# Hydrology and Flooding

## Background

### The 1996 flood

Between February 4, 1996 and February 9, 1996 the Nehalem reporting station received 28.9 inches of rain. Approximately 14 inches fell in one 48 hour period.


By 1:30 in the afternoon of February 8, the stage hydrograph at Foss on the Nehalem river read 29.56 and overtopped the recorder. Best estimates are that the river crested at 31.5 feet, some 17.5 feet above the 14.0 flood stage[1]. River flow at Foss was estimated to exceed 69,000 cubic feet per second. This produced a crest at over 12.25 feet in the city of Nehalem.

The total damage in Tillamook County from this flood event was estimated at over $53 million dollars[2]. Losses to the Nehalem Business District were severe. The flood had a very significant impact on the Sunset Drainage District[3] and all of its members. The Nehalem Sewage Treatment Plant ponds and most of the facility were flooded. The city of Wheeler lost its drinking water supply.
Damage estimates in the Nehalem[4] area included :

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| Port of Nehalem | $1,571,571 |
| City of Wheeler | $120,545 |
| Nehalem bay Wastewater Agency | $94,226 |

1 19,600 cu ft per second at flood level.

2 Tillamook County Flood Mitigation Plan; Final Report; Tillamook County; November 1996. Appendix pp. 15.

3 The district encompasses nearly 1000 acres, most of which is agricultural land supporting six dairy farms,

4 Tillamook County Flood Mitigation Plan; Final Report; Tillamook County; November 1996. Appendix pp 20

## Flood History

Flooding along the rivers and streams is a fact of life in Tillamook County. We will never totally control it, and attempting to do so is risky, extremely expensive and can be environmentally harmful. We can, however, try to minimize the damage resulting from flooding by learning to live in ways that are more compatible with the river's natural processes[5].



Most rivers in Tillamook County rise to flood stage or above at least once each winter. Major coastal flooding has occurred in 1939, 1967, 1976, 1990, 1992, 1996 and 1999. Coastal streams quickly reflect the rainfall on the steep slopes above them. Streams are normally above flood stage for less than 2 days. High tides combine with storm surges (produced by strong winds) to aggravate coastal flooding.

The damage to agricultural lands account for the most substantial dollar damages. Much of the lowland area around the bay is pasture for dairy cows (see Figure 1 for land zoning in the 100 year flood plain).

## Flood Damage Control[6]

Methods ordinarily used to reduce flood damage are:

- individual flood proofing measures,
- restriction of development in flood plains
- maintaining a flood warning system
- flood control storage reservoirs
- building levees, and
- channel modifications (making the channels wider, deeper, or straighter)

In most cases, the **flood proofing** of individual homes and businesses can be achieved by setting

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5 Tillamook County Flood Mitigation Plan; Final Report; Tillamook County; November 1996. pp. 11

foundations elevations one to three feet above the 100 - year flood level. This strategy was used extensively after the 1996 flood.

Major flood protection in the Nehalem Basin depends on restriction of development through **flood plain Zoning**. The federal and local government establishes a 100-year flood plain which is divided into two Zones: a "floodway" and a "flood fringe". Zoning regulations controls construction in these areas.

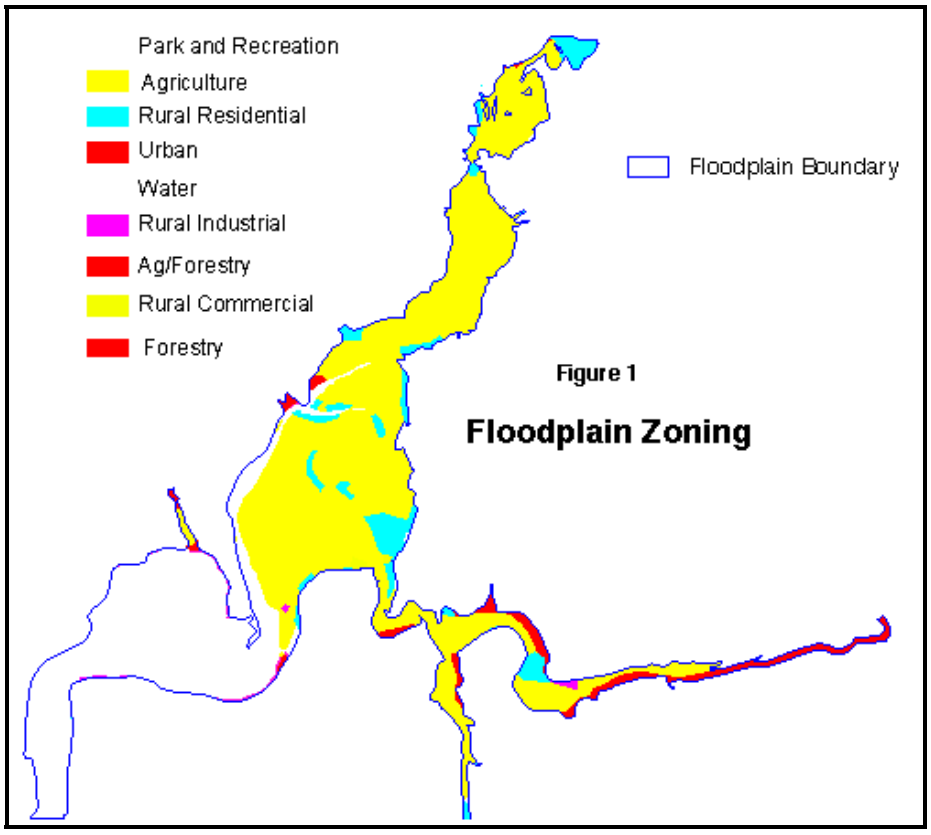


**Figure 1**

**Floodplain Zoning**

**Flood warning systems** allow some time to prepare for the rising waters. The flood warning system in the Tillamook basin has been one of the most successful aspects of the emergency management program[6]. However, flood-warning systems are primarily useful in saving lives. They do little to reduce major structural damage, since options for protecting structures and their contents are very limited during the flood event.

David Godsey of Nehalem has discovered that river levels in the North Fork of the Nehalem respond to rain events more quickly than in the main stem. It is his belief that this rise in river level can be used to predict when the slower responding and higher water levels from the main stem of the river will occur.

**Flood control storage reservoirs** are not considered to be cost effective. Environmental considerations, including blocking of fish passage also argue against using such structure[7].

The debate concerning flood mitigation in the Nehalem basin centers on the remaining two alternatives.

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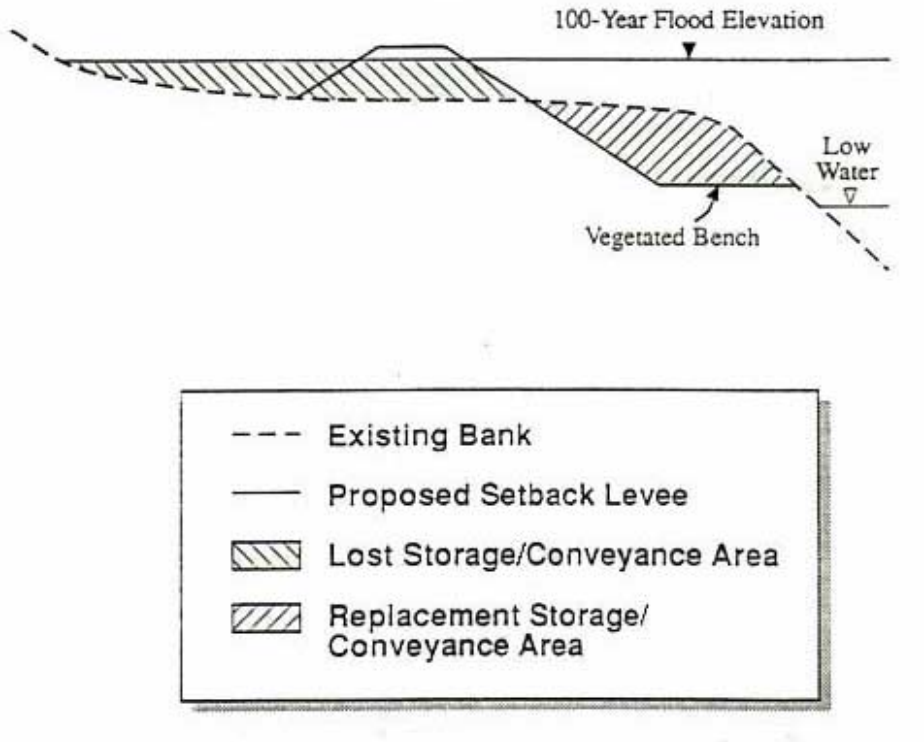
6 Adapted from Tillamook County Flood Mitigation Plan; Final Report; Tillamook County; November 1996. pp. 25

7 Nehalem Wetlands Review; U.S. Army Engineer Distract, Portland; 1977.

**Building levees**[8]: Levees are most cost effective where numerous and/or highly valuable properties are protected. New levees, for example can cost $3 to $6 million dollars per mile. In addition these structures usually require recurrent, expensive maintenance.

**Figure 2**




Levees have tended to degrade habitat for salmon and trout. They tend to reduce vegetative cover in the stream. This in turn increases water temperatures, reduces the complexity of the stream channel, and lowers the population of insects and macro-organisms. Newer setback levees (see Figure 2), on the other hand allow for trees and other vegetation along the stream bank that can enhance the habitat for fish.

**Channel Modifications:** The 1997 Army Corp. assessment[9] of the Nehalem bay and river concluded, "Channel clearing and enlargement could be expected to provide only slight reduction in flood heights." It is uncertain whether any system of levees or channel modifications designed to control floods like the 1996 flood would be cost effective.

**Hydraulic Models**[10]

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8 Tillamook County Flood Mitigation Plan; Final Report; Tillamook County; November 1996. pp. 23-24

9 Nehalem Wetlands Review; U.S. Army Engineer Distract, Portland; 1977.

10 Tillamook County Flood Mitigation Plan; Final Report; Tillamook County; November 1996. pp 78-80

A hydrologic computer model simulates what would happen if a given flow had to travel through a particular cross section of channel and over bank (i.e. flood plain) area. Flows are typically routed through the hydraulic model to determine the width and depth of inundation under a range of flow events.
The first step in creating a hydraulic model is collecting data on the physical characteristics of the stream channel and its over bank areas. Cross-sections of the channel, topographic maps of the flood plain, detailed survey of the bridge and culvert crossings, and the roughness of the channel are used to set up the hydraulic model.

The information readily available in Geographic Information Systems (GIS) and Digital Elevations Models (DEM) can be used to reduce the need to collect new data. The model converts these data plots of the channel and valley cross-section.

Different flows are input to the model hydraulic, which in turn, predicts water surface elevations under the different flows. The flood plain areas around the bay are also affected by tidal and storm surges.

Hydraulic models are very important in evaluating the benefits and impacts of channel changes such as dredging, installing setback levees, and installing flood bypass systems. The cross section of the channel can be altered on the computer to simulate the impacts of these changes on water levels and sediment aggregation.

If set up and applied properly, computer models are valuable analytical tools. However, the models are simplified views of actual conditions and rely heavily on the quality of the input data. Inadequate data collection can have serious repercussions later when actual flood depths vary significantly from model predictions.

The 1996 Tillamook County Flood Hazard Mitigation Plan (pp. 82) recommended that hydraulic models be developed for the main stems of the major rivers in Tillamook County. Currently the Army Corps of Engineers is working with the county to undertake a 3.3 million dollar hydraulic study of the Tillamook basin.

## Flood Control Alternatives for Nehalem Basin

Individuals and groups within the lower Nehalem basin have proposed a number of different channel modification and leveeing strategies to reduce flood damage. These strategies include:

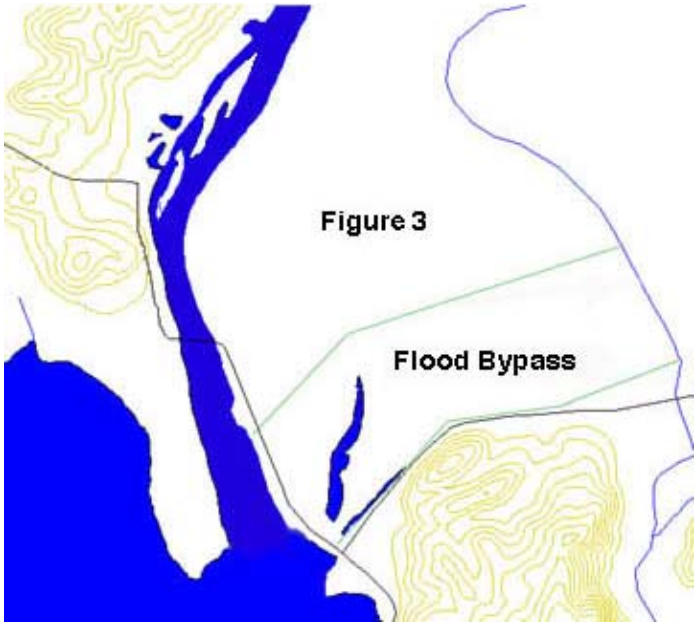
Dredging the river channel between Mohler and Wheeler.

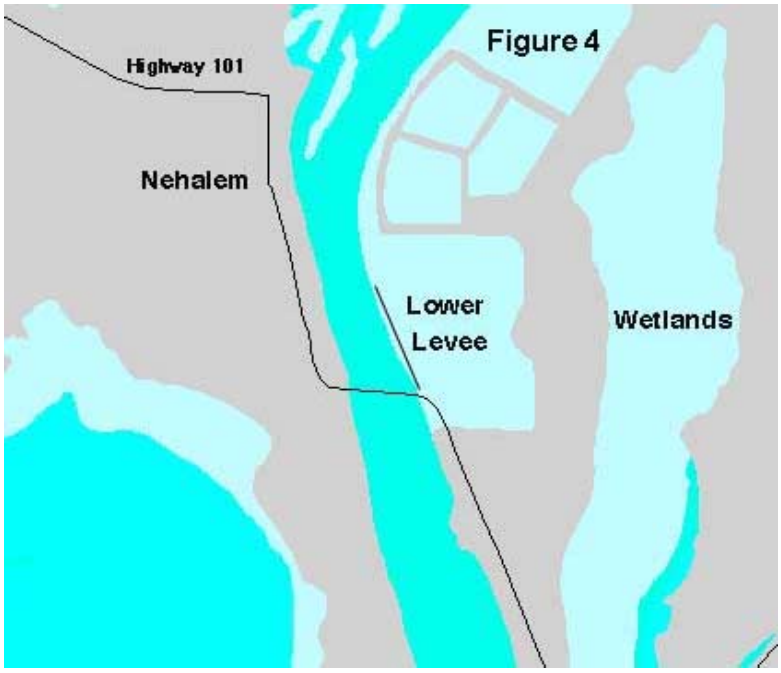
Constructing a floodwater bypass channel through Gallagher slough between Mohler and Highway 101. (See Figure 3)

Dredging the mouth of the Nehalem River.

Setting back levees along the river to widen the channel.

Installing flood gates in the levee south of the wastewater facility and north of the bridge crossing to allow floodwaters to more quickly leave the flooded inland area. (See figure 4).




There are strong advocates for some of these alternatives. There is also much concern that some of the strategies may do little to solve the flooding problem while costing a great deal of money and having severe environmental consequences.

Concern about the consequences of making structural changes in the lower Nehalem are high. A proposal to construct a levee at Mohler was opposed by the Sunset Drainage District because of concern over its effect on flooding in surrounding area. A Ducks Unlimited proposal to convert land around Gallagher Slough to a wetlands area has also raised concerns about its possible effect on flooding.

## Criteria for Evaluating Alternative Flood Control Projects

The 1996 Tillamook County Flood Hazard Mitigation Plan[11] suggest the following criteria for evaluating the utility of flood mitigation projects.

**Risks to life and public health:** The effect of the project on Public health and safety should be evaluated both upstream and downstream of the proposed project site. The project should have a beneficial or negligible impact on public health.

**Benefits vs. Costs**: Benefits are measured as the effect on flood damages over the entire river system; costs are measured as public and private costs for implementing and maintaining the solution over the long term. Flood damage reduction benefits over the entire river system should exceed long-term costs.

**Environmental impacts:** The environmental impacts of the project include its effect on fish and wildlife habitat, wetlands, water quality, and other elements protected by law. Impacts should be evaluated both above and downstream of the proposed site. The net environmental impacts of the project (plus any mitigation measures) over the long term should be positive or negligible.

**Consistency with applicable land-use plans and regulations:** The project should be consistent with land use plans for the area and should not conflict with regulations governing activities in the flood plain and riparian corridor (e.g. from stream buffers), unless the project benefits justify seeking an exception from applicable regulations.

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[11] Tillamook County Flood Mitigation Plan; Final Report; Tillamook County; November 1996. pp. 40