

Flood Hazard

Causes and Characteristics of the Hazard

Flooding occurs when climate (or weather patterns), geology, and hydrology combine to create conditions where water flows outside of its usual course. In Clackamas County, geography and climate combine to create chronic seasonal flooding conditions.

Precipitation

Because Clackamas County spans a wide range of climatic and geologic regions, there is considerable variation in precipitation, with elevation being the largest factor in precipitation totals. Moving east from Oregon City at 55 feet above sea level to Mt Hood at 11,235 feet above sea level, annual precipitation averages range from 47.06 inches to over 124.51 inches, respectively. This change in elevation causes a significant increase in precipitation, in the form of both rain and snow. Although the majority of the county enjoys a fairly mild winter, with less than 5-10 inches of snow per year, the higher elevations surrounding Mt. Hood are covered with snow for the majority of the winter months. This is of primary concern when dealing with potential flood events. Mt. Hood's snowmelt provides a continuous water source throughout the year, and can be a major contributor to high waters.



Sandy River Flooding – January 16, 2011

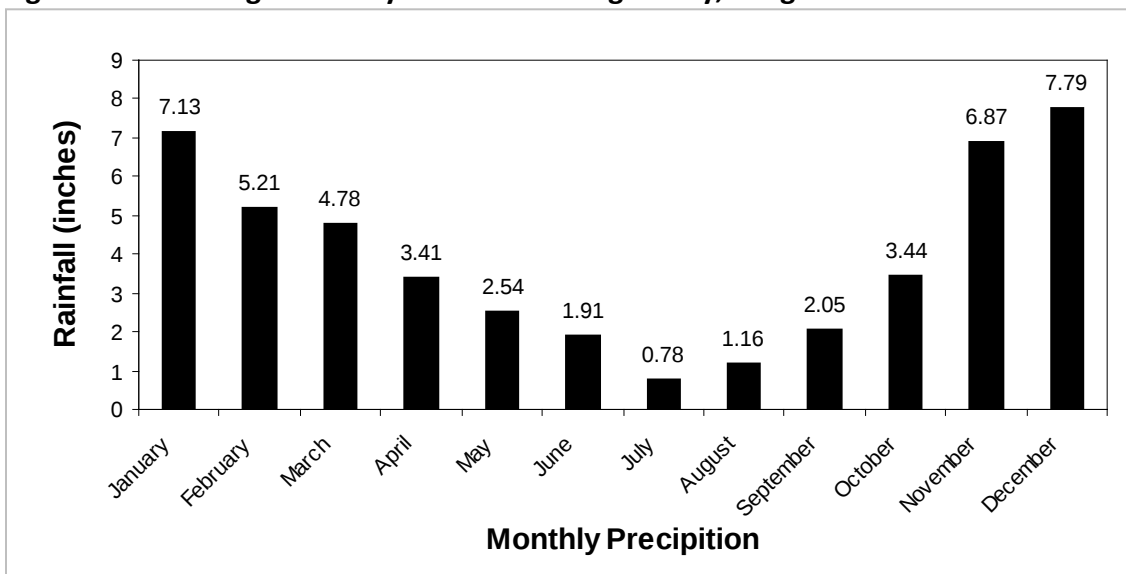
Source: Clackamas County Emergency Management

Flooding is most common from October through April, when storms from the Pacific Ocean, 60 miles away, bring intense rainfall to the area.¹ Clackamas County receives approximately 40 inches of rain on average each year. During the rainy season, monthly rainfall totals average far higher than other months of the year (refer to Figure FH.1). This results in high water, particularly in December and January. The larger floods are the result of heavy rains of two-day to five-day durations

¹ Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon Emergency Management.

augmented by snowmelt at a time when the soil is near saturation from previous rains. Frozen topsoil also contributes to the frequency of floods.²

Figure FH.1: Average Monthly Rainfall for Oregon City, Oregon



Source: The Climate of Oregon

Geography and Geology

A large portion of Clackamas County's area lies in the lower Willamette River basin. The broad floodplain of the valley can be easily inundated by floodwaters. The surface material includes poorly drained, unconsolidated, fine-grained deposits of Willamette silt, sand, and gravel. Torrential flood events can introduce large deposits of sand and gravel that assist in the drainage of the otherwise poorly drained soils.³

The flood events in Clackamas County usually occur when storms move in from the Pacific, dropping heavy precipitation into the Willamette valley. Flooding in the valley becomes a problem when human activities infringe on the natural floodplain.

Two types of flooding primarily affect Clackamas County: riverine flooding and urban flooding (see descriptions below). In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's (ditch or sewer) capability to remove it.

RIVERINE FLOODING

Riverine flooding is the overbank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged

² Taylor, George H., Hannan, Chris, The Climate of Oregon (1999). Oregon State University Press. Corvallis, Oregon.

³ Geologic Hazards of the Bull Run Watershed Multnomah and Clackamas Counties, Oregon. DOGAMI. Bulletin 82. 1974

rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Map 4 shows the various river basins in Clackamas County.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low velocity sheet flows of water.

URBAN FLOODING

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force.

Almost one-eighth of the area in Clackamas County is incorporated, and has a high concentration of impermeable surfaces that either collect water, or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains often back up with vegetative debris causing additional, localized flooding.

CHANNEL MIGRATION AND BANK EROSION

Following the 2011 flood on the Sandy River, County staff began to emphasize the different nature of the flood hazard in the upper reaches of the river, as that of bank erosion due to channel migration. The upper Sandy may not have to reach flood stage in order to achieve a level of flow capable of mobilizing sediments and impounding gravel and woody debris in the channel. These impoundments can redirect the main channel into the bank and cause failures that exacerbate further erosion downstream.



Sandy River Channel Migration Damage – January 16, 2011

Source: Oregonian

History of the Hazard

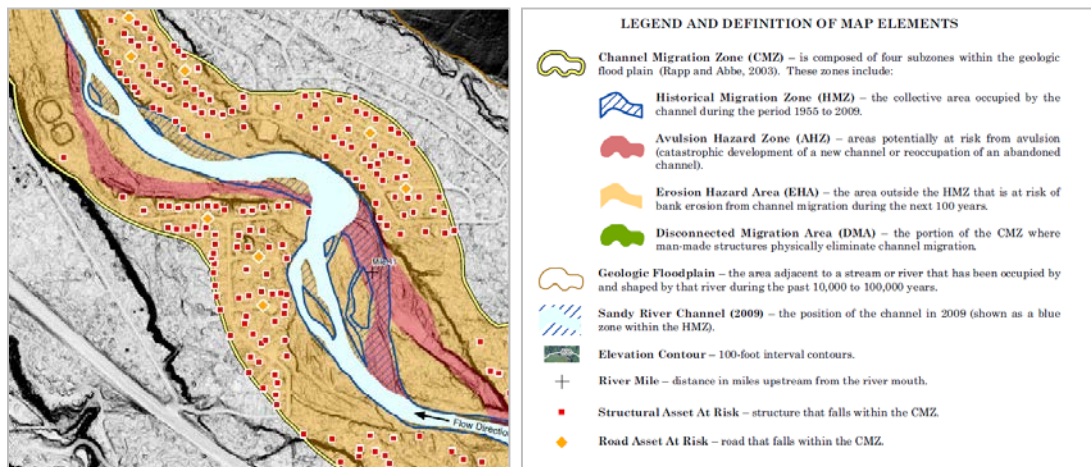
Clackamas County has many rivers and small tributaries in both unincorporated and incorporated areas that are susceptible to flooding. Major floods have affected the citizens of the county since as early as 1861, when it was reported that the streets of Oregon City were inundated with about four feet of Willamette overbank flow. Although the 1996 floods were devastating to the entire region, the floods of 1861, 1890, and 1964 were larger. All four floods have been estimated to exceed the 100-year or base flood.

Risk Assessment

The assessment of risk takes into account the extent and location of the hazard; the probability the hazard will occur; and the extent to which community assets are vulnerable.

Mapping

FEMA flood hazard mapping for updating the Flood Insurance Rate Maps (FIRMs) is underway for the Sandy River and is scheduled to be in public review by mid-2013. The Oregon Department of Geology and Mineral Industries (DOGAMI) has contributed a Channel Migration Zone mapping study for the Sandy River and has been critical in generating LiDAR-based maps for the Sandy Basin and other flood-prone areas of the County.



Channel Migration Map and Legend for Timberline Rim Area on Sandy River

Source: Oregon Department of Geology and Mineral Industries

In 2008 FEMA undertook an update of all FIRMs in Clackamas County as part of a recalibration of the datum for measuring elevation into the Digital FIRM (DFIRM) format. After the January 2009 flood event on South Creek Road along Abernethy Creek, Clackamas County sponsored an inquiry to FEMA into mapping errors for transitioning the 1978 FIRM into DFIRM and argued that the original FIRM Approximate A Zone polygon was incorrectly registered that at least two properties in the Approximate A Zone were now outside of the flood zone, even Abernethy Creek itself. Following the 2009 flood event, the County petitioned FEMA for reconsideration and eventually submitted an inquiry through Senator Wyden's office to the Mitigation Directorate at FEMA Headquarters, but the request was denied.

Table FH.1 below lists the locations of known chronic flooding problems in Clackamas County.

Table FH-1: Locations of Identified Flooding Problems

Location	Stream
Tranquility Lane	Clackamas River
Paradise Park	Clackamas River
Welches	Salmon River
Lolo Pass Road	Sandy and Zig Zag Rivers
Timberline Rim	Sandy River
Dickie Prairie Road	Molalla River
Feryer Park/ Shady Dell	Molalla River
Alder Creek Area	Alder Creek
Canby	Pudding River
Dogwood Drive/ Rivergrove	Tualatin River
Oregon City	Confluence of Willamette River and Clackamas River
Johnson Creek Basin	Johnson Creek
Abernethy Creek Basin	Abernethy Creek

Source: Clackamas County

Probability of Future Occurrence

Based on the Hazard Mitigation Advisory Committee's (HMAC) current assessment, flood hazard is ranked with a high history score along with a high probability of future occurrence. Due to the limited number of residents and facilities directly exposed to flood hazards, the HMAC considers the vulnerability and maximum threat to be ranked as medium.

Climate change will likely be an influencing factor for future flood probabilities. Long-term modeling suggests increases in annual average temperatures may translate in the Pacific Northwest to less total accumulated snow pack and faster storm runoff. This could mean flashier flood events for upper watersheds and the need for greater attention to storm water management in floodplains.

Vulnerability Assessment

Vulnerability assessment combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. Understanding the population and property exposed to natural hazards will assist in reducing risk and preventing loss from future events.

The amount of property in the floodplain, as well as the type and value of structures on those properties, is calculated to provide a working estimate for potential flood losses. Table FH.2 below describes the number of acres, tax lots, and the value of property within Clackamas County's 100-year floodplain.

Table FH-2: Flood Hazard Vulnerability Assessment

Measure	Amount	Percentage
Acres in the 100-year Floodplain	27,627	3%
Number of Tax lots within the 100-year Floodplain (all or partial)	10,859	7%
Total Property Value in the 100-year Floodplain	\$ 5,130,123,907*	10%

Source: Clackamas County Geographic Information Systems 2012

* Percentage and value of property in the 100-year floodplain may include property in tax lots that intersect the floodplain, including property that does not physically reside in the floodplain itself.

Community Rating System

The Natural Hazard Mitigation Plan functions as, among other things, the County's Floodplain Management plan so that the County receives credit for, and maintains compliance with, its membership within the National Flood Insurance Program (NFIP) Community Rating System (CRS), which recognizes jurisdictions for participating in floodplain management practices that exceed NFIP minimum requirements. The County was admitted into the CRS program in April 2004 and received a rating of Class 5, becoming the highest rated jurisdiction in Oregon and one of only 23 nationally. Currently in 2012, the County has a Class 6 rating that results in a 20 percent discount in flood insurance premiums for residents of unincorporated Clackamas County in a special flood hazard zone.

Below are several CRS related activities that the 2012 NHMP documents for credit under the Activity 510 – Floodplain Management Plan:

RISK ANALYSIS - REPETITIVE LOSS PROPERTIES:

Clackamas County works to mitigate problems regarding flood issues when they arise. Some areas in the county are more susceptible to flooding issues, and have incurred repetitive losses, meaning that they could have greater than two NFIP claims in the past ten years, in which the cost to repair the flood damage, on average, equals or exceeds 25 percent of the market value of the structure at the time of each flood loss event. There are currently twenty-one properties in the County that have sustained repetitive loss. The majority of repetitive loss properties are located outside of city limits.

Two repetitive loss properties along South Creek Road have received mitigation assistance against future flood losses. Following the flood of January 2009 along Abernethy Creek, one used HMGP funds to elevate at least eight feet above grade and three feet above the flood of record. The second property was an HMGP flood acquisition along Abernethy Creek that is returning the property to permanent open space in the floodplain.

CULVERT REPLACEMENT WITH IMPROVED FISH-PASSAGE CAPACITY

From 1998 to 2012 the County's Department of Transportation and Development (DTD) lead or partnered with other agencies to install at least 86 expanded culverts or bridges that improved fish passage and reduced flood potential for 203.9 stream miles at a cost of approximately \$11.6 million.



2011 Culvert Replacement Project: Before and After - Removal of two 54" culverts to alleviate flooding and improve fish passage. Partners - US Forest Service, Clackamas River Basin Partners, Clackamas Stewardship Partners, and Oregon Watershed Enhancement Board.

STREAM RESTORATION & HABITAT ENHANCEMENT PROJECTS

Since 2009 at least 17 projects, such as stream bank restorations and opening side channels, have been completed in the County through partnerships with local watershed councils, federal land managers like the Bureau of Land Management, and groups like The Freshwater Trust and Oregon Wildlife Heritage. These types of projects promote water quality and fish habitat and also improve floodplain functions such as increasing water storage capacity during periods of high water events.

STORM WATER DRAINAGE IMPROVEMENT PROJECTS

Since 2010 there have been at least twelve projects completed or initiated to maintain or improve storm drain system capacity: six by the Oak Lodge Sanitary District and six by the Water Environment Services (WES) Clackamas County service District No. 1. Examples include improving storm water conveyance and catchment basins, removing invasive species from drainage areas, and property acquisition for regional water detention facilities.

TITLE 13 - BUFFER ENHANCEMENT AND RESTORATION ACTIVITIES

Title 13, adopted in 2005, is a section of Metro's Urban Growth Management Functional Plan that aims to protect water quality and fish and wildlife habitat throughout the region.

The purpose of this title is to conserve, protect and restore a continuous ecologically viable streamside corridor system that is integrated with upland wildlife habitat and the surrounding urban landscape.

Since 2010 WES worked with a number of groups like the Clackamas River Basin Council, SOLV and the Friends of Trees to implement at least ten streamside-restoration projects, acquire six conservation easements, and worked with three area high schools to train teachers in their Watershed Health Program curriculum.

FLOOD PROTECTION ASSISTANCE

The County provides technical advice and assistance to interested property owners and annually publicizes the service. Following the January 11 Sandy River flood event, the County convened three community-specific workshops for Zig Zag Village, Timberline Rim and the Autumn Lane/Lolo Pass Rd flood-affected areas. The County-facilitated workshops provide an opportunity to go over post-flood property protection options and coordinated with the Oregon Department of State Lands, and the US Army Corps and the National Marine Fisheries Service to provide the broadest level of information regarding permits and legal considerations for flood recovery.

PUBLIC EDUCATION AND OUTREACH

The County attends regular public events and meetings annually to promote flood safety and property protection. Following the Sandy River flood the County held two widely attended town hall meetings in the flood affected community on Mt Hood to address concerns and questions from the community about response and recovery efforts. The County works closely with the Sandy River Basin Watershed Council and participated in the annual Sandy River Expo in April of 2011 and 2012 to highlight floodplain management practices and promote the purchase of flood insurance.

FLOOD WARNING PROGRAM

In 2010 the County began a project with the staff Hydrologist at the National Weather Service (NWS) - Portland Weather Forecast Office to assess which flood prone areas of the County were lacking a commensurate level of flood warning capability compared to the level of risk. Three areas were targeted for the following areas: Shady Dell along the Molalla River; the upper Sandy River Basin; and upper Abernethy creek Basin along S Creek Rd. In autumn of 2011 three flood staff gauges were installed in the Sandy area and one in the Shady Dell area; all on County bridges with agreements for local volunteers to monitor and report the river readings to the NWS during high water events. The Abernethy Creek site is still planned, pending the completion of a flood acquisition project as a flood gauge site.

RIVER STAFF GAUGES IN UPPER SANDY RIVER BASIN

The National Weather Service and Clackamas County have installed three staff gauges in the upper Sandy river basin to help with monitoring river conditions during high water.

1. Salmon River Bridge on Brightwood Loop Road
Elevation 1035 feet



2. Sandy River Bridge on Brightwood Bridge Road
Elevation 1070 feet



3. Sandy River Bridge on E Lolo Pass Road near Zigzag
Elevation 1440 feet

Flood Warning Program and Public Education – Brochure page showing locations of new flood staff gauges. Back page (not shown) detailed how to access NWS website and view river levels on these gauges during periods of potential flooding.

Source: Clackamas County

CLACKAMAS COUNTY CRS PROGRAM REVIEW

In 2009-10 the County requested the University of Oregon's Partnership for Disaster Resilience to lead a project to assess the feasibility and benefits of a more efficient, streamlined and integrated approach to flood mitigation and flood plain management in the county. A 2011 report found that programmatic improvements are expected to reduce the risk of damage to property and life resulting from flood; establish better coordination of mitigation actions and activities across public, private and not-for-profit entities; enhance and restore natural and constructed flood control functionality; and maximize the use of limited resources.⁴

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http://csc.uoregon.edu/opdr/sites/csc.uoregon.edu.opdr/files/docs/CRS%20Report_Final_Full_sm.pdf

Implementing Flood Hazard Mitigation

Clackamas County works closely with Oregon Emergency Management and FEMA to reduce flood losses and seeks to best utilize federal mitigation grant funds to minimize future flood risk. With that said, Clackamas County has demonstrated in the two most recent disaster their investment in flood mitigation actions through prioritizing substantially damaged properties and repetitive loss properties when applying for flood acquisition projects. The County considers these buyouts of flood prone properties to be the most cost effective approach to reduce future flood losses for property owners, minimize future disaster-related expenses to the community and provide savings to federal tax payers on a permanent reduction in flood exposed properties.

Since 2007 Clackamas County completed two flood elevations: upper Sandy River in February 2008 using a Flood Mitigation Assistance Grant and along Abernethy Creek in March 2010 using the Hazard Mitigation Grant Program (HMGP).



Mitigation Success - Abernethy Creek elevation completed in March 2010 and successfully tested on January 19, 2012.

Source: Clackamas County

Following the 2009 flooding along Abernethy Creek, the County completed three flood acquisitions or “buyouts” using HMGP and returned the properties to the functional floodplain as open space. The County is currently pursuing three additional buyouts on the upper Sandy River following the January 2011 flood event and federal declaration DR-1956-OR.

Additional HMGP projects include a flood erosion study for the upper Sandy River to re-characterize the nature of the flood hazard as one more likely to erode banks due to channel migration than typical riverine flooding. Another HMGP project is a flood warning system for the upper Sandy Basin to install five sonar-based river level gauges on five County bridges to provide automated readings and flood levels on the National Weather Service's Portland Office river forecast web site.

One of the best investments for implementing hazard mitigation is not only through projects but to affect policy, such as land use planning and even long-term recovery planning. Following the 2011 flood disaster, Clackamas County convened a standing group to address sustainable flood recovery on the upper Sandy River. This group has begun addressing the interdepartmental roles and responsibilities in transitioning from response activities to recovery phase.

Discussions are underway on how the expected updated 2013 DFIRMS for the Sandy River will influence the DOGAMI Channel Migration Zone study and possible implications for long-term land use decisions on replacing damaged infrastructure and recovery for private property owners. County staff is working with the Sandy River Basin Watershed Council's "restorative flood response" outreach to homeowners and associations on providing education about benefits from combining multiple goals of enriching habitat, cost-effectiveness, elevated bank protection and equitable performance towards neighboring properties.

The County is also reviewing the level of flood insured properties in the upper Sandy Basin and investing in public outreach to encourage more Preferred Risk policies for residences outside of the Special Flood Hazard Zone and that by having flood insurance, homeowners can also take advantage of the Flood Mitigation Assistance Program for projects like acquisitions that do not require a disaster declaration.

Public outreach was employed a number of times since the January 2011 flood event to address public concerns, present flood response and recovery operations status, discuss flood threat issues to property owners and promote the purchase of flood insurance.



If you own a home or business in unincorporated Clackamas County ...

You May Need FLOOD INSURANCE!

If you're a Clackamas County resident or property owner, you have the option to buy flood insurance whether or not you live in a floodplain.



Flood Hazard Mitigation Action Items

Flood actions are listed in Section 3 Mitigation Strategy. For detailed information regarding each action, please refer to Appendix A – Action Items.