flood flow contained within levee
110.78	995.7	991.6	995.5	992.1	994.0	Cross-section at levee breach
110.47	990.9	989.4	990.5	990.1	990.3	
110.22	986.8	984.8	986.9	985.4	985.9	
109.98	983.8	980.0	983.6	980.6	982.4	
109.75	981.1	976.8	980.8	977.7	979.1	
109.46	975.0	972.8	974.9	973.0	974.3	End of levee
109.18	969.6	–	969.6	–	969.5	

a. Left bank levee downstream of SR24 bridge overtops without losing structural integrity. Total predicted flow behind levee equals 8,500 cfs.
b. Left bank levee downstream of SR24 bridge fails at lowest elevation. Total predicted flow behind levee equals 12,000 cfs.
c. Water surface elevation in main channel.
d. Water surface elevation behind left bank levee.

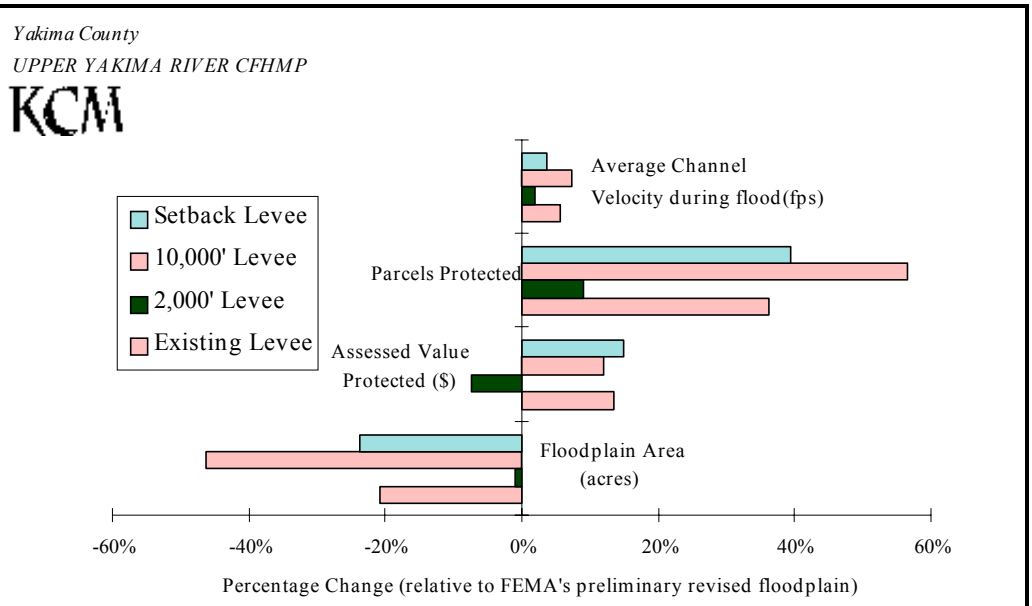


Figure 8-11.
INCREMENTAL CHANGES FOR VARIOUS LEVEE CONDITIONS

Existing Levee: Integrating a structurally sound 25-year left riverbank levee into the existing river hydraulic conditions shows that flood hazards are not as severe as those represented on FEMA floodplain maps. A 25-year levee reduces floodplain area by 21 percent. In addition, the 25-year levee reduces the potential for catastrophic failure and the need for emergency flood fighting that a 100-year levee would create.

2,000 Foot 100 Year Levee: Raising the existing left riverbank levee for 2,000 feet downstream of SR 24 bridge to provide 100-year protection while continuing the FEMA assumption of no DID levee downstream of this point. This option reduces the floodplain area by 1 percent and increases the assessed property value within the floodplain by 7 percent from FEMA floodplain conditions. Assessed property value within the predicted floodplain increases due to high value property becoming inundated on the right bank. This alternative would also increase velocities in the river channel and reduce potential fish habitat.

10,000 Foot 100 Year Levee: Raising the existing left riverbank levee for 10,000 feet downstream of SR 24 bridge to provide 100-year protection, effectively replacing the existing DID levee. This would reduce the floodplain area by 46 percent. Floodplain area decreases on the left bank, but increases on the right bank, where assessed property values are higher. This alternative also increases velocities in the river channel and reduces potential fish habitat.

Setback Levee: Constructing a 100-year setback levee 2,500 feet downstream of SR 24 along Blue Slough would provide protection to development near Riverside Road, reduce the floodplain

area by 24 percent, and decrease assessed property value within the floodplain by 15 percent from FEMA conditions. The existing levee is not represented in this hydraulic analysis. This alternative increases the right overbank flooding and reduces potential future fish habitat.

The above analysis reveals that the setback levee option provides the best overall flood, fish and habitat benefits versus costs and should be preferentially considered. The existing DID #1 levee alignment is also subject to considerable flood damage and continuing maintenance costs

Preferred Alternative and Recommended Actions

Based on the above analysis, and existing and planned projects in this reach, these flooding issues and flood hazards are the highest ranking in the entire CFHMP planning area. Overall, the Yakima River in this area should be managed to:

- Reduce the concentration of energy against the levees to reduce the current and future rates of levee scour and failure.
- Improve sediment transport through this reach to:
  - Lower the bed elevation upstream and raise the bed elevation downstream
  - Reduce the slope through the bridge location, reducing energy
  - Reverse the aggradation process and increase the ability of the levee system to control floods
  - Lower the water table upstream of the bridge and raise the water table downstream of the bridge
- Increase the width of the floodplain to allow for a greater amount of sediment storage and energy dissipation in the floodplain
- On the west side of the river, maintain the ability of the City of Yakima WWTP to continue to discharge in conformance with state law.

Practically, achieving the above management objectives will probably require multiple actions in different areas. The key to implementation of the first three recommendations is the length and configuration of the SR 24 bridge. The configuration of the SR 24 bridge currently under construction will allow the objectives discussed above to be met, reduce energy against the levees, improve sediment transport, and increase floodplain width and function. Levee alignments to meet the objectives are discussed further below.

Levees Upstream of SR 24

In order to meet the recommendations above, the levees should be reconfigured to tie into the new SR 24 bridge abutments. On the east side of the river, levee setback would begin upstream of the Old Moxee bridge and continue to the SR 24 alignment, this includes the demolition of the Old Moxee bridge abutment itself. This would require purchase of two residential parcels and the KOA Campground. Funds are currently available to acquire these parcels, and negotiations are underway between the BOR and the owners of the campground. Negotiations will begin soon for the remaining parcels. Funding and design for relocation of the levees themselves is available from the COE through their 1135 (Environmental Restoration) Program, with a 25 percent match. The match for this section will likely be met through a donation of the existing levee material (owned by Yakima County) to the levee relocation project.

On the west side of the river, there is little opportunity to realign the levee system due to Buchanan Lake and the WWTP, both of which need to be protected into the future. Removal of the western Old Moxee bridge abutment, and reworking of the lower 150 feet of the levee in that area would provide significant benefit to sediment transport and river alignment through this reach. Currently, the abutment is an overlook as part of the Yakima Greenway path and also has a vault toilet located there. These facilities could easily be replaced on the reconfigured levee. Funding for these activities is also available from the COE.

Levees Downstream of SR 24

Levee setback in this area should be designed comprehensively and to meet COE and FEMA standards for protection from the 100-year flood. On the east side of the river, the levees should be set back to allow the incorporation of the Newland Pits into the floodplain. The levee should be located west of Blue Slough for a distance of approximately 2,300 feet south of SR 24. This location is preferred since Blue Slough in this area was constructed and functions as an irrigation ditch and the response of Blue Slough to flood events would be negative from both a habitat and flood hazard standpoint. Due to the topography in that area, levee construction costs (levee height and overall amount of materials) will be lowest directly adjacent to Blue Slough. After approximately 2,300 feet south of SR 24 (near the northern boundary of the Central Pre-Mix property proposed for the East Valley Mine), Blue Slough is a natural spring-fed channel and incorporation into the floodplain would have large environmental benefits. The levee could either extend downstream a similar distance as the current levee, or stop in the vicinity of the lower boundary of the CMP property, to allow the wetlands and lower elevation property in that area to be re-incorporated in to the floodplain. If the levee is shortened, small levees could be constructed to protect several homes adjacent to the BOR's property in this area.

Design of this levee system should be done by the COE, in cooperation with the Yakima County Flood Control Zone District, Diking District #1, WSDOT, BOR, WDFW, and the Yakama Nation. Most of the property that would be subjected to increased flood frequency from this alignment is currently owned by BOR or other public entities, gravel pits, pasture, and some properties with residences. These properties could either be purchased under existing funding programs or remain in use, although some residences would be subjected to fairly extreme flood hazard. Funding for levee design and construction is also available from the COE for this portion, but finding the 25 percent match may be difficult. The large environmental (fish habitat) benefits of this proposal make the funding sources such as the Bonneville Power Administration or the Salmon Recovery Funding Board appropriate sources of match.

On the west side of the river, the ability of the City of Yakima WWTP to continue to discharge in conformance with state law must be maintained. Meeting this requirement will require a study of discharge alternatives, which will include a re-analysis of the expected 10-year, 7-day low flow (this flow has recently increased due to changed operation of the river by BOR, which should actually make the discharge standards easier to achieve), and alternative outfall locations or configurations, or changing the point of discharge to existing or constructed wetlands adjacent to the WWTP. In any event, setback of the levees downstream of SR 24 should not occur until the WWTP's ability to continue to discharge is assured. Funding for this action is not currently secured, and will be required. Currently, the Flood Control Zone District, the BOR, and Ecology are working cooperatively to secure funding for this action. Incorporation of this action into the CFHMP, as integral to reduction of flood hazard in this

reach, is a crucial step in broadening the funding sources (including flood hazard reduction as well as fisheries restoration grants), which could be used to implement this action.

Effects of the Action

Obviously, the effects of relocation of the levee would be large, and would be examined in detail by the COE in their design process. Several things should be stressed at this point in consideration of this recommendation. The models cited above regarding the extent of the floodplain do not take the existing DID #1 levee into account, because the levee does not meet COE standard for a 100-year levee. Conceptually, therefore, there is a very large difference between the regulatory floodplain (which has direct relationship to land use and building code regulations) and the actual area that is flooded during a 100-year event (57,900 CFS). Figure 8-12 shows the extent of the regulatory floodplain and the location of the current DID #1 levee. While the DID #1 levee does not meet COE standards, it is a large and durable facility, and did not fail or overtop in the 1996 flood, which peaked just above the modeled 100-year flood (57,900 CFS). The actual area flooded in events less than a 100-year flood (57,900 CFS) occurs to the west of the levee, and the depth of water in the floodplain is much greater than the floodplain models predict.

Due to the flood mapping model assumptions, the areas between the existing DID #1 levee and I-82 are actually much more prone to flooding and damage than is depicted on the floodplain maps. This includes the City WWTP and several areas along I-82 that are not mapped to show they will overtop, although they will overtop during a 100-year event. Conversely, the areas east of the levee are not subjected to very high flood hazard, but are mapped as if they are. This has a significant effect on the suitability of the areas north of SR 24, which are currently zoned for Light Industry, for industrial development. The current floodplain maps do not depict accurately the current flood hazard or what actually happens during a flood event, due to the presence of DID #1 levee.

Setback of the levees south of SR 24 and constructing them to meet a 100-year protection standard will result in expansion of the floodplain, and actual lowering of flood elevations and flood hazard to the WWTP and I-82. From a regulatory standpoint, the regulatory floodplain will actually decrease in size, and the modeled flood elevations will increase. Once the floodplains are re-modeled after levee setback, we should be in a situation where the practical effects of a flood in terms of elevations and hazard are shown on the floodplain maps, and reflected in the floodplain land use and building regulations.

Diking Improvement District #1 supports the actions as outlined above.

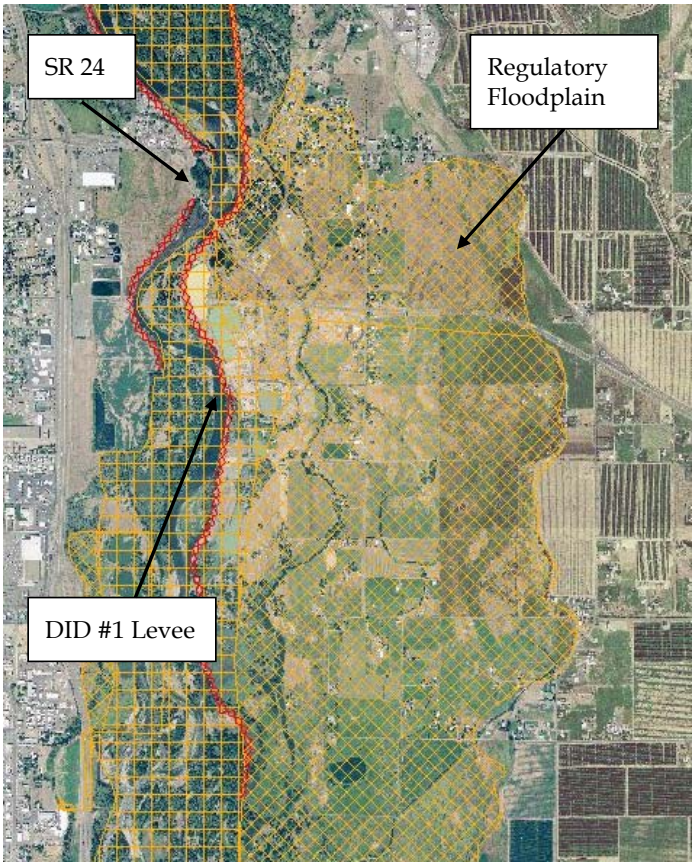


Figure 8-12. Regulatory Floodplain and DID #1 Levee Downstream of SR 24.

MR2—Yakima Beech Street Gravel Pit Levee (2)
UR5—East Selah Gravel Pit Levee (24)

Problem Definition

Gravel resources continue to be a concern within the study area. Two floodplain gravel pits were specifically mentioned in the CFHMP planning process; however, this discussion could apply to any floodplain surface mining operation within the Yakima Valley. In the recent past, four floodplain gravel pits have been operated, extraction of gravel at these sites has ceased, but gravel processing and processing of other materials still occurs at these locations. These current and former operations in the study area include the following:

- East Selah Pit
- Yakima Beech Street Pit
- Newland Pit
- Riverside Pit
- Edler Pits

In addition there are many other former gravel pits in the study area, most of these were associated with the construction of SR 12 or I-82 and include Myron Lake, Willow Lake, Lake Aspen, Bergland Lake, and Rotary Lake along the lower Naches river and near the Naches/Yakima River confluence. Several other gravel pits, immediately above the Terrace Heights bridge, and downstream of the Valley Mall Boulevard interchange, have been captured by the Yakima River and are no longer discernable as former gravel mines.

Many of these gravel extraction areas shown in Figure 8-13, are designated natural resource lands under GMA (RCW 36.70A). This assures the conservation of natural resource lands while minimizing potential conflicts between adjacent land uses.

Concerns with floodplain gravel mining include the following:

- Providing a long-term source of gravel
- Protection of gravel resources and extraction equipment from flood damage
- Potential for severe flood damage caused by a sudden channel avulsion
- Increased flooding downstream or adjacent to gravel operations
- Increased river bank and riverbed erosion
- Impacts to groundwater quality and fisheries resources
- Consistency with future land use plans
- Maintaining floodplain storage capacity
- Gravel pit reclamation.

The Yakima Beech Street pit is separated from the Yakima River by a riverbank levee. The levee is part of the COE-authorized levee system and provides 100-year flood protection. A levee breach or failure during a significant flood event could cause a sudden and drastic channel migration, which could direct floodwaters into areas that previously experienced minimal flooding. This could result in significant flood damage, and could damage fish habitat. During the November 1990 and February 9, 1996 floods, County crews observed levee erosion and were concerned about a levee failure or breach.

The East Selah gravel pit is located adjacent to I-82, south of Harrison Road. The pit was protected by a riverbank levee along the west perimeter of the property prior to the February 9, 1996 flood. During that flood event, the levee failed and the river channel shifted through the gravel pit. The gravel pit was inundated, channel degradation and aggregation occurred, and part of southbound I-82 was lost to bank erosion just upstream of the pit. In addition, gravel pit levees directed floodwaters toward the right riverbank, which overtopped and created an additional flow path toward the Selah Wastewater Treatment Plant and Elks Golf Course. Following the February 1996 flood, gravel pit levees were rebuilt to pre-flood conditions.

Recent studies by Dr. Mark Lorang (in Stanford *et al*. 2002) related to sediment transport capacity and sediment availability indicate that the levee adjacent to the Beech Street pit is subjected to extremely high levels of erosive force. Figure 8-4 shows the relative energy levels in the Gap-to-Gap reach during a 15,000 cfs (moderate 3-year) event. Note that the area in the vicinity of the Beech Street levee is shaded black, indicating that the greatest amount of energy in this reach is focused at the levee. Across the river and upstream, the levee just downstream of the Terrace Heights bridge is also subject to high levels of erosive energy (Figure 8-14). Both of these areas were the focus of emergency levee protection (i.e., end dumping rock armor onto the levee face) during the 1996 flood. In both locations, energy was high enough to move the existing large riprap in the levee and the material end dumped during the event. After the flood, both areas were significantly armored.

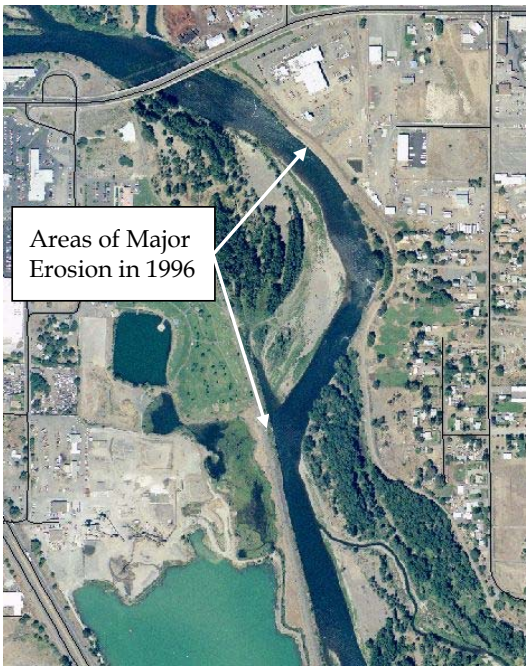


Figure 8-14. Location of Levee Erosion below Terrace Heights Bridge and near the Beech St Pit.

According to estimates of gravel transport in the Gap-to-Gap Reach prepared by Dr. Lorang, if the levee were to fail it would take several decades to refill the Beech Street Pit with natural supply. Even if the river could be separated from the Beech Street Pit after a flood event (which would undoubtedly be extremely expensive) the change to sediment transport while the pit was connected to the river would dramatically increase the potential for failure of levees, bridges, and other infrastructure downstream of the pit breach. Prevention of a breach at this pit should be a high priority of the CFHMP. It is of special concern however, that high energy at this site may prevent the reinforcement of the levee face, based on the 1996 flood experience. Because the levee is located adjacent to the pit, if the levee face cannot be reinforced, then the levee cannot be reinforced in the rear, as was done in 1996.

Discussion of Alternatives

Gravel mining is and will continue to be an essential activity in the Yakima Valley. However, gravel mining does have an impact on flooding conditions and environmental resources. One of the goals of this CFHMP is to maintain the varied uses of existing floodplains while integrating flood management measures that preserve or enhance other beneficial uses. Therefore, the CFHMP process should prevent or mitigate increased flood hazards or environmental impacts that might result from future gravel mining, while still allowing mining to occur.

In addition to increased flood hazards associated with gravel mining in the floodplain, concerns associated with gravel mining include the potential for adverse impacts on groundwater, fisheries, and the natural ecological and hydraulic functions of the Yakima River, and can be divided into two broad categories:

1) Concerns associated with the location of new floodplain gravel mines in the study area, and
2) Concerns associated with existing or former gravel mining sites and their management into the future.

To address concerns associated with gravel mining, the following alternatives were evaluated:

- Construct spur dikes or overtopping levees near gravel operations to address immediate erosion and flooding problems
- Develop a Surface Mining Advisory Committee to work with gravel operators in developing reclamation plans that fulfill the objectives of this CFHMP, future land use plans, and other local river management plans and regulations (e.g., The Greenway Master Plan)
- No action.

If no action is taken, the potential for loss of gravel production, channel avulsion, bank and channel erosion, increased flooding near or downstream of gravel operations, loss of fish habitat, and elimination of floodplain storage will remain. Alternatives that enhance flood control, reduce environmental impacts, and provide economical gravel extraction include the following:

- Siting gravel pits in areas of minimal channel migration or areas of future compatible land uses
- Using structural measures such as spur dikes or overtopping levees
- Using interconnecting, backwater, and egress channels between abandoned pits to convey floodwaters, add flood storage capacity, and enhance fisheries
- Stockpiling and processing extracted gravel off site in low flood hazard areas
- Limiting gravel removal to average annual bedload recruitment.

Private operators, who carry out the majority of gravel removal in Yakima County, are generally responsible for obtaining required permits, excavating and processing the material, finding purchasers, and transporting the material to the purchaser. Operators are required to obtain lease agreements and report regularly to the Washington State Department of Natural Resources (DNR) on the volume of gravel they remove. DNR regulates surface mining under RCW 78.44. In addition, gravel operators must follow regulatory requirements outlined in the Washington State Hydraulic Code (WAC 220-110-010), Shoreline Management Program (WAC 173-19-470), State Environmental Policy Act (RCW 43.21), Washington State Growth Management Act (RCW 36.70A), and local Flood Hazard and Critical Areas Ordinances.

As numerous regulations govern gravel mining, it is necessary to work closely with gravel operators to develop an approach that is consistent with economic, regulatory, and CFHMP goals. Gravel operators are interested in a profitable operation; state agencies are concerned with limiting environmental impact; citizens are concerned with limiting flood potential; local agencies are concerned with compatible land use; and gravel consumers are interested in maintaining a reliable source of building materials. Incorporating these varied interests is critical to the success of providing a reliable source of gravel while maintaining the natural function of the Yakima River floodplain.

Preferred Alternative and Recommended Actions

To address immediate and future flooding issues, both short-term and long-term alternatives are proposed. Short-term recommendations address erosion and flooding issues while long-term recommendations address many of the issues voiced by a variety of affected parties.

Short-term

Spur dikes and additional bank protection are recommended along the Beech Street levee to reduce levee erosion. Spur dikes recently installed at the East Selah Gravel Pit should be monitored during flood events to ensure that they are protecting I-82 and the East Selah Pit levee.

Actions at this location should be designed to reduce the overall amount of energy exerted against the levee, and therefore the potential for levee erosion, at this location and across the river upstream where conditions are similar. Actions should also seek to reduce or at least not increase energy downstream, which is also experiencing erosion at the toe of the levee. Installation of spur dikes at this location could reduce flood hazard here, but would increase the danger of levee erosion downstream, while further decreasing conveyance capacity in a

relatively constricted reach. Energy available for erosion of levees can be reduced in several ways – by restoring sediment transport (the energy is expended on natural river processes instead of against the levees), by decreasing the depth and concentration of flow (widening the channel).

The opportunity exists at the Beech Street Pit location for widening of the channel and improving (for sediment transport) the configuration of the levee system by setting back the levee opposite from the pit, and this action should be taken. This levee setback would impact areas currently managed as pasture, and could be a portion of the larger levee reconfiguration above. The previously recommended actions of levee reconfiguration upstream of SR 24 will benefit this area as well by improving sediment transport through this reach. Setting back the levee in this action will also increase the benefits derived from actions below by increasing natural riverine functions such as allowing the river to meander and regrade the floodplain between the levees to a lower elevation. Additional armoring of both locations with spur dikes should occur in conjunction with levee realignment.

Long-term

Existing Gravel Mining Sites: Due to the location of the East Selah Gravel Pit, large flood events will continue to affect the property in this area. Following gravel extraction, long-term modifications should include a levee designed to overtop during large flows. The existing levee constricts the floodway and directs waters to the opposite bank. Long-term gravel pit restoration should enhance some of the floodway function. An overflow channel should be constructed within the gravel excavation area to provide conveyance of flood waters; this would increase floodway conveyance capacity and floodplain storage, reduce flood water elevations on the west bank, enhance fish habitat, and limit the potential for a sudden channel avulsion.

- To reduce the potential for avulsion or levee failure at the Buchanan Lake/Beech Street Pit over the long term (i.e., in approximately 15-20 years or sooner if possible), the existing Terrace Heights bridge should be modified to improve sediment transport and reduce the concentration of energy downstream, especially against the levee that protects the Beech Street Pit. The current configuration of the piers and wingwalls of the bridge make the bridge very inefficient at sediment transport and "fix" the river in place upstream and downstream of the bridge. Given the location of the bridge in the valley and the conditions upstream, the bridge should not have to be widened greatly, if at all, but the conveyance capacity needs to be dramatically improved. In the shorter term, the Flood Control Zone District should examine the possibility of altering the upstream alignment of the levee/Greenway trail system on the west bank and the Corps levee on the east bank to improve conveyance through this structure and to reduce energy concentrated against the west bank levee that protects the Beech Street Pit.

- In addition, an inventory of the existing structural adequacy and capacity of all levees that protect existing floodplain mines and pits should be undertaken. Once the adequacy of each levee or other protective work is known, each pit should be evaluated for either permanent isolation from the river environment, partial opening (as in the recommendation above) for floodwater storage, or planned reclamation (consistent with fishery concerns) into active, functioning floodplain.

Future Gravel Mining Sites: Development of future gravel extraction sites in the floodplain of the Yakima River and Naches River will be driven by the Yakima County Comprehensive Plan and Mineral Resource areas established in that plan. Such recommendations are before the public at the writing of this plan and should be finalized by late summer of 2007. Staff recommendations for a new proposed Mineral Resource Overlay Zone are in compliance with the recommendations in the CFHMP. Individual development and reclamation plans for new sites that may be allowed within the floodplain should follow the principles outlined in the Floodplain Mining Impact Study (Washington State Department of Natural Resources *et al*. 2002), and clearly state the long-term objectives for reclamation – either permanent removal of these sites from the active floodplain, with appropriate standards for levee protection and maintenance in perpetuity, or incorporation of these sites into the active floodplain as a component of reclamation, while recognizing and mitigating the potential flood hazard, ecological, and riverine functions that are known to be effected by gravel mining operations that have occurred in floodplains in the past.

LR3—Increased Flood Elevation near Union Gap (3)

Problem Definition

Continued confinement of Yakima River floodwaters between levees can have an impact on flood elevations downstream. The City of Union Gap and residents in the City and adjacent areas are concerned that flood elevations have been rising over time, affecting existing and potential land uses as well as flood hazard.

Discussion of Alternatives

Flood Control Zone District staff investigated the hydraulic and sediment transport conditions in this reach (channel confinement, rates of sediment accumulation, and meander movement). They determined, based on as-built drawings of I-82 surveyed in the late 1970s, that it is likely that the channel and floodplain in this area is experiencing sediment aggradation on the order of 4 feet over the last 4 decades. This aggradation is to be expected given the hydraulic influence of Wapato Dam located just downstream from Union Gap (see Figures 8-15 and 8-16). The observed rate of aggradation is also likely accelerated by the loss of floodplain area upstream and in this area. Floodplain loss reduces floodplain area available for deposition of sediments that are generated from upstream sources. Levees and other constrictions (in this case, I-82 and the Union Farm levees) also raise flood elevations or stage, increasing the amounts of sediment available for deposition in this reduced floodplain area.

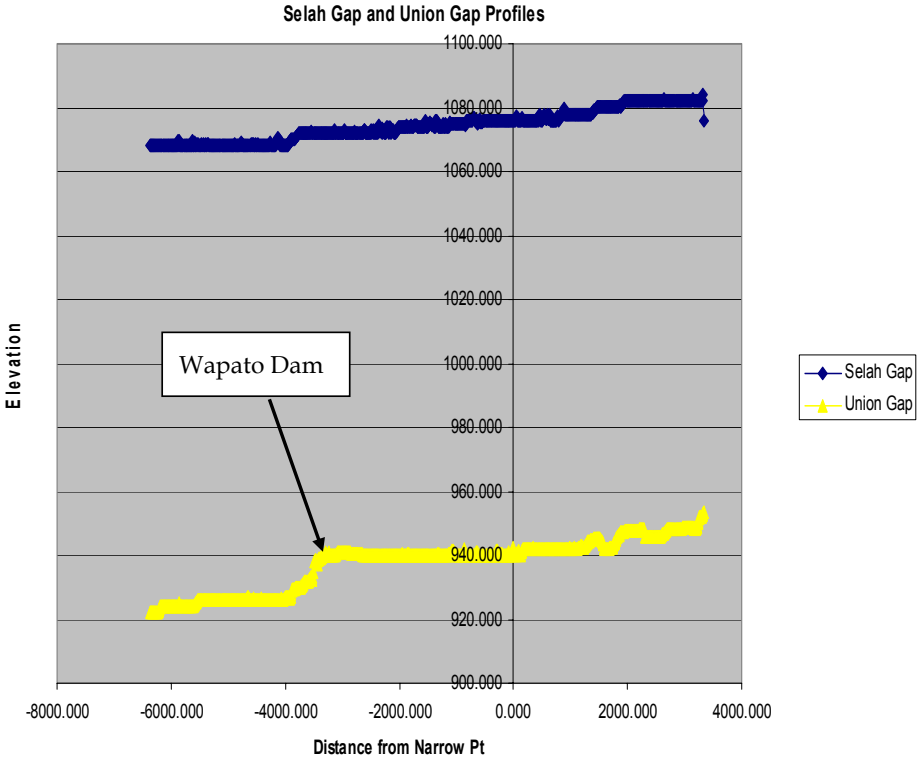


Figure 8-15. Comparison of the Water Surface Gradients through Selah Gap and Union Gap. These are profiles generated from the LIDAR data; the zero point is the narrowest point within either gap to facilitate comparison. Note how far upstream from Selah Gap the river gradient increases, while at Union Gap the gradient is flat, the difference between the two indicates the amount of sediment deposition upstream of Union Gap.

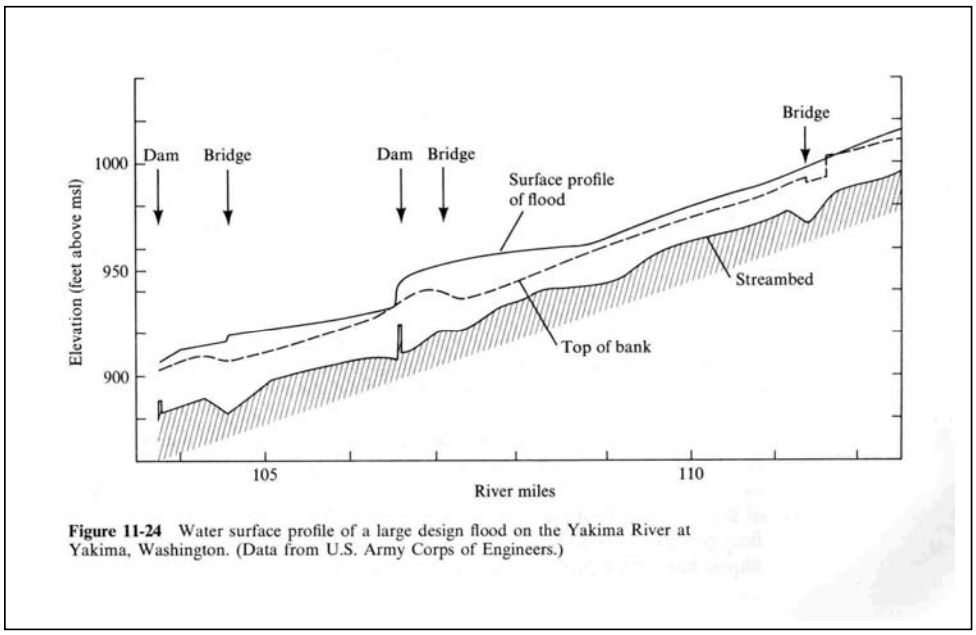


Figure 11-24 Water surface profile of a large design flood on the Yakima River at Yakima, Washington. (Data from U.S. Army Corps of Engineers.)

Figure 8-16. The 100-year Flood Profile through Union Gap. Taken from Dunne and Leopold (1978). The information presented is based on hydrologic models that produced the 1984 COE flood model. Note how far upstream Wapato Dam influences water surface slope therefore reducing sediment transport capacity upstream, especially at the point where the water surface slope changes (over 2 miles upstream at the 100-year flood flow). The most recent FIRM studies also reveal a change in slope at lower discharges.

While it is probably not possible to accurately estimate the degree to which flood elevations have risen in this location, due to the large shift in river location that occurred in 1972, some general observations can be made. Comparison of the water surface elevations shown in the as-built drawings for I-82 (completed in 1968) with current conditions indicate that the current water surface elevation (at normal summer flow) is a minimum of 2.7 feet higher than it was in 1968. Assuming that standard specifications for the installation of culverts were used as shown on the plan, and taking into consideration the dimensions and elevations of the culverts that were installed to carry Spring Creek back under I-82 to the freeway, then the rise in water surface elevation at that specific location would be approximately 3.8 feet. This corresponds well with the cross-sections derived from the LIDAR data shown in Figures 8-17 and 8-18. Figure 8-19 shows a larger scale view of aggradation in this area. This figure is a shaded relief topographic map generated from a 2003 Yakima County LIDAR flight. Note that the areas in the yellow box are generally higher than the areas west of I-82; these areas were essentially the same elevation prior to the construction of I-82 in the late 1960s. Note also that the areas to the east of the yellow box are also higher in elevation; this area is the former channel of the Yakima River and was occupied from before the 1890s to 1972, when the river avulsed to the west through several gravel pits and against the recently-constructed freeway.

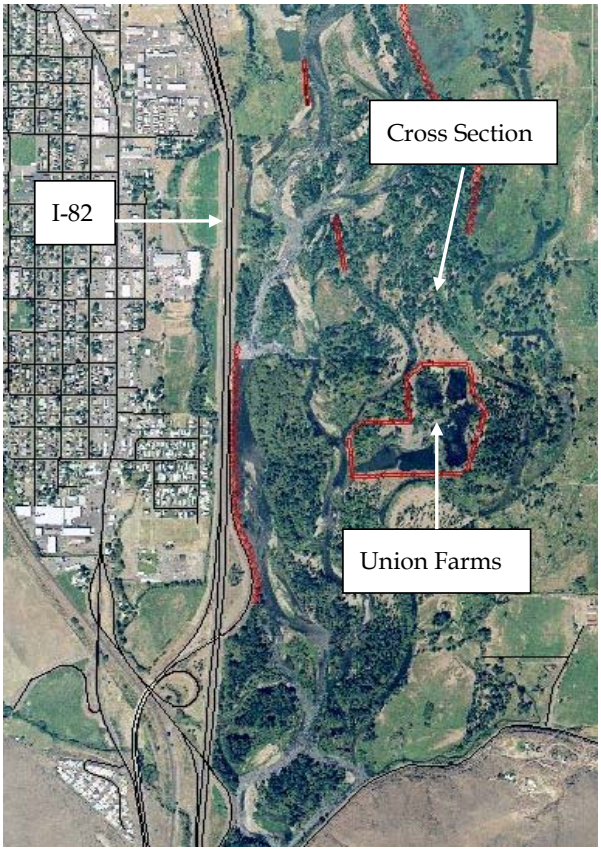


Figure 8-17. Cross-Section Location. Note Union Farms, multiple River channels, I-82, and Spring Creek. Levees shown in red cross hatch.

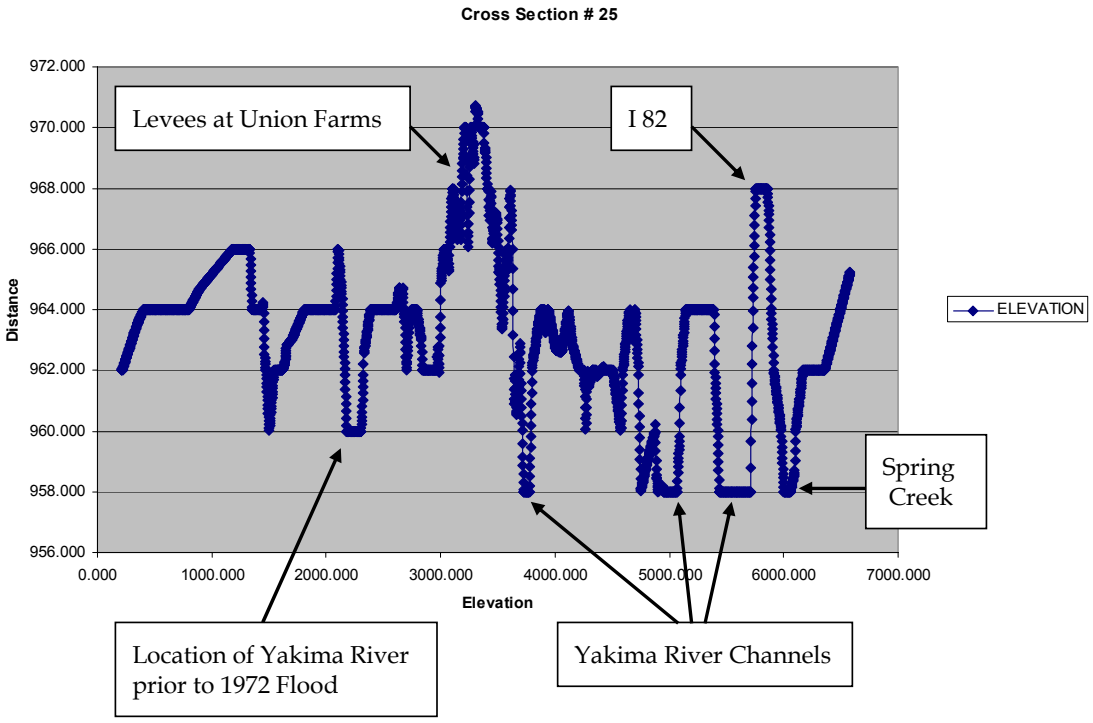


Figure 8-18. Cross-Section of Floodplain near Union Gap. Note that the floodplain left (east) of I-82 is higher than the Spring Creek floodplain right (west) of I-82.

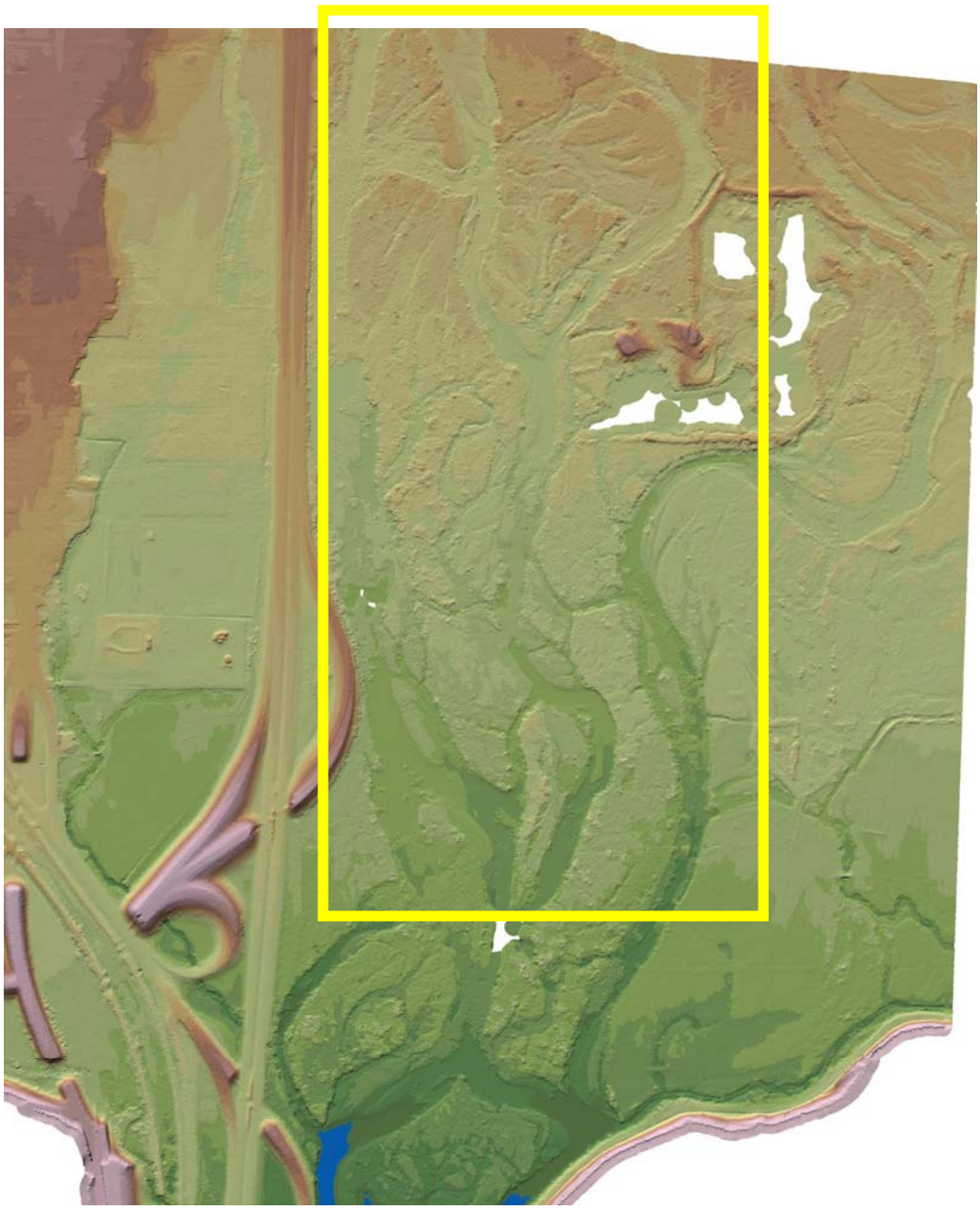


Figure 8-19. Areas of Aggradation (rise in channel and floodplain elevation due to sediment accumulation) in the Vicinity of the City of Union Gap.

Preferred Alternative and Recommended Actions

Given that there is strong indication that this reach of the river has aggraded almost 4 feet since 1968, and that there is only 4 feet from the normal water surface elevation to the surface of I-82 (which acts as a levee and protects large areas of the City of Union Gap), addressing this item is a high priority. Additionally, sediment accumulation in this, the most valuable fisheries habitat portion of the reach, has negative consequences on fish habitat in this reach, and the reach downstream, by starving it of sediment. The Bureau of Indian Affairs (BIA), which operates the Wapato Dam, has indicated that sediment accumulation has also made the dam more difficult to operate as irrigation infrastructure since the upstream pool is being lost, reducing the capacity of the channel to route water toward the irrigation intake. In addition, sediment accumulation increases the damage the dam sustains during flood events since the water surface slope is becoming steeper, resulting in greater scour at the dam toe, and more damage from bedload passing over the dam. For these reasons, the BIA is in favor of replacing or modifying the Dam to pass sediment more efficiently (Harrison, personal communication), but has been unable to obtain funding to do so.

- The Flood Control Zone District should work with BIA, BOR, and other interested parties in replacing or modifying Wapato Dam to pass bedload and fine sediment. This will reduce or reverse the rising of the riverbed and flood elevations upstream of Union Gap, improve fish habitat and riverine function for several miles upstream and downstream of Wapato Dam, and improve the dam's primary function as irrigation infrastructure. It would also reduce risk and damage to Wapato dam from floods, which is in and of itself an extremely high flood hazard to adjacent property owners, the agricultural community, and the Yakama Nation.

While the dam has a large influence on this reach, there is little doubt that loss of floodplain upstream from Union Gap has resulted in a greater amount of sediment available to deposit at this location. Action items to increase net floodplain area available for storage associated with Issue LR5 will also aid in reduction of the sediment deposition rate in this reach.

- The levees at Union Farms also act as a choke point in this section of the river forcing the river against I-82, and taking a fairly large amount of floodplain surface out of the active floodplain. Removal of these levees would relieve the pressure against I-82 and lower flood elevations by allowing the river to expand across a larger floodplain.

Future flood hazard management measures should ensure minimal increases in downstream flooding. If no action is taken, decisions could be made without considering the effects on downstream flooding conditions. To limit the possibility of worsening flooding conditions in other areas of the Yakima Valley, the following actions are recommended:

- Develop a high water elevation database to evaluate changes in river channels and trends in high water elevations. The database could include flood elevations over time at a specific location, historical aerial photographs, changes in surveyed river cross-sections, and the historical record of flood damage areas.
- Adopt and follow the existing *Plan 2015* County policy for management of the riverine environments to "protect the hydrologic functions of natural systems to store and slowly release floodwaters, reduce flood velocities, and filter sediment." Protecting the natural storage function of the Yakima River

floodplain will reduce the potential for increased flood elevations near Union Gap and in the Lower Valley.

- Add compensatory storage requirements to the County's CAO. This requirement is a method of reducing the effects of filling in the floodplain. Whenever fill material is added, the area that the fill occupies is removed from the potential flood storage area. Under compensatory storage requirements, an individual placing fill in the floodplain must excavate an area of equivalent volume to eliminate the effects of the fill on flood storage. For other jurisdictions, compensatory storage requirements need to be addressed in any specific ordinances that implement the standards for the National Flood Insurance Program.

LR7 – Capture of Edler Ponds (4)

Problem Definition

The "Edler Ponds" are a series of four mined gravel pits located on the Edler property, which is east of the Valley Mall Boulevard exit on I-82. The pits parallel the river for a distance of approximately 2,500 feet. The pits are generally 25-30 feet deep, 500 feet wide, and are separated from each other by about 100 feet. In 2002, the most downstream of these pits was connected to the Yakima River during normal flows. The river partially moved into the lower pit during the flood event of February 2003 (approximately 22,400 cfs at peak), and probably as a result of loss of bedload to the pit, portions of the floodplain downstream were converted to channel, while existing channels downstream deepened. This process continued during the Spring 2006 flood. Generally, the river and new channels are moving closer to I-82, or adjacent to I-82, in the vicinity of the Spring Creek gate under I-82. In addition, there is a portion of the old Diking Improvement District #2 levee, which was abandoned in 1968, just downstream and riverward from the pit that has been captured.

In general, the situation is similar to the situation that occurred in 1972 when the river avulsed from its former channel on the east side of the valley to its current location along I-82. This situation is aggravated by the existing abandoned levee, as this levee could force the river against I-82. As occurred in 1972, there is the potential for significant erosion of I-82 in the short term should avulsion occur. At present, some erosion of I-82 is occurring (photo) along the Spring Creek channel. Also, as currently exists for the area where the Yakima River is directly adjacent to I-82, fish habitat would be extremely poor in this reach if the riparian zone were eliminated and the west bank of the river converted to riprap.

If the river does avulse toward I-82, there is a high probability that the Spring Creek gate will be closed permanently, as the volume of water in the river (even under normal flows) would cause significant flood damage in the City of Union Gap to the west of I-82.

Discussion of Alternatives

Capturing of the Pit

The course of the river in this location is at least partially determined by the configuration of the DID #1 levee on the east side of the river, which forces the river to the west at this location.

Relocation of that levee as called for above will reduce the potential for damage to I-82 at this location. Another alternative is to build a new levee or lengthen the existing DID #2 levee in an upstream direction to prevent capture of the pit by the river. The practicality of such an action may be low due to the elevation of the bed of the river at this location (i.e., very downcut inside the pit itself).

Protection of I-82

Near to and for 700 feet downstream of the Spring Creek gate, I-82 is currently unarmored. Below that point there are four large barbs in the floodplain that prevent the river from running directly adjacent to I-82. Downstream of the barbs, the river is directly adjacent to I-82. Installing additional groins in the small area of floodplain which remains next to I-82 should be possible with a minimum of permitting difficulty.

Spring Creek Gate

During the February 2003 flood event, there was significant flow upstream of the gate and along I-82. After the flood, there was significant flow against I-82 down to approximately 8,000 cfs, which is well below what is considered "flood" stage. It is likely that the gate will have to remain closed for the foreseeable future. Landowners who have water rights on Spring Creek are affected by this closure, but flow in Spring Creek remains fairly strong even with the gate shut due to the creek's elevation relative to the river, as discussed in the previous flooding issue. Closing the gate may have some negative effect on fish habitat and migration by eliminating the potential for restoration of Spring Creek as a side channel of the Yakima River.

Possibly of greater concern is that the Spring Creek gate is currently not armored, nor does it appear to be constructed to withstand significant flow velocities. The gate should be armored or reinforced to prevent erosion or failure of the gate during a flood event.

Preferred alternative and Recommended Actions

The WSDOT has committed to constructing barbs similar to the existing downstream barbs to protect I-82. They are presently scoping and starting project design. The Spring Creek gate should be reinforced to prevent failure during a future flood event or avulsion caused by pit capture. A new channel for Spring Creek (approximately 550 feet in length) should be constructed outside of the I-82 clear zone, with fish habitat elements installed in this new channel.

RW1—Floodplain Mapping (5)

Problem Definition

The extent of the 100-year floodplain boundaries has been debated since FEMA issued the initial floodplain maps in 1985. The accuracy and methods used to determine the floodplain boundaries have been questioned. Floodplain residents say the maps are frequently inaccurate or do not reflect existing conditions and historical flooding information. Specifically, floodplain boundaries are questioned in East Selah, and generally in other locations in the study area, especially the lower ends of the Gap-to-Gap reach.

Discussion of Alternatives

FEMA maps have been updated to reflect a revised Yakima River Flood Insurance Study (FIS) performed in 1994. The Geographic Information System (GIS) representation of the revised FEMA floodplain maps is included in Appendix C. The maps were issued December 7, 1995, and incorporate the following changes in hydrologic and hydraulic conditions:

- Revised hydrologic analysis to determine flood flows
- Installation of flood-control structures on Spring Creek. These include a flood gate installed north of Valley Mall Boulevard and diversion of Spring Creek flow to Wide Hollow Creek near its outlet by plugging Spring Creek's outlet culvert
- Incorporation of I-82 as a barrier to prevent floodwater from spreading to the west along the river reach between Selah Gap and the Burlington Northern Railroad bridge
- Raising and repairing the east bank levees upstream from West Birchfield Road to Terrace Heights Boulevard to provide 100-year level of protection
- Incorporation of COE-certified, 100-year KOA levee.

While these known physical changes have been incorporated, the degree to which the floodplain itself has changed due to riverine processes (i.e., changes in elevation of the river channel and floodplain, changes in channel cross section, changes in channel gradient) have not been incorporated into the most recent FIS.

Many of the concerns over past floodplain boundaries have been addressed by incorporating the above changes. However, floodplain boundaries are still questioned in one specific area, namely East Selah, east of I-82.

To assess the accuracy of predicted floodplain boundaries, historical information was examined, especially the extent of inundation and flow paths associated with the February 9, 1996 flood. This flood provided significant information on how a 100-year event would affect the study area. During this event, the peak flow was estimated at 57,500 cfs at the Parker gage, near the predicted 100-year flood flow of 56,300 cfs. Table 8-3 compares high water elevations collected by the County following the February 9, 1996, flood to those predicted by FEMA for the 100-year flood event. Locations of the high water elevations are displayed in Appendix C. The largest discrepancies between the February 1996 flood and the predicted elevations by FEMA occur at river mile 114.55, 112.52, 110.7, and 107.27.

East Selah

In this area, floodwaters are predicted to overtop I-82 south of the Harrison Road interchange and extend toward East Selah Road. Based on this prediction, a large portion of East Selah would be inundated. However, this did not occur during the February 9, 1996, flood event. I-82 actually acted as a barrier to limit the spreading of floodwater into East Selah. The river eroded portions of the I-82 embankment downstream of the Harrison Road interchange, but did not overtop the freeway. Floodwaters entering East Selah appeared to be a result of a drainage canal east of I-82 that is linked to the Yakima River. The limited conveyance capacity of this

drainage channel resulted in some flooding, but not as severe as was predicted in the preliminary floodplain maps.

TABLE 8-3
YAKIMA RIVER WATER SURFACE ELEVATIONS

Cross-section Location (river mile)	Location Description	February 9, 1996 Flood[a] (Flow=58,150 cfs)[c]	Predicted Base Flood[b] (Flow=56,300 cfs) [c]
117.20	Left side of Harlan Landing access road	1085.4	1084.7
115.78	Upstream end of R Street parking area	1066.5	1065.8
114.55	Left river bank ≈ 900 feet downstream of Burlington Northern Railroad bridge	1050.2	1043.8
113.27	Terrace Heights bridge	1030.8	1030.7
112.52	Left bank levee ≈ 1,000 feet upstream of Blue Slough closure structure	1011.4	1013.7
111.58	KOA campground levee downstream of power pole	1005.4	1005.5
110.07	Left bank levee ≈ 3,000 feet downstream of SR 24 bridge	995.8	994.0
109.46	Spring Creek flood gate	974.4	974.3
107.27	Union Gap upstream of SR 12 bridge (USGS gauging station)	953.8[d]	951.7 [d]

a. *SOURCE: 1996 County Field Survey*
a. *SOURCE: 1995 Revised Preliminary FEMA Flood Insurance Study*
a. Peak flow at Parker gage as reported by the Bureau of Reclamation.
a. *SOURCE:* USGS gauging station near Union Gap.

Preferred Alternative and Recommended Actions

If no action is taken, potentially inaccurate floodplain maps will continue to be used to enforce floodplain ordinances. Building standards, such as floodproofing and elevation requirements, may be incorrectly applied to areas that do not lie within the 100-year floodplain, such as at East Selah, or under- or over-estimate flood elevations in other areas.

The County should compile data for other areas of floodplain inaccuracies. The data should incorporate information collected from the February 9, 1996 flood. Actions should include the following:

- Obtain accurate topographic data throughout the floodplain specifically for the left bank levee and floodplain downstream of the new SR 24 bridge, I-82, and the floodplain near East Selah. Yakima County has obtained high water data and a new hydrologic and hydraulic analysis will be performed to FEMA standards that will allow the design of the facilities specified above in issue LR5, and shorten the time needed to amend the FEMA maps after implementation of those actions.

- Yakima County has requested that FEMA produce a digital floodplain map that combines all jurisdictions and reflects recent data for use in the County's GIS and this map is in process.

RW20—Loss of Channel Capacity due to Sediment Accumulation (6)

Problem Definition

As mentioned in Chapter 3, since the completion of the "Federal Flood Control Project" in 1948, the Corps of Engineers has conducted numerous studies (COE, 1970, 1973, 1977, 1986, 1996) to evaluate the project or proposed additional flood protection measures in the Gap-to-Gap reach. In each of these studies, the Corps noted the continual aggradation of the river bed resulting in reduced ability of the federal project to carry flood flows. This has resulted in the raising of several portions of the levees in the 1970s and early 1980s, and large areas of the former DID #1 levee in the 1990s to bring that levee up to Corps standards so that ownership and maintenance responsibility could be transferred to Yakima County.

These processes of aggradation are continuing today. A continued effort to raise levees in response to aggradation has occurred in many locations in the United States and other countries. Typically, the eventual result is catastrophic levee failure at some point in the future. Over the long term, a means for reducing sediment accumulation in these confined areas should be examined.

Discussion of Alternatives

There are essentially three approaches to reducing sediment aggradation; floodplain gravel mining, in-channel gravel mining, and levee reconfiguration. This CFHMP proposes levee reconfiguration in several areas to combat aggradation and increased energy against the levees. However, there will be areas, such as the Naches River at 16th Avenue and the Yakima River near the old Burlington Northern Railroad bridge, where levees are not proposed, or cannot practically be reconfigured.

Floodplain gravel mining has already had a long and extensive history on the Yakima River. Additional floodplain gravel mines would have to be located somewhat close to the flowing channel to be effective at reducing sediment. In addition, pits would have to be located very close to the specific areas of aggradation to be effective. This configuration of floodplain gravel mines is contrary to the recommendations in the Floodplain Mining Impact Study, and would likely result in a local increase in risk of levee failure downstream of the problem area, as has occurred with other gravel mines in leveed reaches, which are relatively confined, such as the Yakima River.

Directly mining areas where gravel accumulations occur, and only to a "safe" level to prevent downstream effects, has been shown to be effective over time in several rivers (Fraser, Dungeness, Bogachiel, etc.) as long as there are thresholds established to reduce the risk of downstream effects and minimize or eliminate negative effects on fish habitat through the design and timing of the mining process and configuration of mined areas.

Preferred Alternative and Recommended Actions

Currently, the total sediment transport load and energy available for sediment transport or levee erosion is not known in either the Naches or Yakima River. In order to evaluate whether in-channel gravel removal can be applied in the CFHMP project area, these values for sediment transport and energy would need to be calculated and monitored over time. Given the long-term nature of this type of flood hazard, (channel migration, sediment accumulation, erosion), a study to determine these values and to monitor sediment transport and energy should be implemented. Besides their use in determining the potential for gravel extraction to reduce aggradation, such data would have value in the design or monitoring of many other flood hazard reduction projects, including levee reconfiguration, bridge or irrigation diversion design, and maintenance and monitoring of habitat maintenance processes.

NA1—Bedload Movement and Channel Instability of Naches River (7)

Problem Definition

The lower end of the Naches River in the study area for this CFHMP has been extensively modified by irrigation diversions and floodplain loss from construction of US Highway 12. The Naches River channel is responding to these dramatic changes in energy. Currently, even relatively minor floods result in shifting of the channel and damage to these same irrigation facilities (primarily the Fruitvale Diversions operated by the City of Yakima) and US 12 at the 16th Avenue exit. In addition, the channel is actively downcutting at the I-82 bridges, causing damage to the bridge abutments and the adjacent Yakima Greenway trail. In addition, recent studies have identified the importance of the sediment supply from the Naches River to the Yakima River in the Gap-to-Gap reach, and sediment aggradation and starvation of this reach as a result of the Nelson Dam just upstream of the study area.

Alternatives Analysis

The Lower Naches River Coordination Project (Calvin et al., 2005) was started in 2003 by the City of Yakima, Washington State Department of Transportation, and Yakima County. The purpose of the partnership was to coordinate implementation of numerous capital projects that each jurisdiction is going to undertake in this reach. Another objective was to increase understanding of the riverine processes and habitat values of this reach, so that these projects could be better designed to function in this unstable reach, and also benefit fish and wildlife habitat. The reader is referred to that document for a much more thorough alternatives analysis.

Preferred Alternative and Recommended Actions

Implement Projects Contained in the Lower Naches River Coordination Project

The major goals of the project are to reduce flood hazard over the long term, improve fish and wildlife habitat and habitat function, and protect critical public infrastructure. Specifically, this portion of the lower Naches River should be managed for improved bedload transport from Nelson Dam to the confluence with the Yakima River. Major projects necessary to implement these goals include the following:

Retirement of the Fruitvale Diversion and Consolidation with the Current Nelson Dam Diversion: This action removes the Fruitvale Diversion from the lower Naches River. This diversion has been repeatedly damaged and repaired even in minor flood events. The diversion also functions very poorly during low-flow years, requiring additional maintenance and channel disturbance. Actions associated with the removal of the Fruitvale Diversion will include removal of the associated infrastructure (e.g., fish screens, fish ladder, levees, and canals). These actions will improve floodplain function in the Naches River and Cowiche Creek, reduce flood hazard (by removal of facilities subjected to repeated damage), improve habitat by correction of the partial fish blockage and false attraction at Cowiche Creek/Naches River confluence, and improve habitat conditions in both the Naches River and Cowiche Creek. Consolidation of the diversion at Nelson Dam will require eventual reconstruction of that facility, including the associated fish screens and ditch outlets. Reconstruction of Nelson Dam should include provisions for passing bedload through that structure during flood events, which will improve channel function and reduce flood hazard both upstream (at Rambler's Park) and downstream of Nelson Dam.

Implementation of Bank Protection on US Highway 12 at the 16th Avenue Exit: This action will follow State of Washington's Integrated Streambank Protection Guidelines (Aquatic Habitat Guidelines Program Steering Committee, 2003). Accordingly, it should be implemented to not only provide bank protection for the highway over the long term, but also to address the causal factors of erosion and channel instability at this site, and allow sediment to transport downstream to the Yakima River. This project is currently funded and is in the design and right-of-way acquisition phase.

RW13—Funding for Flood Control Work and Restoration Projects (8)

Problem Definition

The County had historically relied on federal and state disaster funding or on its local road budget to repair damage associated with floods. Creation of a Flood Control Zone District (FCZD) was one of the recommended methods to help fund flood and restoration work in the original 1998 CFHMP. Yakima County established a county-wide FCZD in 1998 for the express purpose of taking a more comprehensive approach to flooding issues in the county. The FCZD also provides stable funding for maintenance and operation of county levees.

Chapter 9 of the CFHMP describes funding requirements, examines available funding options, and provides additional information about the funding structure of the FCZD. The FCZD provides funding for grant matches, an emergency flood fund, levee operation and maintenance, developing flood plans, and doing restudies of FEMA flood maps. Chapter 9 also includes a discussion of limitations for this type of funding, especially for large expensive structural flood projects (including capital improvement projects).

Preferred Alternative and Recommended Actions

The following is a summary of the actions the County and Flood Control Zone District should undertake to fund the flood hazard management program to the benefit of local governments and citizens:

- Review the adequacy of dedicated Flood Control Zone District funds versus projected costs.

- Actively pursue state and federal grant programs to supplement funding provided by flood control district (see Tables 9-1 and 9-3, in Chapter 9).
- Because the County now has several CFHMPs, adopt a funding policy similar to polices developed in existing *Plan 2015* outlining methods to be used to finance flood hazard management needs in the entire County.
- Continue to investigate the value and need for sub-zones within the FCZD to address localized issues.
- Yakima County Flood Control District will provide the advocacy, and support to secure funding for large scale actions which involve cooperation across jurisdictions and agencies. The objective would be to maximize benefits from these large scale actions and studies, and to ensure that multiple objectives can be met.

RW6—Public Disclosure of Floodplain Status (9)

Problem Definition

Buyers are often unaware of the floodplain status and associated flood hazards of the land they purchase. Construction on or purchase of property in a floodplain may result in human health or property damage to the purchaser, as well as additional cost to taxpayers of the County.

Alternatives Analysis

RCW 64.06.020 (1994) requires sellers of real property in Washington State to disclose to buyers if a property is within a designated floodplain or designated flood hazard zone (items 7(d) and item 7(e) of the real property transfer disclosure statement). Disclosure is based on the seller's actual knowledge of the property at the time the disclosure form is completed. Response options for floodplain disclosure include "yes," "no," and "don't know." No further explanation or documentation is required. However, the seller is advised to obtain and pay for the services of a qualified specialist to determine the floodplain status of the property.

Many benefits may be accrued from encouraging and supporting floodplain disclosure. If the County participates in determining floodplain status for floodplain residents, citizens will become more aware of the magnitude of the flood threat and associated risks, will be more active in reducing flood risks, and could receive lower flood insurance rates (see issue RW7—Flood Insurance and Public Education). Currently, zoning regulations in the Yakima Urban Area implicitly support property disclosure by triggering project reviews for new projects or use changes within the established flood overlay zone. However, new developments outside the existing flood overlay zone, or floodplain property transfers, may take place without proper disclosure of floodplain status.

If no action is taken, floodplain notification will continue per RCW 64.06.020, supported implicitly in the urban area by flood overlay zoning when a new project or modification is proposed. No formal County actions would be taken to increase public awareness of floodplain location, potential impacts, or insurance availability.

The opportunity exists to increase floodplain disclosure by using the County's GIS to publish notifications of floodplain occupancy to each affected property owner. These notifications could be accompanied by information on the NFIP. This action would reduce the incidence of "don't know" disclosure statements, increase flood insurance coverage in the County, and possibly decrease flood insurance rates. GIS information, already in the possession of the County, would save taxpayers the fees commonly associated with professional floodplain determination services.

Preferred Alternative and Recommended Actions

The County would achieve flood hazard reduction benefits by participating in a public disclosure of floodplain status program. Actions to implement such a program include the following:

- Require disclosure of floodplain status in the subdivision ordinance for all newly created parcels. Subdivision plats could show floodplain boundaries, or a notice made to a title when a floodplain determination has been made.

RW12—Protection of State and County Roads (10)

Problem Definition

Numerous County roads suffer damage during flood events; this damage accounts for a significant portion of flood repair costs. State and federal roadways are also susceptible to flood damage. Much of the damage is caused by bank erosion in drainage channels along roadways, undercutting of channel banks adjacent to roadways, or by overtopping floodwater. Drainage and river channels adjacent to roadways experience high velocity flow that undermines and erodes roadbeds. Flood damage results in a substantial strain on the County's road maintenance budget in addition to limiting transportation and emergency response routes during significant flood events.

Discussion of Alternatives

Chapter 4 describes road damage within the County by historical floods. Most of the road damage is outside the study area. Damaged County roads within the CFHMP study area are listed in Table 8-4, with a description of the type of damage and recommended corrective action. Alternatives examined to reduce future flood damage and increase available transportation routes during flood events include the following:

- Installation of drainage structures
- Roadbed / bank protection
- Road elevation or relocation
- Drainage channel alignment control
- Road closure database
- Emergency routing plan
- No action.

In general, damaged roads within the study area are located near Selah and Union Gap. Roads are damaged by the erosive forces of floodwaters; erosion is greatest within high-velocity

drainage and river channels. Much of the damage could be mitigated by providing additional bank protection or by directing flood flows toward the main river channel.

TABLE 8-4.
DAMAGED ROADS IN CFHMP STUDY AREA

Road Name	Type and Estimate of Damage	Recommended Corrective Action
Rushmore Road	Road closure from overtopping floodwater (minimal damage)	No action since flooding resulted in minimal damage and Rushmore Road is not a critical access route
I-82 between mile post 27 and 29	Washed out southbound lanes, embankment and shoulder damage, fencing and guardrail damage ($300,000)	Monitor performance of recently installed spur dikes during future flood events
SR 823 near Yakima Elks Golf Course	Erosion of embankment slopes ($50,000)	Install additional bank protection integrating bioengineering techniques
I-82 at Selah Interchange	Road closure from overtopping floodwater, minimal damage (estimate not available)	Obtain detailed topographic data in this area to define flow paths and examine the feasibility of raising the highway to direct floodwaters toward the main channel
SR 12 near 16th Avenue	Erosion of embankment slopes ($80,000)	Install additional bank protection integrating bioengineering techniques
I-82 Twin Bridges over Naches River	Erosion/channel downcutting at bridge abutment.	Improve sediment transport from Naches system to stop or reverse downcutting.
I-82 at Union Gap Interchange	Road closure from overtopping floodwater (damage estimate not available)	Obtain detailed topographic data in this area to define flow paths and river hydraulics to examine the feasibility of improving sediment transport through this reach or raising the highway or railroad grades.
Thorp Road	Road closure from overtopping floodwater, embankment damage ($5,000)	Install additional bank protection integrating bioengineering techniques
I-82 near South Union Gap	Northbound lanes washed out and southbound lanes embankment damage ($550,000)	Obtain detailed topographic data in this area to define flow paths and river hydraulics to examine the feasibility of improving sediment transport through this reach or redirecting flood flows from the east side of the freeway near the I-82 bridge to the main channel.

SOURCE: Washington Department of Transportation, Yakima County

Preferred Alternative and Recommended Actions

Recommended corrective actions for roads within the study area are listed in Table 8-4. Additional actions to mitigate future road damage include the following:

- Based on the county-wide road closure database, prioritize roads requiring flood damage mitigation. Obtain engineering information to develop effective mitigation alternatives similar to the information in Table 8-4. Implement recommended road damage corrective actions in order of priority, based on available funding. Road enhancements should focus on critical transportation routes.

RW3—Channel Migration (11), and
LR1—Erosion of Agricultural Land (15), and
UR1—Erosion of Agricultural Land (22)

Problem Definition

Rivers have a natural tendency to change alignment, which may result in damage to property. The extent and frequency of river movement vary by river reach. The Yakima River has a greater tendency to migrate at the following areas: downstream of Selah Gap to Marsh Road, from Hartford Road to Terrace Heights Drive, from west Birchfield Road upstream to the Central Pre-Mix gravel pit, and downstream of the SR 24 bridge, as described in Chapter 4.

Channel migration or sudden channel shifts present flood hazards because they can erode property and flood control structures and divert floodwaters into areas that historically experience minor flooding. During a large flood, floodwaters may cause levees to fail, directing flow away from the main channel. The resulting new channel may be a significant distance from the former main channel, isolating businesses, homes, or farmland, or eroding significant portions of land.

Private land owners have voiced concerns about protection of land from erosion. Near Valley Mall Boulevard for instance, old levees that washed out in previous floods have not been replaced. This has resulted in increased erosion of private land. Downstream of Harrison Road and SR 24 bridge, the river continues to shift laterally, resulting in loss of agricultural land.

Discussion of Alternatives

To control bank erosion effectively, riverbank management must be compatible with the nature of the river system and the composition of its banks. Before erosion control can be applied, it is essential to understand the mechanism of erosion. Within the study area, a hydraulic mode of bank erosion is most prevalent. When bank erosion occurs because water flowing in the channel exerts pressure that exceeds the critical shear stress for soil erosion, the mode of failure is hydraulic (Fischenich, 1989). Hydraulic failure is generally associated with noncohesive gravelly banks in a river such as the Yakima River, and is characterized by lack of vegetation and high boundary velocities. Therefore, preferred alternatives to reduce erosion within the study area should integrate techniques that increase riverbank vegetation and reduce riverbank velocities.

Preferred Alternative and Recommended Actions

If no action is taken, erosion will continue on private property and along the County's flood control facilities. Continued erosion could eventually increase risk of future flood damage in areas historically experiencing limited damage. Actions to manage excessive erosion include the following:

- As bank erosion areas are identified, the County should implement bank protection projects following established guidelines (e.g., King County 1993 or ISPG, 2003), modified for Yakima County.
- County should provide guidance in designing private bank protection projects. Residents should continue to fund and implement bank protection projects for their property on an as-needed basis. During project review, the County should prefer bioengineering methods to address the hydraulic nature of bank erosion.
- Limit development in rapid channel migration areas by promoting the Open Space Taxation Program in a public awareness campaign (see issue RW10—Acquisition/Preservation of Floodplain Open Space) and inclusion of channel migration areas and regulations in the Critical Areas Code.
- Adopt and enforce design standards, such as onsite detention, to limit or mitigate increased erosion potential resulting from new development.

RW9—Diversity of Opinions Relating to River Management (12), and RW8—County Policy on Flood Hazard Management (17)

Problem Definition

There is a diversity of opinion within the County regarding management of the Yakima River floodplain and its tributaries. Interested parties include state regulators, local officials, property owners, private interest groups, recreational users, and Tribal groups. Their interests include floodplain development potential, protection of private property, enhancement of fisheries habitat and water quality, preservation of aesthetic qualities, water conservation, and open space preservation, among others. Prior to GMA and CFHMP planning, there was no continuing forum for the various interested parties to discuss flood hazard management issues nor were there specific goals and policies to direct flood hazard planning decisions.

Discussion of Alternatives

If no action is taken, the potential for inconsistent management of the Yakima River corridor will continue. As issues arise, single-interest groups tend to overshadow multiple public interests. The County is in a position to continue the public planning process, given its current investment in GMA and CFHMP development. Continued facilitation of the CFHMP planning process will reinforce the importance of the Yakima River corridor as a public resource to the community. The net effect will be increased public awareness of floodplain management issues and consistent planning throughout the Yakima River corridor.

Development of flood hazard policies is underway. The Flood Hazard Ordinance states its goal as minimizing the impact of flooding on lives and public and private property. The Natural Setting element of *Yakima County Comprehensive Plan* includes draft stormwater and flood hazards goals and polices. The CFHMP defines planning goals and objectives. Consistency across all planning efforts is needed to ensure a common vision in river management.

Table 8-5 compares CFHMP goals and objectives to *Comprehensive Plan* goals and polices. Overall, they are similar and complementary. The only inconsistency is the exclusion of a *Plan 2015* draft policy from the goals and objectives of the CFHMP. The excluded policy states, "Yakima County should conduct additional analysis and mapping of frequently flooded areas in cases where the 100-year floodplain maps prepared by FEMA do not adequately reflect the levels of risk or the geographic extent of flood hazards." While this is not included in the CFHMP as a policy, it is addressed as a flood management issue.

Preferred Alternative and Recommended Actions

The preferred alternative is to address the diversity of opinions relating to river management and County policy on flood hazard management through the following actions:

- The FCZD should re-institute an Upper Yakima CFHMP Advisory Committee and hold meetings on an ad hoc basis to assist policy development related to floodplain management.
- The County should prepare CFHMPs specific to other areas of the County, as funding becomes available, to provide consistent floodplain management across the County
- The County should review and participate in the development of other plans, such as the Watershed Management Plan, recently prepared by the Tri-County Water Resources Agency, for consistency with the CFHMP. The County should participate in other river management planning processes, and invite personnel from other river interest groups to future CFHMP Advisory Committee meetings.

RW4—Flood Hazard Ordinance (13), and
RW5—Revision and Consistency of Critical Areas Ordinance (25)

Problem Definition

Flood damage prevention ordinances for jurisdictions in the study area are the basic regulatory tools for flood hazard management. Yakima County incorporated flood hazard regulations into their recently adopted Critical Areas Ordinance (CAO). The CAO combined requirements of the Growth Management Act, the Shoreline Management Act, and the National Flood Insurance Program into one ordinance to limit the amount of regulatory redundancy and to provide a single ordinance regulating environmental impact near the Yakima mainstem.

With the goal of attaining a regulatory program for flood hazard management that is comprehensive, enforceable, and simple, the issue was raised of the inconsistency of ordinances across political boundaries and the potential for ordinance enhancement to further reduce flood hazards in the future.

TABLE 8-5.
COMPARISON OF PROPOSED CFHMP GOALS AND *PLAN 2015* GOALS

Proposed CFHMP Goal	Proposed CFHMP Objective	Related Goal / Policy proposed in Plan 2015
Identify flood hazards, propose alternatives, and select appropriate flood hazard management measures.	Prepare a comprehensive flood hazard management plan to address flooding problems in study area: • At a minimum, propose permanent management measures for the principal flood problems • Select flood hazard management measures based on the following criteria: – Severity of problem – Effectiveness, with emphasis on solving regional problems – Cost – Public acceptance – Impacts • Prepare a Capital Improvement Program (CIP) from selected alternatives • Secure County and Ecology approval of the CFHMP.	Goal NS-SW 4 Prevent increased flooding Policy NS-FLH 5.5 Support comprehensive flood control planning
Implement short-term actions to help alleviate current flooding problems.	Identify maintenance actions and other changes to existing City and County programs that can be achieved with existing resources.	Policy NS-FLH 5.2 Prevent the loss of life or property and min public and private costs assoc with repairing/preventing flood damages from development in freq flooded areas
Ensure that development proposals are consistent with goals and objectives of the CFHMP.	Communicate with private developers to convey the results of interim CFHMP analyses affecting proposed development parcels. Review development proposals to ensure consistency with flood hazard management alternatives that are likely to be developed in the CFHMP.	Goal NS-FLH 5 Establish land use practices in flood hazard areas so that development does not cause or exacerbate natural processes which endangers the lives, property, and resources of the citizens of Yakima County. Policy NS-FLH 5.7 Direct critical facility development away from areas subject to catastrophic, life threatening flood hazards where the hazards cannot be mitigated.
Establish and adopt a systematic and comprehensive approach to flood hazard management.	Pursue strategies for flood haz management that balance engineering, economic, environmental, and social factors in relation to stated goals and objectives Evaluate goals and objectives every five years to maintain consistency with current policy. Maintain consistency with Yakima County and local comprehensive plans, the state Growth Management Act, and related policy plans through measures including: • Providing appropriate public services for new developments. • Preserving natural drainage areas, especially known floodplains. • Adopting development codes that reflect policies on flood hazard management. Coordinate flood hazard planning with all interested and affected parties in both public and private sectors: • Coordinate with the Yakama Indian Nation • Cooperate with reclamation district, utilities, WSDOT, etc. • Coordinate with cities to solve mutual flooding problems • Establish an Advisory Committee while developing the CFHMP • Provide public opp to comment on flood haz management decisions Improve pub understanding of flood haz management through public educ.	Policy NS-FLH 5.5 Support comprehensive flood control planning

TABLE 8-5 (continued).
COMPARISON OF PROPOSED CFHMP GOALS AND *PLAN 2015* GOALS

Proposed CFHMP Goal	Proposed CFHMP Objective	Related Goal / Policy proposed in Plan 2015
Establish a stable, adequate, and publicly acceptable long-term source of finance.	Determine flood hazard management funding needs and alternatives in the CFHMP (i.e., a Capital Improvement Plan). Establish a funding mechanism to help implement the CFHMP.	Policy NS-FLH 5.5 Support comprehensive flood control planning
Prevent the loss of life, creation of public health or safety problems, or damage of public and private prop.	Implement flood hazard management measures as approved in the CFHMP. Give preference to nonstructural measures such as regulations and preservation of existing drainage corridors.	Goal NS-FLH 5 Establish land use practices in flood hazard areas so that development does not cause or exacerbate natural processes which endanger the lives, property, and resources of the citizens of Yakima County.
Maintain the varied uses of existing drainage pathways and floodplains within the County	Preserve opportunities for floodplain uses that are compatible with periodic flooding. Discourage land uses in the floodplain that are incompatible with periodic flooding. Adopt flood control measures that preserve or enhance existing fishery, wildlife, and other natural uses of the riparian zone. Ensure that changes in land use in natural drainage corridors protect and restore the natural character wherever possible.	Goal NS-FLH 5 Establish land use practices in flood hazard areas so that development does not cause or exacerbate natural processes which endanger the lives, property, and resources of the citizens of Yakima County. Policy NS-FLH 5.3 Yakima County should not authorize flood control measures which obstruct fish passage or result in the net loss or damage of fish and wildlife resources. Policy NS FLH 5.4 Encourage and support the retention of natural open spaces or land uses which maintain hydrologic functions and are at low risk to property damage from floodwaters within frequently flooded areas. Policy NS-SW 4.2 Maintain natural drainage courses.
Prevent the degradation of surface and ground water	Minimize the impact of contaminants and sediment in stormwater runoff on receiving waters (Yakima River) and groundwater aquifers. Integrate water quality needs with flood control needs to provide consistency in flood hazard management.	Goal NS-SW 5 Improve water quality through improved stormwater management. Policy NS-SW 5.2 Control stormwater in a manner that has positive or neutral impacts on the quality of both surface and ground water, without sacrifice of one for other.
Minimize the expenditure of public funds, including funding of emergency measures, through effective flood hazard management.	Develop structural and nonstructural measures to prevent or minimize existing flood problems that are the responsibility of the County. Adopt regulations to prevent new development from causing flood damage or from being susceptible to damage by floods. Adopt a drainage design guidance manual that includes uniform standards for design and construction of private facilities and minimum criteria for new development to mitigate the impact of development on water quality, flooding, and erosion.	Policy NS-FLH 5.2 Prevent the loss of life or property and minimize public and private costs associated with repairing or preventing flood damages from development in frequently flooded areas. Policy NS-FLH 5.8 Where the effects of hazards can be mitigated, require appropriate standards for site development and for the design of structures in areas subject to flood hazards. Policy NS-SW 5.1 Review the recommendations of the Yakima Urban Area Storm Water Management Plan, and develop a realistic implementation schedule.

Alternatives Analysis

Chapters 4 and 5 of the County's CAO address flood hazard management pertaining to Hydrologically Related Critical Areas (HRCAs) and Flood Hazard Areas, respectively. Floodways and the 100-year floodplain are by definition included in HRCAs, and are therefore subject to the regulations described in Chapters 4 and 5.

Chapter 4 of the CAO deals with requirements and conditions for receipt of a critical area development authorization. This authorization is required before construction in a designated critical stream corridor may begin. General development requirements include avoiding contributions to stream degradation; conserving and protecting soils, surface water, subsurface water, vegetation, and wildlife; avoiding degradation or impairment of the stream from the cumulative impact of individual projects; and preserving natural conditions using native vegetation unless manmade solutions better serve the purpose. In addition, designated Flood Hazard Areas, as defined by FEMA, must comply with the standards in Chapter 5 of the CAO.

Chapter 5 of the CAO incorporates the County's Flood Hazard Ordinance (FHO), and supports the minimum requirements established for participation in the NFIP. Some additions and revisions have been made to the FHO to maintain consistency with the overall CAO.

To compare consistency of FHOs across jurisdictional boundaries and to identify possible ordinance enhancements, Chapter 5 of the CAO was compared to the FHOs of the Cities of Selah, Yakima, and Union Gap. In addition, comparisons were made to NFIP requirements and the recommendations set by Ecology.

Each jurisdiction's ordinance fulfills the minimum requirements for participation in the NFIP. However, variations occur beyond this minimum. Inconsistencies exist in areas such as type of development allowed, setbacks and buffers, and required lowest floor elevations for structures within the floodplain. Table 8-6 lists requirements of the County's CAO that differ from the NFIP and other jurisdictions.

Any CAO updates that occur in the future will address SMP and Washington State Legislature Bill 5248, and will insure that there is consistency across jurisdictional boundaries.

Ordinance Inconsistencies

The County makes a distinction between residential and non-residential construction elevation requirements. For new residential development located between the 100-year floodplain boundary and a 100-foot buffer from the floodway boundary, structures must be elevated to or above BFE. For new commercial/industrial development in the same location, structures must be elevated a minimum of 1 foot above BFE, or be floodproofed. This distinction is not present in NFIP requirements; however, by requiring a more stringent standard, the County is obtaining a higher degree of safety than required by the NFIP. A standard consistently applied to both residential and non-residential structures would make the ordinance easier to understand, to apply, and to comply with.

In the same clause, the County allows non-commercial development to apply floodproofing techniques in lieu of elevation requirements. This allowance is deemed permissible by NFIP minimum standards; however, those who choose to floodproof rather than elevate are assessed

higher flood insurance premiums based on the lower recorded building elevation. Thus, the landowner incurs the cost of both increased insurance premiums and floodproofing tasks.

TABLE 8-6.
SUMMARY OF DIFFERENCES IN FLOOD HAZARD ORDINANCES FOR YAKIMA COUNTY, CITIES OF SELAH, YAKIMA, AND UNION GAP, AND REQUIREMENTS OF THE NATIONAL FLOOD INSURANCE PROGRAM

Item	Yakima County	City of Selah	City of Yakima	City of Union Gap	NFIP
Title of Ordinance / Regulation	Yakima County Critical Area Ordinance, Ordinance No. 8 - 1995, Section 5	Flood Hazard Protection - Chapter 11.19	Flood Hazard Protection - Chapter 11.58	Flood Hazard Protection - Chapter 14.28	44 CFR 59- 77, National Flood Insurance Program
General Standards for Flood Hazard Zones	All development within 100 feet of the floodway (or OHWM if no floodway exists) must be elevated to Base Flood Elevation (BFE) using zero rise methods, unless nonzero-rise methods do not impede movement of floodwater	Not specified	Not specified	Not specified	Not required
	Roads and utilities serving proposed subdivisions must be located and constructed to minimize flood damage	Section 11.19.060(d)(2)	Section 11.58.140(4.1,4.3,4.4)	Section 14.28.170(a,c,d)	Exceeds Section 60.3 (a)(4)(3)
Specific Standards for Residential Structures	New construction and substantial improvements must elevate the lowest floor to or above the BFE	Section 11.19.065(a)(1)	Section 11.58.150(1.1) requires elevation 1 foot or more above BFE.	Section 14.28.200(a)	Section 60.3(c)(2)
	Fully enclosed areas below lowest floor prohibited unless they equalize hydrostatic forces by allowing entry and exit of floodwaters. Such designs must be certified	Section 11.19.065(a)(2)	Section 11.58.150(1.2)	Section 14.28.200(b)	Not Required
Specific Standards for Commercial, Industrial, and Other Non-Resid. Structures	Comply with standards for development within 100 feet of floodway/OHWM	Not specified	Not specified	Not specified	Not required
Specific Standards for Average Structures	Low potential for flood damage	Not specified	Not specified	Not specified	Not required
Conditions for exemptions from BFE	Structure is designed to allow free passage of water	Not specified	Not specified	Not specified	Not required
elevation requirements	All electrical and mechanical equipment is elevated to a minimum of one foot above BFE, or floodproofed	Not specified	Not specified	Not specified	Not required
	Buildings are placed on site to offer minimum resistance to flood	Not specified	Not specified	Not specified	Not required
	Buildings will not be used for human habitation	Not specified	Not specified	Not specified	Not required
Specific Standards for Manufactured Homes	Must be elevated to or above BFE, and must be anchored to a foundation system	Section 11.19.065(c)	Section 11.58.150(1) requires elevation to 1 foot or more above BFE	Section 14.28.220 requires elevation to 1 foot or more above BFE	Section 60.3(c)(6)

TABLE 8-6 (continued).
SUMMARY OF DIFFERENCES IN FLOOD HAZARD ORDINANCES FOR YAKIMA COUNTY, CITIES OF SELAH, YAKIMA, AND UNION GAP, AND REQUIREMENTS OF THE NATIONAL FLOOD INSURANCE PROGRAM

Item	Yakima County	City of Selah	City of Yakima	City of Union Gap	NFIP
Floodway Fringe Permitted Uses	Any use normally permitted by Co Zoning or Yakima Urban Area Zoning (includes both underlying zone and floodplain overlay zone)	Not specified	Not specified	Not specified	Not required
	Utility transmission lines permitted when primary purpose is to transport bulk energy products	Not specified	Not specified	Not specified	Not required
	Transmission lines permitted to cross floodway fringe by most direct route	Not specified	Not specified	Not specified	Not required
	In channel migration areas, buried hazardous material transmission lines permitted if placed at a minimum depth of four (4) feet	Not specified	Not specified	Not specified	Not required
	In non-channel migration areas, buried hazardous material transmission lines permitted if placed below existing natural and artificial drainage features according to standard practice and soil conditions	Not specified	Not specified	Not specified	Not required
	Transmission lines in floodway fringe permitted if floodproofed	Not specified	Not specified	Not specified	Not required
	Above-ground transmission lines (not including electric) permitted for non-hazardous materials	Not specified	Not specified	Not specified	Not required
Floodway Fringe Prohibited Uses	New mobile home parks or expansion of existing mobile home parks prohibited	Not specified	Not specified	Not specified	Not required
	Utility appurtenances (pump stations, valves, control facilities) prohibited, except where no alternative is available. Exceptions must prove no appreciable effect on flood depth, and must be floodproofed	Not specified	Not specified	Not specified	Not required
Floodway Permitted Uses	All uses permitted under County Zoning or Yakima Urban Area Zoning that meet general standards and have a negligible effect on the floodway are permitted	Not specified	Not specified	Not specified	Not required
	Surface mining permitted with evidence that it will not divert flood flows, accelerate flooding, or increase threats to upstream areas. Mass removal must comply with the Shoreline Management Master Program	Not specified	Not specified	Not specified	Not required

TABLE 8-6 (continued).
SUMMARY OF DIFFERENCES IN FLOOD HAZARD ORDINANCES FOR YAKIMA COUNTY, CITIES OF SELAH, YAKIMA, AND UNION GAP, AND REQUIREMENTS OF THE NATIONAL FLOOD INSURANCE PROGRAM

Item	Yakima County	City of Selah	City of Yakima	City of Union Gap	NFIP
Floodway Permitted Uses	Utility lines permitted for purposes of serving customers in the floodway	Not specified	Not specified	Not specified	Not required
	Utility lines permitted for transfer of bulk power prods if lines cross floodway by most direct route	Not specified	Not specified	Not specified	Not required
	Electric transmission lines permitted if lines span the floodway with support towers in the floodway fringe areas	Not specified	Not specified	Not specified	Not required
	In channel migration areas, buried hazardous material transmission lines permitted if placed at a minimum depth of four (4) feet below the established scour of the waterway	Not specified	Not specified	Not specified	Not required
	In non-channel migration areas, buried hazardous material transmission lines permitted if placed below existing natural and artificial drainage features according to standard practices and soil conditions	Not specified	Not specified	Not specified	Not required
	In agricultural areas in the floodway, buried hazardous material transmission lines permitted if placed at a minimum depth of six (6) feet below ground surface	Not specified	Not specified	Not specified	Not required
	Above-ground lines for non-hazardous materials (not including electric) permitted where existing or new bridge or structure is available and capable to support the line. When the structure is elevated below BFE, the transmission line must be placed on the downstream side of the structure and protected from flood debris	Not specified	Not specified	Not specified	Not required
	Improvements to existing residences that are not classified as "substantial" under the CAO are permitted	Not specified	Not specified	Not specified	Not required
	Dikes are permitted, provided adverse effects on adjacent properties do not result in increased floodwater depths and velocities, natural drainage ways are minimally affected, and proposal is coordinated through appropriate diking district(s)	Not specified	Not specified	Not specified	Not required
	Roads and bridges are permitted	Not specified	Not specified	Not specified	Not required

TABLE 8-6 (continued).
SUMMARY OF DIFFERENCES IN FLOOD HAZARD ORDINANCES FOR YAKIMA COUNTY, CITIES OF SELAH, YAKIMA, AND UNION GAP, AND REQUIREMENTS OF THE NATIONAL FLOOD INSURANCE PROGRAM

Item	Yakima County	City of Selah	City of Yakima	City of Union Gap	NFIP
Floodway Prohibited Uses	Construction or storage of objects subject to flotation or movement during flood periods is prohibited	Not specified	Not specified	Not specified	Not required
	Filling of wetlands is prohibited unless otherwise permitted by the CAO	Not specified	Not specified	Not specified	Not required
	Solid waste landfills, dumps, junkyards, and outdoor storage of autos are prohibited	Not specified	Not specified	Not specified	Not required
	Damming/relocation of watercourses that would result in downstream increases in BFE are prohibited	Not specified	Not specified	Not specified	Not required
	Utility appurtenances (pump stations, valves, control facilities) are prohibited	Not specified	Not specified	Not specified	Not required
Procedure	Variances allowed, but limited to considerations of elevation requirements for the lowest floor, elevation requirements for floodproofing, and type/extent of floodproofing	Section 11.19.050(d) allows variances for lots of ½ acre or less contiguous to and surrounded by lots with existing structures constructed below BFE	Section 11.58.130(5) allows variances for lots of ½ acre or less contiguous to and surrounded by lots with existing structures constructed below BFE	Section 14.28.120(c) allows variances for lots of ½ acre or less contiguous to and surrounded by lots with existing structures constructed below BFE	Section 60.6(a)(2) allows variances for lots of ½ acre or less contiguous to and surrounded by lots with existing structures constructed below BFE
	Variances not considered for procedural issues or use prohibitions	Not specified	Not specified	Not specified	Not required
	Appeals process for variances established through County Hearings Examiner	Not specified	Section 11.58.130(1) establishes process through City Hearings Examiner	Section 14.28.110 establishes process through City planning commission and City Council	Not required
	FIRM revisions/ amendments referenced, and subject to federal regulations	Not specified	Not specified	Not specified	Section 70.1 - 70.9

Depending on the level of risk the County assumed when creating this regulation, it may be worth reconsidering the floodproofing clause and revising the ordinance to require all non-residential development to elevate.

Within a 100-foot buffer from the floodway, all structures must be elevated to BFE using zero rise methods. Yet beyond the setback, commercial/industrial structures would be required to elevate to one foot above BFE. There is also a discrepancy in elevation requirements for manufactured homes. Yakima County and Selah require manufactured homes to be elevated to or above BFE, while the cities of Yakima and Union Gap require these structures to be elevated 1 foot or more above BFE. Consistency in elevation requirements is needed across County and City jurisdictional boundaries.

Requirements in Chapter 4 of the CAO for siting utility lines in HRCAs duplicate those requirements in the floodway fringe and floodway in Chapter 5. Since the floodway is by definition an HRCA, it seems that the specific requirements of Section 5.32.010 (2) and Section 5.36.010 (2), pertaining to siting of utilities in the floodway fringe and floodway, could be consolidated with Section 4.14, pertaining to siting of utilities in HRCAs.

Chapter 5 of the CAO permits surface mining provided there is evidence that it will not divert flood flows, accelerate flooding, or increase threats to upstream areas. Chapter 4 allows industrial mining of gravel, but requires authorization by the County, Ecology, and WDFW, and excludes such activity from the 100-foot "zero-rise" buffer area. These conflicting descriptions of mining activity should be rectified and presented as a single comprehensive set of standards in Section 4.18.

Ecology's model ordinance recommends the use of an optional clause promoting siting of critical facilities outside the floodplain, and outlining elevation and floodproofing conditions for critical facilities constructed within the floodplain. Chapter 5 does not contain this optional provision, which should be considered for inclusion.

Yakima County maintains a 100-foot zero-rise buffer area surrounding the OHWM or regulatory floodway. In many cases, the County's CAO will apply only to the east bank of the river. The west bank of the river will be regulated by varying requirements of City ordinances, none of which include zero-rise methods.

Preferred Alternative and Recommended Actions

The following actions are recommended to increase regulatory consistency and reduce future flood hazards as discussed above:

- Sections 5.28.020(1)(a), 5.28.020(2), and 5.28.020(3) of the County's CAO should be revised to require all new construction and substantial improvement, regardless of intended land use, to be elevated or floodproofed 1 foot or more above the revised BFEs, and be accessible to emergency vehicles during a flood
- CAO Sections 5.32.010(2) and 5.36.010(2) pertaining to requirements for siting utility lines in the floodway fringe and floodway should be consolidated within Section 4.14 pertaining to siting of utilities in HRCAs. The existing sections in Chapter 5 should reference standards set forth in Section 4.14

- CAO Section 5.36.010(1) should be deleted. Provisions requiring evidence that surface mining will not divert flood flows, accelerate flooding, or increase threats to upstream areas should be relocated to Section 4.18.040. Surface mining in floodway fringes and floodways would change from a permitted use as described in Section 5.36.010(1) to a conditional use as described in Section 4.18
- A new CAO Section 5.28.010(d) should be added as follows:

  (d) Critical Facilities

  Construction of new critical facilities shall be, to the extent possible, located outside the limits of the base flood plain. Construction of new critical facilities shall be permissible within the base flood plain if no feasible alternative site is available. Critical facilities constructed within the base flood plain shall have the lowest floor elevated to 3 feet or more above the level of the base flood elevation at the site. Floodproofing and sealing measures must be taken to ensure that toxic substances will not be displaced by or released into floodwaters. Access routes elevated 2 feet or more above the base flood elevation shall be provided to all critical facilities to the extent possible.

  Add the following definition to CAO Chapter 2:

  Critical Facility means a facility for which even a slight chance of flooding might be too great. Critical facilities include, but are not limited to, schools; nursing homes; hospitals; police, fire, and emergency response installations; and installations that produce, use, or store hazardous materials or hazardous waste.
- The County should review other jurisdiction's shoreline ordinance for zero-rise development for the area within 100 feet of the OHWM or floodway. If they do not contain such standards, the County would suggest language and seek to incorporate changes during the code revision process.
- City jurisdictions should integrate flood hazard items included in the County's CAO that are not specified in their respective FHOs or CAOs or develop an inter-local agreement creating a FHO that applies across all jurisdictional boundaries.

The primary benefits of these alternatives are regulatory clarity, elimination of redundancy, consistent floodplain management, and a possible decrease in future flood hazards if enhancements are adopted.

RW2—Loss of Fisheries Habitat and Riparian Areas (14), and MR8—Borrow Pit Levee Upstream of Terrace Heights Bridge (31)

Problem Definition

The Yakima River supports populations of spring and fall Chinook salmon, Coho salmon, steelhead and bull trout. The historical floodplain has been significantly modified, with development resulting in the loss of off-channel rearing habitat for fish and riparian habitat for wildlife. Channel complexity has been reduced, causing loss of critical rearing and spawning habitat for salmonids. Further encroachment of the floodplain would reduce fisheries habitat,

riparian buffers, and floodplain storage. One identified encroachment is the old borrow pit levee on DOT property upstream of the Terrace Heights bridge.

Discussion of Alternatives

Fishery run sizes show continual decline over time (Table 8-7). Current run sizes are estimated to be 1 to 0.4 percent of historical levels. The number of fish has drastically declined due to a variety of causes, including low stream flows, impassable dams, loss of habitat, fishing preserves, and poor water quality.

Opportunities are available to enhance fish habitat as well as increase floodplain storage for flood reduction. The availability of areas to re-establish backwater channels is one opportunity to improve salmonid spawning and rearing as well as floodplain storage. Several studies have documented the use of backwater channels to increase overwinter survival and growth of juvenile Coho salmon (Cederholm 1991; Bonnel 1991). The technique involves grading down, deepening, and widening relic side-channels on river floodplains to intercept subsurface flow, or constructing channels to interconnect existing floodplain ponds that allow flow outside of the main channel (Figure 8-20). Channels are often located to take advantage of existing roads, railways, or levees so that floodwater does not enter at the upstream end. Re-established backwater channels increase overwinter survival, increase the growth rate of juvenile salmon, and provide a net benefit in fish production, as well as providing backwater flood storage. There are large areas within the CFHMP study area which are suitable for this type of habitat enhancement, mostly located in the lower portions of the Gap-to-Gap reach, and in some locations on the Naches. Areas that exhibit potential for use as backwater channels include the following:

- Selah gravel pit following gravel extraction.
- The abandoned mid-channel borrow pit upstream of Terrace Heights bridge.
- Yakima Beach Street Gravel Pit.
- Newland gravel pit following gravel extraction.

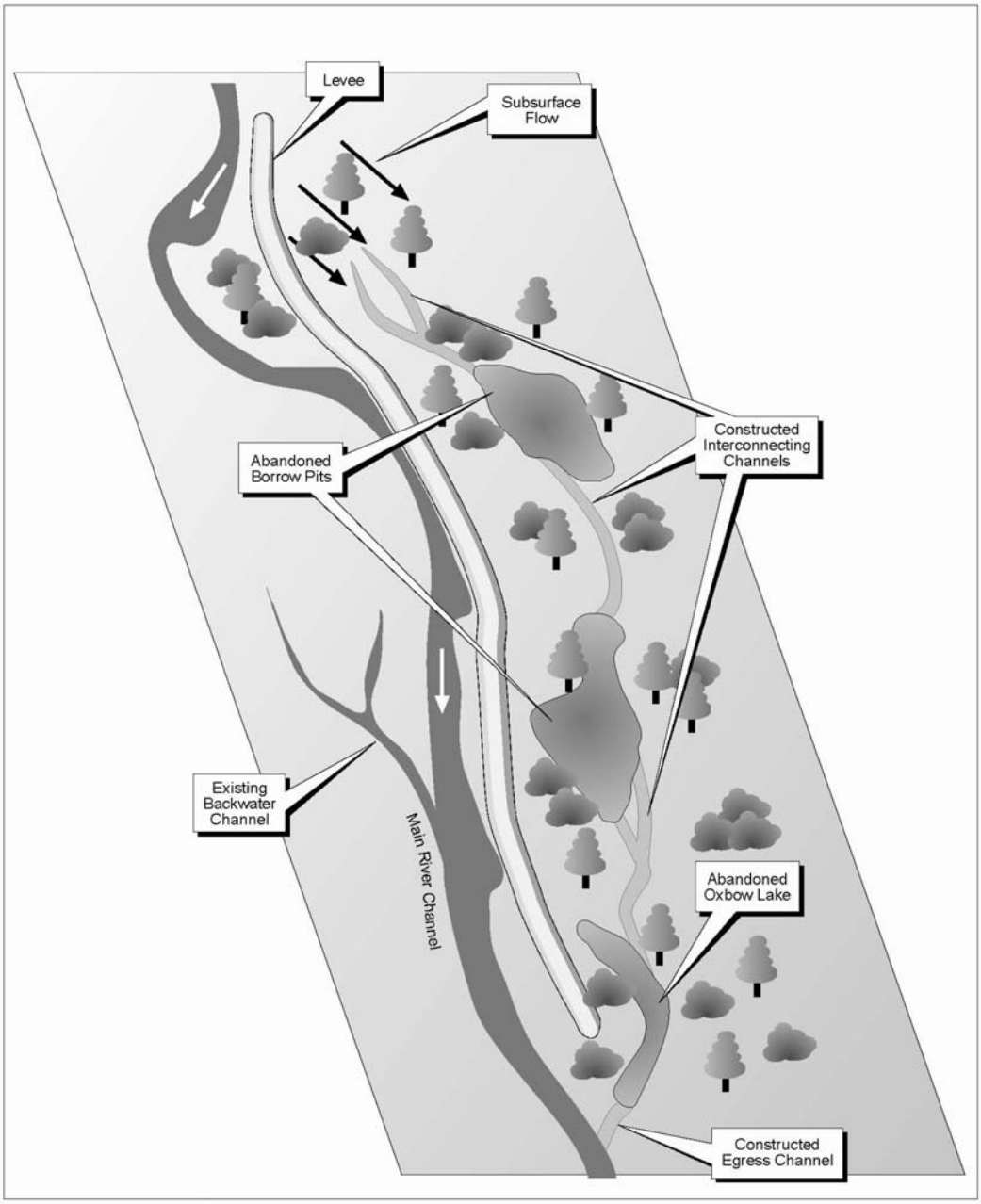
Gravel Pits in this reach of the Yakima River provide suitable habitat for non-native species such as shiners, smallmouth bass, and northern pike minnow, due to temperature increases. These species act as predators for salmonids, therefore restoration of these gravel pits is not recommended for fish habitat improvement.

Assistance is available under Section 1135 of the Water Resources Development Act (Public Law 99-662) to provide funding to modify structures of a COE project to restore fish and wildlife habitat. Fish and wildlife benefits must be associated with past COE projects in the Yakima Valley. The extensive COE levee project within the CFHMP study area provides a specific opportunity to apply this program. Planning studies, detailed design, and construction are funded with a 75 percent federal cost-share. The program requires a non-federal sponsor to contribute the remaining 25 percent funding match. The potential sponsor requests by letter that the COE initiate a feasibility study. Following receipt of the letter of intent, the COE will request study funds.

TABLE 8-7.
HISTORIC AND CURRENT RUN SIZES TO THE YAKIMA RIVER

Species	Lowest Historic Estimate[a]	Current 1995 Estimate
Summer Chinook	107,780	0
Spring/Fall Chinook	80,460	1,727[b]
Coho	40,280	633[c]
Sockeye	20,620	0
Steelhead	21,940	918
Total	271,080	3,278

a. *SOURCE:* McNeil 1993
a. 644 spring Chinook, 1,081 fall Chinook
a. All hatchery fish, wild stock extinct since approximately 1984.



KCM 1917 First Avenue Seattle, Washington 98101	Yakima County UPPER YAKIMA RIVER CFHMP	Figure 8-20 BACKWATER CHANNELS FOR FISH HABITAT ENHANCEMENT

Preferred Alternative and Recommended Actions

If no action is taken, run sizes may continue to decline, as will areas for floodplain storage. Opportunities are available to increase floodplain storage while enhancing fish habitat through the use of backwater channels. The levee setback actions presented above provide many opportunities to recover salmonid habitat and reduce flood hazard. This is consistent with the CFHMP objective to adopt flood control measures that preserve or enhance existing fishery, wildlife, and other natural uses of the riparian zone. To mitigate loss in fish habitat resulting from past and future flood control measures, the following actions are recommended:

- The County, WDFW, and the Yakama Indian Nation should identify and specifically list fish habitat enhancement areas that are consistent with comprehensive floodplain management planning and could be quickly acted upon as funding becomes available.
- The County should submit a letter of intent for participation in the COE 1135 program to obtain funding for fish habitat restoration consistent with flood protection within the plan river reaches . WDFW and the Yakama Indian Nation should act as the lead agencies in identifying enhancement opportunities, with the County providing a support role. Prior to submitting a letter of intent, the County, the Yakama Indian Nation, and WDFW should agree on who will provide the 25 percent matching funds.
- The County should incorporate fish habitat enhancements or mitigation into future flood hazard management projects and gravel pit reclamation by using backwater channels, riparian planting, and placement of large woody debris.

RW17—Existing Structures in the Floodplain (16)

Problem Definition

Numerous structures currently exist in the Yakima River floodplain. Many of the structures were built prior to flood hazard ordinances and have no floodproofing or flood protection. Therefore, these structures experience repetitive flood damage; the severity of flood damage depends on structure location and elevation relative to flood elevations. If the flood risk is not reduced, damage can be expected to continue, which could result in public expenditures.

Discussion of Alternatives

As part of the 1998 CFHMP, a floodplain survey was conducted from Selah to Union Gap. The survey consisted of a field reconnaissance and review of aerial photographs to identify the number of structures in the floodplain, their location, current use, type of construction and foundation, and height of the first floor above ground level. Floodplain survey data sheets are included in the 1998 Upper Yakima River Comprehensive Flood Hazard Management Plan.

The survey identified, by quarter section, the number of structures within the floodplain. Table 8-8 and Figure 8-21 summarize survey results. A total of 609 structures were identified within the surveyed floodplain. Of the identified structures, 54 percent are residential, 38 percent commercial, and 8 percent agricultural. The highest concentration of structures exists in Selah, East Selah, Terrace Heights, and near SR 24. Overall, structures exhibit minimal floodproofing.

TABLE 8-8
STRUCTURES IN THE FLOODPLAIN

River Reach	Number of Structures	Percent Residential	Percent Commercial	Percent Agricultural
Yakima Canyon to Selah Gap	229	46	12	42
Selah Gap to SR 24 Bridge	313	58	6	36
SR 24 Bridge to Union Gap	67	57	7	36
Total	609	54	8	38

In the Selah and East Selah areas, 161 structures were identified in the floodplain; 51 percent residential, 42 percent agricultural, and 7 percent commercial. Residential structures are typically elevated 0.5 to 3 feet above ground level; agricultural structures are elevated 0 to 3 feet; and commercial structures are elevated 0 to 4.5 feet. Residential structures are more densely concentrated and consist largely of mobile homes (over 40 percent). Structures near Pomona Road and Naches Avenue East experience greater flood damage due to frequent inundation.

In the Terrace Heights area, 112 structures were identified in the floodplain; 57 percent residential, 41 percent agricultural, and 2 percent commercial. Residential structures are typically elevated 0.5 to 2 feet above ground level; agricultural structures are elevated 0 to 1 feet; and commercial structures are elevated 0.5 feet. Historically, structures near Keys Road have experienced the most flood damage, but these are now protected by a certified levee.

Near and downstream of SR 24, 195 structures were identified in the floodplain; 58 percent residential, 34 percent agricultural, and 8 percent commercial. Residential structures are typically elevated 0 to 4 feet above ground level; agricultural structures are elevated 1 to 3 feet; and commercial structures are elevated 0 to 2.5 feet. The highest density of structures is located north of SR 24. Recent flood damage occurred to structures near First Street in Union Gap.

To address structures in the floodplain, several alternatives were evaluated, including the following:

- Develop a public education program on floodproofing
- Perform a detailed flood audit of floodplain structures
- Participate in cost-share program (voluntary program as funding becomes available) to floodproof existing floodplain structures
- Actively pursue funding through the Hazard Mitigation Grant Program for structure acquisition
- Allow floodplain structures to continue to be damaged during flood events (no action).

Citizens residing in flood-prone areas should be made aware of floodproofing techniques if they desire to floodproof their homes. The County could make floodproofing references and fact sheets available to citizens. Information can be obtained from the FEMA publications *Flood-Proofing Non-Residential Structures* (FEMA 1986) and *Design Manual for Retrofitting Flood-prone Residential Structures* (FEMA 1989), or from many of the publications distributed by FEMA's outreach program. Floodproofing materials could be distributed with flood information brochures to libraries, fire departments, chambers of commerce, and city offices throughout the County. Educational material distribution would increase the probability of educating property owners unfamiliar with preventative flood-control measures.

Detailed flood audits have also been used in the past to provide information on specific flood hazards at habitable structures within floodplains. The goal of the flood audit is to provide each resident with information on actions to take prior to, during, and after a flood that are specific to their location and residence. The major activities of a flood audit include the following:

- **Field Reconnaissance:** A field reconnaissance is performed to collect elevation data and record structural characteristics of each specific structure.
- **Nonstructural Evaluation Computer Program:** A nonstructural evaluation computer program, developed by the COE, uses the data collected in the field and predictions of floodwater elevations to evaluate costs and benefits of a variety of nonstructural flood reduction measures.
- **Mailing to Floodplain Residents:** A packet of materials is mailed to each resident describing actions to take prior to, during, and after a flood; evacuation routes; areas of floodwater inundation; neighborhood homes below flood warning levels; and recommended nonstructural measures to floodproof their home.

The County could work with the COE or FEMA to perform a flood audit or obtain the COE's nonstructural evaluation computer program and perform similar flood audits in-house. Flood audits could provide information on specific flood hazards at habitable structures within floodplains and educate floodplain residents so that they may initiate corrective flood protection measures.

Raising or moving structures also provides permanent flood protection to floodplain structures. Relocation or elevation has high short-term costs; however, in the long term, these actions may provide the lowest cost alternative in very high flood hazard areas. Several state and federal programs are available to assist in this type of mitigation. Recent catastrophic flooding in the Midwest resulted in a modified approach for state and federal buyout, relocation, and floodproofing programs. The changed approach is reflected in new programs targeted at mitigation and prevention of repetitive flood damage. A detailed description of federal and state programs is included in Chapter 9, including funding options for program implementation. The County could limit the amount of repetitive flood damage by pursuing and implementing these types of programs.

Preferred Alternative and Recommended Actions

If no action is taken, repetitive flood damage is likely to continue. Residents will rebuild flood-damaged structures without taking measures to reduce the potential for future flood damage. This will result in continued private and public expenditures for disaster relief.

To provide the greatest reduction of future flood damage to floodplain structures at minimal cost, the following actions are recommended:

- The County should work with FEMA to make floodproofing references and fact sheets available to citizens. Floodproofing materials could be distributed with flood information brochures to libraries, fire departments, chambers of commerce, and city offices throughout the County. Educational material distribution will increase property owners' knowledge of preventative flood-control measures.
- The County should pursue funding through the Reigle Community Development and Regulatory Improvement Act, Robert T. Stafford Disaster Relief and Emergency Assistance Act, and Flood Control Assistance Account Program to provide cost sharing to floodplain residents for floodproofing, elevation, and relocation of previously flood-damaged structures on a voluntary basis. Effort should focus on recently damaged property and mobile homes near Pomona Road, Naches Avenue East, Keys Road, and First Street in Union Gap.

RW16—Operation and Maintenance of Flood Control Facilities (18)

Problem Definition

The County routinely inspects federal flood control facilities and PL-84-99-eligible levees. The County follows the 1955 *Operation and Maintenance Manual* (COE 1955), developed for federal facilities, with a few modifications. A draft memorandum of agreement (MOA) between the COE, Ecology, and WDFW guides the County on vegetation and habitat management for flood control structures. In addition, the County performs levee maintenance under a modified mitigated determination of nonsignificance (MDNS), which incorporates the MOA and additional conditions. Therefore, maintenance of flood-control works is defined in several documents; this produces the potential for inconsistency and inadequate clarity of maintenance procedures and responsibilities. Specifically, the following operations and maintenance issues have been identified:

- The 1955 *Operation and Maintenance Manual* does not reflect current conditions
- Detailed information on each flood control facility is not readily available
- Maintenance crews need additional guidance on vegetation maintenance requirements for certain plant species
- County inspection forms are inconsistent with the identification system used by the COE

- Maintenance requirements differ according to the type of structure. For example, maintenance requirements differ for federal levees and PL84-99 levees, as they do for basic levee sections and overbuilt levee sections. The different types of structures are also not clearly defined in the maintenance procedures
- No policy exists describing the County's role in maintaining future flood-control structures that are not constructed by the County.

Discussion of Alternatives

Updating and documenting clear maintenance procedures for each flood-control facility in the County could resolve many operations and maintenance issues. Documenting this information would eliminate outdated information, provide clear guidance to maintenance crews, provide consistency for all agencies involved, and ensure adequate recording and repair of identified deficiencies. This would ensure the proper operation of each facility and adequate vegetation maintenance to benefit fish and wildlife. Several steps could be taken to better define O&M procedures.

Conduct a Detailed Flood Control Works Inventory

Detailed information on each flood control facility is not readily available. Flood facility information is scattered throughout COE and County reports, COE inventory records and drawings, and surveying field books. As part of the CFHMP, the first step in compiling this information was conducted. Historical information was collected on facilities located throughout the County and placed in a database to provide a detailed record for each facility. The information in this format is readily available for future maintenance or repair decisions. Database information, supplied in Appendix D, includes the following:

- Facility name and location
- Type of structure
- Managing agency
- Physical characteristics (dimensions, construction material, elevations)
- Level of protection, freeboard, and internal drainage structures for levee facilities
- Agency responsible for maintenance, schedule of maintenance, and previous maintenance performed
- Inspection deficiencies, if applicable.

The County should field-verify and update the database to reflect the most recent information. In addition, the database could be expanded to include supporting documentation such as drawings, survey data, maintenance reports, photographs, and references to specific maintenance procedures. A file should be kept for each facility, updated by maintenance crews after each inspection.

Clearly Define Vegetation Maintenance Requirements

General vegetation management procedures are described in the draft MOA and MDNS. The MOA recommends plant species, vegetation densities, and thinning requirements for levee maintenance. However, vegetation maintenance requirements vary by type of levee section. Each levee needs to be field-verified to check the type of levee section. Each levee should be classified as a standard levee section or an overbuilt levee section per the MOA. Once this classification is made, appropriate vegetation maintenance procedures can be applied.

In addition, maintenance crews need additional guidance on vegetation maintenance requirements for certain plant species. Per the MOA, WDFW and the COE should aid in determining plant species that support habitat and limit the structural impact on levees. The County should work with WDFW and COE to better defined thinning, cutting, and planting procedures for each facility. These procedures should be developed for each facility and include photographs so that maintenance crews can clearly identify plant species that require thinning.

Update the 1955 Operation and Maintenance Manual

The 1955 operations and maintenance manual is outdated. New facilities have been constructed, and other structures are no longer needed. For example, the recently constructed KOA levee is not included in the maintenance manual, and the stop plank closure structure near Gordon Lake levee is no longer needed due to the construction of SR 12. The County should evaluate the 1955 O&M manual item by item, remove outdated information, and update sections to include new facilities and new procedures described in the MOA and MDNS.

Combine Maintenance Requirements into One Document

Once the 1955 O&M manual has been updated and specific vegetation procedures have been defined for each facility, the requirements should be consolidated into one document. The document would incorporate applicable procedures in the 1955 O&M manual, procedures outlined in the MOA and MDNS, and site-specific vegetation maintenance requirements. Prior to implementation, the County should seek final approval from the COE and WDFW.

Standardize County Inspection Forms

The County inspects federal flood-control facilities semi-annually; PL-84-99-eligible levees are inspected annually. The County maintains an inspection form for each facility. Confusion arises in cross-referencing levee identifications on the County inspection forms and on COE inspection forms—levee segments are identified with different numbers and at different locations. The County should create an inspection form for each flood facility data sheet included in the 1998 Upper Yakima River Comprehensive Flood Hazard Management Plan. Facility data sheets were based on COE data; therefore, creating County inspection forms for each data sheet would provide consistency with the COE.

In addition, two levees are misclassified by the COE. The COE still lists the KOA levee as under PL 84-99 status even though the COE has inspected and approved the levee as meeting federal standards. The KOA levee, identified as PL99-YSEG7A on the data sheets in Appendix D, should be changed to federally authorized status. The COE lists a federally authorized levee as

PL-84-99. This levee, identified as FED-LB1 on the data sheets, is identified as PL84-99 Segment 9 by the COE. The County should request that the COE also reclassify this levee.

Continually Update the Flood Control Works Inventory

The flood-control works database should be updated as information becomes available. Following inspections or the collection of additional information such as elevations, maintenance crews should routinely update the facility's file. This will provide a continuous record of work performed on each facility.

Preferred Alternative and Recommended Actions

The following actions are recommended to address operations and maintenance issues:

- Consolidate maintenance requirements into one document following the steps outlined above
- Adopt a policy requiring all new flood-control projects to define maintenance responsibilities and a funding source for operations, maintenance, and repairs before acceptance by the County
- Continually update and maintain a flood control facility inventory database to document the current condition of each flood control facility.

RW10—Acquisition / Preservation of Floodplain Open Space (19)

Problem Definition

One option for preventive flood hazard management is the acquisition or preservation of open space in and adjacent to the floodplain. The limited extent of development in the upper and lower reaches of the study area provides an opportunity for acquisition of open space. However, available incentives have not been communicated to private property owners, and funding sources have not been identified for potential acquisition of property for open space.

Discussion of Alternatives

The need to restrict development in floodplain areas leads naturally to their use as open space. Many open space preservation programs identify floodplain areas as high priority: land is usually available, is often inexpensive, and is suitable for the development of trails, parks, and natural interpretive areas. Several opportunities exist to expand open space within the Yakima floodplain.

Open Space Taxation Program

Yakima County currently administers an open space taxation program under Ordinance No. 4-1989, as amended. The program defines the floodplain as a priority open space resource. Properties that meet open space criteria may be reclassified from their original designations to open space. Land value is then reassessed, usually resulting in lower property taxes to the landowner.

Yakima Greenway Foundation

The mission of the Yakima Greenway Foundation is to conserve, enhance, and maintain the Yakima River corridor as a continuing, living resource for future generations. The Foundation is guided by the Yakima Greenway Master Plan, originally developed in 1976 and recently updated in 1995. The Foundation is actively seeking to expand its 3,600-acre conservation area throughout the Yakima River corridor.

The Foundation's vision suggests additional development alternatives within the Yakima River corridor. Suggested Greenway enhancements that affect open space land use in the floodplain include the following:

- Locate enterprises related to tourism and recreation between the Greenway and the parkway, with industrial parks and residential communities located along the eastern edge
- Integrate attributes of the Greenway into urban design and planning decisions
- Establish circulation routes between downtown Yakima and the Greenway
- Extend the Greenway corridor along the Yakima River from Selah north to the Yakima River Canyon.

Yakima County has a number of options for involvement in implementation of the Greenway Master Plan. Currently, the County and the City of Yakima maintain the Greenway Overlay Zone within their respective jurisdictions as part of the Urban Area Zoning Code. The implications of the overlay zone are essentially similar to those of the floodplain overlay: permitted uses that would ordinarily receive a Class 1 review are upgraded to a Class 2 review, which requires submission of a site plan and review by the Planning Division. The County has the opportunity to use the design guidelines proposed by the Master Plan in the process of conducting Class 2 review. The County Zoning Code that applies to areas outside the Yakima Urban Area does not contain provisions for overlay zoning.

Existing Public Use Parcels

Figure 2-11 (Chapter 2) shows the location of existing public use parcels and Yakama Nation land within the study area. Owners of public use parcels include Yakima County, City of Yakima, WSDOT, BOR, and DNR. Table 8-9 lists County-owned parcels and describes their location. Future development of some of these parcels is yet to be decided; therefore, this provides an opportunity for designation to open space or integration into the Yakima Greenway.

TABLE 8-9
COUNTY-OWNED PARCELS IN THE FLOODPLAIN

Number of Parcels	Location
1	West of SR 821, north of Corriedale Road
1	Adjacent to Harrison Road
3	East of SR 12/I-82 interchange
1	West of Hartford Road
1	Adjacent to Terrace Heights Boulevard
10	Near Keys Road
4	Near SR 24
2	Northwest of Thorp Road

Federally Funded Programs

As described in issue RW17—Existing Structures in the Floodplain, state and federal programs are available to fund the acquisition of property for open space. The programs allow local agencies to acquire homes or other structures and private property, if property owners agree, for the purpose of reducing or eliminating risk and damage from future disaster events. Normally, this requires a 25 percent local funding match. The County could limit future flood damage by pursuing and implementing programs of this type.

Preferred Alternative and Recommended Actions

Preserving and promoting open space within the floodplain is consistent with the long-term CFHMP objective of promoting floodplain uses compatible with periodic flooding. Recommended actions to enhance open space within the floodplain include the following:

- The County should continue to operate and promote the Open Space Taxation Program. A public awareness campaign should be conducted to promote the program, especially to property owners in the middle reach of the floodplain. General information on the program can be distributed with the floodplain information mailing recommended in issue RW7—Flood Insurance and Public Education.
- The County should continue to cooperate with other agencies such as the Bureau of Reclamation, the Yakama Nation, WDFW, Yakima Greenway, WSDOT to acquire areas of high flood hazard within the CFHMP study area.
- Designate undeveloped County-owned parcels as open space or integrate these parcels into the Yakima Greenway master plan.
- Apply design standard of the Greenway Master Plan during Class 2 review of developments within floodplain or Greenway overlay zones.
- Extend Greenway overlay zoning beyond the Yakima Urban Area within conservation, recreation, and natural areas designated in the Master Plan.

- Pursue funding through state and federal programs to purchase high-hazard floodplain properties or development rights for open space use. Acquisitions should be focused on repetitive loss areas near Pomona Road and Naches Avenue East.

RW19—Flood Warning and Emergency Response (20)

Problem Definition

CFHMP Advisory Committee expressed a few concerns about the flood early warning system in Yakima County. The following needs were identified:

- Better management of road closure information
- Increased flood warning, especially along tributaries
- Availability of flood response equipment such sandbags/sandbag machines
- Better transfer of information from the Emergency Operations Center (EOC) to public officials
- Better public education.

Discussion of Alternatives

The elements of an early warning system – flood forecasting, flood monitoring, flood warning, flood response, and public education – are defined as follows:

- **Flood Forecasting**—determining meteorological conditions expected to cause a flood, and predicting flood levels
- **Flood Monitoring**—spatially and temporally tracking flood conditions as they develop
- **Flood Warning**—maintaining appropriate communications with key government officials and the public to relay information about the magnitude and extent of impending flooding
- **Flood Response**—acting to mitigate or prevent property damage or threats to public health due to floods (includes evacuations, rescue, establishment of temporary shelters, and road closures).
- **Public Education**—community awareness and understanding of flood hazards prior to flood events and knowledge of the appropriate actions to take during flood emergencies. Public education is relevant to each of the elements described above.

Early warning issues identified in Yakima involve public education, flood monitoring, flood warning, and flood response. Public education is addressed in issue RW7—Flood Insurance and Public Education. Several other alternatives can be implemented to address the remaining issues.

Installation and Real-time Use of New Staff Gages and Snow Telemetry Stations

The Bureau of Reclamation (BOR) maintains numerous gauging stations on the Yakima and Naches Rivers. Stage (river elevation) measurements are recorded at each station and translated into flow using rating curves that relate the two variables. The majority of the gauging stations transmit data hourly to BOR computers monitored in real-time by County officials. Emergency management personnel feel that river information is sufficient and timely for flood monitoring (Thompson, D., 6 May 1996, personal communication). However, limited information is available for tributary creeks.

Data from automated real-time gages in the upper Ahtanum (two exist), Bachelor, Wide Hollow, and Wenas Creek watersheds could be used to predict the time and magnitude of flooding along these tributaries. Installation of automated gages would increase flood warning, monitoring, and forecasting capabilities. Gages could be installed as part of the BOR system or to supplement existing USGS gauging stations.

The February 1996 flood in the area was caused by heavy rainfall on significant snowpack combined with warm weather. Telemetry stations at mid level elevation (around 3400 ft) are needed on some watershed areas including the Naches River and Ahtanum Creek; these two watersheds contribute to the Yakima River.

Currently, the County relies on local observations of river stage and BOR readings from their gage stations. The County could formalize a system of dispatching field teams to critical locations along rivers and creeks to supplement gage data. A list of critical locations and responsibilities of field teams should be prepared by the OEM and Department of Public Services. Field teams should be trained and assigned to complete specific tasks during flood events. Appropriate procedures and methods of communication between river watch teams and the EOC should continue to be refined based on available communication equipment and past flood experience. During a flood event, field teams should communicate to the EOC information on river stage, bank failures, culvert failures, overland flow, road closures, and public and private property damage.

Stage and Inundation Database and Inundation Maps

For the lower Naches River basin, flood inundation digital maps were generated for different flood events including the following: 0.34, 0.5, 1, 1.5, 2, 5, 10, 25, 50, 100, 500 year, with each event having an associated discharge value. These flood events were generated through detailed hydrologic and hydraulics studies as part of the County's efforts to update its flood maps and to generate Digital Flood Insurance Rate Maps (DFIRMs). These flood inundation maps will contain information on inundated parcels, inundated roads and their closures, depth of flood water in the river and its flood plain system, overtopped levees, overtopped bridges, and overtopped culverts. The database information was generated from a 2 foot by 2 foot grid. The database was generated for each flood event and the information in the database will be used to alert the public and to respond effectively to flood events and flood emergencies. County use of inundation maps would result in flood warnings and responses that are more timely and targeted at appropriate areas.

Detailed flood inundation maps for the Yakima River would come from future detail hydraulics and hydrologic studies to generate the DFIRMs. In the interim, the County is in the process of generating preliminary flood inundation maps using old FEMA maps, new topographic data (LIDAR), photography from past flood events, and other available data. These flood inundation maps for the Yakima River will be generated from FEMA 10-, 50-, 100-, and 500-year flood events. Database information for the inundation maps, similar to the ones generated on the Naches River, will be created for the Yakima River.

The County should record the following information in a stage and inundation database during each flood event:

- Stage, discharge, and time from all stream gages
- Mapped areas of inundation corresponding to specific times, river stages, and discharges during the flood event, based on reports from citizens and river watch teams
- High water marks and associated peak stages and discharges from the flood event
- Time and location of critical infrastructure and corresponding river stages and discharges
- Time and location of overland flows and corresponding river stages and discharges.

The database and inundation map should be updated with new information following each flood event. Updated versions of the database and inundation map should be issued to the public periodically.

Database of Time Delays of Flood Peaks

The greatest impact from flood events occurs during the flood peak. This makes predictions of when a flood peak will reach a location particularly important. In order to tackle these issues, the County has been working on the following:

- Finish compiling time delays of flood peaks for major flood events and for different rivers in Yakima County including the Yakima River. Most flood peak time delays need to come from hydraulic modeling.
- Digitized dam break inundation maps for major dams located on the Yakima and Naches River system; flood travel time for these dam breaks are also compiled. These data were acquired from BOR.
- The County has created a draft web-based Operational Flood and Weather Forecasting Model on the Naches River, Ahtanum Creek, and Wide Hollow Creek (tributaries to the Yakima River). The model forecasts flood and weather for seven days in advance; the data generated by the model is being evaluated for potential use by the County for flood emergencies. The County is currently using the data generated by the National Weather Service/Northwest River Forecast Center.

- The above compiled and generated data would be used to improve flood response.

Yakima County Flood Response Plan

The County recently finished writing a draft Flood Response Plan. The plan will help minimize flood damages, insure coherent and continual integration among entities responding to flood emergency, and accelerate return to normal conditions after flooding. The plan is composed of the following three parts:

1) **Flood Emergency Response Plan**—This plan describes basic strategies, assumptions, and mechanisms through which entities within the County will mobilize resources and conduct activities to guide and support local emergency management efforts through response and recovery.
2) **Public Services Flood Action Plan**—This plan describes the functions of the different divisions within the Public Services Department responding to flood emergencies.
3) **Tactical Response Guide and Implementation Procedures**—This plan describes the functions of other local jurisdictions in the County responding to flood emergencies.

Appended with the Flood Response Plan is a flood exercise for the real-time flood event that occurred in Yakima County during February 1996. The flood exercise contains information on the following:

- Availability of sandbags (numbers, locations, and policy of usage and distribution).
- Sandbag machines; the County recently purchased four sandbag machines. Two machines were provided to two cities; the other two machines were kept for use by the County in case of a flood emergency.
- Rip rap stockpile for flood emergency (locations, amounts). The County recently purchased additional rip rap for use in a flood emergency.
- Private vendors that that have sand bags/sand for the public to access.
- Yakima County Small Works Roster; the roster would be used to access local and private resources needed for flood emergency.
- Fire Districts in the County and their resources.
- Hydrologic/hydraulic information for the rivers, creeks, and dams in the County (gauging station locations, real time access data, historical data, etc.).
- Flood forecast information and link for both the County web-based Operational Flood and Weather Forecast Model and the National Weather Services/Northwest River Forecast Center.
- Flood travel times for major flood events and dam breaks in the County.

- GIS layers for flood boundaries for different flood events and dam breaks in the County.

The Flood Response Plan document includes four levels of flood response that have been created for different positions responding to a flood emergency. These levels include: Level One (Get Ready), Level Two (Get Set), Level Three (Go), and Level Four (Re-Entry/Recovery). Each level has a specific set of tasks/responsibilities identified in the plan. The County is in the process of associating these flood response levels with a particular flood event. For example, Level Two (Get Set) could be associated with a 7-year flood event on the lower Naches River. Level Two may be associated with a different flood event on the Yakima River, as compared to the Naches River, since flood events are typically larger. Current terms used in flood warnings, such as bankfull stage and flood stage, will be used in the association of flood response level with a particular event.

As part of the public education program, the County will be conducting training sessions periodically about the flood response plan and the flood exercise beginning in the Fall 2007. Different entities within the County that are involved in flood response will be participating in the training sessions and the flood exercise. Knowledge gained by the participant will be disseminated to the public through the participant's jurisdiction.

Community Alert Network

Currently, OEM staff must make numerous telephone calls and fax information to a wide range of individuals to inform them of flooding conditions and related actions. The system of manual phone calls and use of a limited number of fax machines is time-consuming and inefficient. Complete or partial automation of this system would allow a greater number of individuals to be contacted in a shorter period of time and provide more time for OEM staff to pursue other activities.

One option is to create an automatic telephone notification system, such as provided by the Community Alert Network (CAN). CAN will store all relevant phone numbers in its database. During a flood emergency, the OEM can contact CAN to record an emergency message, and specify the phone numbers that should receive it. Phone numbers to be called can include all residents (inundated parcels) generated for each specified flood event, specific governmental personnel including police, fire, public services, and political officials, or a combination. Appropriate phone lists should be developed in coordination with CAN prior to the flood event. Yakima County has recently completed this task.

Another option is to purchase additional fax machines or computer systems that can quickly fax emergency information to numerous people. This hardware should be installed at the EOC so that updated emergency information can be quickly distributed to public officials.

Road Closure Database

Managing road closure information is difficult during a flood event. Road closures change rapidly, so relaying accurate and timely information to the public can be a large task. An option to manage this information effectively is to compile a road closure database prior to flood events. The County has created a database for inundated roads for different flood events on the lower Naches River. Flood water is reported as both a minimum and maximum water depth

for the inundated roads. Road closures will depend on the depth and velocity of flood water on the roads. Where combinations of water depth and velocity are identified as a hazard, the roads will be closed. Similar inundation maps will be generated for the remainder of the study area along the Yakima River. Having this database in place allows public officials to respond quickly to potential road closures areas as the river stage approaches the predicted closure stage. This would result in more efficient use of river watch teams and allow more accurate and timely communication to the public on road closures.

Supply of Emergency Response Equipment

During a significant flood event, citizens typically express concern about adequate availability of sandbags for flood protection. Historically, Yakima County OEM or Public Services supplied sand for sandbags; however, Public Services does not supply sandbags, but OEM will deliver sandbags to fire stations for distribution. The County should adopt this as a formal policy. Yakima County Flood Response Plan has a new policy related to sand bag distribution/storage and emergency usage:

> "Yakima County will provide sand and/or sandbags to the residents of Yakima County for the purpose of protecting private property from flooding when local supplies of sand and/or sandbags have been exhausted and/or Proclamation of Emergency has been declared by the Board of County Commissioners or by proper authority."

The policy should continue to be communicated to the public so that they are aware of availability or non-availability of sandbags from public agencies.

During the February 1996 flood event, County maintenance crews also had difficulty obtaining an adequate supply of barricades for road closures. The County's supply was insufficient to cover the extent of the February flood. The County should purchase additional barricades or secure a private source of barricades for use during a flood event. Using a private source of barricades seems most appropriate, since they will be used only during significant flood events.

If no action is taken, the current preparedness and warning systems would be activated in the event of a flooding emergency. Residents would be notified of flood events primarily through public announcements and outreach by the Yakima County Sheriff. The Office of Emergency Management would operate its Emergency Operations Center (EOC) in cases of flood emergency, using information obtained from Yakima County/Surface Water Management Division, Bureau of Reclamation, and other sources to advise evacuation and response.

Preferred Alternative and Recommended Actions

Implementation of the following actions are recommended to improve the level of flood preparedness in the Yakima Valley:

Short-term

- Formalize procedures for dispatching field teams and volunteers to critical locations along rivers and creeks to manually collect real-time river information
- Finish compiling time delays from the BOR in flood peaks between locations along the Yakima River for various flood magnitudes

- Continue reviewing and compiling information on past flood events to create a database that correlates road closures with river stage and discharge
- Develop and communicate to the public a policy on sandbag distribution during flood events (use periodic public outreach methods to reiterate this policy).

Long-term

- Develop a flood inundation map for distribution to the public
- Install real-time, automatic gauging stations within the upper watershed of tributary creeks
- Create a Community Alert Network for use at the EOC.

RW18—Community Rating System (21)
RW7—Flood Insurance and Public Education (28)

Problem Definition

The cost of federal flood insurance and the lack of knowledge about the federal flood insurance program may limit homeowners from purchasing flood insurance. In addition, the lack of public knowledge about flood hazards may result in lack of appreciation of the magnitude of the flood threat and associated risks an individual property owner faces, thereby limiting property owner involvement in the flood insurance program or taking proper steps to floodproof their property. Lack of public education is displayed in a newspaper account describing the November 1990 flood (*Yakima Herald*, November 28, 1990). Yakima Valley residents were quoted as saying "I didn't even think of this [floodwaters] hitting us" and "We didn't know what to do."

The County is currently pursuing entry into the CRS program.. The CRS program, administered by FEMA, provides a reduction in flood insurance premiums for communities that initiate flood protection activities beyond the minimum NFIP requirements, such as flood hazard management planning. Many of the activities that earn credit through the program involve public education about flood hazards, flood insurance, and flood protection. It is anticipated that membership in CRS will help increase public knowledge of flood risks in our area.

Discussion of Alternatives

The overall benefit of increasing public education of flood hazards is the long-term reduction of flood damage and possible reduction in flood insurance premiums. As shown in Table 8-10, $866,675 has been paid in claims since 1978 for all jurisdictions in Yakima County. This is equivalent to approximately $30,400 in claims per year. Comparing average annual claim amounts to the annual premiums of $347,294 shows that Yakima Valley residents are paying annual premiums over 11.4 times larger than average annual claims. This is significantly greater than in Washington State as a whole (4.9). This shows that Yakima County residents are paying a larger portion for flood insurance. This may be a result of Yakima County not

experiencing a significant flood event between 1978 and 1994, minimal citizen participation in the NFIP, or high flood insurance rates.

Review of the data presented in Table 8-10 also reveals that the City of Selah's paid insurance claims are high compared to the number of current polices. This may be attributed to repetitive losses experienced near Naches Avenue East. In addition, the number of current policies in Yakima County is low compared to the number of private parties requesting disaster assistance following the February 1996 flood: 401 policies and 1,782 people requesting assistance. This indicates the limited use of flood insurance throughout the County.

TABLE 8-10
NATIONAL FLOOD INSURANCE PROGRAM AS OF JUNE 30, 2006

Community	Current Number of Policies	Annual Premium	Total Coverage (1,000)	Claims Since 1978	Dollars Paid Since 1978
Yakima County (unincorporated)	592	$347,294	$87,301	175	$866,675
City of Yakima	22	$11,501	$4,417	9	$14,964
City of Selah	5	$7,068	$864	38	$537,239
City of Union Gap	14	$4,214	$1,715	1	$3,291
Study Area Total	633	$370,077	$94,297	223	$1,422,169
Washington State Total	32,092	$18,041,623	$5,722,096	8,090	$104,195,930

SOURCE: FEMA 2006.

The CRS program gives communities credit for implementing flood reduction activities that result in a reduction of flood insurance premiums. CRS credits are available for 18 categories of flood hazard reduction activity. The number of credits received in each category depends on the degree to which CRS objectives are achieved. The total number of credits earned in all categories determines the class level assigned to the community. The CRS provides for 10 classes, Class 1 having the highest credit and Class 10 for communities receiving no credit. A community is automatically a Class 10 community unless it applies for a CRS reclassification and shows that the activities it is implementing warrant a better classification. A minimum of 500 points is needed to receive a CRS classification of Class 9, which will reduce premium rates. Activities for which points are awarded under the CRS are shown in Table 8-11.

If the County submits CRS documentation for current flood reduction programs and various alternatives recommended in this CFHMP, it is estimated that over 1,500 credit points would be earned. This would give the County a Class 7 rating, potentially reducing annual flood insurance premiums by 15 percent in addition to reducing the potential for flood damage.

A key element of the CRS is public education. The overall objectives of an educational program for government representatives and local citizens include the following:

- Develop community awareness and understanding of flood hazards

- Provide instructions on where and when to obtain information during flood emergencies
- Describe the appropriate actions in response to flood emergencies.

These objectives can be met through educational opportunities, including the following:

- Distributing educational material on preventive flood-control measures to libraries, public offices, and chambers of commerce
- Publishing newspaper articles on flood hazard management and the County's early warning system during the pre-flooding season

TABLE 8-11.
FEMA COMMUNITY RATING SYSTEM ACTIVITIES

300	**Public Information Activities**
310	Elevation Certificates: Maintain FEMA elevation certificates on new buildings in the floodplain and make copies available upon request.
320	Map Determinations: Respond to inquiries to determine what Flood Insurance Rate map zone a property is in and publicize this service.
330	Outreach Projects: Send information about the flood hazard, flood insurance, and flood protection measures to residents.
340	Hazard Disclosure: Ensure that potential purchasers of flood-prone property are aware of the flood hazard through disclosure by real estate agents or deed records.
350	Flood Protection Library: The public library maintains and publicizes references on flood insurance and flood protection.
360	Flood Protection Assistance: Give inquiring property owners technical advice on how to protect their buildings from flooding and publicize this service.
400	**Mapping and Regulatory Activities**
410	Additional Flood Data: Develop new flood elevations, floodway delineations, etc., or have the flood insurance study based on higher standards.
420	Open Space Preservation: Guarantee that portions of currently vacant floodplain will be kept free from development.
430	Higher Regulatory Standards: Adopt building and development regulations with higher standards than the minimum NFIP requirements.
440	Flood Data Maintenance: Keep flood and property data on computer records or better base maps, maintain elevation reference marks.
450	Stormwater Management: Require new developments throughout the watershed to ensure that their stormwater runoff will be no greater than the runoff from the sites before development.
500	**Flood Damage Reduction Activities**
510	Repetitive Loss Projects: Develop and implement a plan to reduce damage in repeatedly flooded areas.
520	Acquisition and Relocation: Acquire or relocate flood-prone buildings so that they are out of the floodplain.
530	Retrofitting: Document floodproofed or elevated pre-FIRM buildings.
540	Drainage System Maintenance: Conduct periodic inspections of all channels and retention basins and remove debris as needed.
600	**Flood Preparedness Activities**
610	Flood Warning Program: Provide early warnings and have a detailed plan keyed to flood crest predictions.
620	Levee Safety: Maintain levees that are not credited with providing base flood protection.
630	Dam Safety: Credit dependent upon state dam safety program.

- Distributing flood inundation maps
- Developing and distributing a video on flood hazard management
- Publicizing and conducting emergency preparedness classes as developed by FEMA and the Red Cross
- Conducting outreach programs to citizens in high flood hazard areas to educate them on flood hazards, floodproofing, preparing for flood events, flood insurance, floodplain development permit requirements, and natural and beneficial functions of the local floodplain
- Holding annual flood exercises to exchange information among government officials and review procedures in preparation for the flood season.

Dedicated staff is required to implement an effective public education program. The County should dedicate a public education officer (PEO) to manage such a program. The PEO should be trained in floodplain issues. PEO responsibilities would include managing and implementing the educational opportunities listed above, in addition to administering the local CRS. The PEO would coordinate with FEMA, Ecology, resource agencies, and local departments of Emergency Management and Public Services (including Planning Division).

If no action is taken, County floodplain residents will continue to be uninformed about the NFIP, magnitude of flood hazards, and property protection alternatives, and will possibly pay higher flood insurance premiums.

Preferred Alternative and Recommended Actions

To increase public education and reduce flood insurance premiums the following actions are recommended:

- The County should hire a public education officer to manage a public education and CRS program
- The County should enroll in the CRS using a "short form" (Appendix E of the CRS Coordinator's Manual). The purpose of the short form is to assist a jurisdiction with at least 500 credit points to achieve a Class 9 rating quickly and realize immediate savings on policy premiums. The full application containing additional details may be completed at a later date to realize additional savings
- The County should submit the full set of required documentation to update its CRS rating following adoption of the CFHMP. Full application will provide the largest benefit when many of the structural and nonstructural recommendations of the CFHMP have been implemented. Many of the CFHMP recommendations would receive CRS credit.

RW15—Use of Geographic Information System (GIS) Data (23)

Problem Development

The County GIS system can be a valuable tool for flood hazard management, County planning, and building permit review. GIS data can be used to identify parcels within the floodplain,

maintain an inventory of flood control works, and show elevation requirements for floodplain development. However, the County has not yet achieved full integration of GIS into the floodplain management, planning, and permitting processes.

Discussion of Alternatives

GIS offers numerous applications that could support planning decisions and increase the efficiency of permit reviews. The following GIS applications are examined as ways to improve flood hazard management and permit reviews:

- Integrate digital FIRM and floodway maps from FEMA into the County's GIS.
- Create GIS coverages that include information on historical flood damage areas, road closures, emergency transportation routes at various flood stages, and accurate topographical data.
- Integrate GIS into the permit process by generating reports to be used for pre-application conferences.
- Continually update the GIS parcel database to reflect annual rezones, comprehensive plan amendments, and updates to critical flood hazard information.

Digital Flood Insurance Rate Maps

FEMA is the agency responsible for creating, updating, and distributing Flood Insurance Rate Map (FIRM) information to local governments and other private sector users. As the development of GIS systems expanded during the 1980s, FEMA investigated the potential of digital versions of traditional FIRMs. These would allow rapid reproduction of FIRMs, as well as the distribution of flood hazard data contained within them to GIS systems throughout the country. This allows the FIRM data to be used in conjunction with other data contained in a jurisdiction's GIS to correlate the potential for flooding with other community variables. Beginning in 1992, FEMA initiated a program to develop digital FIRMs that would accomplish these purposes.

There are currently four distinct types of digital flood hazard data available from FEMA under the DFIRM program (DFIRM, DFIRM-DLG, FIRM-DLG, and Q3 Flood Data). Each of these types of data serves a distinct purpose, and is generated according to different specifications. The choice of data to obtain and use depends wholly upon the task to be performed, and extreme caution should be used in selecting the data format to use. The four data types are summarized in Table 8-12.

TABLE 8-12.
DIGITAL FLOOD INSURANCE RATE MAP FORMATS

Name	Description	Contents	Uses	Availability
DFIRM	Literally, a digital FIRM. The DFIRM becomes the official record for purposes of the NFIP, taking the place of a hardcopy FIRM	Base map, graphics, text, shading, other geographic and graphic information specific to standards	To produce (plot) hardcopies of FIRMs	Limited
DFIRM-DLG	Flood risk thematic data extracted from DFIRMs	100-year and 500-year floodplains, SFHA designations, floodway boundaries, hydrographic features, political boundaries, BFEs, cross sections, roads and names, elevation references, FIRM panels, USGS 7.5′ quads	To distribute contents of DFIRMs to GIS systems through public-domain format (USGS DLG3). These can then be used to perform floodplain and elevation determinations, and a variety of other engineering applications	Limited. Availability is limited to jurisdictions for which DFIRMS have been completed
FIRM-DLG	Digitized or scanned version of an original hardcopy FIRM for counties in which no DFIRM has been prepared; FIRM remains official NFIP record	100-year and 500-year floodplains, SFHA designations, floodway boundaries, hydrographic features, political boundaries, BFEs, cross sections, roads and names, elevation references, FIRM panels, USGS 7.5′ quads.	To distribute contents to GIS systems through public domain format (USGS DLG3). These can be used to perform floodplain and elevation determinations according to FEMA's "Good Faith Standards". They also will support a variety of other engineering functions traditionally performed using a hardcopy FIRM	Less limited than DFIRMS or DFIRM-DLGs, but not widely available nationwide
Q3 Flood Data	Scanned and vectorized representations of existing hardcopy FIRMs without elevation data; does not replace existing FIRMs or DFIRMs as official NFIP documentation.	100-year and 500-year floodplains, SFHA designations, floodway boundaries, political boundaries, FIRM panels, USGS 7.5′ quads. Q3 data maintains no horizontal control	To make widely available a selection of characteristics from the hardcopy FIRM for purposes of planning, flood insurance marketing, and partial compliance with CRS objectives. May be used in conjunction with other GIS data of similar scale to perform floodplain determination, but must be checked against existing FIRM. Not to be used for engineering applications such as BFE determination. The end user accepts responsibility for the accuracy and appropriate use of this data.	Will be distributed for 880 counties nationwide in 1996

Given the range of data being generated, it will be important for the County to define objectives for the flood hazard data, and to design meaningful applications appropriate to the scale, content, and quality of the data selected. The following objectives should be followed to evaluate the selection and use of digital flood information.

- *Accuracy:* Establish definitive and accurate representations of the floodway, 100-year floodplain, Special Flood Hazard Areas (SFHAs), and Base Flood Elevations (BFEs)
- *Completeness:* Ensure that all of the items listed above are present in the GIS database and that the database includes all jurisdictions within Yakima County
- *Accessibility:* Enhance the County's ability to perform floodplain determinations, measure areas of SFHAs, determine BFEs of specific locations, and realize time savings in the permit process
- *Community Review:* Ensure that sufficient local review of flood hazard information has occurred prior to release of that data for public use.

In order to achieve fully the objectives set forth, the County must continue to demand DFIRM or FIRM-DLG data from FEMA, or must seek some process to generate the data internally based on manuscript FIRMs (essentially creating its own version of a FIRM-DLG). Without the advantages afforded by base flood elevation information, accurate placement of features, and official record status, Q3 data are little more than a public information and flood insurance marketing tool. While that may be entirely appropriate for response/recovery applications and general planning use, when it comes to the review of a development proposal or rating of a flood insurance policy, practitioners still must resort to manuscripts and documentation because the federal government has not provided jurisdictions digital data of sufficient scale and detail to accomplish these tasks. Until FEMA provides the County a DFIRM, DFIRM-DLG, or FIRM-DLG, the objectives listed above cannot be met in whole, and the reliability of conclusions reached using digital flood data must continue to be questioned.

Additional Flood Hazard Data Development

In addition to flood hazard data from a FIRM or FIS, the County has the ability to assemble additional GIS coverages that describe historical flood damage areas, road closures, emergency transportation routes at various flood stages, and accurate topographical data.

Historical flood damage can be recorded based on preliminary damage assessments, individual assistance applications, and damage survey reports conducted following floods declared federal disasters. FEMA has begun compiling this information as point surveys using a GIS. Each application or survey is geocoded as it is entered into the disaster application system, allowing for creation of point coverages that maintain all attributes of the application or survey. Similar coverages have also been created by researching past disasters and coding results in order to measure repetitive damage. Privacy issues surround release of this data to the public because some of the attributes of an application for disaster assistance, such as the name and address of each applicant, violate privacy act regulations if they are released for use beyond their direct purpose (the distribution of federal aid). However, once the data have been geocoded and points created, any privacy-sensitive attributes can easily be dropped from the attribute tables, creating a valuable indicator of the extent of a disaster that would be available to the public. Collection and distribution of these data are still in an infancy stage. The County should explore with FEMA the possibility of obtaining this information for use in the future.

The County Public Services Department also maintains a record of roads (by log number) closed during major flood events. GIS was used to log these data during the February 1996 event. It would benefit the County to create additional coverages to show damaged and closed roads during each of the major historical floods analyzed in the CFHMP. Alternative emergency routes should be defined for each affected road segment and added to the GIS. Trends over time would also be useful in the creation of a database that catalogues which roads are affected and should be closed at specific river stages on the mainstem or tributaries of the Yakima River.

The road closure database would be one of the most useful applications of flood hazard data afforded by the GIS. For each road in each affected area, a range of flows observed in the associated stream should be developed to dictate if a warning should be issued, which alternative emergency routes should be activated, and if the road should be closed. These thresholds (warning, emergency route activation, road closure) should then be integrated with corresponding levels of response initiated by OEM during a flooding activity (warning, alert, emergency). The EOC would be an appropriate place to maintain this GIS database.

Permit Process

EHSB 1724 (1995), a new regulatory reform law, streamlines local land use permitting, enhances public notice, and establishes new procedures for judicial appeal of local land use decisions. This law requires local governments to combine environmental review with their project permit process and provide for no more than one open-record hearing and one closed-record appeal. The law also requires that the County's shoreline master program be an element of the comprehensive plan. Due to the limited number of hearings and appeals, as well as the requirement to accomplish environmental and permit review concurrently, quick access to a wide range of accurate information is vital to the successful completion of pre-application hearings. If a local agency can supply the developer with detailed information on requirements during this hearing, both parties may save time over the course of permit approval.

GIS can be used in a data-rich environment such as Yakima County to provide valuable data for use in the permit process. The GIS could construct a pre-application report driven by the parcel number, legal description, or general location of a proposed project. The report can be constructed as a macro that queries all critical areas, zoning, and floodplain status, and returns mitigation requirements sensitive to the location and desired use of the proposed project. Zoning information should return permitted and conditional uses, as well as factors that may force a variance from the Urban Area Zoning Ordinance and County Zoning Ordinance. Flood information should include the SFHA designation and BFE of the site, and should provide a listing of mitigation and absolute elevation requirements sensitive to the location and desired use from the Critical Areas Ordinance. Additional mitigation requirements for steep slopes, geologically hazardous areas, wetlands, and forest resource areas should also be queried and listed in the report. The results may be output in report and map format and given to the developer at the conference. Interpretation of actual project impact should still take place using the professional discretion of the Planning Division, but the report provides a screening tool that would be useful early in the permit review process.

Updates to GIS Information

The County should continue to update and review the contents of its GIS database as it is doing now. System updates should occur after annual rezones and comprehensive plan amendments following a release of new FIRM products, and after parcel boundary changes due to subdivisions. Changes to information obtained from the County Assessor would be automatically incorporated via an external link to the Assessor's database.

Preferred Alternative and Recommended Actions

To accomplish objectives for the use of GIS in day-to-day flood hazard management activity, the County should perform the following actions:

- Obtain from FEMA the best available digital flood hazard map that meets the objectives listed above
- Assemble GIS coverages documenting closed and damaged roads from historic flood events discussed in the CFHMP. Analyze spatial trends relative to stream stage levels to build relationships between flow rates and road closures
- Obtain flood damage GIS coverages for recent and historical floods as they become available from FEMA. Observe privacy act requirements in reporting this information
- Construct a GIS permit review tool, which will also substantially increase the effectiveness of evaluating flood hazards over the long term
- Continue Standard GIS data updates.

OSA1—Continued Flood Damage Outside the CFHMP Study Area (26)

Problem Definition

Damage from the earliest recorded floods was concentrated in the Mid-Valley area. Following the construction of levees along the Yakima mainstem, damage became more concentrated in the Lower Valley and along tributary streams. Ahtanum, Bachelor, Wide Hollow, Wenas, Toppenish, and Satus Creeks repeatedly produce flood damage. The Yakima and Upper Naches rivers also encroach on homes and inundate roads in the communities of Toppenish, Wapato, Parker, Buena, Naches, and Gleed.

Discussion of Alternatives

As revealed in the descriptions of historical floods (Chapter 4), over 80 percent of the flood damage resulting from the February 1996 event occurred outside the CFHMP study area along tributary creeks. To address flooding in these areas, additional planning needs to be conducted. The CFHMP planning process, as described in Chapter 1, can be easily applied to other drainage basins located throughout the County. Expanding planning to include additional drainage basins would provide guidance to reduce flood hazards, correct poor floodplain management practices, and guide further land use changes. If no action is taken, flood damage will continue to occur.

Preferred Alternative and Recommended Actions

To address flood damage outside the study area, the following actions are recommended:

- The County should expand CFHMP planning to other areas of the County on a watershed basis. Planning should be concentrated on high-damage areas such as Ahtanum, Bachelor, Wide Hollow, and Wenas Creeks, and the Upper Naches and Lower Valley. Planning should begin now by documenting flood issues from historical floods and during future flood events
- The County together with applicable local jurisdiction adopt a Comprehensive Stormwater Management Plan to reduce localized flooding in the Yakima urban areas.

MR6—Flood Damage to Greenway Path near Boise Cascade Pond (32)

Problem Definition

Portions of this levee are currently used by the Yakima Greenway as a bike path. During the February 1996 flood, the pathway breached at several locations downstream of the R Street underpass near the Boise Cascade Pond upstream of the trestles. This caused an estimated $72,000 in damage to Yakima Greenway facilities. None of the levels in this reach overtopped or breached during 1996. Avulsion of the Yakima River into the Boise Cascade Pond may have implications such as downstream effects to other levees and could alter sediment deposition upstream and downstream of the avulsion.

Discussion of Alternatives

To evaluate the potential for flood hazard reduction in this area, the following alternatives were examined:

- Relocate the pathway levee to an area with a lower potential for overtopping and erosion
- Install culverts in the damaged pathway levee to minimize overtopping, and construct an overflow channel
- Build the pathway levee using higher design standards
- Rebuild the pathway levee to pre-flood conditions.

Advantages and disadvantages of each alternative are summarized in Table 8-13. Many of the alternatives are quite costly in comparison with the potential reduction in damage. Each alternative provides a limited incremental increase in property protected or reduction in potential flood damage. Reducing damage from that which occurred during the February 1996 flood (estimated at $72,000) may not justify the cost of many of the alternatives.

TABLE 8-13.
ALTERNATIVES FOR BOISE CASCADE LEVEE PATHWAY

Alternative	Plan Level Cost Estimate	Advantages	Disadvantages
Relocate the pathway levee to an area that has lower flood damage potential without repairing existing levee	$300,000	• Reduces potential for pathway overtopping and eroding • Opens additional floodplain area for floodwater conveyance and storage • Reduces pathway maintenance	• Increased flood risk for property behind existing pathway • Pathway would be located closer to the freeway • Cost
Rebuild the pathway levee to pre-flood conditions with higher design standards	$132,000	• Maintains flood protection to property behind pathway • Reduces potential for erosion	• Continued maintenance and repair costs • Reduces potential right overbank floodplain storage and conveyance area during small flood events
Replace pathway levee to pre-flood conditions	$72,000	• Maintains flood protection to property behind pathway	• Continued maintenance and repair costs • Reduces potential right overbank floodplain storage and conveyance area during small flood events

Preferred Alternative and Recommended Actions

Based on the selection criteria described in Chapter 7, the selected alternative is to rebuild the existing pathway levee using higher design standards. This is the only alternative for which potential benefits exceed costs. Potential public benefits associated with other alternatives do not justify the additional cost. Therefore, the following actions are recommended:

- Rebuild the existing Greenway pathway levee to pre-flood conditions; however, install additional embankment protection by applying heavy riprap in the highly erosive areas. This was accomplished following the February 1996 flood.
- Establish a maintenance budget for Greenway facilities. Rebuilding to higher design standards will reduce damage during smaller flood events, but damage should be expected during large events due to the location of the facilities. Establishing a maintenance budget would provide funds to repair facilities after significant flood events.

LR6—Spring Creek Backwater Flooding (29)

Problem Definition

Historically, Spring Creek conveyed Yakima mainstem floodwaters upstream of Union Gap. Flooding along Spring Creek was reduced with the installation of a floodgate in 1985 near the Valley Boulevard interchange, preventing Yakima floodwater from entering Spring Creek during high flows on the Yakima River. However, during significant flood events, the Yakima River rises to a level that inundates the southeastern portion of Union Gap, with floodwaters near Union Gap extending into the Ahtanum Creek drainage. If high flow is also experienced on Ahtanum Creek, the flooding can be aggravated. Floodwaters inundate residential and public property located near the mouths of Spring, Wide Hollow, and Ahtanum Creeks. In this area, flood damage has occurred to mobile homes and the City of Union Gap sanitary sewer pump station.

Discussion of Alternatives

Southeastern Union Gap floods under the following conditions:

- The Yakima mainstem inundates areas near the mouths of Spring, Wide Hollow, and Ahtanum Creek due to the floodplain topography
- Tributaries of the Yakima River (Ahtanum and Wide Hollow Creeks) experience high flow, causing overbank flooding due to inadequate conveyance capacity (HDR 1993)
- A combination of the two.

Significant structural modifications to the Yakima River floodplain would be required to reduce or eliminate flooding in southeastern Union Gap during significant flood events on the Yakima mainstem or during Yakima mainstem flooding combined with tributary flooding. Floodwaters on the Yakima mainstem would need to be contained east of I-82; floodwaters on Ahtanum Creek would need to be contained south of the railroad grade; Wide Hollow Creek would require a high-flow diversion and a closure structure would need to be constructed near the mouth of Wide Hollow Creek. This would potentially involve raising I-82, raising the railroad grade, constructing a high-flow channel for Wide Hollow Creek, and constructing a closure structure. The financial feasibility of this type of solution is highly unlikely given the anticipated benefits. Therefore, it seems more appropriate to address only the flood damage associated with tributary flooding and to prepare residents within the existing floodplain for flooding during significant events.

The City of Yakima's draft Comprehensive Stormwater Management Plan (HDR 1993) recommended a high water overflow channel within the Wide Hollow drainage to reduce flood damage. The project would redirect high flows in Wide Hollow Creek away from the City of Union Gap. A proposed diversion structure would pass low flows into the existing channel but divert high flows to the south between the two existing railroad embankments. This project would reduce flood damage when Wide Hollow Creek is experiencing high flow; however, flooding is likely to continue when high water is also present on the Yakima mainstem.

As of April 25, 1996, FEMA had five requests for private disaster assistance in the southeastern portion of Union Gap near the confluence of Wide Hollow Creek and Spring Creek. The amount of damage is currently unknown. Many of the residents in this area have experienced flood damage in the past and have taken precautionary measures by floodproofing or purchasing flood insurance. However, additional floodproofing, such as elevating, should be promoted to residents in this area who continue to experience flood damage. Floodproofing is also appropriate for the City of Union Gap's pump station in this area. Elevating the electrical panel or building a flood wall to prevent floodwater from entering the pump station could reduce damage at this public facility.

Preferred Alternative and Recommended Actions

To address flood damage within southeastern Union Gap, the following actions are recommended:

- Integrate floodproofing techniques into the City of Union Gap's pump station
- Promote floodproofing and flood insurance to Union Gap residents who experienced damaged during the February 1996 flood
- Construct the Wide Hollow Creek high-flow bypass as recommended in the 1993 draft City of Yakima Comprehensive Stormwater Management Plan for the urban area, with the knowledge that severe flooding on the Yakima mainstem will continue to flood this area. Prior to final design, maximum flow through the low-flow channel

should be determined using the Yakima River flood stage as a boundary condition and integrating considerations for a temporary closure structure near the mouth of the low-flow channel

- Conduct a comprehensive drainage study for the Ahtanum Creek watershed as recommended in issue OSA1—Continued Flood Damage Outside the CFHMP Study Area.

MR7—Flood Damage to Robertson Landing (30), and UR3—Flood Damage to Harlan Landing (33), and UR4—Inundation of Elks Golf Course (34)

Problem Definition

Robertson Landing is located along the right bank of the Yakima River just upstream of the SR 24 bridge; Harlan Landing is on the left bank just upstream of the mouth of the Naches River. Flooding occurs frequently at these sites due to their location, resulting in loss of boat ramps and picnic areas, deposit of sediment in parking areas, and damage to pathways.

The Elks Golf Course is adjacent to the Yakima River directly upstream of Selah Gap; portions of the course are in the Yakima River floodway. Flooding occurs frequently here as well due to the location, causing sediment deposition and localized erosion throughout the golf course.

Discussion of Alternatives

Within the floodplain, recreational land use is preferable to urban development to limit potential flood damage. However, it should be understood that some flood damage will continue given the location of the facilities. A portion of the golf course and numerous Greenway facilities are located in the Yakima River floodway. Therefore, they will be subject to repetitive flooding and erosive action of floodwaters. Short of removing the facilities from the floodway, the only alternatives to reduce flood damage would be to use higher pathway design standards, remove temporary structures (e.g., picnic tables and trash cans) prior to impending floods, floodproof permanent structures (e.g., vaulted bathrooms and golf course structures), and monitor development so that flooding conditions do not become worse in the future.

Preferred Alternative and Recommended Actions

The following actions are recommended to minimize damage to Greenway and Elks Golf Course facilities:

- Floodproof repetitively damaged structures by moving them to a higher elevation or installing flood walls or sealant

- Rebuild Greenway pathways to higher design standards such as using more erosion-resistant embankment protection
- Establish a maintenance budget to provide funding for the repair of inevitable future flood damage to roadways, pathways, and the Elks Golf Course
- Establish flood response teams to remove temporary structures prior to a impending flood event
- Educate Greenway users about flooding by installing interpretive signs near damaged sites that describe floodplains, floodways, effective floodplain management, and how various actions can aggravate flooding and flood damage
- Continually monitor cumulative effects of development in the area to limit the potential of aggravating flood damage.

The following table (Table 8-14) summarizes the recommended actions discussed above in this chapter and are listed by priority of potential damage of the flood issue as defined above.

Table 8-14
Summary of Recommended Actions

Potential damage	Actions	Types Of Action	Issues Addressed
1	Reconfigured levees upstream of SR24 should tie into the new SR 24 bridge abutments. On the east side of the river, levee setback would begin upstream of the Old Moxee bridge and continue to the SR 24 alignment.	Structural	LR5
2	Remove the western Old Moxee bridge abutment, located upstream of new SR24 alignment.	Structural	LR5
3	Levees Downstream of SR24, on the east side of the river will be set back to allow the incorporation of the Newland Pits into the floodplain. The levee should be located west of Blue Slough for a distance of approximately 2,300 feet south of SR 24, then crossing the slough and continuing downstream.	Structural	LR5
4	Levees Downstream of SR24 on the west side of the river, currently protecting Yakima WWTP should be repaired to ensure protection of the WWTP itself and maintain the ability of the City of Yakima WWTP to continue to discharge in conformance with state law.	Structural	LR5
5	Setback of the levees downstream of SR 24 should not occur until the WWTP's ability to continue to discharge is assured.	Non-Structural (Regulatory)	LR5
6	The opportunity exists at the Beech Street Pit location for widening of the channel and improving (for sediment transport) the configuration of the levee system by setting back the levee opposite from the pit and this action should be taken. Spur dikes and additional bank protection are recommended along the Beech Street levee to reduce levee erosion. Spur dikes recently installed at the East Selah Gravel Pit should be monitored during flood events to ensure that they are protecting I-82 and the East Selah Pit levee.	Structural	UR5, MR2,
7	To reduce the potential for avulsion or levee failure at the Buchanan Lake/Beech Street Pit over the long term (i.e., in approximately 15-20 years or sooner if possible), the existing Terrace Heights bridge should be modified to improve sediment transport and reduce the concentration of energy downstream, especially against the levee that protects the Beech	Structural	UR5, MR2,

Table 8-14
Summary of Recommended Actions

Potential damage	Actions	Types Of Action	Issues Addressed
	Street Pit.		
8	In addition, an inventory of the existing structural adequacy and capacity of all levees that protect existing floodplain mines and pits should be undertaken.	Study	UR5, MR2,
9	*Existing Gravel Mining Sites*: Due to the location of the East Selah Gravel Pit, large flood events will continue to affect the property in this area. Following gravel extraction, long-term modifications should include a levee designed to overtop during large flows.	Structural	UR5, MR2,
10	*Future Gravel Mining Sites*: Development of future gravel extraction sites in the floodplain of the Yakima River and Naches River will be driven by the Yakima County Comprehensive Plan.	Non-Structural (Regulatory)	UR5, MR2,
11	The Flood Control Zone District should work with BIA, BOR, and other interested parties in replacing or modifying Wapato Dam to pass bedload and fine sediment.	Structural	LR3
12	The levees at Union Farms also act as a choke point in this section of the river forcing the river against I-82, and taking a fairly large amount of floodplain surface out of the active floodplain. Removal of these levees would relieve the pressure against I-82 and lower flood elevations by allowing the river to expand across a larger floodplain.	Structural	LR3
13	Develop a high water elevation database to evaluate changes in river channels	Study	LR3
14	Adopt and follow the proposed *Plan 2015* County policy for management of the riverine environments.	Non-Structural (Regulatory)	LR3
15	Add compensatory storage requirements to the County's CAO.	Non-Structural (Regulatory)	LR3
16	The WSDOT should construct barbs similar to the existing downstream barbs to protect I-82. The Spring Creek gate should be reinforced to prevent failure during a future flood event or avulsion caused by pit capture. A new channel for Spring Creek (approximately 550 feet in length) should be constructed outside of the I-82 clear zone, with fish habitat elements installed in this new channel.	Structural	LR7
17	Obtain additional high water elevations throughout the floodplain resulting from the February 9, 1996, flood	Study	RW1
18	Obtain accurate topographic data throughout the floodplain specifically for the left bank levee and floodplain downstream of the SR 24 bridge, I-82, and the floodplain near East Selah	Study	RW1
19	Once this data is obtained, a new hydrologic and hydraulic analysis should be performed to FEMA standards, this will allow the design of the facilities specified above in issue LR5, and shorten the time needed to amend the FEMA maps after implementation of those actions.	Study	RW1
20	Revise base floodproofing and elevation building standards based on February 9, 1996, high water data.	Non-Structural (Regulatory)	RW1
21	Submit certification forms and supporting data to FEMA to obtain a Map Revision in Union Gap following FEMA guidelines (FEMA 1990).	Study Non-Structural (Regulatory)	RW1
22	Request that FEMA produce a digital floodplain map that combines all jurisdictions and reflects recent data for use in the	Study	RW1

Table 8-14
Summary of Recommended Actions

Potential damage	Actions	Types Of Action	Issues Addressed
	County's GIS.		
23	Given the long-term nature of this type of flood hazard (channel migration, sediment accumulation, erosion), a study to determine these values and to monitor sediment transport and energy should be implemented.	Study	RW20
24	Retirement of the Fruitvale Diversion and Consolidation with the Current Nelson Dam Diversion.	Structural	NA1
25	Implementation of Bank Protection on US Highway 12 at the 16th Avenue Exit.	Structural	NA1
26	Review the adequacy of dedicated funds versus projected costs.	Non-Structural (funding)	RW13
27	Actively pursue state and federal grant programs to supplement funding provided by flood control district (see Tables 9-1 and 9-3, in Chapter 9).	Non-Structural (funding)	RW13
28	Adopt a funding policy similar to polices developed in *Plan 2015*.	Non-Structural (funding)	RW13
29	Investigate the value and need for sub-zones within the FCZD.	Non-Structural (funding)	RW13
30	Provide direction and support to secure funding for large scale actions which involve cooperation across jurisdictions and agencies	Non-Structural (funding)	RW13
31	Require disclosure of floodplain status in the subdivision ordinance for all newly created parcels.	Non-Structural (Regulatory)	RW6
32	Based on the county-wide road closure database, prioritize roads requiring flood damage mitigation.	Structural	RW12
33	The County should implement bank protection projects following established guidelines (e.g., King County 1993 or ISPG, 2003), modified for Yakima County.	Structural	RW3, LR1, UR1
34	County should provide guidance in designing private bank protection projects.	Non-Structural (funding)	RW3, LR1, UR1
35	Limit development in rapid channel migration areas by promoting the Open Space Taxation Program in a public awareness campaign (see issue RW10—Acquisition/Preservation of Floodplain Open Space)	Non-Structural (funding)	RW3, LR1, UR1
36	Adopt and enforce design standards, such as onsite detention, to limit or mitigate increased erosion potential resulting from new development.	Non-Structural (funding)	RW3, LR1, UR1
37	The FCZD should re-institute an Upper Yakima CFHMP Advisory Committee and hold meetings on an ad hoc basis to assist policy development related to floodplain management.	Non-Structural	RW9, RW8
38	The County should prepare CFHMPs specific to other areas of the County as funding becomes available to provide consistent floodplain management across the County.	Non-Structural	RW9, RW8
39	The County should review and participate in the development of other plans, such as the Watershed Management Plan provided by the Yakima Basin Water Resources Agency.	Non-Structural	RW9, RW8
40	Sections 5.28.020(1)(a), 5.28.020(2), and 5.28.020(3) of the County's CAO should be revised to require all new construction	Non-Structural	RW4,

Table 8-14
Summary of Recommended Actions

Potential damage	Actions	Types Of Action	Issues Addressed
	and substantial improvement, regardless of intended land use, to be elevated or floodproofed.	(Regulatory)	RW5
41	CAO Sections 5.32.010(2) and 5.36.010(2) pertaining to requirements for siting utility lines in the floodway fringe and floodway should be consolidated within Section 4.14 pertaining to siting of utilities in HRCAs.	Non-Structural (Regulatory)	RW4, RW5
42	CAO Section 5.36.010(1) should be deleted.	Non-Structural (Regulatory)	RW4, RW5
43	A new CAO Section 5.28.010(d) should be added as follows: Construction of new critical facilities shall be, to the extent possible, located outside the limits of the base flood plain	Non-Structural (Regulatory)	RW4, RW5
44	The County should determine if each jurisdiction's shoreline ordinance requires mitigation similar to zero-rise methods for the area within 100 feet of the OHWM or floodway. If so, language from the shoreline ordinances should be repeated in each jurisdiction's flood hazard ordinance. If not, Yakima County CAO Section 5.28.010(a)(3) should be replicated in each jurisdiction's ordinance	Non-Structural (Regulatory)	RW4, RW5
45	City jurisdictions should integrate flood hazard items included in the County's CAO.	Non-Structural (Regulatory)	RW4, RW5
46	The County, WDFW, and the Yakama Indian Nation should identify and specifically list fish habitat enhancement areas.	Study	RW2, MR8
47	The County should submit a letter of intent for participation in the COE 1135 program to obtain funding for fish habitat restoration consistent with flood protection within the plan river reaches.	Non-Structural (funding)	RW2, MR8
48	The County should incorporate fish habitat enhancements or mitigation into future flood hazard management projects and gravel pit reclamation.	Non-Structural	RW2, MR8
49	The County should work with FEMA to make flood proofing references and fact sheets available to citizens.	Non-Structural	RW17
50	The County should pursue funding through the Reigle Community Development and Regulatory Improvement Act, Robert T. Stafford Disaster Relief and Emergency Assistance Act, and Flood Control Assistance Account Program.	Non-Structural (funding)	RW17
51	The following are recommended to address operations and maintenance issues: Consolidate maintenance requirements into one document following the steps outlined above Adopt a policy requiring all new flood-control projects to define maintenance responsibilities and a funding source for operations, maintenance, and repairs before acceptance by the County Continually update and maintain a flood control facility inventory database to document the current condition of each flood control facility.	Structural	RW16
52	The County should continue to operate and promote the Open Space Taxation Program	Non-Structural (funding)	RW10
53	The County should continue to cooperate with other agencies such as the Bureau of Reclamation, the Yakama Nation, WDFW, Yakima Greenway, WSDOT to acquire areas of high flood hazard within the CFHMP study area.	Non-Structural	RW10
54	Designate undeveloped County-owned parcels as open space	Non-Structural	RW10
55	Apply design standard of the Greenway Master Plan during Class 2 review of developments within floodplain or Greenway overlay zones.	Non-Structural (Regulatory)	RW10
56	Extend Greenway overlay zoning beyond the Yakima Urban Area within conservation, recreation, and natural areas designated in the Master Plan.	Non-Structural (Regulatory)	RW10

Table 8-14
Summary of Recommended Actions

Potential damage	Actions	Types Of Action	Issues Addressed
57	Pursue funding through state and federal programs to purchase high-hazard floodplain properties or development rights for open space use.	Non-Structural (funding)	RW10
58	During flood events posing risk, formalize procedures for dispatching field teams and volunteers to critical locations along rivers and creeks to manually collect real-time river information. Finish compiling time delays from the BOR in flood peaks between locations along the Yakima River for various flood magnitudes. Continue reviewing and compiling information on past flood events to create a database that correlates road closures with river stage and discharge. Develop and communicate to the public a policy on sandbag distribution during flood events (use periodic public outreach methods to reiterate this policy). Develop a flood inundation map for distribution to the public Install real-time, automatic gauging stations within the upper watershed of tributary creeks. Create a Community Alert Network for use at the EOC.	Non-Structural (Flood Fight)	W19
59	The County should hire a public education officer to manage a public education and CRS program.	Non-Structural (education)	RW18, RW7
60	The County should enroll in the CRS using a "short form" (Appendix E of the CRS Coordinator's Manual).	Non-Structural (funding)	RW18, RW7
61	The County should submit the full set of required documentation to update its CRS rating following adoption of the CFHMP.	Non-Structural (funding)	RW18, RW7
62	Obtain from FEMA the best available digital flood hazard map that meets the objectives listed below: *Accuracy:* Establish definitive and accurate representations of the floodway, 100-year floodplain, Special Flood Hazard Areas (SFHAs), and Base Flood Elevations (BFEs) *Completeness:* Ensure that all of the items listed above are present in the GIS database and that the database includes all jurisdictions within Yakima County *Accessibility:* Enhance the County's ability to perform floodplain determinations, measure areas of SFHAs, determine BFEs of specific locations, and realize time savings in the permit process *Community Review:* Ensure that sufficient local review of flood hazard information has occurred prior to release of that data for public use.	Non-Structural (Regulatory)	RW15
63	Assemble GIS coverages documenting closed and damaged roads from historic flood events discussed in the CFHMP.	Study	RW15
64	Obtain flood damage GIS coverages for recent and historical floods as they become available from FEMA	Study	RW15
65	Construct a GIS permit review tool.	Non-Structural (Regulatory, education)	RW15
66	Continue Standard GIS data updates.	Non-Structural (Regulatory,	RW15

Table 8-14
Summary of Recommended Actions

Potential damage	Actions	Types Of Action	Issues Addressed
		education)	
67	The County should expand CFHMP planning to other areas of the County on a watershed basis. Planning should be concentrated on high-damage areas such as Ahtanum, Bachelor, Wide Hollow, and Wenas Creeks, and the Upper Naches and Lower Valley.	Non-Structural	OSA1
68	The County should adopt a Comprehensive Stormwater Management Plan to reduce localized flooding in the Yakima urban areas.	Non-Structural (Regulatory)	OSA1
69	Rebuild the existing Greenway pathway levee to pre-flood conditions; however, install additional embankment protection by applying heavy riprap in the highly erosive areas	Structural	MR6
70	Establish a maintenance budget for Greenway facilities	Non-Structural (funding)	MR6
71	To address flood damage within southeastern Union Gap, the following are recommended: Integrate floodproofing techniques into the City of Union Gap's pump station Promote floodproofing and flood insurance to Union Gap residents who experienced damaged during the February 1996 flood Construct the Wide Hollow Creek high-flow bypass as recommended in the 1993 draft City of Yakima Comprehensive Stormwater Management Plan for the urban area, Conduct a comprehensive drainage study for the Ahtanum Creek watershed as recommended in issue OSA1—Continued Flood Damage Outside the CFHMP Study Area.	Structural, Non-Structural Study	LR6
72	The following are recommended to minimize damage to Greenway and Elks Golf Course facilities: Floodproof repetitively damaged structures by moving them to a higher elevation or installing flood walls or sealant Rebuild Greenway pathways to higher design standards such as using more erosion-resistant embankment protection Establish a maintenance budget to provide funding for the repair of inevitable future flood damage to roadways, pathways, and the Elks Golf Course Establish flood response teams to remove temporary structures prior to a impending flood event Educate Greenway users about flooding by installing interpretive signs near damaged sites that describe floodplains, floodways, effective floodplain management, and how various actions can aggravate flooding and flood damage. Continually monitor cumulative effects of development in the area to limit the potential of aggravating flood damage.	Structural, Non-Structural (funding, flood fight, education)	MR7, UR3, UR4