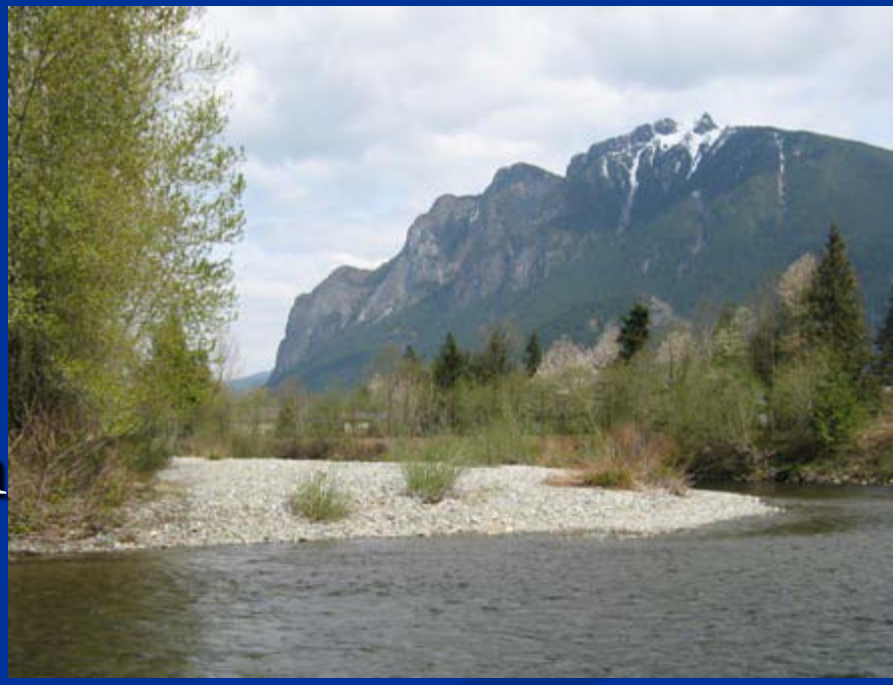
Gravel Removal and Sediment Management: Presentation Overview

- Background
  - Policy, terminology
  - Program components
- Sediment Management Program Implementation Examples



Policy RCM-3: Gravel Removal, excerpt

"King County should remove gravel…for flood hazard management purposes only when:"

…a set of six conditions are met (see Flood Plan Section 2.4.2, pages 21-22)

- Policy RCM-3 is consistent with state and federal regulations
- No revision to Policy RCM-3 is proposed in this Flood Plan update

Proposed Terminology Revision Throughout Flood Plan

- The term "gravel" technically refers to a specific size of sediment (2mm to 64mm)
- Hence, the term "gravel removal" is inaccurate because a wide range of sediment sizes is extracted
- King County proposes to replace the term "gravel removal" with "dredging"

King County Sediment Management Program

Two components:

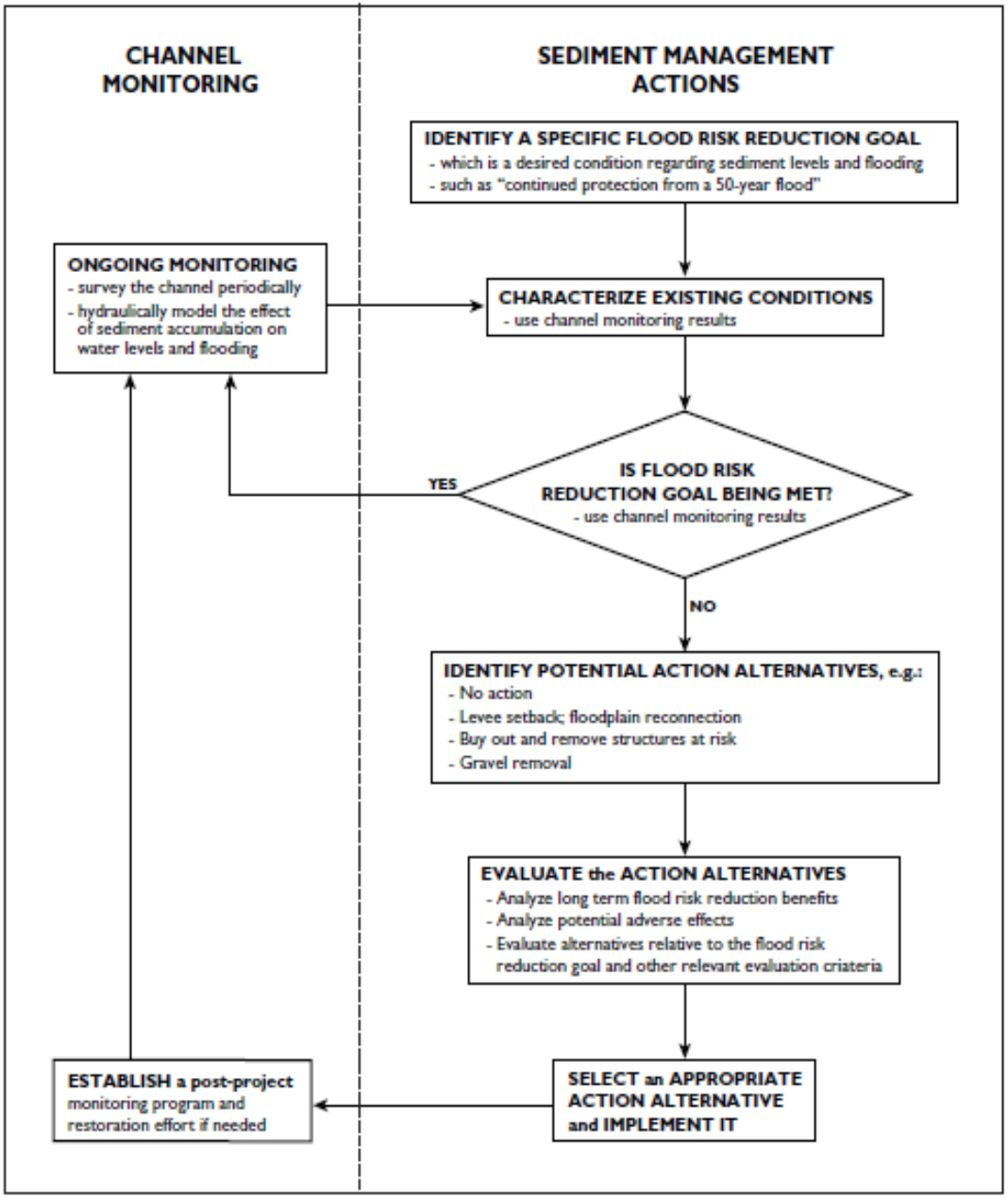
- Channel Monitoring
- Sediment Management Actions

Flood Plan Figure 4-6

Figure 4-6

A SEDIMENT MANAGEMENT PROGRAM AND ITS COMPONENTS

2006 KING COUNTY FLOOD HAZARD MANAGEMENT PLAN

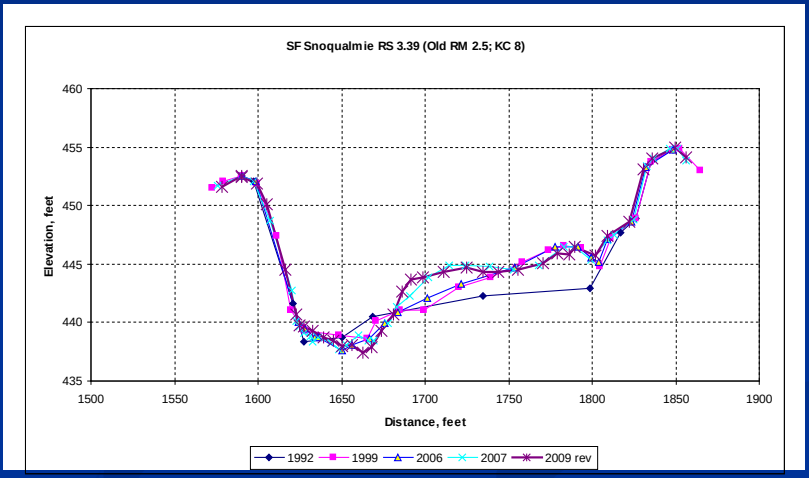


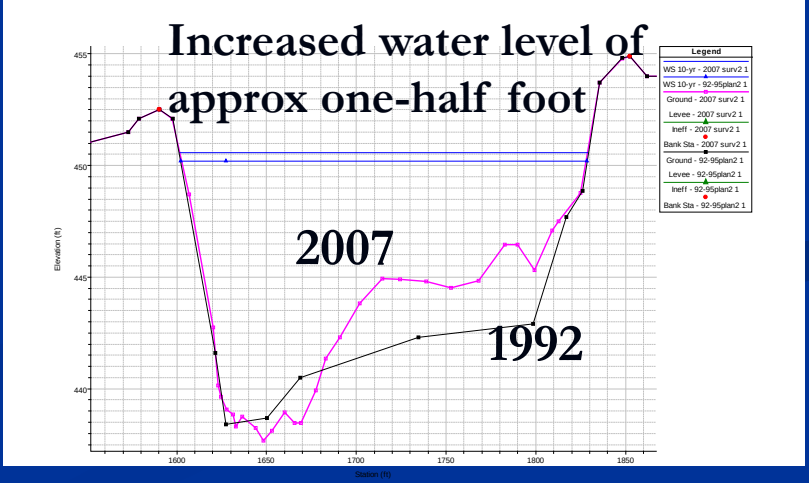
File name: 0604fhmpFIG46.ai wgab **Data source:** Adapted from Kondolf et. al. (2001) Figure 44

Channel Monitoring by Cross Section Survey:

- Calculate sediment deposition volumes & rates

- Hydraulic modeling of floodwater levels





Use Channel Monitoring Results to:

Characterize Existing Conditions:

- In-channel sediment trends
- Trends in floodwaters, flood hazards
- Effect of sediment on floodwater levels

Inform Sediment Management Decisions:

- Have flood hazards increased?
  - … beyond an identified acceptable threshold?
- Are such increases attributable to sedimentation?
  - If so: Consider Sediment Management Actions

Sediment Management Actions (aka Flood Risk Reduction Projects)

Timeframe	Alter the Channel Corridor to Accommodate Sediment and Flows	Alter Sediment Within the Channel to Accommodate Flows
Short Term	Temporary Flood Barrier (e.g., Super Sacs; HESCOs)	Gravel Removal (Dredging)
Long Term	Levee Removal, Setback & Floodplain Reconnection; Acquire and Remove At-Risk Structures; Elevate At-Risk Structures	

Evaluate Sediment Management Action Alternatives

- Identify alternatives
- Evaluate alternatives using evaluation criteria that are based on the 3 main Flood Plan goals:
  1. To reduce flood risks
  2. To avoid or minimize environmental impacts
  3. To reduce long-term costs

  Other criteria may be used as well
- Select preferred sediment management alternative(s)

Channel Monitoring and Sediment Management in King County

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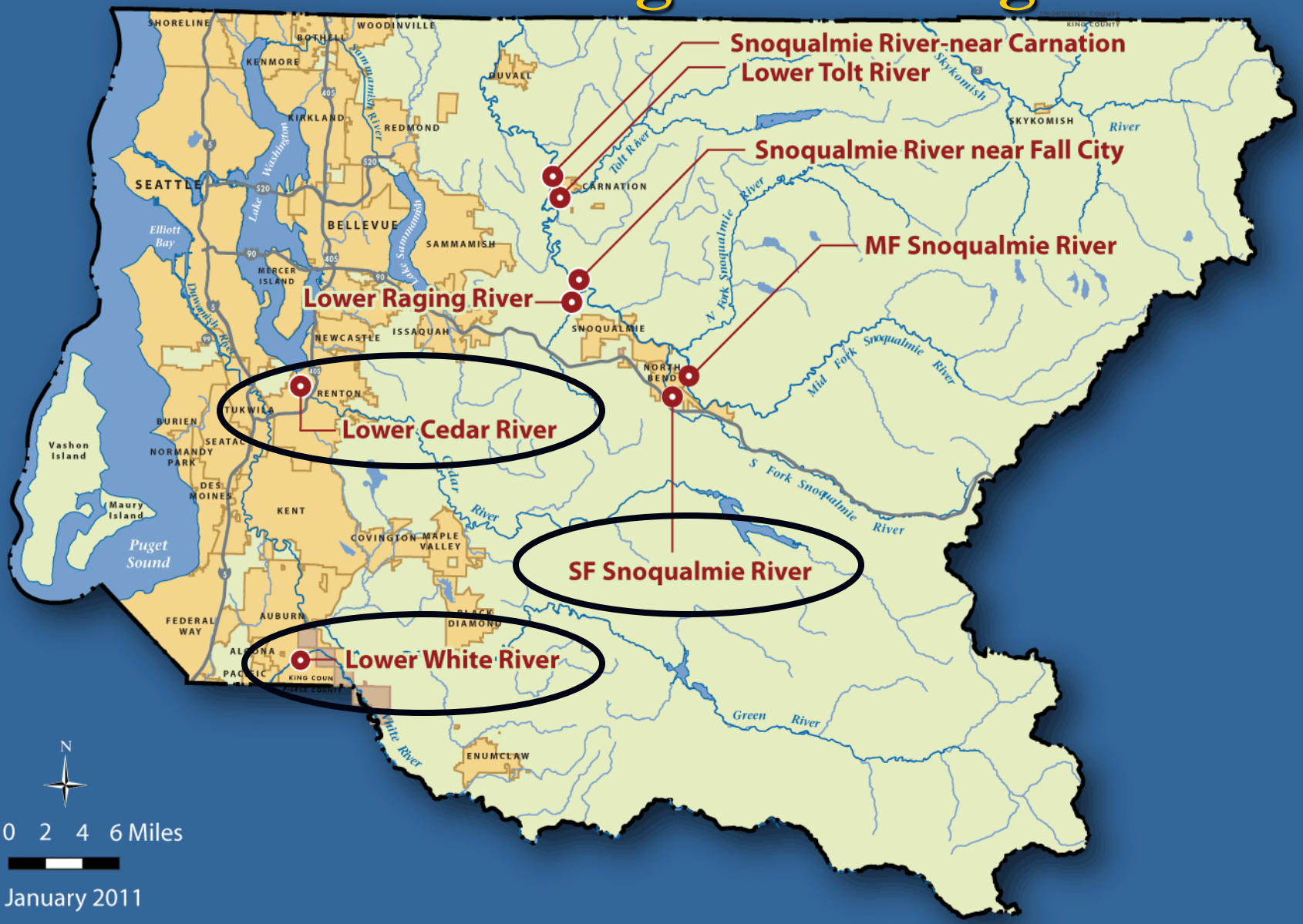
Implementation of Sediment Management Program



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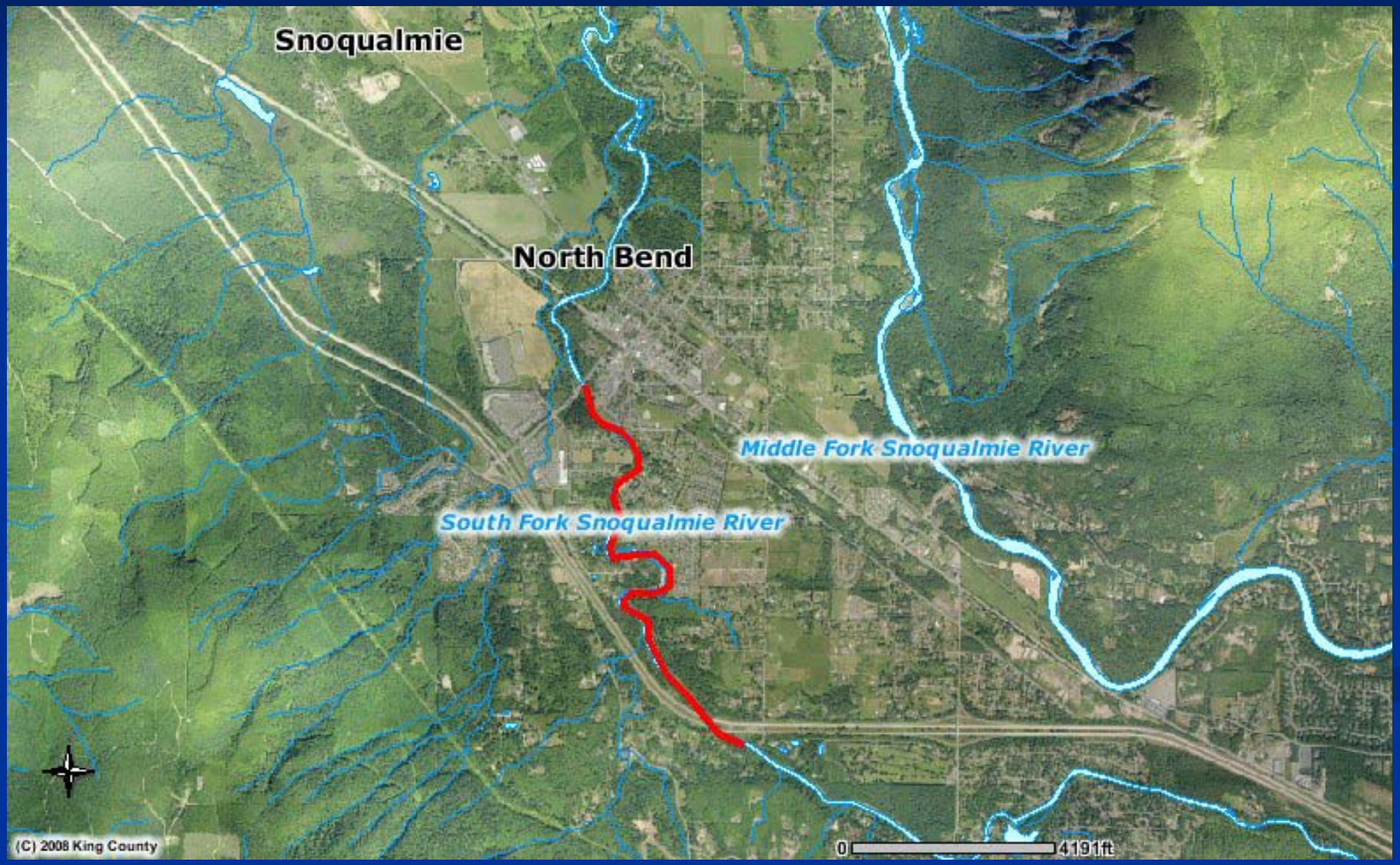
Implementation of Sediment Management Program:

- South Fork Snoqualmie River Gravel Removal Study and Levee Improvement Project
- Lower White River, City of Pacific: Flood Risk Reduction Components
- Cedar River Gravel Removal Project

South Fork Snoqualmie River

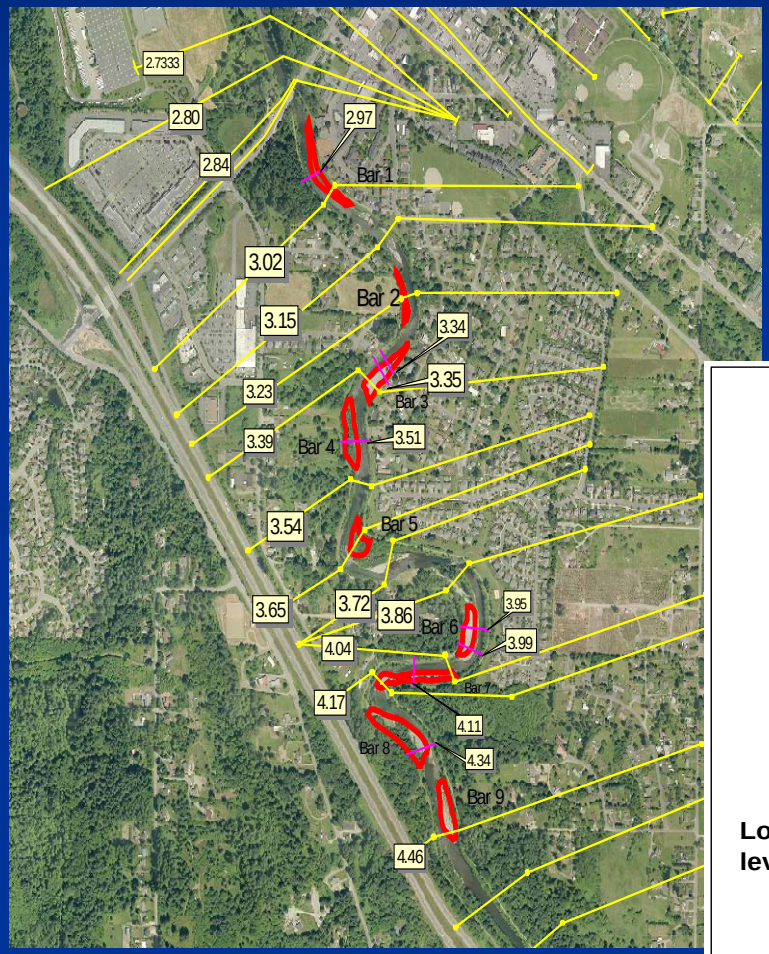


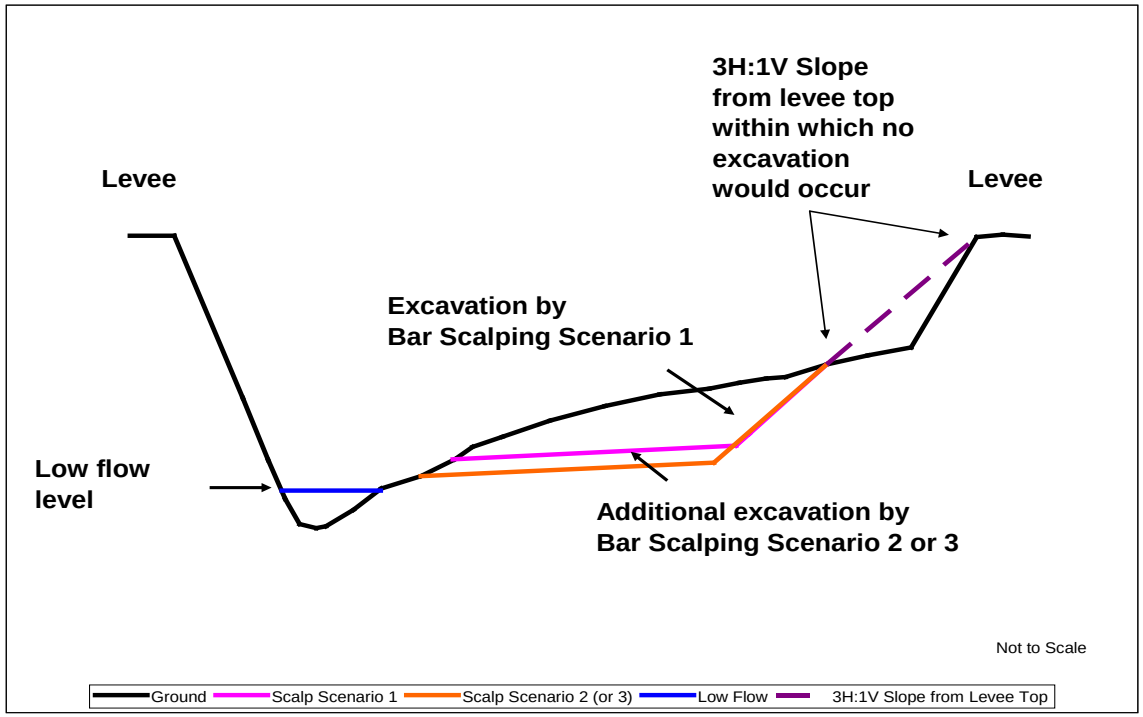
South Fork Snoqualmie River Existing Conditions; Flooding

- Channel capacity has, in places, decreased below an identified flood objective
- Flooding has overtopped at two left bank locations in the downstream area (arrows)
- Decreases in channel capacity are attributed to sediment accumulation

South Fork Snoqualmie River Gravel Removal Study

- Three scenarios analyzed
- One scenario, at left
- Gravel bar scalp schematic, below
- Range of effectiveness, impacts, estimated costs

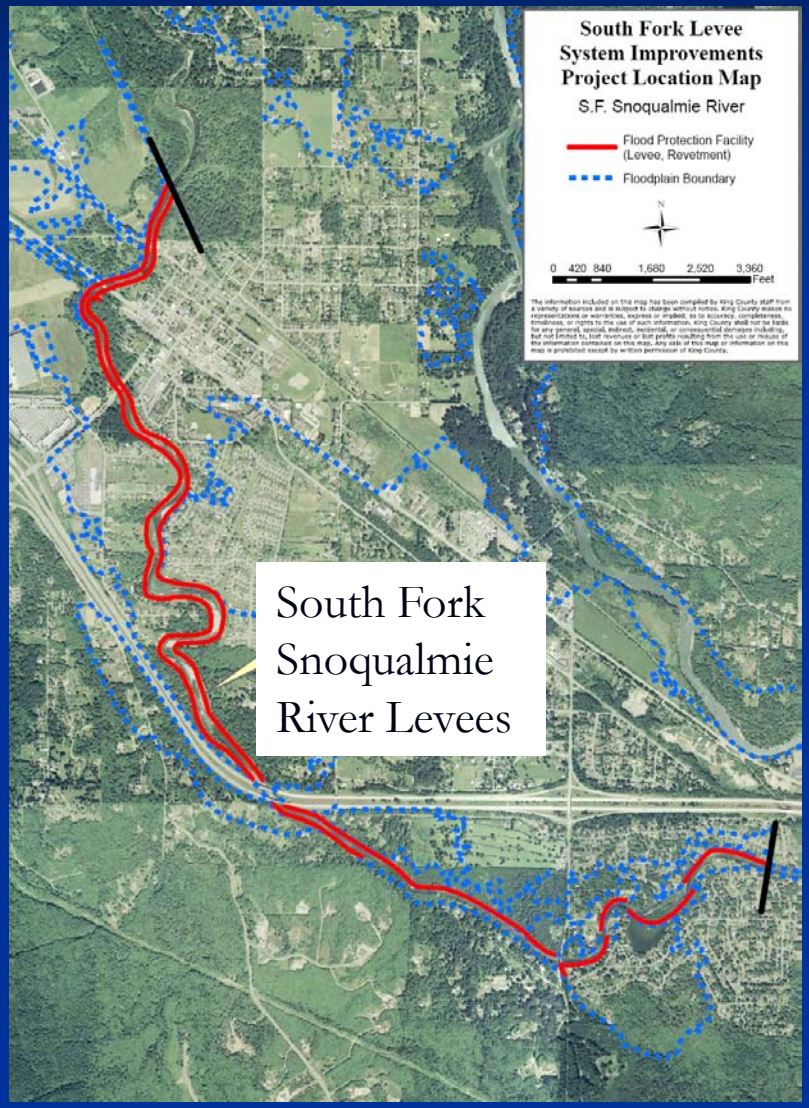




SF Snoqualmie Gravel Removal Study Evaluation Criteria

Main Flood Plan Goal	Evaluation Criteria	Unit of Measurement
1. Reduce flood risks	Channel conveyance capacity relative to flood risk reduction objective	Discharge (cfs)
1. Reduce flood risks	Change in flood water surface elevations	Feet
1. Reduce flood risks	Longevity of flood reduction benefit	Years
2. Avoid/minim. env. impacts	Impacts to existing flood structures or public infrastructure (e.g., bridges)	L/M/H (Qualitative)
2. Avoid/minim. env. impacts	Impacts to nearby or downstream flooding	L/M/H (Qualitative)
2. Avoid/minim. env. impacts	Impacts to salmonid habitat	L/M/H (Qualitative)
3. Reduce long-term costs	Minimize long-term costs	Total cost ($)

Use Gravel Removal Study Results in the SF Snoqualmie River Levee Improvement Project

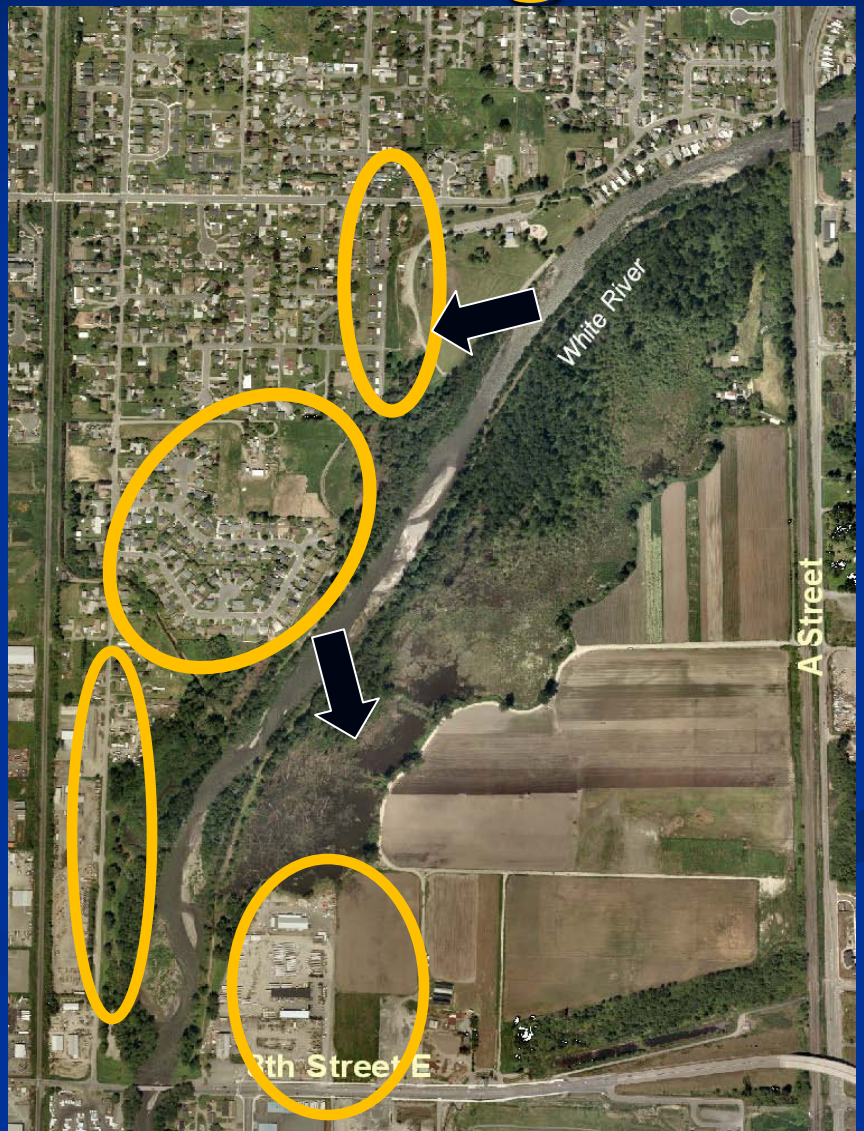


- Alternatives include:
  - Levee structural improvements
  - Levee setback
  - Acquisition and removal of at-risk structures
  - Home elevations
  - Gravel removal
- Alternatives to be evaluated using criteria based on 3 main Flood Plan goals

Lower White River: City of Pacific

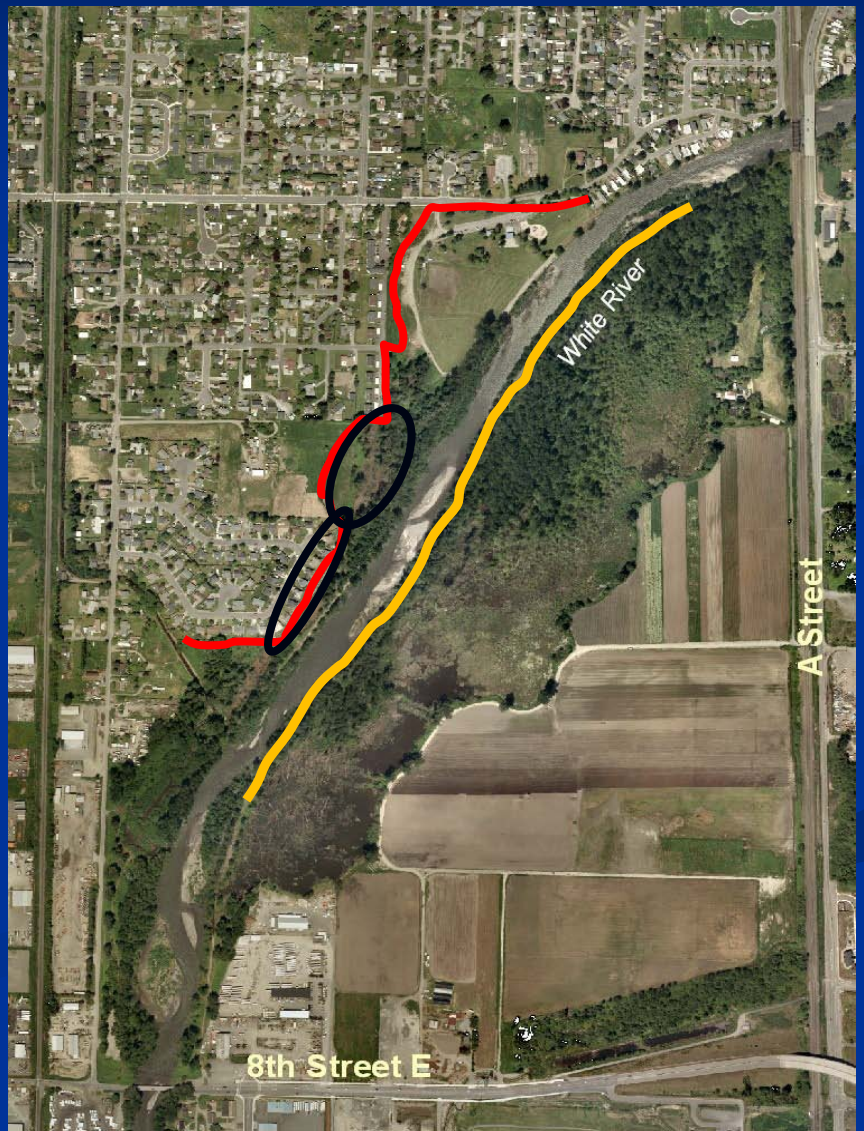
Lower White River Existing Conditions; 2009 Flooding

- Depositional reach in sediment-rich basin
- January 2009 flooding
  - Right (east) bank areas in City of Pacific
  - Left (west) bank into City of Sumner
- Flooding was exacerbated by sedimentation



Lower White River, City of Pacific: Flood Risk Reduction Components

- Temporary Flood Barrier (red)
- Acquire an undeveloped parcel; acquire & remove 11 at-risk residential structures (black)
- Levee removal (orange) and setback project

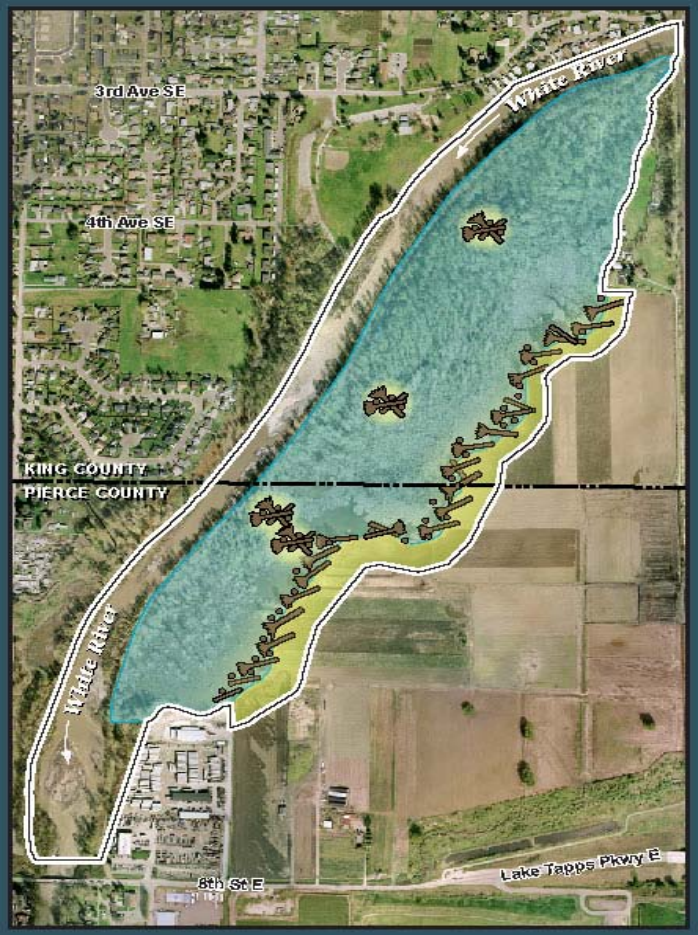


Countyline to A Street Levee Setback and Floodplain Reconnection Project

- Purposes: habitat restoration and flood risk reduction
- Alternatives analysis focus: variations of levee setback due to floodplain reconnection goal
- Evaluation criteria based on 3 main Flood Plan goals
- USGS study found that a levee setback would be much more effective in flood hazard reduction than gravel removal in this same reach

Countyline to A Street Levee Setback and Floodplain Reconnection Project

- Project elements:
  - Remove and set back the left (east) bank levee
  - Allow river to access existing floodplain wetland
  - Biorevetment bank protection along east terrace
  - Engineered log jams
- Wider floodplain would result in decreased flood water elevations, decreased flood risk



Proposed Countyline Levee Setback & Floodplain Reconnection Project; Conceptual Schematic, 2011

Lower Cedar River

Lower Cedar River Existing Conditions; Flooding

- Low channel gradient; sediment deposits
- Historical response to sedimentation has been dredging
- Flooding results in impacts to municipal and industrial infrastructure

(1990 photo)

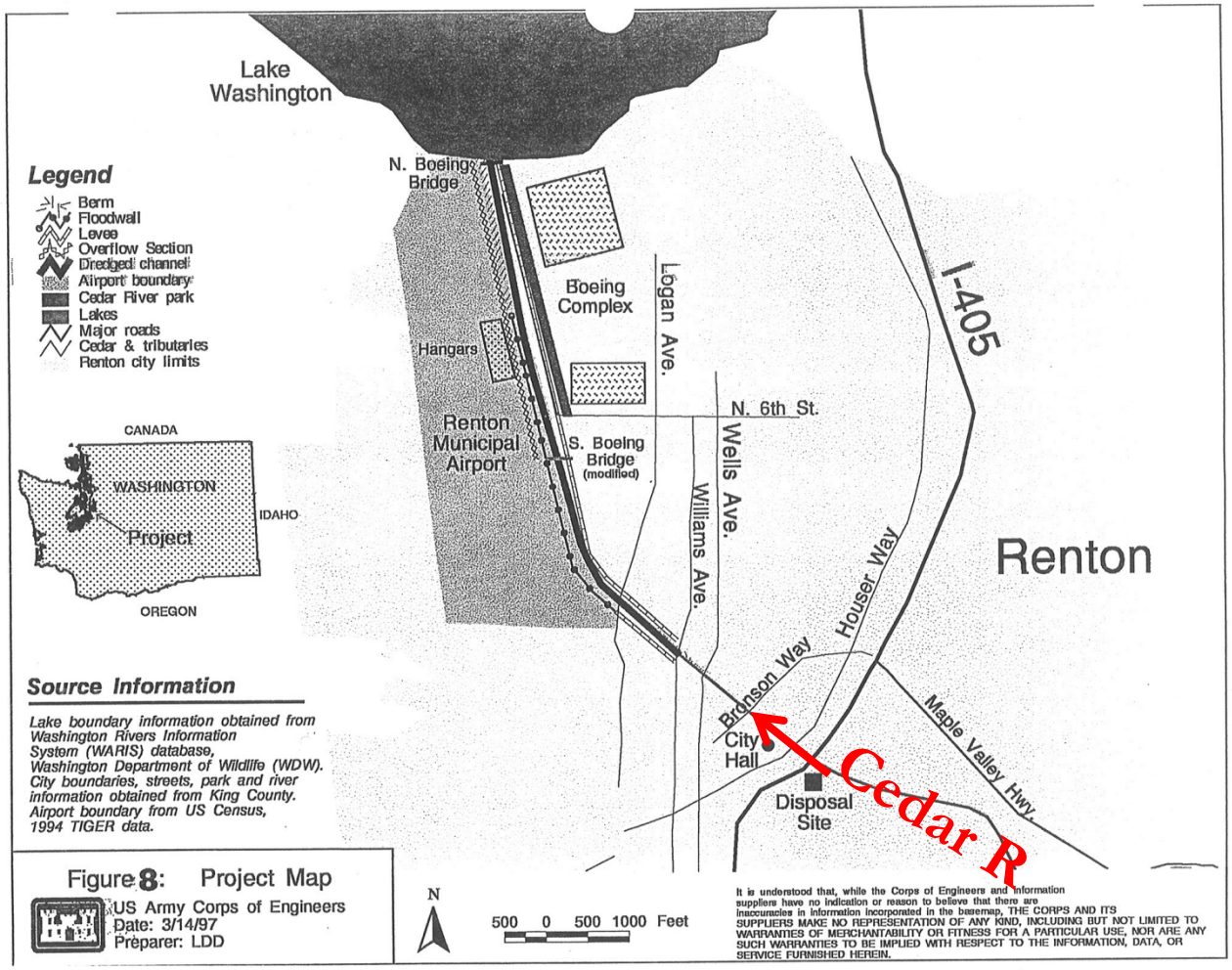
Cedar River Army Corps 205 (Flood Control) Project

- Analysis and project design during mid-1990s
- Several alternatives considered in project EIS:
  - No action; modification of Chester Morse Dam operations; sediment trap; acquisition and channel widening in Renton; setback levee upstream of Renton; floodwall; levees; various depths of dredging.
- Evaluation criteria included:
  - Flood damage reduction effectiveness; cost effectiveness; environmental quality; regional development; and other social effects
- Preferred Alternative selected

Cedar River Army Corps 205 Project Implemented in 1998

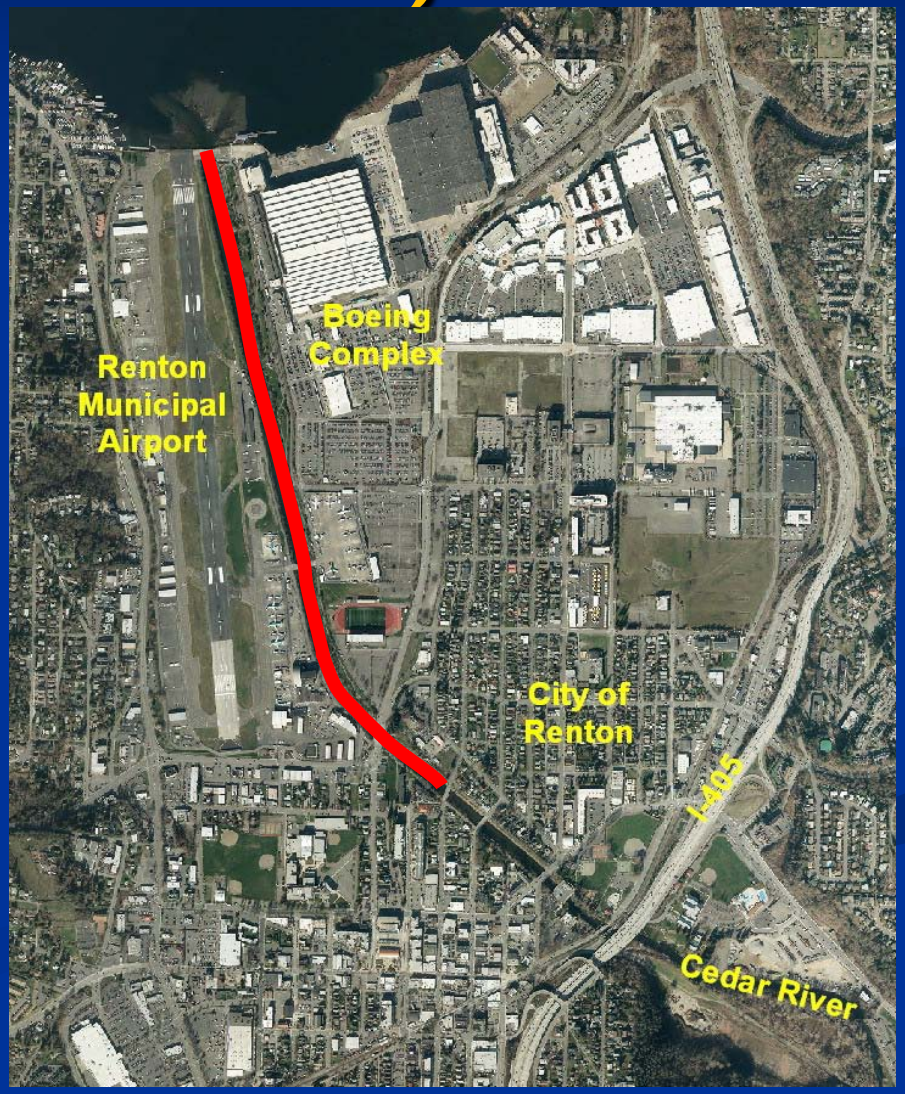
Elements included:

- Left bank: Flood Wall, Levee
- Right bank: Levee
- Modify bridge
- Dredge channel 1.25 miles, for >=100-yr flood capacity



Cedar River Gravel Removal Project

- Channel monitoring shows decreased channel capacity
- Project will conduct maintenance dredging in same 1.25 miles of Cedar River channel (red) as 1998
- Targeted to commence in 2013, subject to obtaining all required permits



Recap of 3 Examples

- Channel monitoring informs decisions
- Analysis of alternatives
- Sediment management actions are evaluated using criteria based on 3 main Flood Plan goals
- Select and implement preferred alternative(s)

Implementation of Channel Monitoring Component: 5 Segments

- Ongoing channel monitoring
- Gravel removal (dredging) will be analyzed and evaluated with other alternatives, using criteria based on the 3 main Flood Plan Goals

Gravel Removal (Dredging) and Sediment Management, Key Question

King County proposes to implement the existing sediment management program as described in Flood Plan Section 4.3.1, with minor edits to update it.

- Do you agree with this proposal?

END

Policy RCM-3: Gravel Removal, excerpts

King County should remove gravel… for flood hazard management purposes only when:

a. …gravel accumulations pose a flood risk,

b. …gravel removal has a long-term flood risk reduction benefit,

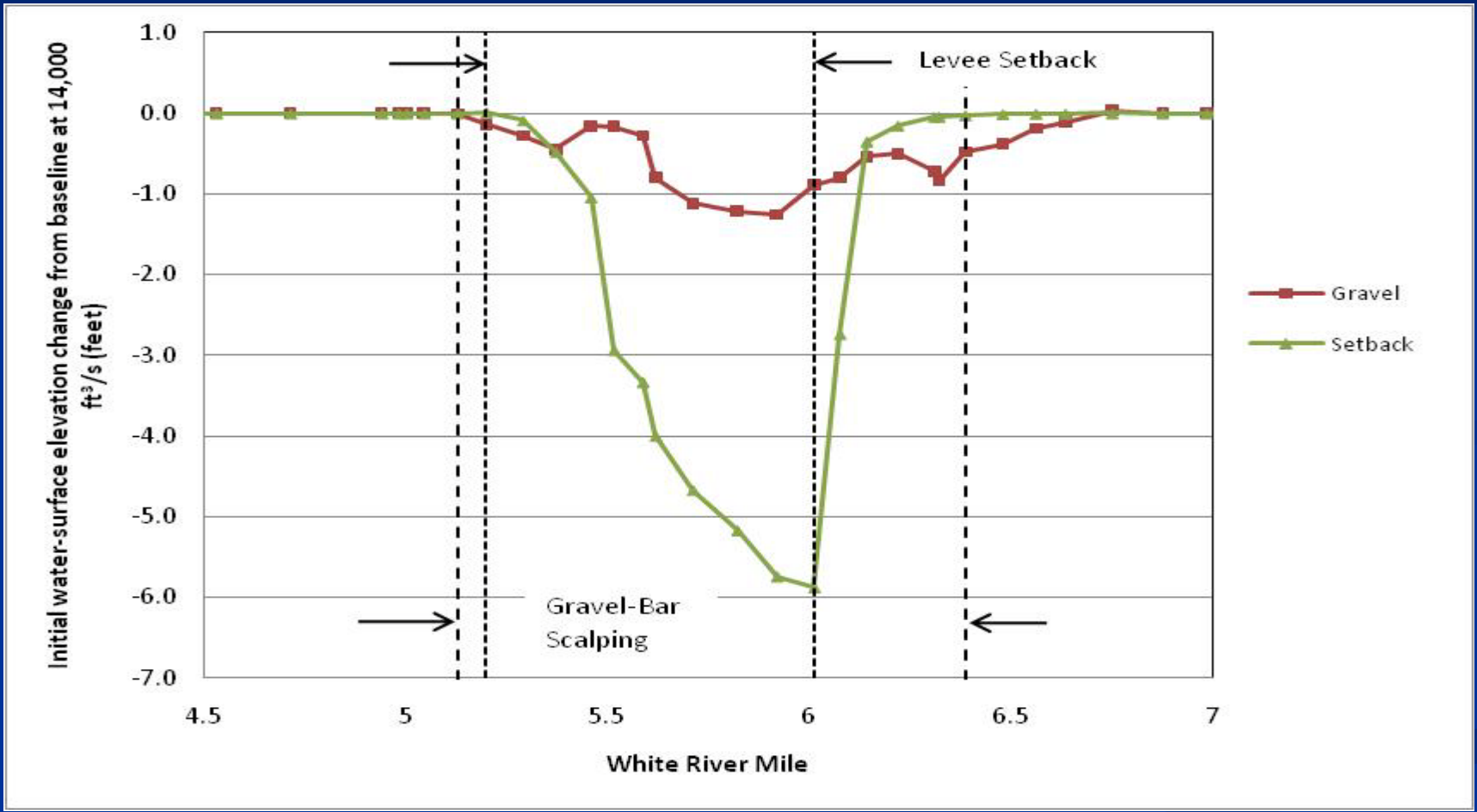
c. … no net loss of ecological function,

d. …part of a long-term flood mgmt strategy,

e. …consistent w/science, this Plan, regulations, and

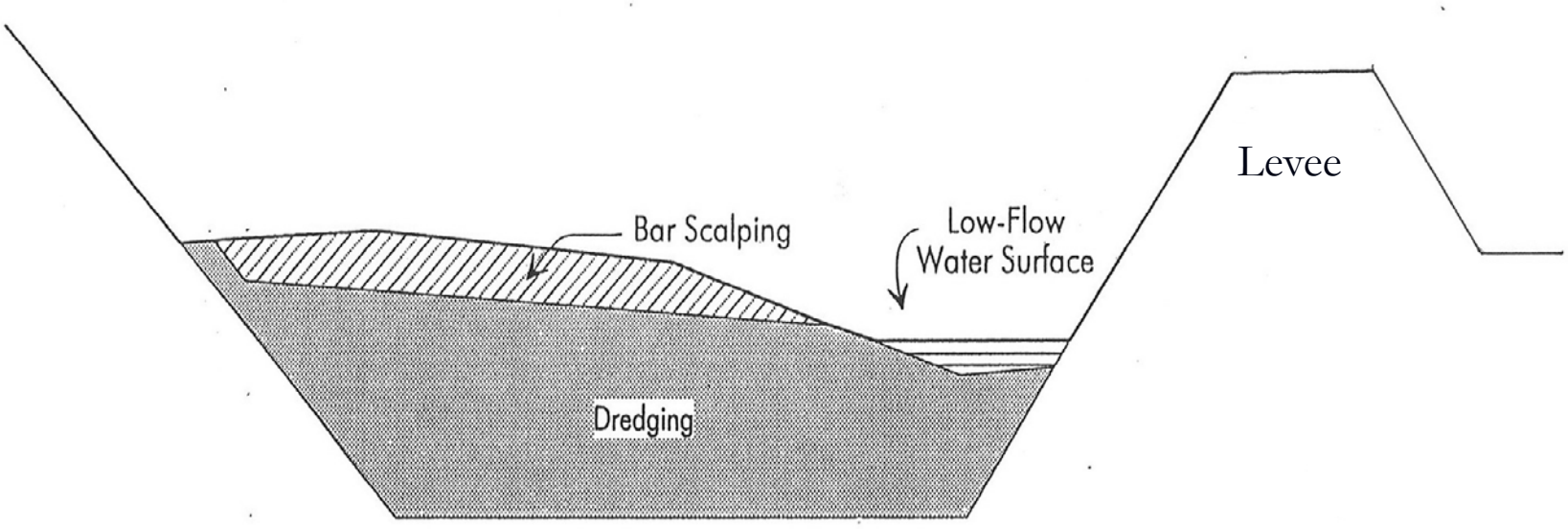
f. … best flood risk reduction alternative available…

Simulated Water Surface Elevations for Gravel Removal and for Levee Setback Alternatives, Countyline Reach of White River

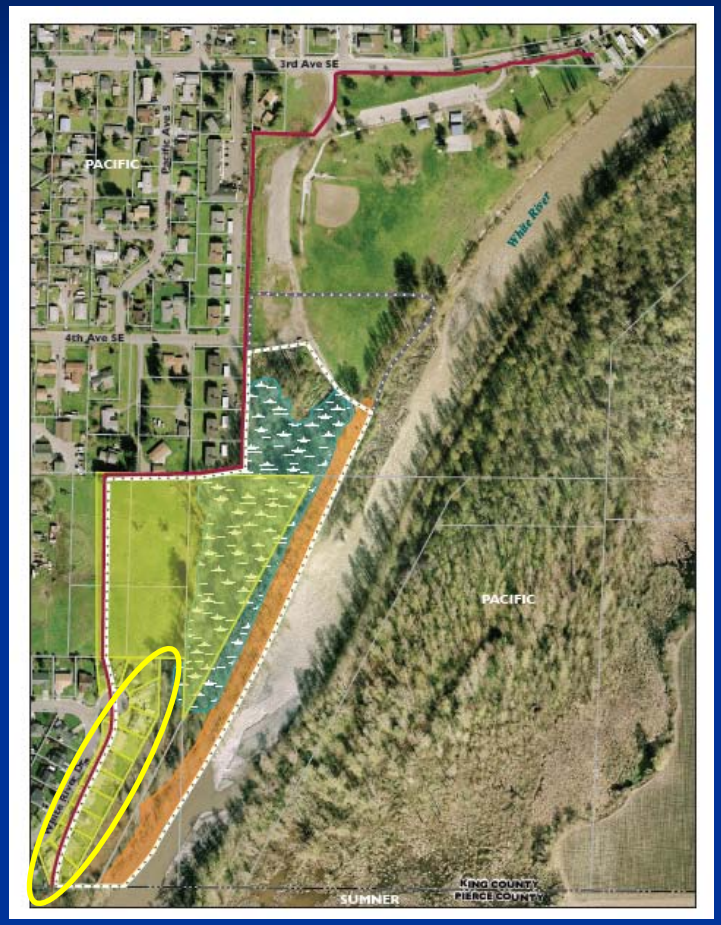


Sediment Management Action: Alter Sediment within a Channel to Accommodate Flows

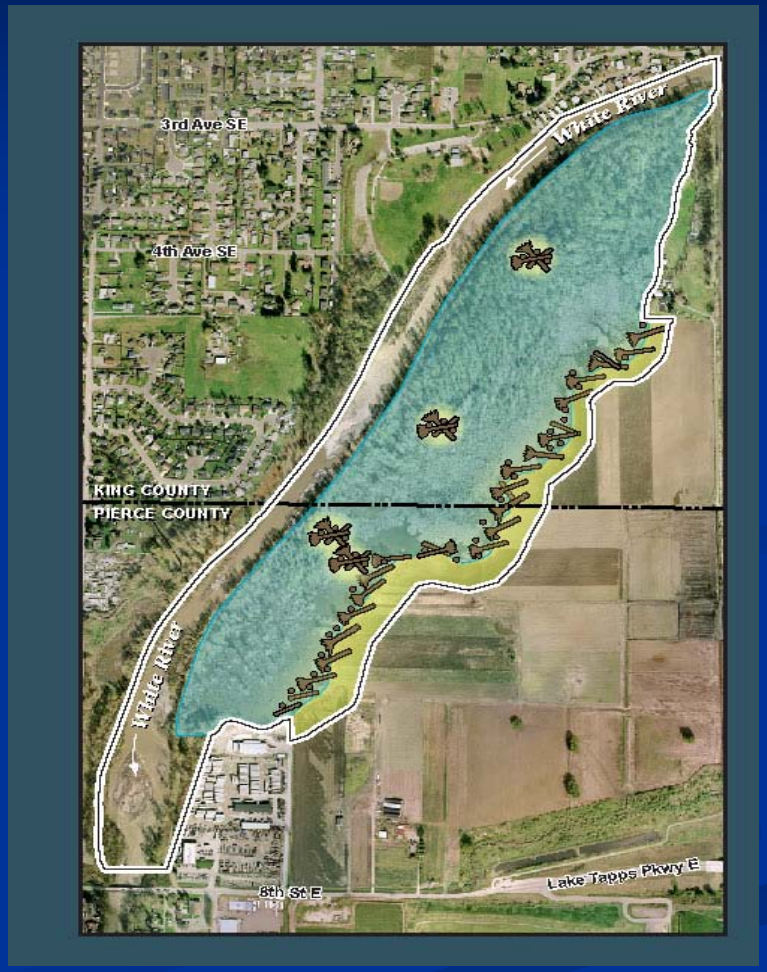
Gravel Removal by Bar Scalping or by Dredging



Sediment Management Actions: Alter Channel Corridor to Accommodate Sediment and Flows



Lower White River Proposed Right Bank Levee Setback Project [Red Line]; White River Estates 2011 Buy-out & Remove At-Risk Structures [Yellow Oval]



Proposed Countyline Levee Setback & Flood-plain Reconnection Project; Lower White River, Left Bank

Renton Airport, Before and After Project Implementation

- Channel dredging to maintain capacity

February 1996

Flood peak 7520 cfs in Renton

January 2009

Flood peak 9470 cfs in Renton

Example: Sediment Deposition within Lower White River Levees

Example Studies or Analyses on Sediment Management/Gravel Removal

- South Fork Snoqualmie River Gravel Removal Study (King County 2011).

http://www.kingcounty.gov/environment/waterandland/flooding/documents/south-fork-snoqualmie-gravel-removal-study.aspx

- Channel Conveyance Capacity, Channel Change, and Sediment Transport in Lower Puyallup, White, and Carbon Rivers WA (Czuba et al. 2010)

http://pubs.usgs.gov/sir/2010/5240/

- Multiple studies and analyses by or for City of Renton for the 1998 Cedar River dredging.

Other Recent, Local Information Regarding Sediment in Rivers

- USGS Fact Sheet: Sediment Load from Major Rivers into Puget Sound and its Adjacent Waters (Czuba et al. 2011)

http://www.pubs.usgs.gov/fs/2011/3083

- Washington Association for Floodplain Management – Sediment Management Issues Group

http://www.co.pierce.wa.us/pc/services/home/environ/water/general/wafm-smig.htm

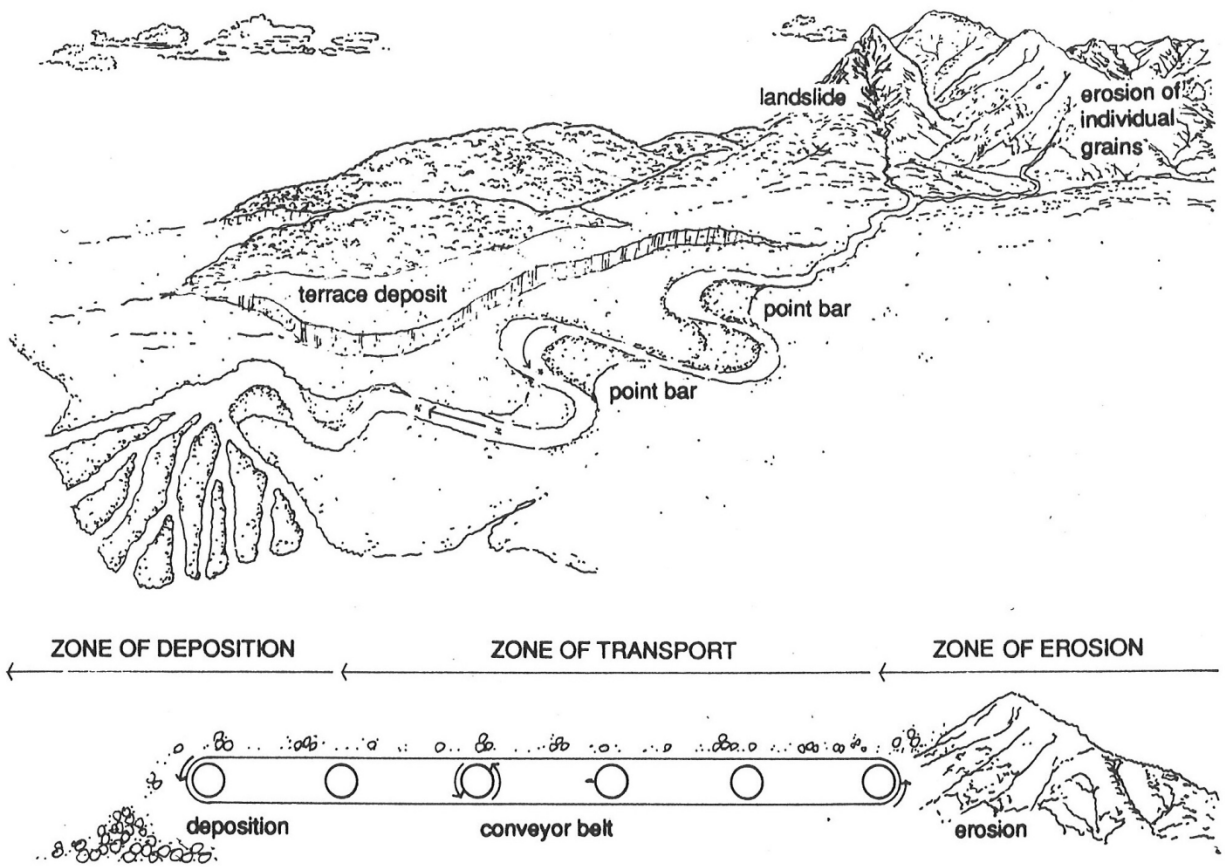
Lower White River flooding in City of Pacific, January 2009

Recent Countywide Actions

- Terminology: “gravel removal”
- Pierce County Flood Plan
- Sediment Management Issues Group

Natural Factors Affecting Sediment in Rivers

- Geology, soils, climate, vegetation
- Channel gradient, channel confinement



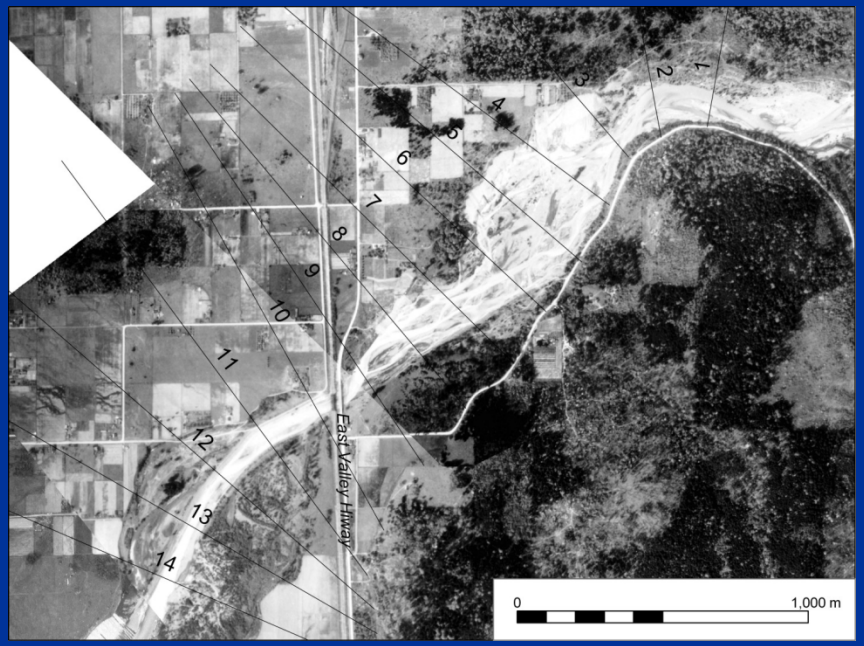
Kondolf and Matthews (1993)

Constructed Features Can Affect Sediment Movement and Deposition

Constructed Feature	Potential Effect
Bridges	Backwater conditions favor deposition.
Containment Levees	Disconnect channel from floodplain where sediments would have deposited in overbank areas.
Bank Armoring	Inhibit lateral channel migration, which is a natural response to sedimentation. Vertical sediment accretion may result.

Example:
Lower White River Alluvial Fan

1931



2000

2006 Flood Plan Section 4.3.1: Sediment Management

Sediment management can involve actions that:

- Alter the distribution of sediment within a channel to accommodate flows, or
- Alter the corridor within which the channel flows in order to accommodate the movement and deposition of sediment.

2006 FHMP, page 61.