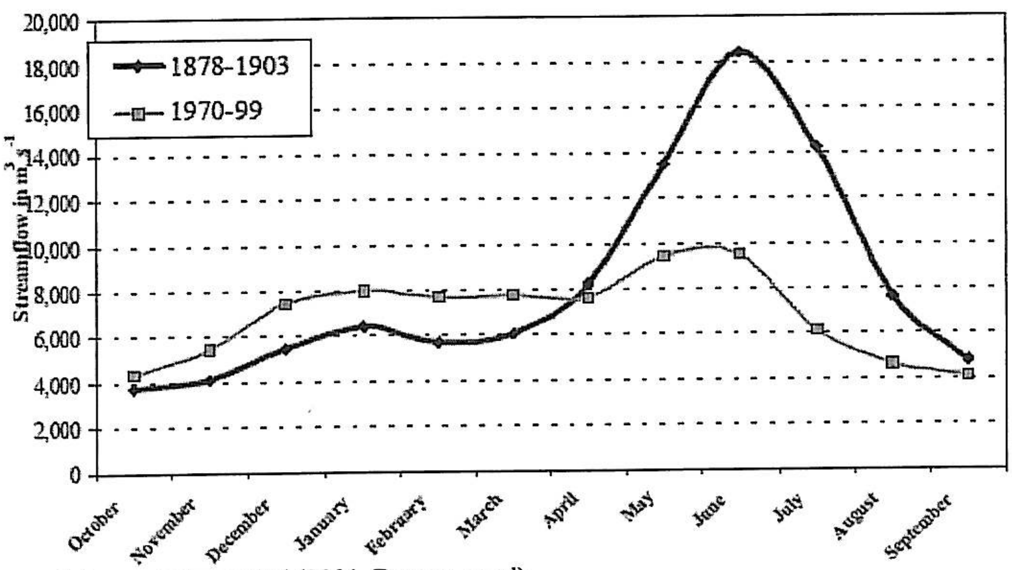
IV. *Identification of Flood Issues-Past and Present*

As described above, the combination of flow conditions from localized climate and flow patterns from the Columbia River Basin result in high risks of flood hazard to citizens of Wahkiakum. Below is a summary of recorded and anecdotal information of both the historic and present flooding issues in the County. In addition, this section includes a summary of efforts used by the County to address flood related issues in the form of flood control management techniques and previous documents referencing flooding conditions and targeted actions.

A. Record of historic flood events

Figure 4.1 Columbia River Flow Patterns Comparison: Virgin vs. Modified Flow Patterns



Source: Salmon at Rivers End (2001, Bottom, et. al)

The watersheds of Wahkiakum are in part a product of the conditions of the Lower Columbia River. Historically, high flow, spring freshets occurring in May-June would inundate the lower portions of Wahkiakum frequently reconfiguring networks of off-channel sloughs and wetland types. The construction of the Hydropower Dam System in the upper portions of the mainstem Columbia combined with irrigation withdrawals, has extensively altered the timing, intensity, and overall volume of water. Figure 4.1 demonstrates the effect these activities have had on the timing of freshets.

Given the intensity of historical Columbia River flow patterns, and localized climate trends, flooding occurred regularly in Wahkiakum County before dam construction and dike installation. Below is a brief summary of the major events affecting Wahkiakum

County based on information from stream gauges, previous assessments, and anecdotal local information.

Figure 4.2: Historic Flooding Records in Columbia River and Wahkiakum County Watersheds

Date	Flow Recorded/ Event
1849	1,201,560 cubic feet/second on Columbia River Mainstem
1859	869,364 cubic feet/second " "
1862	950,646 cubic feet/second " "
1864	749,208 cubic feet/second " "
1866	749,208 cubic feet/second " "
1871	862,296 cubic feet/second " "
1876	961,248 cubic feet/second " "
1880	961,998 cubic feet/second " "
1894	876,432 cubic feet/second " "
1933	Flood Stage of 17.2 feet reported on the Elochoman
1948	999,273 cubic feet/second on Columbia River Mainstem; Major Portions of Puget Island covered
1949	12.66 feet flood elevation recorded on Elochoman
1950	12.51 feet flood elevation reported on Elochoman
1956	12.49 feet flood elevation recorded on Elochoman; 10.23 recorded on Grays River
1962	12.86 feet elevation on Elochoman; 11.1 feet elevation recorded on Grays; Localized flooding reported throughout the County
1966	10.94 feet flood elevation recorded on Grays River
1972	11.29 feet flood elevation recorded on Grays River; 11.93 recorded on Elochoman
1975	10.86 feet flood elevation recorded on Grays River; 11.74 reported on Elochoman
1977	10.32 feet flood elevation on Grays River; 13.6 Feet on Elochoman; Localized Flooding in Towns of Grays River and its Floodplain
1979	USGS gages cease recording
1990	Significant flooding along Nelson Creek;Middle Valley;Seal River; Skamokawa; Closest recorded elevation @ Naselle exceeded 16 feet three (3) times during the year
1994	17.62 and 16.16 feet flood elevation @ Naselle
1997	19.26 feet flood elevation recorded @ Naselle; extensive flooding throughout the County and Pacific Northwest
1998	Dike fails near Gorley Springs requiring emergency evacuation and causing extensive damage to private property
2003	Erosion accelerates on Puget Island

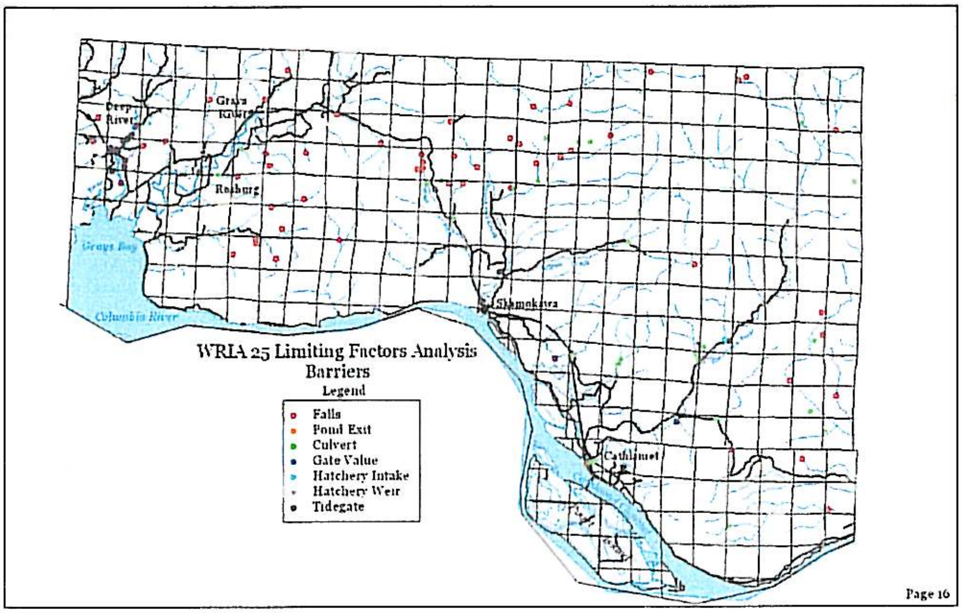
B. Prior flood control actions and investigations

1. Prior Flood Control Actions

As the historic flood information describes, flooding is a regular occurrence for the watersheds of Wahkiakum. Ever since settlement of the area by European culture, localized diking structures were installed in all of the major basins to provide protection from high elevation events resulting from the combination of high tides with river flow events. The building and maintenance of these structures continued through the establishment of local diking districts in partnership with the Army Corps of Engineers during the 1940s and 1950s. Pile dikes were also placed in the Columbia River to direct flow energies toward the navigation channel.

Specifically on the Grays River in 1940s and 50s, the Army Corps, in partnership with the County Conservation District investigated and implemented a variety of opportunities for streambank protection that included the placement of riprap, stone revetments, gravel dikes, gravel removal, etc. The Grays River Habitat District currently maintains these structures formerly the Upper Grays River Diking District. In addition, tidegates were installed in the lower areas of the Grays River area. More than 20 of these structures were constructed in both the Grays and Deep River area. A preliminary inventory shows the distribution of these structures and other barriers throughout the County.

Figure 4.4: LFA Fish Barrier Inventory (map produced by CREST)



Source: Washington State Conservation Commission (2002)

On Skamokawa Creek, in addition to diking, a canal was constructed to divert flow away from the historic channel. The tidegates which were installed effectively created a man-made artificial cut off meander. Additional types of flood control actions also included the installation of pump stations to control channel elevations on Nelson Creek and Puget Island. Pump stations were also installed in 1977 on Brooks Slough on the National Wildlife Refuge managed by US Fish and Wildlife.

Many of the Counties existing flood control structures identified above are in need of maintenance and repair. Dikes are failing or sloughing, increasing the level of risk for the County citizens. In addition, antiquated tidegate structures with heavy lids do not drain surface runoff efficiently consequently raising channel elevations. At Grove Slough on Puget Island, the level of accretion has effectively prevented the tidegates from opening, thereby increasing the drainage burden on the islands pump station.

2. Prior Flood Control Investigations

FEMA Flood Insurance Study

Under authority of the National Flood Insurance Act of 1968 and 1973, Wahkiakum County is a part of the National Flood Insurance Program(NFIP). As a part of the program FEMA provides a detailed technical Flood Insurance Study involving hydrologic and hydraulic analyses. This study forms the basis for the regulatory program.

The products of the study are the Flood Insurance Rate Map (FIRM) and the Flood Insurance Study.

The Flood Insurance Study provides data on the width of the floodway and floodplain, the cross-sectional area, and the floodwater velocity at given points in the stream. The FIRM delineates areas adjacent to rivers that are subjected to flood risks and sets an insurance rate for each area. FIRMs also define flood insurance rate zones, limits of the 100-year floodway and floodplain, and, frequently, the limits to the 500-year floodplain. FIRMs and the associated insurance studies are available from the regional branch of FEMA.

The 100-year flood determines the geographic jurisdiction of NFIP-related programs. The NFIP's floodplain management regulations for buildings and development in special flood hazard areas require that new or substantially improved residential buildings be elevated so that the lowest floor is at or above the base flood elevation (BFE). The same requirement applies to new or substantially improved nonresidential buildings, except that owners have the option of floodproofing these structures instead of elevating them. Two (2) studies have been completed for the County.

In 1986, the first study was completed to investigate the impacts of Birnie Creek and the Columbia River on the Town of Cathlamet. In 1990, a Flood Insurance Study was completed for the whole County creating a set of preliminary set of maps and flood risk information for sections of the Elochoman River, Grays River, Skamokawa Creek, Wilson Creek, and Birnie Creek. Using a combination of off-site methods, fieldwork, and modeling cursory information was compiled on flow patterns for the 100-year flood event. Listed below are the results of the modeling for each of these watersheds.

Figure 4.5: Flood Insurance Study 100 year Discharge by Watershed

Watershed	*100 year Discharge (cfs) at the confluence*
Elochoman River	10,700
Grays River	24,600
Skamakowa Creek	8,820
Wilson Creek	3,630
Birnie Creek	290

Flood Damage Prevention Plan, Wahkiakum County (1974)

In 1974, Wahkiakum County completed a comprehensive plan and investigated the nature of flood hazards and methods for flood control. It represented the first comprehensive look at flooding issues and summarized the programmatic capacity to address these issues from the local, state, and federal level. Moreover, the Plan provided a set of recommended actions that helped spur the development of Flood Insurance Maps and land use restrictions in the floodplains. These actions, were divided into Present and Future Actions:

Present Actions:

1) Continue Flood Insurance Program Requirements;

2) Actively pursue the completion of the Flood Insurance Study through the Federal Emergency Management Agency;

3) Initiate a Permanent Review Committee to work with the County to recommend policy and land use objectives;

4) Adopt a Resolution giving precedence to flood control measures over any conflicting laws and ordinances. Resolve that development in the floodplain will not be expanded but existing non-conforming uses may be modified to meet Federal Insurance requirements;

5) Initiate action to improve the leadership capacity in the various diking districts;

6) Actively pursue a detailed planning program for floodplain development.

Future Actions:

1) Evaluate present and future methods of control of the floodplain.

2) Initiate a Corps of Engineers Survey of all existing flood control works in the County (includes a cost estimate for needed improvements based on 100 year elevations established by the Flood Insurance Study).

3) Investigate and determine financial capabilities and resources of diking districts and the County.

Pacific International Engineering Report (February 2002)
Projects and Solutions to Water Resource Problems on the Lower Columbia River
Sponsored for by the Lower Columbia River Port Communities, this study developed a list of water resource projects and conceptual solutions (figure 4.6). From this list several projects were identified in Wahkiakum County related to flooding issues. The study also broadly estimated the cost of each solution and characterized the economic benefit for the County. Listed below is a summary of those projects and the corresponding solutions that were proposed. This is meant as a preliminary lead into existing flooding issues discussed later in this section (C. Current List of Flooding Issues). A detailed copy of these recommendations is attached in Appendix F.

Figure 4.6: Summary of Flood-Related Project Recommendations from PIE report

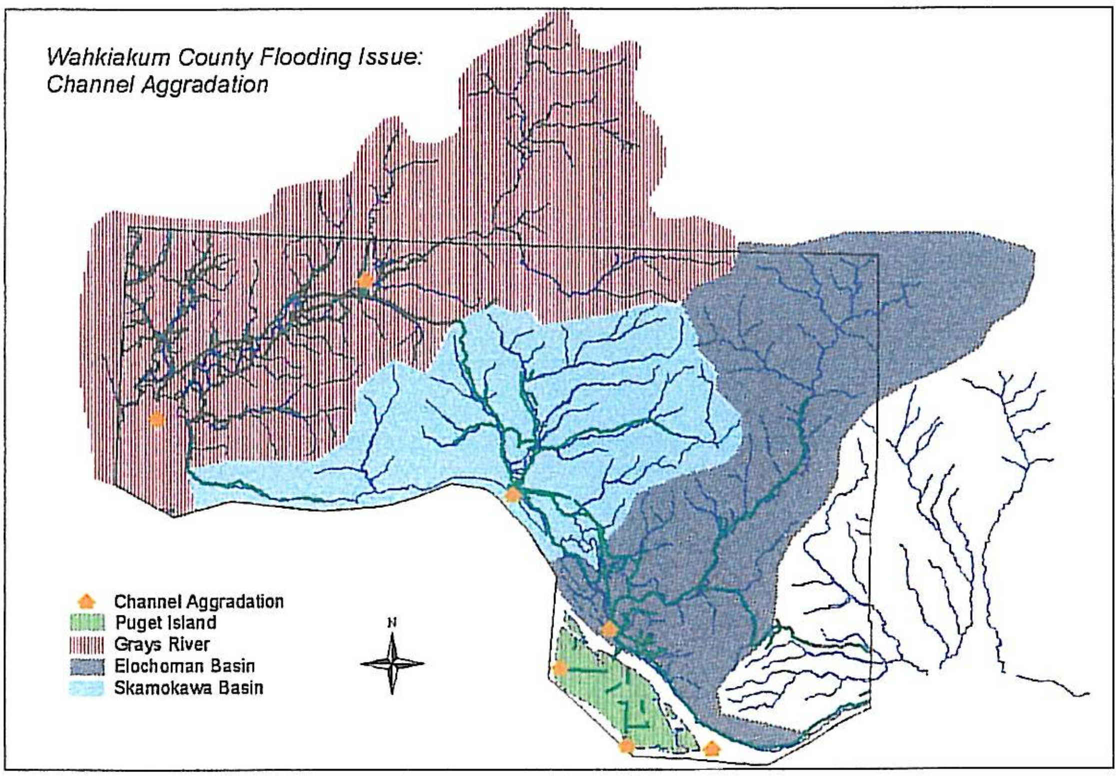
Location	*Problem*	*Solution(s)*
County Sand Pit (Puget Island)	*Deficit of Dredge Material*	*-Use Hopper Dredge to fill site* *-Use Cutterhead Pipeline Dredge*
Brown Slough Pump Station (Puget Island)	*Erosion*	*-Rock Revetment Rehabilitation* *-Beach Nourishment*
Grove Slough Tide Gate (Puget Island)	*Sedimentation*	*-Regular Maintenance Dredging*
North Welcome Slough Road (Puget Island)	*Bank Erosion*	*-Rock Revetment Rehabilitation* *-Steel Sheetpile Wall*
Ferry Terminal (Puget Island)	*Deposition/Shoaling*	*-Coordinated Dredging Schedule* *-Advanced Maintenance Dredging*
Pancake Point (Puget Island)	*Pancake Point Erosion*	*-Beach Nourishment* *-Buried Rock Revetment*
Cathlamet Channel	*Sedimentation*	*-Coordinated Dredging Schedule*
Cathlamet Marina	*Cathlamet Marina Sedimentation*	*-Flow Improvement* *-Dredging*
Skamokawa Creek Channel	*Sedimentation*	*-Federal Dredging* *-Local Dredging*
Grays River Mouth	*Sedimentation*	*-Detailed Hydraulic Evaluation* *-Local Dredging*

C. Current List of Flooding Issues

Building off of the issues identified in previous plans and through meetings/field visits with local community members and County staff, an inventory of flooding related issues was compiled across the four major watershed areas. The issues identified represent a diversity of flooding phenomena in the County. Below is a map showing the distribution of these areas and their location within the watershed. Also included in this list are projects that are being planned related to flood hazard mitigation. It is meant as a "first cut" attempt to characterize the most current and project future flood-related activities at a watershed scale. Because of the nature of flooding these areas are likely to change in both position and extent. Based on flood-related information collected, flood-related issues are defined as follows:

1. Channel Aggradation

Figure 4.7: Areas of Channel Aggradation in Wahkiakum County

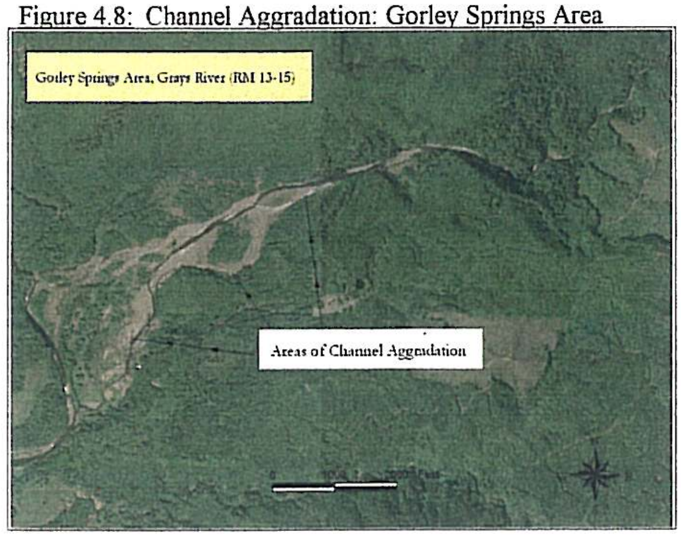


Source: CREST, 2002

Erosion and aggradation are interrelated watershed processes that maintain floodplain equilibrium. Channel aggradation happens when a riverbed elevation is built up by the combination of sediment-flow dynamics identified in Chapter 3. Put simply aggradation occurs when the increase in sediment is not equally matched by an increase in flow or discharge conditions. There are two types of aggradation occurring in Wahkiakum distinguished by the type of hydrology: (1) Fluvial (river dominated) and (2) Tidal-fluvial (combination of estuarine and riverine forces).

Fluvial-based aggradation occurs when sediment material from high sloped, erodible areas in the upper areas of the watershed are mobilized and deposited in lower gradient reaches, overburdening the channels capacity to convey the existing flow regime. The flow then responds to the now limited area of the channel, sometimes directing itself into streambank walls or overtopping banks to reestablish its previous capacity. This can further compound aggradation by entraining new sediment into the channel. Wilson Creek (figure 3.19) had a fairly severe flooding issue in the early and mid 90's. The upper watershed had been logged off and there was mass slope failures resulting in extensive over bank flooding in the valley area. The system has stabilized as trees have grown back and slowed down delivery of sediment for the last five years. The most prominent examples of aggradation occurring in the County are around the Gorley Springs area (figure 4.8) where confined, higher energy channels, abruptly change into broader, low gradient sections whereby sediment material is deposited. This deposition area is dominated by medium sized, unconsolidated material that is used to form new channel networks as witnessed by the 1998 avulsion in this area. To date these areas is extremely unstable with flows patterns occupying multiple channels throughout a water year.

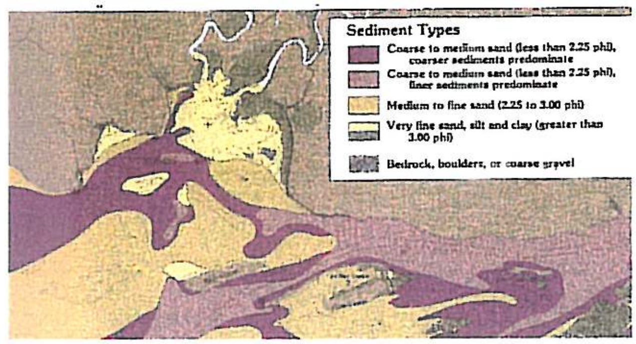
Figure 4.8: Channel Aggradation: Gorley Springs Area



Tidal-fluvial aggradation is different in nature because of the addition of larger, ocean-derived forces. It is important to note that the exact trend of this phenomena is not unique to the Counties watersheds, but all the embayments (i.e. Baker Bay, Young's Bay, Cathlamet Bay) of the Columbia River Estuary. This elevates the complexity of the issue to larger flow-sedimentary processes of the Columbia River Basin where the extent and degree of aggradation is highly variable in each embayment. However, it is along the embayments of Wahkiakum that aggradation is perceived to be contributing to flooding problems in each of the watershed areas, with the exception of Puget Island. The perception is that the accretion of areas like Grays Bay translates to the reduced capacity of the channel to convey or 'drain' a given discharge efficiently. In theory, reducing a channels area for a given flow can confine the active channel requiring a response in the channel direction to find a new channel that can contribute to overbank flooding and/or stream bank erosion.

Figure 4.9: Mouth of Grays River

Figure 4-10: Grays Bay Sediment Types (CREST 1983)

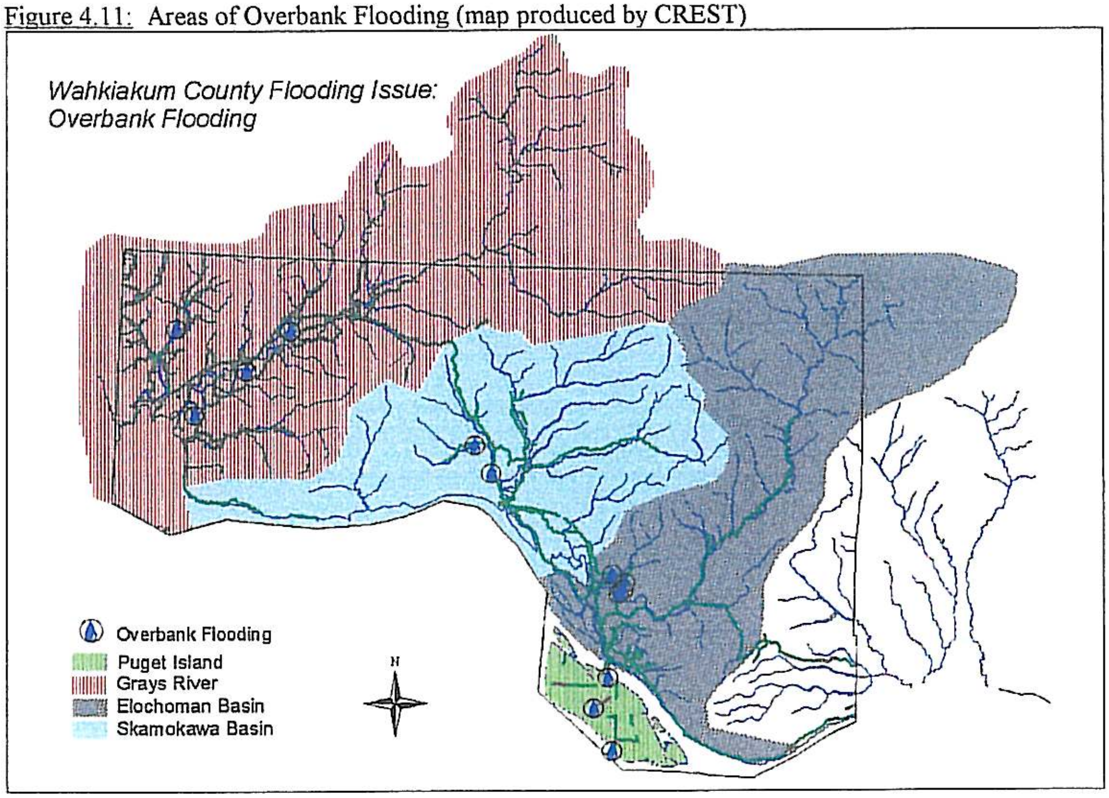


In reality larger, watershed-scale factors influence the accretion patterns. These include: sediment source identification, flow patterns, sediment size distribution, and an understanding of the river-bay transition zone influenced by riverine and tidal dynamics. Man-made alterations in the form of pile diking, dredge material disposal, and hydro-modification also affect the depositional patterns in Grays Bay. Figure 4-10 shows depictions of the sediment distribution for the slough networks of Wahkiakum County based on information compiled by CREST in the 1980s (CREDDP, 1984). Generally speaking, areas with very fine grains reflect lower tidal-fluvial energy environments where lighter, smaller material is able to deposit. Alternatively, areas with coarser material demonstrate higher energy areas.

2. Overbank Flooding

Overbank flooding is a natural process that a channel requires to reach equilibrium within its floodplain. It occurs when the elevation of the stream channel overflows its active channel and spills onto the floodplain. Unfortunately, it often occurs in lower gradient bottom areas of the County suitable for development, including private dwellings, farmland activities, and public access roads. Overbank flooding frequently occurs because of the combination of high flow events, with deteriorating maintenance of existing dike and public infrastructures such as roads. The situation is further exacerbated in tidal areas during bi-diurnal high tides and storm surges that can increase wave amplitudes. Diking can help minimize overbank flooding at the local level, however it can confine the natural tendency of the channel to move laterally increasing the chances of overbank flooding downstream. Another common cause of overbank flooding in the county is undersized culverts that do not possess the capacity to convey discharges during high flow events. Examples of this type of overbank flooding in Wahkiakum County include Altoona-Pillar Road in the Grays River Watershed, Foster Road (adjacent to Nelson Creek) in the Elochoman Basin, and the mouth of Birnie Creek in the Town of Cathlamet

Figure 4.11: Areas of Overbank Flooding (map produced by CREST)

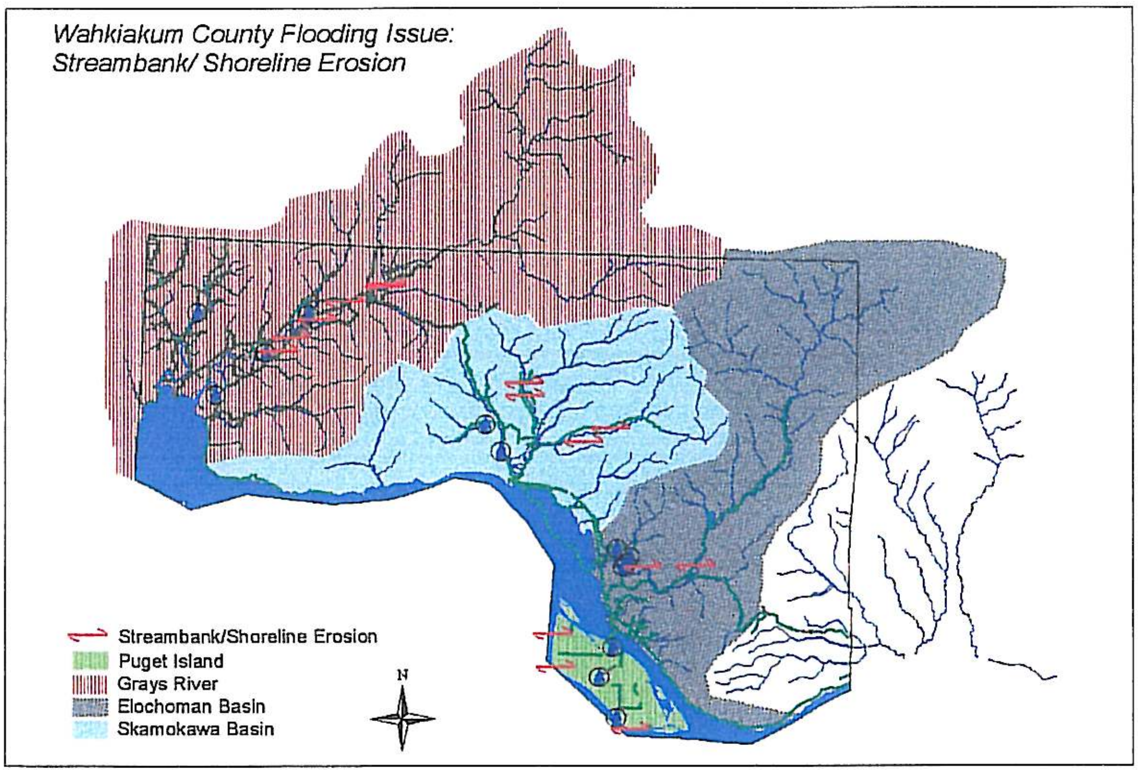


Source: CREST, 2002

3. Streambank/Shoreline Erosion

Opposite of aggradation, erosion occurs when the stream banks wear away due to shear stress placed on it by stream energy velocities. Erosion is very common in the middle portions of the County's watersheds between the base of high gradient slopes and low gradient tidal areas. Large expanses of highly erodible soils combined with ground disturbing activities such as logging and road building can destabilize slopes and cause frequent slope failures. These mass movements often expose tracts of soil to direct rainfall further destabilizing the area and entraining sediment into Wahkiakum streams.

Figure 4.12: Areas of Streambank/Shoreline Erosion



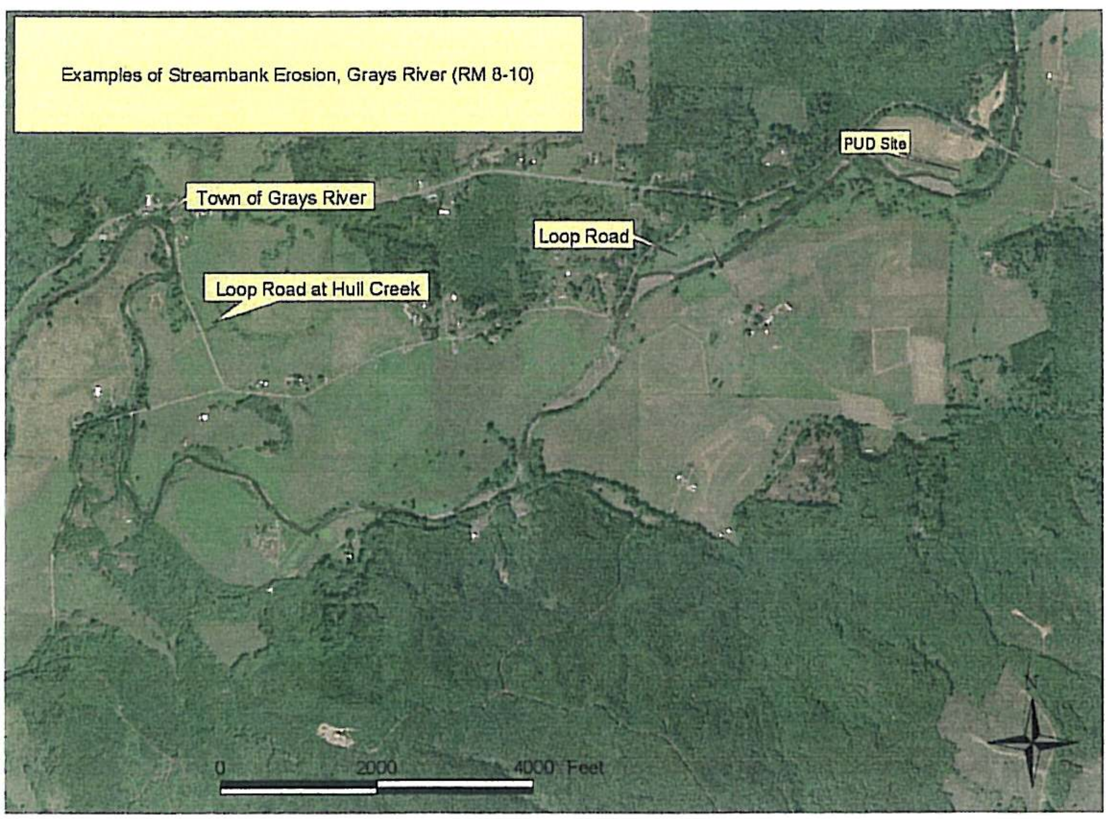
Source: CREST, 2004

The response to this phenomenon is seen throughout the watersheds with alternating patterns of erosion and depositional patches as explained in chapter 3. Currently, the Grays River Habitat Enhancement District contracted with Stream Fix, Inc. to conduct a geomorphic assessment directed toward understanding the nature of erosion on the mainstem. The study area spanned the mouth up to River Mile 14.6 (Gorley Springs). Through a combination of aerial photo interpretation, cross section measurements, and sediment analysis, data was collected leading to a better understanding of existing watershed processes contributing to erosion for this section of the mainstem Grays River. The Objectives of this study entailed the following:

- *Characterize the river in geomorphic terms;*
- *Assess the stability of the river;*
- *Compare selected reaches of the river to a stable reference reach;*
- *Relate the river's fluvial geomorphology to previously-established habitat limiting factors; and*
- *Recommend solutions to problems found.*

The assessment process directed ideas towards a list of conceptual design alternatives that identified specific erosional areas on the Grays River. While the report is not final at this time, planning, engineering, and permitting is moving forward to protect the PUD site downstream from the SR 4 Bridge on the Grays (figure 4.14). Using a combination of structural remedies and riparian plantings the District and StreamFix are moving forward to construct in the next year. Multiple areas along Loop Road have also been identified as areas impacted by erosional forces along the Grays River. Wahkiakum County has recruited the assistance of Army Corps of Engineers to assist with multiple sections of erosion that is endangering access on Loop Road, bridge supports, as well as private property.

Figure 4.14: Streambank Erosion- Grays River



Source: Spencer Gross, 2002 (figure created by CREST)

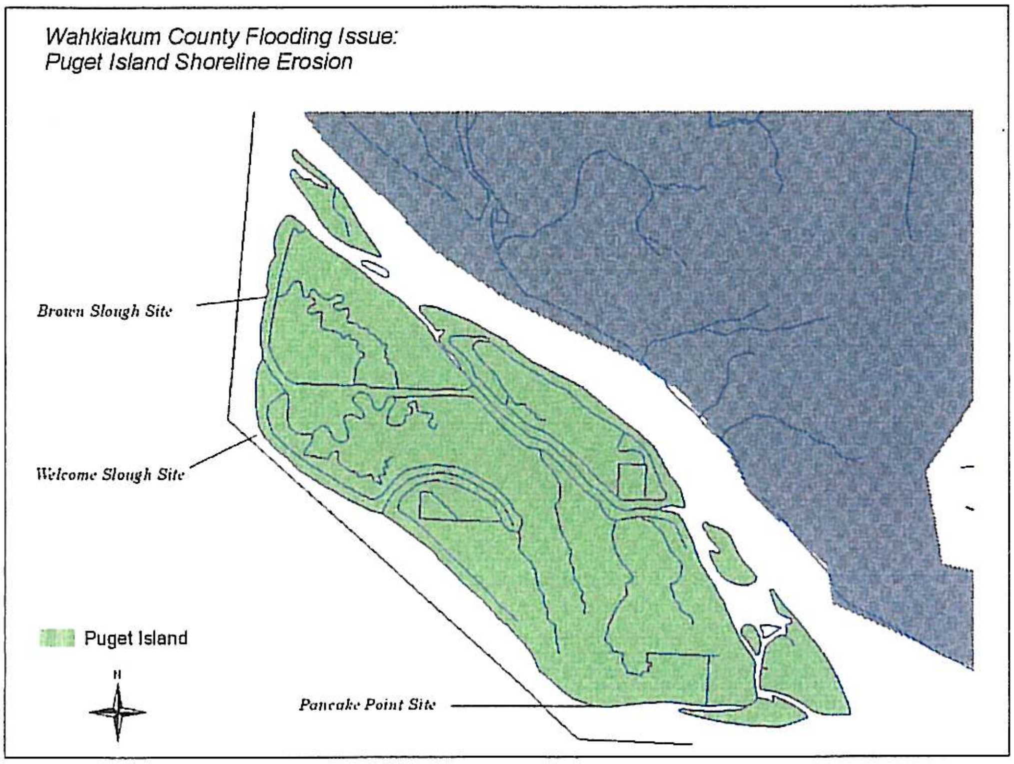
A streambank project completed by the County in the Middle Valley portion of the Skamokawa watershed demonstrated a combination of plantings and geotextile material, this served the dual purpose of on site protection and the slowing down of, rather than the deflection of, erosive velocities. Results on the effectiveness of this project are inconclusive as erosion continues downstream from this site. Further project effectiveness monitoring may be needed to understand its full benefit and to inform necessary design modifications for future projects in the Skamokawa Basin.

Figure 4.12: Middle Valley Streambank Erosion Project, Skamokawa Creek

Source: Wahkiakum County

Other types of erosion are occurring along Wahkiakum's shorelines. On Puget Island, the forces contributing to this erosion are directly related to structures and activities associated with the Columbia River navigation channel. Pile dikes and jetties along the channel were installed to direct flow velocities into the navigation channel to minimize maintenance of the existing channel configuration for transportation needs. The position and angle of these structures is such that they currently contribute to erosive forces along the Puget Island shoreline. A Technical Memorandum produced for the County by Coast & Harbor Engineering characterized the nature of the erosion and proposed several design alternatives (see Appendix F). According to the Memo, the erosion forces at the Welcome Slough and Pancake Point sites are in part due to the placement and orientation of pile dikes. Currently, several design alternatives are being discussed, including the placement of dredged material to protect the shoreline from further erosion. At the writing of this report, the County is working with CREST, Army Corps of Engineers and other permitting agencies to find feasible short term and long-term solutions for these areas. This will be discussed in further detail in Section VI of the plan.

Figure 4.13: Areas of Shoreline Erosion Puget Island



Source: CREST, 2004

4. Localized flooding

In many of the valley-bottom lowlands, extensive ponding takes place that can be further compounded by any of the flood hazards identified above. This phenomenon is especially true of diked pasturelands that often maintain some of their native wetland soil structure. Wetland soils are characteristically poorly drained. Due to the common but sporadic occurrence of localized flooding, no areas of this type of flood hazard were identified on any map.

Figure 4.15: Localized Ponding: Grays River Area