



## SECTION 6

# Evaluation of Alternative Flood Hazard Management Measures

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Flood hazard management measures can be categorized as nonstructural or structural. Nonstructural measures refer to land use regulations and policies. Structural measures usually involve the construction of facilities in the channel or floodplain. This section presents both nonstructural and structural alternatives. The feasible measures are evaluated with respect to cost, environmental impacts, funding, schedules, benefits, and the plan goals.

## Nonstructural Management Measures

While structural alternatives for flood hazard management address problems already identified, nonstructural alternatives seek to prevent future problems by addressing the causes of flooding. The key characteristic of a nonstructural approach is that it modifies *susceptibility* to flooding, as opposed to simply attempting to *control* flooding through structural methods such as dams, levees, and channels.<sup>1</sup> Key nonstructural approaches to flood hazard management include the following:

- Land Use Regulations/Permitting
- Accurate Floodplain Mapping
- Inter-Jurisdictional coordination
- Floodplain Conservation Easements
- Educational Materials on Flood Hazard Management
- Flood Warning System
- New Standards for Design, Construction, and Maintenance
- NFIP Community Rating Program

Nonstructural alternatives also include measures that homeowner's can take to protect their homes from flood damage. Examples include:

- Floodproofing
- Elevate Affected Structures
- Relocate Affected Structures
- Buyout and Demolition of Affected Structures

The guidance document *Homeowner's Guide to Retrofitting, Six Ways to Protect Your House from Flooding* (FEMA, 1998) provides information on each of these measures. Advantages and disadvantages of these alternative flood protection measures are presented in Appendix D.

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<sup>1</sup> "Federal Programs Offering Nonstructural Flood Recovery and Floodplain Management Alternatives." Executive Office of the President. A Federal Interagency Publication. June 1998.

## Land Use Regulations/Permitting

Regulation of land use activities in a floodplain is an important tool for flood hazard management in a watershed. Such regulation is a controllable factor that can reduce flooding and damages caused by flood events. Homes and structures built within a floodplain, fill, or other development in a floodplain can cause flooding upstream or downstream. Destruction or filling of wetlands removes their natural capabilities to store floodwaters. The overall effect of development within a watershed is the addition of impervious surfaces, which increases stormwater runoff, displaces water, diverts flow, and raises flood elevations. These impacts can be addressed in a cost-effective manner by regulating land uses within the floodplain.

Land use regulations are a means of limiting actions taken by individuals that may put their property or them at risk or adversely affect others or the environment. As detailed in Section 4, there are federal, state, and local regulations intended to reduce flood hazards and to protect private property and the environment. Any new development in a floodplain should strictly follow the requirements of these regulations, where applicable. It must be recognized that many areas of Grays Harbor County are by nature exceptionally prone to flooding. Given the nature of the area, flooding will continue to occur even when land use regulations are strictly implemented and enforced.

To reduce localized flooding, the County must continue to enforce regulations that protect drainage courses. The County should identify permanent natural drainage pathways and prevent them from being altered, filled, or blocked. The County should also continue to enforce regulations that restrict future development in the floodplain and in other natural drainage courses to only flood-compatible uses. This can be done by vigorously enforcing the County's zoning regulations and the Uniform Building Code.

The County should evaluate all proposed filling activities for potential adverse impacts both downstream and upstream, and the amount of fill material for new development or improvements should be limited to the minimum necessary to elevate structures above the designated flood level, according to the County's zoning requirements. Filling in the floodplain could hamper the effectiveness of other flood control measures. The County should prohibit filling in the floodplain in areas that have been heavily damaged in the past by flooding.

To properly implement and enforce the floodplain requirements of the zoning code, the County should continue to limit issuance of variances for development in the floodplain.

The County should continue to enforce the Shoreline Management Act and Shoreline Master Program guidelines as a minimum land use measure. The state's new guidelines for updating the Shoreline Master Program should be adopted and integrated with applicable sections of the County's existing zoning and subdivision regulations. Channel Migration Zones within the floodplain should be identified and incorporated into County regulations and maps.

The County should continue to prevent filling or development of wetlands. Destruction of wetlands decreases natural floodwater storage, in addition to limiting other benefits for water quality and wildlife habitat. The County could consider a wetlands protection.

ordinance to preserve wetlands, particularly for their flood storage capacity, and establish and enforce policies to ensure compliance with Section 404 of the Clean Water Act.

Development of impervious surfaces contributes to increased runoff and flooding. The County should minimize runoff from both existing and new development by reducing the area of impervious surfaces and incorporating stormwater management practices that allow precipitation to infiltrate into the ground.

Land use activities in the floodplain can continue to be regulated under existing regulatory programs with minimal impacts to operating budgets.

### **Accurate Floodplain Mapping**

The requirements for development in a floodplain, as outlined in Section 13.07 of the County zoning code, apply only to areas within the 100-year floodplain as mapped by FEMA. Many of the Federal Flood Insurance Rate Maps are out of date and do not adequately represent flood hazard or flood risk. These maps were revised in 1986 (one map was revised in 1990), and FEMA has indicated that the maps are not scheduled to be revised in the near future. In addition, many portions of the County's existing floodplain maps are delineated Zone A, which are areas that did not have detailed studies to identify floodways or base flood elevations.

The County should consider updating the floodplain maps using computer modeling and up-to-date topography and hydrologic data. These analyses could identify whether additional areas should be subject to floodplain development permit requirements. Citizen input on recurring flooding events should also be considered in the revision process. More accurate floodplain boundary information would ensure proper restrictions on development in the floodplain and, therefore, enhance protection of property and increase safety from flooding events.

As shown in Figure 6-1, numerous areas along the Humptulips, Wynoochee, and Satsop Rivers are recommended for revision of the existing floodplain mapping. These areas were selected because they include the majority of flooding problem areas as described in Section 5. Areas A-C are within the Humptulips River basin, Areas D-E are within the Wynoochee River basin, and Area F is within the Satsop River basin.

To accurately map the 100-year floodplain, it is recommended that 4-foot contours be developed by obtaining aerial photographs with photo control and by surveying cross sections of the river. These data could then be used in hydraulic models to develop floodplain maps.

The costs to develop revised floodplain mapping will vary considerably depending on who performs the work and how detailed the study is. The cost estimate presented assumes that 4-foot contours of the floodplain will be developed and that County staff will perform the survey. The estimate does not include the cost of the modeling necessary to develop the 100-year floodplain map, because the cost will vary depending on the size of the area the County wants to delineate. Actual costs should be determined when the County decides which areas to study. The costs below include the collection of the data necessary to develop topographic maps with 4-foot contours:

- Humptulips (Areas A-C) \$80,000
- Wynoochee (Areas D-E) \$75,000
- Satsop (Area F) \$87,000

### **Inter-Jurisdictional Coordination**

This plan recognizes the importance of and encourages coordination among County divisions, including the Utilities, Building, and Planning Departments. Each of these departments should be informed and involved in all regulations, programs, and activities regarding floodplain/flood hazard management. For example, these departments can facilitate a coordinated process to ensure proper review and permitting of all new development that have the potential to be subject to flooding or to exacerbate flooding. Each of these departments should review its own regulatory, permitting and enforcement processes and make any necessary improvements to facilitate coordination on floodplain programs with the other departments.

Because flooding occurs on a watershed basis, not just within city and county boundaries, inter-jurisdictional coordination is an important aspect of flood hazard management. The County should try to coordinate its planning efforts with those of other jurisdictions and agencies that have authority over or are affected by activities that can contribute to flooding in the same watershed. Other jurisdictions might include cities within the County limits, other Counties within a common watershed, and agencies (e.g., WSDOT) that have jurisdiction over roads or facilities that might contribute to or reduce the risks of flooding. Coordination with these other entities will help ensure consistency in permitting procedures, in protection of resources, and in enforcement of floodplain regulations. The County should work with these other jurisdictions to make improvements to regulatory programs and develop mechanisms for cost sharing on flood hazard management projects of mutual benefit.

Planning projects within watersheds are often a multi-jurisdictional issue, which makes continued coordination with other jurisdictions important. The costs associated with inter-jurisdictional coordination can be only a minimal investment of staff time.

### **Floodplain Conservation Easements**

As noted above, floodplains and wetlands serve as natural storage for floodwaters. Filling and development of these lands contributes to increased flooding. Floodplain easements and land acquisition programs allow land retirement and/or land use restrictions in which property owners voluntarily agree to forgo development in exchange for property tax reductions or other incentives. Protecting these areas will reduce future flood hazards because it allows them to continue to provide their natural flood storage functions. It also provides benefits such as recreation and open space. Voluntary programs such as these can be cost-effective means to reduce flood damages without increased regulations.

The costs of a voluntary easement program are difficult to quantify because participation is unpredictable. The costs to the County would depend on the types of incentives offered to property owners.

## Educational Materials on Flood Hazard Management

Educational programs are effective because they help raise citizens' awareness of the causes of flooding and the ways that they can prevent increased flood hazards. Educational materials can be posted in County office and other public places and made available from the County. Educational posters, maps, pamphlets, and other materials can inform residents of the flooding issues throughout the County, help property owners understand land use regulations, and facilitate the permitting processes for development activities within the floodplain.

Examples of educational materials on floodplain and flood hazard management include:

- Location of floodways and floodplains and how to interpret FEMA maps
- Importance of floodplain protection (i.e., reduce environmental, property damages/losses)
- Potential for damages when buying/building a structure in the floodplain
- Methods to reduce flooding (e.g., maintain existing drainage courses, preserve natural wetlands, minimize fill material)
- Explanation of regulations and permits related to development in floodplains and improvements on private property
- Discussion of watershed-wide linkages between flood hazard management and protection of water quality and aquatic habitat
- Description of the County flood warning system

The County should establish policies to ensure that warnings are posted of flooding hazards during events that cause closure of roadways, bridges, or facilities, and that flood elevation poles are placed near rivers to show high water marks from previous floods.

While education programs of this type serve to inform people of the dangers of development within floodplains and of the need to maintain natural drainage courses, they do not guarantee changes in existing practices. This is a choice that must be made by individuals and the community as a whole; therefore, safety, flood hazard reduction, and environmental benefits depend on public attitudes and actions. Without significant interest or acceptance of the goals of flood hazard management, these benefits might not be realized.

These programs rely heavily on volunteers and can be successfully completed for approximately \$5,000 to \$10,000 annually. In addition, numerous educational materials have already been prepared by FEMA about flood-related issues. These materials could be copied and located in the County office for no cost.

## Flood Warning System

The National Weather Service and the Northwest Forecast Center Portland take data from gauges throughout the County to determine flood watches and warnings based on projected forecasts, current river conditions, and river modeling. Grays Harbor Emergency Management uses the watch and warning information from the National Weather Service

Seattle to broadcast river forecasts and information to local residents. Grays Harbor has a telephonic warning system to notify residents and agencies of hazardous situations so that they can take actions and prepare themselves when serious flooding occurs.

The National Weather Service collects data from only a few gauges in Grays Harbor County. There are no gauges on some rivers (e.g., Humptulips River) and there are no tide gauges near the mouth of the Chehalis River; thus, the National Weather Service is modeling based on trends or inferences. To correct this lack of data, it is recommended that the following gauges be installed and/or upgraded:

1. Upgrade as many as four of the existing real-time reporting gauge stations with High Rate Goes transmitters. The upgraded transmitters would decrease transmission time from 4-hour transmissions to 1-hour transmissions for all sites. The estimated cost is \$2,500 per station, or \$10,000 for all four. The four sites to be upgraded would be selected from the current real-time reporting stations:

- Chehalis River near Grand Mound #12027500
- Chehalis River at Porter #12031000
- Satsop River #1203500
- Wynoochee River near Grisdale #12035400
- Wynoochee River above Save Creek #12036000
- Wynoochee River above Black Creek near Montesano #12037400

2. Reestablish USGS gauge station No. 12039300 Humptulips River near Humptulips. This station location has a drainage area of 130 square miles. It was operated by the USGS from 1933 to 1935 and from 1942 to 1979. The station would be equipped with satellite telemetry and might require installation of a cableway for measurement of flow. The station would provide early flood warning data and additional inflow data for watershed planning. This station location has a long period of hydrologic peak flow record that could be useful for determining flood frequency in the Grays Harbor area. However, field reconnaissance will be required to determine if this location is still suitable for siting the station. Estimated installation cost, pending field reconnaissance, is \$35,000. Station monitoring by the USGS is estimated to be \$13,000 for a full year or \$26,000 for the 2-year period of the grant. The availability of USGS Cooperative Funds is unknown; however, the cost for monitoring these stations could potentially be reduced to \$13,000 for the 2-year monitoring period if these funds are made available.

3. Install three stage/tide gauges equipped with satellite telemetry. These stations would be located on the Satsop River, the Chehalis River in Grays Harbor, and the Upper Humptulips River. Estimated installation cost for electronic recording gauges is \$15,000 per site, a total of \$45,000. Costs for non-recording gauges installed and surveyed to mean-low tide are \$2,600. These gauges could be monitored by a volunteer flood-watch team, but would not provide the continuous record of electronic gauges.

### **New Standards for Design, Construction, and Maintenance**

There are new standards for the design, construction, and/or maintenance of river facility projects that the County could adopt. These standards incorporate habitat-sensitive design elements in river repair projects (e.g., bank stabilization projects and flood control facilities)

to decrease the adverse effects to salmonid habitat. In addition, the banks become naturally stronger as vegetation becomes established, reducing the need for maintenance. Biostabilization projects thus provide effective erosion control and environmental enhancement and lower maintenance requirements.

Guidelines for Bank Stabilization Projects ([dnr.metrokc.gov/wlr/biostabl](http://dnr.metrokc.gov/wlr/biostabl)) by King County can be used to assist the County in identifying appropriate structural and fish-friendly solutions to riverine bank stabilization and flood control problems. The Washington Department of Fish and Wildlife (WDFW) is also in the process of developing a design manual for projects within river systems.

The costs for implementing standards for design, construction, and maintenance within a riverine system would be associated with the staff time required to understand and implement the standards. The manuals created by King County and WDFW could be adopted or used by Grays Harbor County.

### **National Flood Insurance Program Community Rating System Program**

The NFIP Community Rating System (CRS) is a program that encourages floodplain management activities that exceed the minimum NFIP standards. Through the CRS program, flood insurance premium rates are adjusted to reflect the reduced flood risk resulting from community activities that meet the following goals of the CRS:

- Reduce flood losses
- Facilitate accurate insurance rating
- Promote the awareness of flood insurance

The CRS program consists of 10 classes. Class 1 requires the most credit points and provides the largest premium reduction; Class 10 receives no premium reduction. As shown in Appendix E, the CRS has 18 floodplain management activities available for credit, which are divided into four categories. The main categories or series are (source: FEMA, *National Flood Insurance Program Community Rating System CRS Coordinator's Manual*, January 1999):

- **Public Information Series**—Credits programs that advise people about the flood hazard, flood insurance, and ways to reduce flood damage. These activities also provide data needed by insurance agents to establish accurate flood insurance rates. These programs generally serve all members of the community and work toward all three goals of the CRS.
- **Mapping and Regulations Series**—Credits programs that provide increased protection to new development. These activities include mapping areas not shown on the FIRM, preserving open space, enforcing higher regulatory standards, and managing stormwater. The credit is increased for growing communities. These activities work toward the first and second goals of the CRS, damage reduction and accurate insurance rating.
- **Flood Damage Reduction Series**—Credits programs for areas in which existing development is at risk. Credit is provided for a comprehensive floodplain management



plan, relocating or retrofitting flood-prone structures, and maintaining drainage systems. These activities work toward the first goal of the CRS, damage reduction.

- **Flood Preparedness Series**—Credits flood warning, levee safety, and dam safety programs. These activities work toward the first and third goals of the CRS, damage reduction and hazard awareness.

As shown in Table 6-1, the more credit points that a community has, the lower its class. Grays Harbor County is currently Class 10 because it has not applied to the CRS program. To lower flood insurance premiums for its residents, the County should evaluate its flood planning activities. A minimum of 500 points is necessary to receive a CRS classification of Class 9. See Appendix E to determine if the County already meets this minimum requirement to apply. If the County meets the requirement, then it should submit a CRS application with appropriate documentation to its CRS Specialist.

**TABLE 6-1**

NFIP CRS Classification System (Source: FEMA web site [fema.gov/nfip/crs.htm](http://fema.gov/nfip/crs.htm))

Credit Points	Class	SFHA*	Non-SFHA**
4500+	1	45%	5%
4000-4499	2	40%	5%
3500-3999	3	35%	5%
3000-3999	4	30%	5%
2500-2999	5	25%	5%
2000-2499	6	20%	5%
1500-1999	7	15%	5%
1000-1499	8	10%	5%
500-999	9	5%	5%
0-499	10	0%	0%

\*Special Flood Hazard Area

\*\*Preferred Risk Policies are available only in B, C, and X Zones for properties that are shown to have a minimal risk of flood damage. The Preferred Risk Policy does not receive premium rate credits under the CRS because it already has a lower premium than other policies. Although they are in SFHAs, Zones AR and A99 are limited to a 5 percent discount. Premium reductions are subject to change.

The costs associated with the CRS program include the costs incurred implementing creditable floodplain management activities and staff time needed to prepare the CRS application.

## Floodproofing

Effective floodproofing measures can be used effectively to limit flood damage to structures. Floodproofing will prevent damage from floodwaters but will not protect the structures from wave action, erosion, impact of debris, or high-velocity flood flows. There are two types of floodproofing: wet floodproofing and dry floodproofing.

Wet floodproofing measures rely on allowing floodwaters to enter uninhabited portions of the structure (such as a crawlspace or walkout basement) without causing significant damage. Utilities might need to be relocated and the flooded area must be constructed of flood-resistant material. Wet floodproofing is usually not practicable for slab-on-grade structures.

Dry floodproofing completely seals the exterior of the house. Dry floodproofing is practicable for structures made of flood-resistant materials in areas with relatively low flood depths. This method might require protection measures, such as placement of door shields, immediately preceding a flood. Hydrostatic and buoyant forces must be evaluated when considering dry floodproofing measures. Dry floodproofing is usually not practicable for wood-frame structures. In addition, dry floodproofing cannot be used to bring a substantially damaged or improved house into compliance with the floodplain management ordinance.

As a rough guideline, the cost of wet and dry floodproofing a 1,000-square-foot house ranges from minimal to \$10,000 (FEMA, 1998).

### **Elevate Affected Structures**

Elevating structures located in the floodplain can protect them from future flood damage. To protect these properties, it is necessary to elevate the structures and possibly the septic tank drainfields to an elevation above the 100-year floodplain. If interested in pursuing this alternative, property owners should contact local contractors and obtain bids for the work.

As a rough guideline, the cost of elevating a 1,000-square-foot house 2 feet might average \$20,000 to \$50,000 and the cost of elevating a drain field or installing a mound system could cost an additional \$10,000 or more (FEMA, 1998).

### **Relocate Affected Structures**

Relocating structures out of the floodplain provides a very high level of protection from future flood damages. Additionally, the mitigation alternative might result in a significant reduction or elimination of flood insurance premiums. Generally, single-story, wood-frame houses are easiest to move because they are relatively lightweight. On the other hand, multistory, masonry structures are the most difficult to move. The moving process for structures of all types is complex and requires the services of a professional.

As a rough guideline, the cost of relocating a house can range from \$40,000 to \$80,000. This cost does not include land acquisition (FEMA, 1998).

### **Buyout/Demolition of Affected Structures**

The most cost-effective measure might be to buy out the owner of a house with severe flood damage (or repetitive losses) and remove the structure from the floodplain.

## **Structural Management Measures**

There is a range of structural improvement alternatives that provide flood protection. Structural improvements presented in this section include:

- Levees
- Setback Levees
- Floodplain Excavation
- Flood Control Reservoir
- Overflow Culvert/Channels
- Onsite Detention and Retention
- Biostabilization and Other Engineered Solutions

Each of the techniques presented in this section requires careful planning and analysis before implementation. The riverine systems in Grays Harbor County are dynamic and complex and the impact of any structural management measure must be fully understood before implementation. Additionally, flooding in the Humptulips, Wynoochee, and Satsop River basins is widespread and extensive. As a result, it is unlikely that the structural flood hazard management measures presented in this section will solve regional problems, but they might be appropriate for local flooding problems. Table 6-2 shows the advantages and disadvantages of these measures.

## **Levees**

Levees are earthen embankments constructed parallel and adjacent to the river channel. Levees provide flood protection by confining flood flows to a relatively narrow channel area. A typical cross section of a levee is trapezoidal in shape with relatively flat side slopes (3 feet horizontal to 1 foot vertical) and a top width of 10 feet or more. Bank protection is crucial to protect the embankment from being undermined by channel movement. Flood protection is provided as long as the depth of flow is below the top of the levee. When overtopping occurs, property behind the levee will be flooded and damage will occur.

The impacts of levee construction on river hydraulics must be evaluated as part of the design process. Levees remove floodplain storage from the basin, which increases peak flow rates downstream. The stage increase required to pass the flood flow within the levee system will also increase flood stage upstream of the protected area. Levees also confine the channel, which affects the channel geomorphology. Additional measures are needed to mitigate each of these impacts.

Levees have been constructed at numerous locations around the County, including along the Chehalis and Humptulips Rivers and around the Grays Harbor Estuary.

## **Setback Levees**

Setback levees are typically located at the edges of the floodplain and are used to protect property from shallow and/or infrequent flooding. The impacts of setback levees are less severe than those of typical levees because the floodplain is maintained and stage increases are minimal. However, any potential impacts must be investigated and fully mitigated.

## **Floodplain Excavation**

Excavation of the overbank area of the channel provides additional conveyance capacity of floodwater during peak flow events, which reduces flood stage. Floodplain excavation might also be necessary to provide compensatory storage as mitigation for other structural measures (i.e., levees).

**TABLE 6-2**

Advantages and Disadvantages of Various Structural Flood Mitigation Measures

Mitigation Measure	Advantages	Disadvantages
Levee	<ul style="list-style-type: none"> <li>Provides very high level of protection for flood stages below top of levee</li> </ul>	<ul style="list-style-type: none"> <li>Provides false sense of security that area is protected from all events</li> <li>Overtopping can cause much larger amount of damage due to surge</li> <li>Not cost effective for sparsely populated areas</li> <li>Requires high level of maintenance</li> <li>Disrupts sediment-carrying capacity of river</li> <li>Difficult to permit, requires mitigation</li> <li>Removes floodplain habitat</li> <li>Removes floodplain storage, which increases downstream peak flows</li> <li>Increases flood stage, which might cause more inundation upstream</li> </ul>
Setback Levee	<ul style="list-style-type: none"> <li>Provides very high level of protection for flood stages below top of levee</li> <li>Might be cost-effective for sparsely populated areas</li> <li>Maintains natural river hydrology if located out of floodplain</li> <li>Preserves natural riverine habitat</li> </ul>	<ul style="list-style-type: none"> <li>Might be difficult to permit if within floodplain</li> <li>Might remove floodplain storage, increasing downstream peak flows</li> <li>Might increase flood stage, causing more inundation upstream</li> <li>Overtopping can cause much larger amount of damage due to surge (high-velocity flows)</li> </ul>
Channel Improvement	<ul style="list-style-type: none"> <li>Provides increased conveyance capacity which reduces flood stage</li> </ul>	<ul style="list-style-type: none"> <li>Might not be cost-effective for sparsely populated areas</li> <li>Difficult to permit</li> <li>Might increase river velocity, causing increased peak flows downstream</li> </ul>
Flood Control Reservoir	<ul style="list-style-type: none"> <li>Provides very high level of protection</li> <li>Multi-use opportunities such as recreation, water supply, and power generation</li> </ul>	<ul style="list-style-type: none"> <li>Very high cost</li> <li>Instream facilities very difficult to permit</li> <li>Disrupts natural hydrologic regime</li> <li>Traps sediment, which reduces storage volume and leads to downstream erosion</li> <li>Water quality impacts to temperature, dissolved oxygen, and nutrients</li> </ul>
Onsite Detention	<ul style="list-style-type: none"> <li>Provides very high level of protection</li> <li>Cost effective for urbanized areas</li> <li>Easily permitted</li> <li>Reduces peak flow rates</li> </ul>	<ul style="list-style-type: none"> <li>Not practicable for rural areas</li> </ul>

**TABLE 6-2**

Advantages and Disadvantages of Various Structural Flood Mitigation Measures

Mitigation Measure	Advantages	Disadvantages
Overflow Culvert	<ul style="list-style-type: none"><li>• Might eliminate flooding for more frequent, lower magnitude events</li><li>• Relatively low cost</li><li>• Reduces upstream river stage</li></ul>	<ul style="list-style-type: none"><li>• Will not provide protection from large flood events</li><li>• Might increase peak flows downstream</li></ul>
Overflow Channel	<ul style="list-style-type: none"><li>• Lowers flood stage</li><li>• Opportunities for riverine habitat creation or enhancement</li></ul>	<ul style="list-style-type: none"><li>• Might not be cost effective for sparsely populated areas</li><li>• Might require additional structures for road crossing</li><li>• Risk of altering course of river due uncontrolled release into channel</li></ul>
Biostabilization	<ul style="list-style-type: none"><li>• Protects streambank from erosion</li><li>• Restores natural river hydrology</li><li>• Maintains or enhances natural riverine habitat</li><li>• Adds aesthetic value</li><li>• Easily permitted</li></ul>	<ul style="list-style-type: none"><li>• Will not provide protection from large flood events</li></ul>

## **Flood Control Reservoir**

A flood control reservoir provides peak flow attenuation by storing a portion of the flood flow for release after the event. Flood control reservoirs are sized to provide release at or below the damage discharge level. Flood flows are currently regulated on the Wynoochee River by the Wynoochee dam (see section 5). There are no other flood control facilities in the County.

## **Overflow Culvert/Channels**

Overflow culverts can provide additional conveyance capacity for restricted locations. Overflow culverts provide the most benefit where they can be used to convey floodwaters that normally flow around a structure. These culverts should not be used to reduce large volumes of impounded water unless the downstream impacts are thoroughly investigated. Overflow channels can also provide increased flood flow conveyance, resulting in a reduction in flood stage.

## **Onsite Detention and Retention**

Increased flooding and erosion is directly related to an increase in the area of impervious surfaces (e.g., pavement, roads, rooftops), which prevents the runoff from soaking into the ground. In addition, clearing land of vegetation also increases the amount of surface water runoff from a site. Both the volume and velocity of runoff increases, which increases streambank erosion. Onsite detention and retention is intended to reduce the frequency and magnitude of these high flows by storing or infiltrating runoff. In addition, detention and retention facilities can also provide water quality treatment.

## **Biostabilization and Other Engineered Solutions**

Numerous County residents described erosion and loss of property due to floodwaters. It is recommended that biostabilization techniques be implemented to stabilize riverbanks. In addition, woody debris could be added to the river system to stabilize gravel upstream and to provide roughness to the river, which will help reduce the velocity of the water. Other techniques to channelize the water away from the banks and toward the middle of the channel include installation of rock and woody debris vanes. Some projects that have been identified for biostabilization include (source: Section 905b Analysis, *General Investigation Reconnaissance Study, Chehalis River Basin, WA*, U.S. Army Corps of Engineers, Seattle District, 2001):

- Chehalis River Bank Restoration near Oakville
- Chehalis River Bank Restoration near Porter
- Satsop River Bank Stabilization near Satsop
- Satsop River Bank Stabilization near Satsop Riviera
- Keys Road Chehalis River Bank at Boat Launch near Satsop River
- West Satsop River Bank Restoration at Boat Launch

The public involvement process indicated that many residents were concerned that gravel accumulation is causing increased flooding. If small-scale gravel removal was performed in limited situations, under specific circumstances, and in a manner consistent with regulations to minimize impacts to fisheries resources, then interim gravel removal from gravel bars

might be effective in providing flood control for localized areas. Long-term gravel removal can result in loss of resources, increased erosion and sedimentation, and flooding downstream. It is recommended that this technique be performed only in conjunction with bank stabilization.

The costs of biostabilization and other engineered solutions are difficult to quantify because the extent of the project and technique will vary. It is recommended that the County create a stockpile site for woody debris that can be used for these projects.

## Local Problem Areas

As discussed in Section 5, there are extensive flooding problems in the Humptulips, Wynoochee, and Satsop River basins. Section 5 identifies six areas with chronic flooding problems. Projects that could potentially reduce flooding were identified for four of the six areas. These areas are Wynoochee Tracts, Satsop Riviera, Humptulips Dike Road, and the Walker Bottom area.

Flood hazard reduction measures were conceptualized and evaluated for cost<sup>2</sup> and the potential to improve flooding conditions. The projects identified for these areas are conceptual only. Detailed analysis will be required before these projects can be constructed. The potential for flood reduction at the Monte-Elma Road area was also investigated, but was found to be infeasible.

The County has limited funds to address local drainage and flooding problems. Such projects are more likely to be implemented if they are initiated by and have the active support of local residents. Local sponsorship and, where appropriate, cost sharing by the benefiting residents is encouraged by the County.

It is important to note that some of the structural projects described below include berms, which reduces existing floodplain storage and could intensify flooding at other nearby properties. Floodproofing, elevation, or relocation of the existing homes in these areas should be considered as an alternative to the measures described below. It is also important to highly scrutinize any further development in these areas.

The main purpose of including these projects are for comparison purposes. Most of these problem areas have a limited number of homes affected by flooding and a cost to benefit analysis would not likely support structural projects for these areas.

### Wynoochee Tracts

Wynoochee Tracts is located in the Wynoochee River Valley west of Wynoochee Valley Road and about 1,000 feet north of U.S. Route 12. This area is currently outside of the mapped floodplain as shown on the Flood Insurance Rate Maps (FIRM) published by FEMA. Approximate methods were used to establish the flood hazard area for this reach of the Wynoochee River area and, as a result, no base flood elevation was computed. Extensive flooding occurred in this area during the 1997 and 1999 events.

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<sup>2</sup> Order of magnitude cost estimates were developed for the local projects discussed in this section. These costs are in 2001 dollars and do not include land acquisition, escalation, financing charges, or operation and maintenance. Detailed cost information can be found in Appendix F.

Figure 6-2 shows a schematic of the conceptual plan developed for this area. This plan consists of an earthen berm constructed on the western and northern sides of the development. The berm would need to be approximately 2,000 feet long and 5 feet high.

Flood protection levels have not been quantified for this project, but it is likely that these mitigation measures would prevent flooding for events that have magnitudes similar to those of the 1997 and 1999 events. Total estimated cost for this project is \$350,000.

### Satsop Riviera

The Satsop Riviera area is located in the Satsop River basin. The Satsop Riviera is a development in the mapped floodplain. This area contains a high number of repetitive loss properties and experienced extensive flooding during the 1997 and 1999 events.

Figure 6-3 shows a schematic of the conceptual plan developed for this area. This plan includes a 6,000-foot-long overflow channel located on the eastern boundary of the development. The channel cross section is 15 feet deep, trapezoidal in shape with 3:1 side slopes. The top width of the channel varies and depends on the level of protection desired. A bridge is required to maintain access to the development. Table 6-3 shows the size and associated estimated costs for each level of protection.

**TABLE 6-3**  
Satsop Riviera Project Estimated Costs

Protection Level	Top Width	Channel Cost	Structure Cost	Total Cost
10-year	170 feet	\$460,000	\$1,760,000	\$2,220,000
50-year	260 feet	\$777,000	\$2,574,000	\$3,351,000
100-year	300 feet	\$900,000	\$2,891,000	\$3,791,000

### Humptulips Dike Road

The Humptulips Dike Road area is located in the Humptulips River basin where Humptulips Dike Road crosses the Humptulips River. This area is partially outside the mapped floodplain as shown on the FIRM published by FEMA. Approximate methods were used to establish the flood hazard area for this reach of the Humptulips River area and, as a result, no base flood elevation was computed. Extensive flooding occurred in this area during the 1997 and 1999 events.

Figure 6-4 shows a schematic of the conceptual plan developed for this area. This plan restores the integrity of the dike by repairing locations where breaching has occurred. This plan also includes installing three 24-inch-diameter culverts with flap gates through the dike.

This project will not provide any additional flood protection than exists with the current levee system. Installation of the culverts will reduce the duration of flooding behind the levee by allowing this area to drain. Total estimated cost for this project is \$51,000.

### Walker Bottom Area

The Walker Bottom Area is located in the Humptulips River basin in the vicinity of Walker Bottom Road. This area is adjacent to the mapped floodplain as shown on the FIRM



published by FEMA. Approximate methods were used to establish the flood hazard area for this reach of the Humptulips River area and, as a result, no base flood elevation was computed. Extensive flooding occurred in this area during the 1997 and 1999 events.

Figure 6-5 shows a schematic of the conceptual plan developed for this area. This plan includes construction of an earthen berm generally following the floodplain boundary. The berm would need to be between 800 to 2,600 feet long and 5 feet-high. Additional analysis might show the need for a longer berm.

Flood protection levels have not been quantified for this project. However, it is likely that it will prevent flooding for events with magnitudes similar to those of the 1997 and 1999 events. Total estimated cost for this project is between \$160,000 and \$490,000.

## Environmental Impacts

Environmental impacts have been reviewed for the recommended nonstructural and structural measures presented in this section. In general, the nonstructural improvements proposed would enhance environmental and natural resources by furthering the protection of habitat and water quality and by reducing flooding.

Structural alternatives might have both positive and negative impacts to water quality and fish and wildlife resources. Any construction project could potentially increase erosion and sedimentation into nearby waters. Because many of the proposed structural measures are near rivers, careful practices would be necessary during the construction phase. All capital projects with the potential for environmental effects during construction or operation are subject to review under the State Environmental Policy Act (SEPA) to determine whether there are significant impacts requiring mitigation.

All activities involved in floodproofing, elevation, or relocation of affected homes are subject to the Grays Harbor County permitting process and must follow all land use and building codes.

Projects that include biostabilization or other engineered solutions are subject to the environmental review and permitting process.

The three conceptual projects for Wynoochee Tracts, Humptulips Dike Road, and Walker Bottom were reviewed with respect to environmental impacts. The environmental review presented focuses on the potential environmental impacts to the elements of the environment as required by SEPA (Table 6-4a), general environmental impacts (Table 6-4b), and potential permits that might be required (Table 6-5).

Each project will likely require a number of permits before construction can begin, and permitting agencies must evaluate potential impacts to the environment as required by SEPA before making a permit decision. The elements of the environment covered by the SEPA environmental checklist are shown in Table 6-4a. Each project will have some potential impact to the environment, although not always an adverse impact. For example, all four projects would likely have a beneficial impact to land use, housing, and public services. All four projects would likely require fill or excavation in wetlands, which is considered an adverse impact.

**TABLE 6-4a**  
SEPA-Related Environmental Impacts Associated with Structural Measures

Project	Earth	Water	Air	Plants	Animals	Energy & Natural Resources	Environmental Health	Land Use	Housing	Light & Glare	Recreation	Historic/Cultural	Transportation	Public Services	Utilities
Wynoochee Tracts—Install Berm	a	b	c	d	h	h	h	f	f	h	h	h	h	g	h
Humptulips Dike Road—Install Culverts and Raise Dike	a	b	c	d	e,f	h	h	f	f	h	h	h	h	g	h
Walker Bottom—Install Berm	a	b	c	d	e,f	h	h	f	f	h	h	h	h	g	h

- a) Fill required in wetland or floodplain.  
b) Flooding and erosion controlled by project.  
c) Short-term dust and construction vehicle exhaust.  
d) Loss of minor amounts of vegetation. Possible removal of riparian habitats.  
e) Temporary disruption to habitat could occur during construction.  
f) Properties and habitat protected by confinement of floods.  
g) Need for community and emergency services reduced.  
h) Likely not applicable.

General environmental impacts associated with the alternatives are shown in Table 6-4b. Each project will have some potential impact to the environment, although not always an adverse impact.

**TABLE 6-4b**  
General Environmental Impacts Associated with Structural Measures

Project	Fish Resources	Wildlife Resources	Scenic Aesthetic Historic	Water Quality	Hydrology	Existing Recreation	Other
Wynoochee Tracts—Install Berm	--	1	--	--	2,3	--	--
Humptulips Dike Road—Install Culverts	4	1	--	4	--	--	--
Walker Bottom—Install Berm	--	1	--	--	2,3	--	--

- 1) Localized habitat disruption would occur during construction. Placement may require removal/loss of habitat.  
2) Analyses would be needed to ensure flow conditions are not worsened upstream or downstream of project  
3) Property would be protected by confinement of flood on river side of berm.  
4) Temporary localized disruption to fish habitat and water quality would occur during construction.

Table 6-5 provides a list of potential permits and approvals that might be required for each project. All will require SEPA approval because all will require permits. All will also require Shoreline Substantial Development Permits because all are within 200 feet of a river, with the exception of the Wynoochee Tracts project.

A Hydraulic Project Approval (HPA) will be required from WDFW for installing the culverts with the Humptulips Dike Road projects.

It is assumed that each project will require work in a wetland, which also will require a permit from the U.S. Army Corps of Engineers, 401 Water Quality Certification, and Coastal Zone Management Certification.

All will likely require construction in a floodplain, which requires a Flood Plain District Permit from the County. The new dikes for each project will require a Clearing and Grading Permit from the County.

**TABLE 6-5**  
Required Permits for Conceptual Projects

Project	SEPA	Shoreline Substantial Development	Flood Plain District Permit	Clearing and Grading	WDFW HPA	Corps 404	401 Water Quality Certification	CZM Certification
Wynoochee Tracts—Install Berm	x		x	x		x	x	x
Humptulips Dike Road—Install Culverts	x	x	x		x	x	x	x
Walker Bottom—Install Berm	x	x	x	x		x	x	x

## Funding

There are several potential sources of funding that can be considered for the various projects. The first to be considered by most residents is property tax revenues. In Grays Harbor County, the majority of property taxes are distributed for special purposes such as schools, roads, the Port District, and the cities. Only 11 percent of property tax revenue is available to the County government and is placed in the general fund or the current expense fund. These funds support police, fire, parks, planning, administration, and other basic County services. Seventy percent of these funds go to support the criminal justice system. As a result, there is substantial competition for the remaining funds and there is generally minimal money left for special needs such as drainage and flood hazard reduction. Other potential sources to be considered are shown in Table 6-6.

Table 6-6 Funding Alternatives for Flood Hazard Management Measures

	Primary Purpose	Process to Form or Obtain	Cost to Obtain	Control	Revenue Potential	Public Acceptance	Adverse Impacts
<b>Basic County Revenues</b>							
Current Expense	Provide general County government services.	Already exists	None	County Commissioners		Good	Competes with other County service needs.
Road Fund	Develop and maintain roads.	Already exists	None	County Commissioners	Moderate, restricted to those services required as a result of road impacts or to provide roads.	Good	Competes with other road needs.
River Improvement Fund	Provide services related to flooding or erosion along rivers.	Commissioner vote	None	County Commissioners	Minimal, competes with other County revenues and is subject to overall tax levy lids.	Generally good	Competes with other demands for County revenues.
Bonding	To spread costs of capital projects that have long-term benefits over long periods of time.	Commissioners have limited authority to issue General Obligation Bonds and may issue revenue bonds without a public vote. A ballot is required for bonds that exceed basic limits.	Moderate, includes interest	County Commissioners	Moderate, subject to statutory limits, ability to repay and limited to capital programs.	Variable	Requires repayment in future, may limit debt available for other purposes.
Real Estate Excise Tax for CIP Related to Development	RCW 82.46 authorizes optional real estate excise taxes to fund capital projects.	Commissioner vote	Minimal	County Commissioners	Moderate	Variable	Minimal, potential voter resistance.
Conservation Futures for Open Space Acquisitions	N/A						
<b>Special Districts</b>							
Stormwater Utility	RCW 36.89 authorizes stormwater programs including capital and maintenance programs to address problems associated with stormwater runoff such as flooding and water quality.	Vote of County Commissioners	Minimal, generally includes preparation of a plan for use of the funds and a public involvement program to assess acceptance of proposal.	County Commissioners	Significant	Generally acceptable, widely implemented throughout Puget Sound region and other areas of the country.	May be perceived as another "tax" and another government bureaucracy.

Table 6-6 Funding Alternatives for Flood Hazard Management Measures

	Primary Purpose	Process to Form or Obtain	Cost to Obtain	Control	Revenue Potential	Public Acceptance	Adverse Impacts
Flood Control Zone District	RCW 86.15 authorizes formation to address flood control or stormwater related issues.	Resolution of intent, public hearing and vote of County commissioners.	Moderate, generally includes cost to prepare program proposal and conduct public involvement program to assess public acceptance.	County Commissioners	Substantial, can assess taxes or utility rates and charges.	Generally favorable if need is understood.	May be viewed as additional bureaucracy and as unnecessary.
Special District	RCW 85.38 authorizes formation to provide drainage and flood control services.	Petition, public hearing and vote of property owners affected.	Moderate, includes preparation of plan for operation, assessment role, public hearing and vote.	Three locally elected board	Moderate, based on benefit.	High if locally supported.	Narrow purpose, may conflict with broader purpose governments.
Water and Sewer Services	RCW 36.94 authorizes Counties to provide water and sewer services, may provide stormwater services by amending comprehensive sewer plan.	Amend or prepare comprehensive sewer plan, Commissioner vote.	Moderate, cost of developing or amending comprehensive sewerage plan.	County Commissioners	Moderate, may use utility rates or taxes.	Moderate.	May be viewed as another tax and unnecessary bureaucracy.
Water and Sewer Districts	RCW 56.04 authorizes formation of sewer districts. Sewer district may provide stormwater control services.	Petition, hearing, vote of affected property owners.	Moderate, cost to develop plan, assessment roll, hearing, petition and vote.	Locally elected board	Moderate.	Moderate.	May compete with other agency programs or local funding needs.
Lake Management District	RCW 36.61 authorizes formation to protect water quality of lakes, not applicable in South Beach.	Petition or resolution, public hearing and vote of property owners.	Moderate, cost to develop plan, assessment roll, hearing and vote.	County Commissioners	Moderate, subject to benefit of clean lake.	Variable depending on perceived threat to local lake.	May compete with other local funding needs.
Shellfish Protection District	RCW 90.72 authorizes formation to protect shellfish areas from pollution.	Vote of County commissioners	Minimal.	County Commissioners	High, subject to political will.	Variable, dependent on perceived threat to shellfish.	May be perceived as competing with other local funding needs.
Local Improvement District	See below.	See below.	See below.	See below	See below.	See below.	See below.
Utility Local Improvement District	RCW 36.94 authorizes to provide funding for capital improvements.	Petition or resolution, hearing and vote of affected property owners.	Moderate, cost of preparing plans, cost estimates and assessment role.	County commissioners following vote of property owners to establish.	Moderate.	Generally high because those benefiting are paying.	Minimal, cannot be used to assess those causing flood problems, only those benefiting.

Since some of the flood hazard management measures affect private property owners, a potential source of funds for improvements comes through the formation of Local Improvement Districts (LIDs). This involves an assessment made against the properties benefiting from the improvements.

Because funding is limited to support projects within Grays Harbor County, it is important to obtain grant funding when possible. Two important sources of grant funding include the Flood Control Assistance Account Program (FCAAP) and the Flood Mitigation Assistance and Hazard Mitigation Grant Program:

- **Flood Control Assistance Account Program (FCAAP).** Matching grants ranging from 50 percent to 75 percent of the project cost are available through Ecology to help local jurisdictions reduce flood hazards and flood damages. The grants can be used for comprehensive flood hazard management planning and flood damage reduction (construction) projects. The latest grant round for 2001-2003 included funding for mapping, flood warning systems, biotechnical bank stabilization projects, public awareness programs, and acquisition projects. These grants are competitive and available on a biennium basis.
- **Flood Mitigation Assistance and Hazard Mitigation Grant Program.** FEMA provides limited funds for flood hazard mitigation annually, which are administered by the State Division of Emergency Management. The grants can be used for assistance in developing and updating Flood Mitigation Plans.

Two other funding sources are available after an area is declared a disaster area by the federal government:

- **FEMA Hazard Mitigation Grant Program.** The State Division of Emergency Management administers this program. This competitive grant becomes available after a flooding event is declared a federal disaster. FEMA pays 75 percent of the project costs and there is a 25 percent local match, which may be shared between State and Local agencies. The State's participation in the local match is based on appropriation approval by the State Legislature and their percentage can vary.
- **FEMA Public Assistance Program for Repair or Restoration of Damaged Facilities.** The State Division of Emergency Management administers this program. Assistance becomes available after a flooding event is declared a federal disaster. FEMA pays 75 percent of the project costs and there is a 25 percent local match, which may be shared between State and Local agencies. The State's participation in the local match is based on appropriation approval by the State Legislature and their percentage can vary. Communities prepare damage survey reports to qualify for financial assistance to make repairs. Alternative projects (e.g., buyout) might be requested in any case where an applicant determines the public welfare would not be served by restoring a public facility. Funds for alternative projects can be used to repair or expand other selected public facilities, to construct new public facilities, or to fund hazard mitigation measures.

## Schedules and Terms of Benefits

If the necessary funds are available, all of the nonstructural measures presented in this section should be implemented as soon as possible. The majority of these measures require minimal costs, if any. However, they do require staff time to set up some of the recommendations. The County applied for 2001-2003 FCAAP grant funding to revise some of the floodplain mapping and to install river gauges. Depending on the amount of funding, the County might be able to perform some of these measures within the next 2 years. All nonstructural recommendations should be ongoing efforts, and the time of benefits is expected to be indefinite.

The schedule and length of time of the benefits vary for the structural recommendations. Floodproofing, elevation, and relocation of homes are the concerns of individual property owners. For this reason, the process will be an ongoing one that proceeds as individuals decide the process is necessary and can allocate and/or obtain funding. The time of benefits for floodproofing or elevating a home is expected to equal the life of the structure. The time of benefits for relocation is indefinite, assuming that the property is allocated for open space or another suitable use. Biostabilization and other engineered solutions should be implemented as soon as specific sites are identified and as funding becomes available. Because the river system is dynamic, the length of time of the benefit will vary. Small-scale gravel removal should be done only under special conditions and circumstances. It should be performed only as an interim measure until other measures, such as biostabilization and engineered solutions, help stabilize the gravel and direct the river toward the middle of the channel. The length of time of the benefit for gravel removal will vary, and it is likely that the area will require continued maintenance because more gravel will accumulate. The capital projects described for the local problem areas should be considered when funding becomes available. With proper maintenance, these benefits are expected to last 50 years for the culverts (when the culverts will need to be replaced) and indefinitely for the berms. Floodproofing, elevation, and relocation of homes should be considered as alternatives to the capital projects as well.

Improvements that require the establishment of a local improvement district and/or grant funding will take longer to implement. Because of the need to build a consensus, the petition to the County Commissioners, the public hearing and property-owner vote required to establish a special district, and the length of time involved in obtaining grants, the establishment of funding for improvements could take 1 to 2 years.

## Conformance with Goals

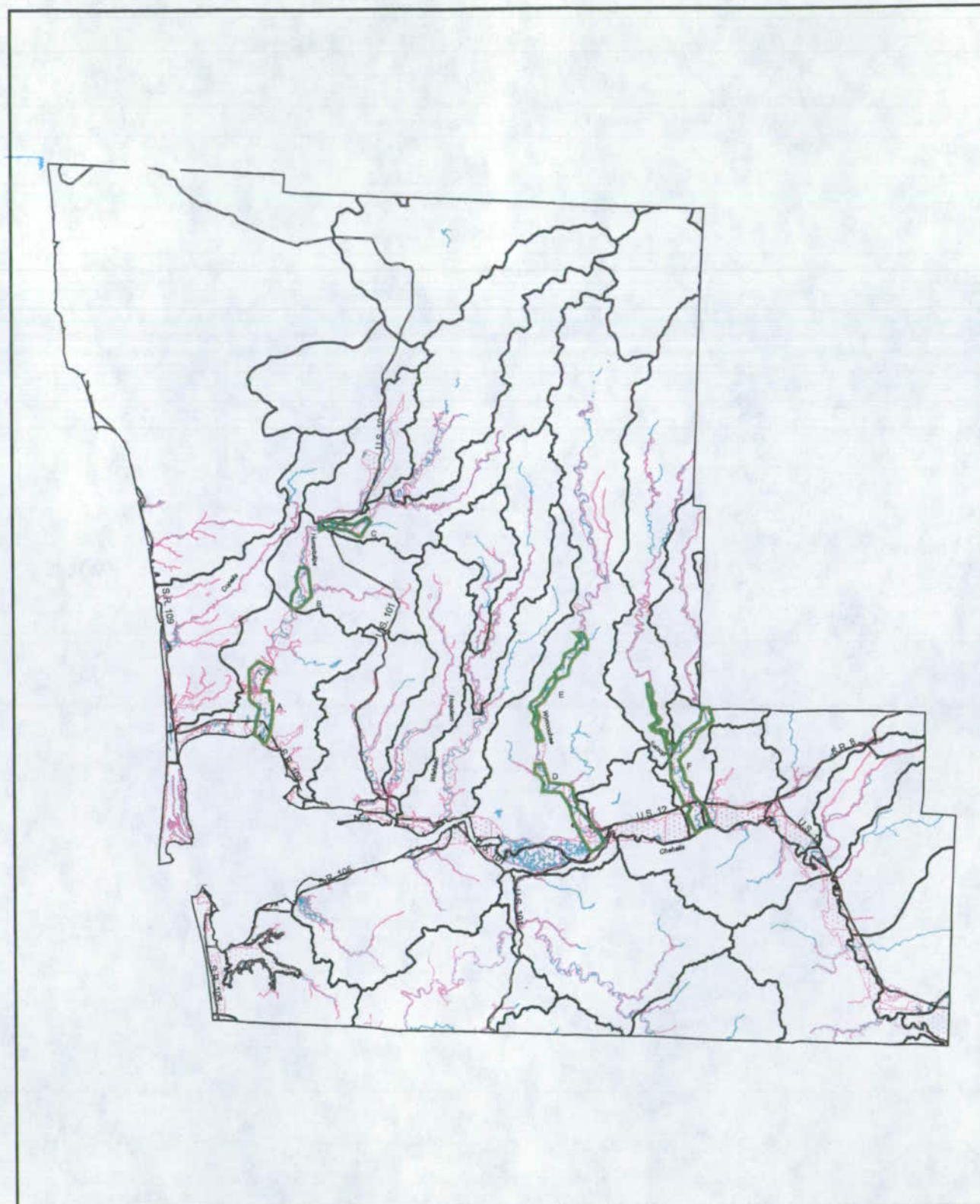
Comprehensive goals were developed to provide an organized framework to guide the planning process. As described in Section 2, the main goals of this CFHMP are:

- Improve the protection of public health and safety from flooding events.
- Provide practical, cost-effective solutions that will result in measurable reductions in flood frequency, flood duration, and the amount of damage that occurs in frequently flooded areas.

- Identify and assess Countywide problem areas through public meetings and existing FEMA mapping.
- Develop a community-driven plan with positive working relationships among the community and governmental agencies.
- Ensure that all parties are aware of the issues, processes, and implications of a CFHMP, and reach public and agency consensus on solutions and funding options.
- Document recommendations consistent with Ecology's FCAAP to permit further grant funding opportunities for plan implementation.
- Develop a plan consistent with FEMA Flood Hazard Mitigation Planning so that the County can be eligible for flood hazard mitigation assistance for the projects detailed in the plan.

The nonstructural and structural measures presented in this section are consistent with all of the goals listed above.





Comprehensive Flood Hazard Management Plan  
Recommended Areas  
for Revising Floodplain Mapping

Figure 6-1

LEGEND

- Recommended Floodplain Mapping
- Highway
- 100 Year Floodplain
- Basin
- River



1" = 30000'

15000 0 15000 30000 Feet







Comprehensive Flood Hazard Management Plan  
Wynoochee Tracts  
Conceptual Structural Recommendation

Figure 6-2

LEGEND

-  Conceptual Project
-  Highway
-  100 Year Floodplain
-  River
-  Basin
-  Roads



1" = 400'

200 0 200 400 Feet







Comprehensive Flood Hazard Management Plan  
 Satsop Riviera  
 Conceptual Structural Recommendation

Figure 6-3

- LEGEND**
- Conceptual Project
  - Highway
  - 100 Year Floodplain
  - River
  - Basin
  - Roads



1" = 500'

250 0 250 500 Feet











Comprehensive Flood Hazard Management Plan  
 Humptulips Dike Road  
 Conceptual Structural Recommendation

Figure 6-4

LEGEND

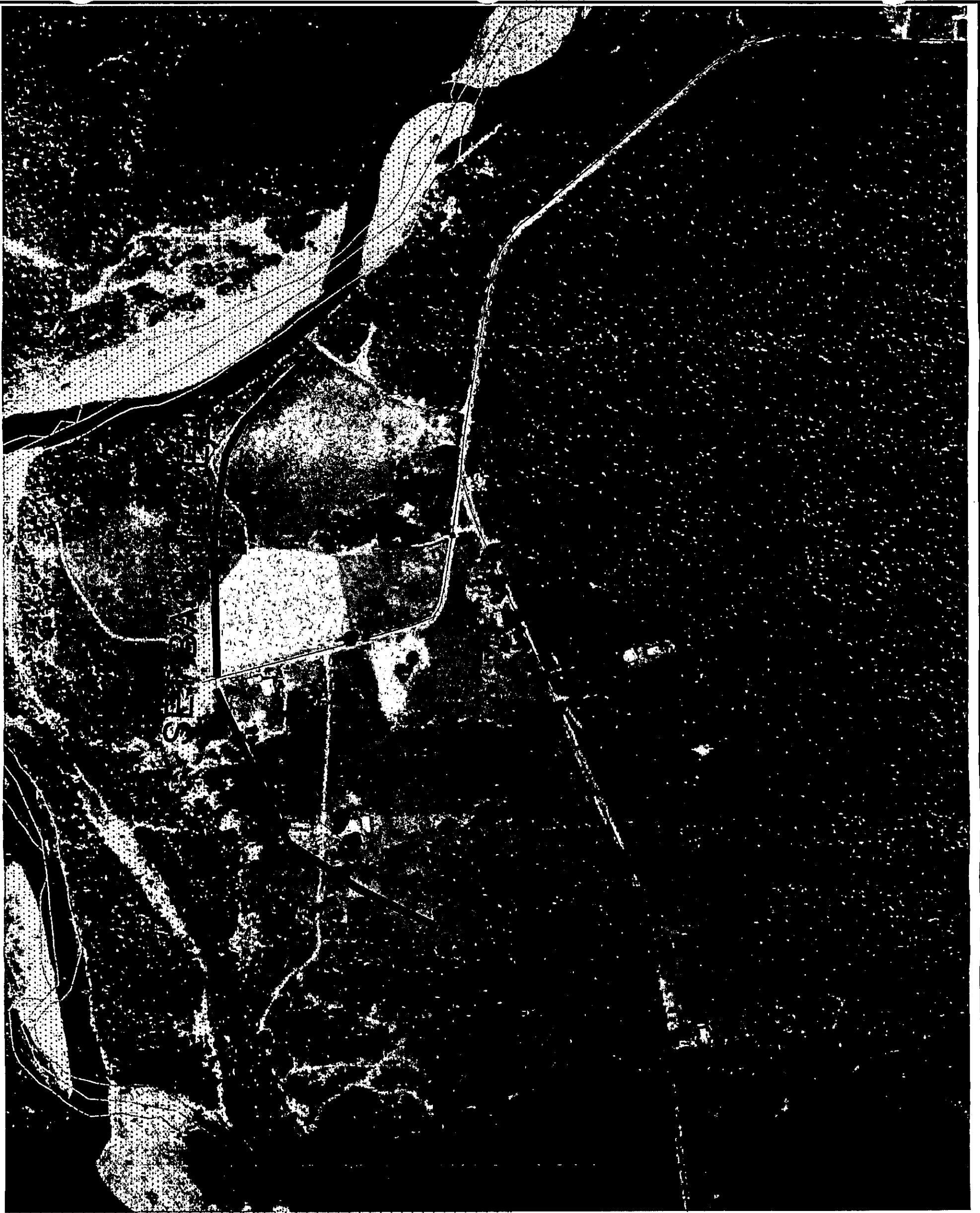
-  Conceptual Project
-  Highway
-  100 Year Floodplain
-  River
-  Basin
-  Roads



1" = 400'





200 0 200 400 Feet





Comprehensive Flood Hazard Management Plan  
Walker Bottom Area  
Conceptual Structural Recommendation

Figure 6-5

- LEGEND
-  Conceptual Project
  -  Highway
  -  100 Year Floodplain
  -  River
  -  Basin
  -  Roads



1" = 400'

200 0 200 400 Feet

