Section 7
Flood Hazards

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Why are Floods a Threat to Portland?

The City of Portland is located at the confluence of two major rivers, the Columbia and Willamette. The city has a long history of flooding and repetitive flood losses. Since its incorporation in 1851, the City has experienced dramatic changes through growth and development that have increased the risk of floods in some areas. This is especially true in the tributaries draining to the Willamette, where development has removed vegetation, increased impervious surfaces, and filled stream channels and floodplains. Ultimately, this combination increases storm water runoff and confines flows into a smaller area, thereby increasing downstream flow velocities. In both large and small watersheds, development in floodplains also puts more people and property in the path of floodwaters and increases the risk of damages even when flood levels are stable.

History of Flooding

Portland residents share a statewide concern regarding flood events. According to the National Flood Insurance Program (NFIP), Oregon has 256 flood-prone communities throughout the State's 36 counties.[1] That number includes Portland and most of Oregon's other 239 incorporated communities and counties. Flooding can cause severe damage to public and private property and poses a threat to life and safety; Oregon's largest economic loss from natural disaster resulted from flooding.[2] Damage during the Christmas Flood of 1964 totaled over $157 million dollars, and 20 Oregonians lost their lives.[3]

Flooding has greatly impacted Portland in the past and has the potential to do so in the future. In 1996—one of the more severe flood years on record—many rivers and creeks throughout the Willamette River watershed rose to 100-year flood levels. (For more information on the 100-year flood definition see section beginning on Page 7-5). On Friday, February 9, 1996, the Willamette River crested 10 feet 6 inches above flood stage, just inches from the plywood placed above Portland's downtown seawall. The Columbia River crested at 11 feet 2 inches above flood stage, causing concern about the levees that protect Portland International Airport and areas north of Columbia Boulevard. Johnson Creek crested at 6 feet 5 inches above flood stage. Each year, there is about a one in 25 chance of a similar storm; a more serious storm could bring floodwaters over the downtown seawall and into the central business district.[4]

High water in the Columbia and Willamette Rivers during the 1996 flood caused significant erosion along the levee on the Columbia River and the Lower Columbia Slough. Concurrently, heavy rain and high water in the Upper Columbia Slough and secondary slough systems caused 117 landslides and bank failures along these water conveyance systems. Marine Drive was closed due to levee saturation, and barge traffic was also stopped on the Columbia River due to wave wash erosion on the levee. These levee and water conveyance systems are managed and maintained to United States Army Corps of Engineer Standards by four Drainage Districts; Peninsula Drainage District #1, Peninsula Drainage District #2, Multnomah County Drainage District #1, and Sandy Drainage

Improvement Company. The levees, pump stations, and conveyance channels make up a Federal Flood Protection System that protects approximately 12,764 acres of property within the managed floodplain. Repairs from the 1996 floods cost the Drainage Districts about $2.5 million. The City of Portland sought and received a Presidential Disaster Declaration to obtain federal assistance for its flood recovery effort in February 1996.

In general, floods in Portland are caused by spring snowmelt from the Columbia River and other basins and intense winter rainstorms. Local flooding also occurs as a result of winter storm run-off in tributaries such as Johnson Creek. The flood season for western Oregon (including the City of Portland) extends from late October through April. Historically, the majority of flooding has occurred in Portland during December, January, and February. The City has considerable areas of existing development in the floodplain, most of which was developed prior to the establishment of the existing floodplain-related development codes. Several of these areas have a high potential for new development and redevelopment, so flooding will continue to be a lengthy maintenance and cleanup issue for Portland.

The City's most recent flooding incident occurred during January 31, 2003, along Johnson Creek. The event was relatively small when compared to the 1996 events but nonetheless flooded nearly 131 acres and affected a total of 11 businesses and 39 residences. Between 1996 and 2004, Johnson Creek has exceeded its bank two times.

Repetitive Flood Losses in Portland

There are a total of nine "repetitive loss" properties in Portland. Repetitive loss is a term that is usually associated with the National Flood Insurance Program (NFIP); for Flood Mitigation Assistance (FMA) program purposes, the term refers to a structure that has suffered flood damage on two or more occasions over a 10 year period where the cost to repair the flood damage equals or exceeds 25% of the structure's market-value at the time of each flood event. Portland participated in the Community Rating System (CRS), which uses a slightly different definition of "repetitive loss" property. CRS uses the term for any property on which the NFIP has paid two or more flood claims of at least $1,000 in any give 10-year period. Repetitive loss structures are important to the NFIP since structures that flood frequently put a strain on the flood insurance fund. On a local level, the structures are also important because residents' lives are disrupted and may be threatened by the continual flooding.

The properties are dispersed throughout the City, though seven of the nine properties are located in the Johnson Creek Watershed. Properties tend to cluster in the following locations:

- In the east-side Willamette floodplain north of the Sellwood Bridge
- In the west-side Willamette floodplain near SW Miles Street
- In the Johnson Creek floodplain near SE Foster Road and 103rd Avenue
- In the Johnson Creek floodplain near SE Harold and 113th Avenue

- In the Johnson Creek floodplain near SE Brookside Drive and 122nd Avenue
- In the Johnson Creek floodplain near SE 143rd and 159th Drive

The Columbia River and Lower Columbia Slough also pose a potential (though unlikely) threat to property within the managed flood plain. Properties protected by the flood works are valued at more than $10 billion and include the Portland International Raceway, the Expo Center, the Portland International Airport, the Columbia Industrial Corridor, several residential neighborhoods, and the City of Portland's drinking water well system. Cost of replacing the infrastructure protected by the flood works would be devastating.

Protecting Portland from Flood Losses

The Federal Flood Protection System that protects the managed floodplain along the Columbia River consists of approximately 60 miles of ditches. The Columbia Slough, and a series of smaller sloughs protect the managed floodplain from flood damages. The ditches and sloughs were constructed and are maintained to accommodate a 100-year internal flood event. Storm water enters into these ditches and sloughs through a series of pipes that drain water from the streets and parking lots of Portland. Additionally, approximately 31 miles of federal levees protect the City from external flooding due to high water in the Columbia River and Lower Columbia Slough.

The system has been extensively improved since the flood of 1996. Pump station, levee, and conveyance system upgrades—as well as a series of computers, repeaters, and antennas that allow 24-hour real-time monitoring from remote locations—all make the system a very reliable means to protect the managed flood plain from catastrophic flooding. Continued management of the system insures future protection of the properties within the managed flood plain.

Factors That Create Flood Risk

Flooding occurs when climate or weather patterns, geology, and hydrology combine to create conditions that enable water to flow outside of its usual course. In Portland, geographic and climatological conditions combine to create a situation of chronic seasonal flooding.

Precipitation

Flooding is most common from October through April when storms from the Pacific Ocean can bring intense local rainfall. In fact, most of the area's average annual precipitation—nearly 42 inches—falls within these seven wettest months of the year. During this seven-month period, Portland receives an average 29.8 inches—or 88 percent—of its total 34 average annual inches of precipitation. By contrast, snowfall occurs a few days each year and depths seldom exceed six inches. Figure 7-1 illustrates Portland's average monthly precipitation.

The high level of rainy season precipitation saturates the ground and often fills rivers and streams to bank full conditions. Bank full conditions exist

when rivers and streams rise and exceed their channel capacity; any additional water begins to fill the surrounding floodplain. The City typically experiences flooding after more than three days of heavy rainfall or when saturated conditions combine with significant rainfall or storms over short periods of time.

Figure 7-1. Average Monthly Rainfall, Portland, Oregon

Month	Average High	Average low	Warmest on record	Coldest on record	Average dew point	Average precipitation
January	45	34	65	-2	33	5.4
February	50	36	71	-3	36	4.1
March	56	39	83	19	38	3.7
April	61	42	93	29	41	2.5
May	68	48	100	29	46	2
June	73	53	102	39	50	1.6
July	80	57	107	43	53	0.5
August	79	57	107	44	54	0.9
September	74	52	105	34	51	1.6
October	64	46	92	26	47	3.1
November	52	40	73	13	40	5.5
December	46	36	65	6	36	6.5

Source: State Climatology Office

The City of Portland is located in the Willamette River Basin, which is approximately 11,460 square miles. The Willamette River Basin is the largest watershed in the State with 13 major tributaries joining it between the headwaters at Waldo Lake (southeast of Eugene) and the confluence with the Columbia River at Kelley Point. Though the City of Portland only occupies 1% of the drainage basin, the city's 17 miles are the most urbanized and heavily used along the entire basin length.

Soils

Soils on the west side of the Willamette River vary from clay loam with low permeability and relatively high erosion potential to gravelly loams that are relatively well drained and moderately permeable. Because of landslide potential, stormwater infiltration may not be advisable in many parts of the West Hills; however, soils that provide the opportunity to infiltrate stormwater are scattered around the area. The flat areas along the west bank of the Willamette River are urban and highly disturbed, and many consist of fill.

On the east side of the Willamette River, soils are highly variable; similar to the west side, however, they are generally urban and highly disturbed. Much of the area along the Columbia River has been filled with dredged sand that drains very well. In undisturbed areas along the Columbia River, percolation rates are very slow. Areas south of Columbia Boulevard also have soils that drain well. In the southeast areas of the City, soils vary from moderate to low permeability. In areas with well-draining soil, stormwater can be managed through infiltration.

Floodplain Terminology

Floodplain

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe (see Figure 7-2). See the Natural Hazards Map in this plan's Map Section for Portland's 100-Year Floodplain.

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What is the Floodway?

The floodway is one of two main sections that make up the floodplain. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For National Flood Insurance Program (NFIP) purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

What is the Flood Fringe?

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

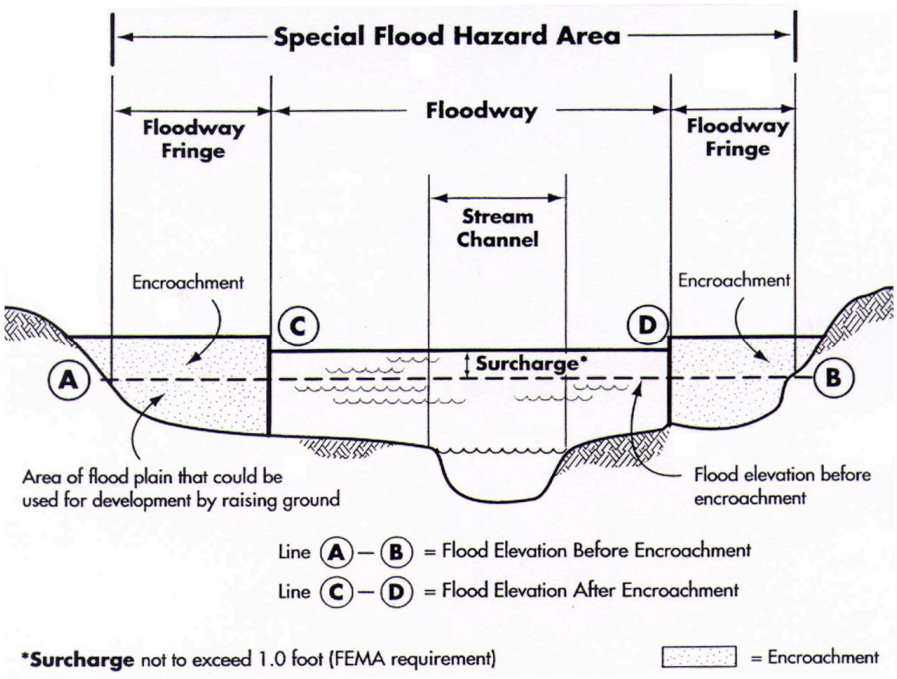
Floodway

The floodway is one of two main sections that make up the floodplain. Floodways are defined only for regulatory purposes; unlike floodplains, floodways do not have a recognizable geologic feature or floodwater path. For National Flood Insurance Program (NFIP) purposes, the floodway is defined as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the 100-year flood without cumulatively increasing the water surface elevation more than one foot (PCC 24.50.030.P). The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties. Similarly, City of Portland regulations prohibit development in the floodway with certain exceptions. Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

Flood Fringe

The Floodway Fringe is the area of the floodplain lying outside the floodway that does not contribute appreciably to the passage of floodwater but serves as a retention area.[5] These outer portions of the floodplain begin at the edge of the floodway and continue outward. City of Portland regulations allow development within the flood fringe with several conditions. For example, structures must be protected by elevating or flood-proofing, and compensatory storage must be provided for fill placed below the base flood elevation. For NFIP purposes, development is defined as any man-made change to improved or unimproved real estate, including but not limited to buildings and other structures and mining, dredging, filling, grading, paving, excavation, fencing, landscaping, drainage facilities, or drilling operations (PCC 24.50.030F).

Figure 7-2. Floodplain Schematic



Source: Floodplain Management in Missouri. (March 1999) Missouri Emergency Management Agency

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the height of the base flood, usually in feet, relative to the National Geodetic Vertical Datum of 1929, the North American Vertical Datum of 1988, any other datum referenced in the Flood Insurance Study report, or the average depth of the base flood, usually in feet, above the ground surface.[6] Base flood elevations can be set at levels other than the 100-year flood; some communities choose to use higher frequency flood events as their base flood elevation for certain activities but use lower frequency events for others. For example, a 25-year flood event might serve as the base flood elevation for the purpose of storm water management while the 500-year flood event may serve as base flood elevation for the tie-down of mobile homes. NFIP regulations focus on development in the 100-year floodplain.[7]

Characteristics of Flooding in Portland

Flooding of developed areas may occur when the amount of rainfall and runoff exceeds a storm water system's (creek, ditch, or storm drain) capability to remove it. Two types of flooding primarily affect Portland: *urban* flooding and *riverine* flooding. In addition, any low-lying area has the potential to flood. Urban flooding impacts related to ongoing stormwater drainage problems are not a significant issue in Portland because major overflows of the system are repaired immediately by the City's Maintenance Engineering Department. The 1997 Surface Stormwater Facility Maintenance and Management Manual guides this group's work. The

Hansen 7.0 database is used to track and prioritize work orders related to the maintenance of the sewer and stormwater system in Portland.

Urban Flooding

Urbanization of the watershed changes the basin's hydrologic systems. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb and then slowly release rainfall. Heavy rainfall also collects and flows faster on impervious concrete and asphalt surfaces. Water therefore 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. The resulting high water volume and turbidity both contribute to erosion of stream banks.

Many of the natural hazards definitions found in this plan come from existing state resources, including the *Planning for Natural Hazards: Technical Resource Guide,* the *Oregon State Natural Hazards Plan,* and FEMA-adopted local plans. For more information on existing resources for natural hazards and mitigation planning in the state of Oregon, please visit www.OregonShowcase.org.

A majority of land within Portland is urbanized and has a high concentration of impervious surfaces that either collect water or concentrate flow in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains and catch basins can also back up with vegetative debris and cause additional, localized flooding.

Numerous areas are currently subject to urban flooding and the number of at-risk areas could increase as development continues throughout Portland. The continued increase of impervious surfaces related to development significantly contributes to Portland's future flood risk as increased runoff subsequently exceeds the capabilities of existing drainage infrastructure. Portland does not currently have a comprehensive policy regarding impervious surfaces in the 100-year floodplain or anywhere else. The Johnson Creek Plan District is the only area in the City where impervious surfaces are limited by the zoning code.

Riverine Flooding

Riverine flooding, or flooding that occurs along channels of rivers and streams, is the largest single form of flooding in Portland. 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 rainfall over a wide geographic area, causing floods in hundreds of smaller streams that drain into major rivers.[8] Terrain helps determine the dynamics of riverine flooding. In relatively flat areas, shallow, slow-moving floodwater may cover the land for days or even weeks. In hilly, mountainous areas, a flood could begin only minutes after a heavy rain. Such a flash flood gives short notice and can move so fast that it is particularly dangerous to people and property in the hills.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards in *"areas that are inundated by the 100-year flood with flood depths of only 1 to 3 feet*." These areas are generally flooded by low-velocity sheet flows of water.

What is the Effect of Development on Floods?

When structures or fill are placed in the floodway, water is displaced. Development raises the base flood elevation by forcing the river to compensate for the reduced flow space. When structures or materials are added to the floodway and no fill is removed to compensate for the addition, flood levels may increase beyond their historic floodplain areas both near the area of fill and downstream.

Local governments must manage development in floodplains and floodways to minimize such encroachments in the floodway or floodplain. Techniques include cut and fill balance and other methods used to prevent the rise of pre-development flood levels. Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event and the inundation of many homes, businesses, and other facilities. Careful attention must be paid to development that occurs within the floodway to ensure that structures can withstand base flood events without exacerbating flood levels.

In the City of Portland, development encroachment on the floodway is prohibited unless a technical analysis from a registered engineer demonstrates that the development will result in no increase in the base flood elevation. Development in the flood fringe is permitted with conditions. For example, structures must be protected through elevation or floodproofing, and compensatory storage (cut and fill balance) must be provided for fill placed below the base flood elevation (PCC 24.50). Also, the zoning code section 33.631 requires land divisions to place the floodway in a flood hazard tract unless river-dependant uses are proposed.

In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event and can exacerbate potential flood hazards. Care should be taken in the development and implementation of stormwater management systems to ensure that these runoff waters are managed effectively.[9] Though there is no comprehensive policy to limit impervious surface in Portland, impervious surfaces in the Johnson Creek 100 year floodplain (where flooding is a frequent problem) can equal no more that 50 percent of a lot for all uses and development. This policy also applies in areas with steep slopes.

How are Flood-Prone Areas Identified?

Flood maps and Flood Insurance Studies are often used to identify flood-prone areas. The National Flood Insurance Program (NFIP) was established in 1968 as a means of providing low cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and what we have come to know as "sound floodplain management."[10] The City of Portland joined the NFIP and implemented the related codes and regulations in 1980. NFIP regulations

(44 Code of Federal Regulations (CFR) Chapter 1, Section 60.3) require that all new construction in floodplains be elevated at or above base flood level. The Oregon Building Code requires new construction to be elevated to one foot above the base flood elevation.

Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but they cannot adopt less stringent standards.[11] In Portland, all homes and other buildings legally constructed in the floodplain after January 1980 must be built to NFIP standards with the first floor being elevated at least one foot above base flood level, or in the case of non-residential buildings, flood proofed to at least one foot above the base flood level.

FIRM Maps and Flood Insurance Studies

Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by the Federal Emergency Management Agency (FEMA) that delineates Special Flood Hazard Areas or floodplains where National Flood Insurance Program regulations apply. The maps are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply.

The City of Portland considers the 100-year (1% annual chance of flooding) flood to be the base flood event.

Water surface elevations are combined with topographic data to develop FIRMs. These maps illustrate areas that would be inundated during a 100-year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases, they also include base flood elevations (BFEs) and areas located within the 500-year floodplain.

Development:

For floodplain ordinance purposes, development is broadly defined to mean "any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations or storage of equipment or materials." The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the elevation (normally measured in feet above sea level), which the base flood is expected to reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, using lower frequency events for others. For example, for the purpose of stormwater management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the National Flood Insurance Program focus on development in the 100-year floodplain and the City of Portland, has established the 100-year flood as the base flood event.

Flood Insurance Studies and FIRMs produced for the National Flood Insurance Program (NFIP) provide assessments flood probability at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s; these studies and maps represent flood risk at the point in time when FEMA completed the studies. *They do not reflect changes within the study area that might affect flooding since the studies.* For example, many areas in the City of Portland have experienced significant urbanization and changes in hydrology during the past 20 years. The original study for the City of Portland was completed in 1979. The study has been revised on several occasions since 1979 to reflect updated conditions and improvements. Most recently, the study has been revised to reflect new hydrologic and hydraulic analyses for Johnson Creek, Fanno Creek, Crystal Springs Creek, and Peninsula Drainage District Number 1.

Flood Mapping Methods and Techniques

In general, the City of Portland relies upon the Flood Insurance Rate Maps (FIRM) devised by the FEMA to guide implementation of the City's floodplain ordinances. If a proposed property is within the floodplain delineated on the FIRM, the ordinances apply. In the Johnson Creek Plan district, additional regulations apply that are designed to reduce flood levels; these regulations limit tree cutting and impervious surfaces.

GIS (Geographic Information Systems) analyses are becoming an important tool for flood hazard mapping. FIRM maps can be imported directly into GIS for analysis of flood hazard areas. Communities find it particularly useful to overlay flood hazard areas on tax assessment parcel maps. However, the original mapping efforts by FEMA in the 1980's did not contain adequate horizontal controls; as such, any overlay is subject to potential error. Local communities have found that the only useful pieces of mapping information are the water elevation and cross section locations contained in the flood studies. This information can be added to topographic maps that more accurately define the areas prone to flood hazard. This allows a community to evaluate the flood hazard risk for a specific parcel during review of a development request.

Coordination between FEMA and local planning jurisdictions is key to making a strong connection with GIS technology for the purpose of flood hazard mapping. FEMA and the Environmental Systems Research Institute (ESRI), a private company, have partnered to provide multi-hazard maps and information to the public via the Internet. ESRI produces GIS software, including ArcView© and ArcInfo©. The ESRI web site has information on GIS technology and downloadable maps. The hazards maps provided on the ESRI site will assist communities in evaluating geographic information about natural hazards. Flood information for most Oregon communities is available on the ESRI web site. Visit http://www.esri.com for more information.

Community Flood Issues

Development in the floodplains of Portland will continue to be at risk from flooding. Flood damage occurs on a regular basis throughout the City, and

property losses resulting from flood damage can be extensive. The City of Portland has experienced more than $200 million in flood damage to both private and public property in the past three decades.

Property loss resulting from Flooding Events

The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive flood damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Surface water entering into crawlspaces, basements, or daylight basements is common during flood events not only in or near floodplains but also on hillsides and other areas that are far removed from floodplains.[12] Most flood damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). Most of the losses in the 1996 floods were related to saturation damage.

Private property flood issues

In 1996, flood damage to private property accounted for one-third of total damages statewide.[13] In Portland, damage occurred to structures in the floodplain, as well as structures impacted by localized urban flooding. The highest levels of damage from 1996 floods occurred for structures that were constructed prior to the adoption of floodplain management measures required by the National Flood Insurance Program. The concentration of damage clearly demonstrates the success of the mitigation measures required and implemented through the NFIP.[14]

Homes

Housing losses accounted for the largest share of private property damage during the 1996 flood events.[15] Homes with access to rivers and creeks may be located in areas especially at risk to chronic flooding. The City of Portland's flood ordinances provide baseline rules governing the construction of homes within identified floodplains. Flood damage problems may continue to arise for homes that were constructed prior to the implementation of city regulations.

Homes in frequently flooded areas can also suffer damage to septic systems and drain fields. Homes in rural floodplain areas often depend on private sewage treatment systems. Inundation of these systems may result in leakage of wastewater into surrounding areas. In many cases, flooding damage to homes renders them unlivable.

In the wake of the 1996 floods, the City of Portland received just over $1.5 million in Housing and Urban Development funds and FEMA Hazard Mitigation Grant Program funds totaling $1.5 million. This money was matched by local stormwater fees and regional bond measure funds and has been applied to the Willing Seller program in the Johnson Creek Watershed. The Federal Government provides disaster funding for people who cannot or should not live in their homes because of damage or other disaster-related reasons.[16]

Table 7-3 illustrates Multnomah County's rank as the third highest county in the State for total flood damage during the 1996 events and the fifth highest county for housing disaster assistance. Housing Assistance funds went primarily to urban counties with high populations and relatively high property values.[17]

Table 7-3. 1996 Oregon County Losses and Housing Program Fund Payments

County Losses	Housing Fund Payments to Counties
1. Tillamook	1. Clackamas
2. Clackamas	2. Marion (tied)
3. Multnomah	3. Columbia (tied)
4. Marion	4. Washington
5. Columbia	**5. Multnomah**
6. Lane	6. Tillamook
7. Washington	7. Linn

Source: 1996 Flooding and Landslides and Stream Erosion In the State of Oregon

Manufactured Homes

Statewide, the 1996 floods destroyed 156 housing units. Of those units, 61% were mobile homes and trailers.[18] Many older manufactured home parks are located in floodplain areas. Manufactured homes have a lower level of structural stability than "stick-built" (standard wood frame construction) homes. Manufactured homes in floodplain zones must be anchored to provide additional structural stability during flood events. Because of confusion in the late 1980's resulting from multiple changes in NFIP regulations, there are some communities that do not actively enforce anchoring requirements. Lack of enforcement of manufactured home construction standards in floodplains can contribute to severe damages from flood events.[19] In all areas of special flood hazards, Portland's Development Code requires that all new construction and substantial improvements shall be anchored to prevent flotation, collapse, or lateral movement of the structure. Additionally, all manufactured homes must likewise be anchored to prevent flotation, collapse, or lateral movement and shall be installed using methods and practices that minimize flood damage (PCC 24.50).

Business/Industry

Flood events impact businesses by damaging property and interrupting transactions. Flood events can cut off customer access to a business and can close businesses for repairs. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. A recent risk assessment conducted for the City of Portland estimates potential damages totaling $258.7 million for commercial and residential general building stock due to a 100-year flood event.[20]

Public Infrastructure

Publicly owned facilities are a key component of daily life for all citizens of Portland. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the government's ability to deliver services. Government can take action to reduce risk to public infrastructure from flood events and can craft public policy that reduces risk to private property.

Buildings and Roads

Of particular importance during flood events are critical facilities located in flood hazard areas (i.e., facilities that are critical to government response and recovery activities). During natural hazard events or any type of emergency or disaster, dependable road connections are critical for providing emergency services. The roads in Portland are maintained by multiple jurisdictions depending on ownership and maintenance agreements. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. Road networks often traverse floodplain and floodway areas, and transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding.

Bridges

Bridges are key points of concern during flood events for two primary reasons:

(1) They are often important links in road networks, crossing water courses or other significant natural features; and

(2) They can be obstructions in watercourses and can inhibit the flow of water during flood events.

There are an estimated 64 bridges (railway and highway) at risk in a 100-year flood event and 112 in a 500-year event.[21]

Storm Water System

Most ongoing local drainage problems have been addressed in Portland, but temporary problems can occur in recently developed areas. In some areas with local drainage problems, city maintenance crews must concentrate time and resources until a solution is determined.

Water/Wastewater Treatment Facilities

No major pumping or treatment facilities relating to water systems are likely to fail during flood events due to the elevation of pumping stations and other facilities. However, some portions of the delivery system including trestles and supply conduits in the Bull Run system and transmission mains across the Willamette are vulnerable to flood, landslide, and earthquake impacts.

Parks and Open Space

Current efforts to increase public open space in Portland have been paired with the need to restore and preserve natural systems that provide wildlife habitat and help to mitigate flood events. Public parks and publicly owned open spaces can provide a buffer between flood hazards and private property. In 1997, the City of Portland developed a Willing Seller Land

Acquisition Program to purchase frequently flooded properties. The program seeks to move people and property out of harm's way, minimize repetitive losses, and restore floodplain function. Willing sellers are offered fair market value for their property and are under no obligation to sell. Once the City purchases properties, structures and hard surface are removed. The City places deed restrictions on each property permanently designating it as open space.

The City is taking a particularly proactive stance in the Johnson Creek watershed. In 2001, the Johnson Creek Restoration Plan was published and identified the "nuisance" flood – the flood event that occurs about every 10 years – as the goal for flood management. The Restoration Plan also identifies project areas throughout the watershed to restore natural floodplain functions and provide long-term flood mitigation that is realistic in our modern, built environment. Historic projects to control or direct floods such as levees, dams, and channelization have proved ineffective over time. Restoring natural floodplain functions is ultimately less expensive, more effective, and more sustainable in the long term.

Floods and Natural Systems

Well-maintained or restored natural systems can mitigate the impact of flood events on the built environment. The watershed's natural system includes the soils, nutrients, water quality and quantity, and diverse species of plants and animals that exist in the areas between the water's edge and the higher ground adjoining flood-prone areas. These can be considered as natural infrastructure that, if present, can reduce the spread of flooding downstream. The distinctive attributes of soils in riparian ecosystems are directly influenced by the periods of water that engulf them which in turn affect the structure and function of the plan communities. This ecosystem is more biologically diverse than its neighboring systems and as such, the wildlife, small organisms, and trees and shrubs living within the watershed are varied.

Floodplains and wetlands can make an important contribution to the sources of water supply for human consumption. The slowing and dispersal of runoff and floodwater by floodplain vegetation allows additional time for this water to infiltrate and recharge groundwater aquifers. Floodplain soils and vegetation can also help to purify the water as it filters down to the aquifer. The ability of wetlands to contribute to groundwater recharge varies with geographic location, season, soil type, water table location and precipitation, and wetland type.[22]

Natural resources in floodplains interactively function to determine the distinctive attributes of soils, vegetation, habitat, and water. They also carry out valuable functions that provide benefits both to humans and to wildlife.

Title 3: (Metro Code 3.07.310-3.07.370), Water Quality and Flood Management Conservation[23]

The goal of the Stream and Floodplain Protection Plan (Title 3) of the Metro Regional Government Framework is to protect the region's health and public safety by reducing flood and landslide hazards, controlling soil

erosion, and reducing pollution of the region's waterways. Title 3 implements Oregon Land Use Goals 6: Air, Water, and Land Resources Quality and 7: Areas Subject to Natural Disasters and Hazards, by protecting streams, rivers, wetlands, and floodplains by avoiding, limiting, or mitigating development impact on these areas.

Title 3 contains performance standards to protect against flooding. The standards limit development in a manner that requires balanced cut and fill and require floor elevations at least one foot above the flood hazard standard. The areas subject to these requirements have been mapped and adopted by Metro Council. The areas are the FEMA 100-year floodplain and the area of inundation for the February 1996 flood. Title 3 also contains performance standards related to streams, rivers, and wetlands.

These standards seek to protect and enhance water quality. The water quality areas are rivers and streams with a protected vegetated corridor whose width depends on the slope of the land adjacent to the water feature and the width of the property. The performance standards require erosion and sediment control, prohibit the storage of uncontained hazardous material in water quality areas, are require planting of native vegetation on the stream banks when new development occurs. The performance standards first require an alternative analysis to explain what other development locations were considered and how the proposed development location meets the performance standards and has the least detrimental impact on resources. Also, after demonstrating that there is no practicable alternative to the location proposal, the development must take action to reduce impact and must replace the ecological functions that are damaged or destroyed by the development. Portland currently complies with all of the adopted Title 3 elements. The water quality element is implemented via the environmental regulations of Title 33, Portland Zoning Code. Erosion control is regulated by Title 10.

Flood Hazard Assessment Overview

Hazard Identification

Hazard identification, the first phase of a hazard assessment, refers to the process of estimating the geographic extent of the hazard, its intensity, and its probability of occurrence.[24] This process usually results in a hazard map. Hazard maps can provide detailed information in a clear format and can assist in policymaking and land use decisions. For the purposes of this hazard identification process, FEMA's Flood Insurance Rate Maps (FIRM) of the 100 and 500-year floodplain were used to identify areas that could be impacted by flooding.

Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through landslide identification with an inventory of the existing development exposed to flood hazards. Vulnerability assessments help predict how different types of property and

population groups will be affected by a hazard.[25] The optimal method for conducting this analysis at the county or jurisdictional level is to use parcel-specific assessment data on land use and structures.[26] Data that includes known flood locations can be used to assess the population and total value of property at risk from future landslide occurrences.

This plan uses the results of a pilot study for the Hazard US – Multi-Hazard software program. HAZUS-MH applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates; these methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards and locations. Flood data from the HAZUS-MH software package was supplemented with local data for critical facilities and hazard areas. Inventory data were superimposed over the hazard areas to enable GIS queries to estimate the quantity of assets at risk (population, structures, critical facilities, etc.)

Flood ranked high in comparison to the other three severe ranked hazards, earthquake, landslide, and wildland fire. For a 100-year flood, 11,200 households could be exposed and 29,900 persons impacted, with commercial class occupancies accounting for 37% of the losses. Annualized loss from flood could reach $15.4 million.

More detailed results of the HAZUS-MH study for flood are listed on the following page. They provide an overall summary description of the jurisdiction's vulnerability to the hazards and address the impacts of the hazards on the jurisdiction. Additionally, they identify the extent of the hazard and document previous occurrences of landslide events in the Portland metropolitan area. A complete risk assessment for landslides is included in *Risk Assessment Pilot Project Results for DMA 2000 Plan.*

Multnomah County Hazard Analysis		Summary of Risk Factors	
Severity Score	Medium	**Period of occurrence:**	October through April
History (2)	20	**Probability of event(s):**	Highly likely
Vulnerability (5)	25	**Warning time:**	General flooding – 0 to 3 hours
Maximum Threat (10)	60	**Major contributor(s):**	Intense precipitation, increase in impervious surface, vegetation loss
Probability (7)	42	**Cause injuries?**	Yes, and risk of death
Total Score	147	**Potential facilities shutdown?**	30 days or more

FLOOD HAZARD PROFILE

Background and Local Conditions

Flooding results when rain or snowmelt creates water flows that exceed the carrying capacity of river channels or other watercourses and storage facilities (for example, reservoirs). Flooding poses a threat to safety and can cause severe damage to public and private property. In Oregon, flooding is most common when storms from the Pacific Ocean bring intense rainfall (typically between October and April). The area's major rivers include the Columbia, Willamette, Clackamas, and Tualatin. There are also many streams in the area that drain to these rivers and can exacerbate riverine flooding primarily during prolonged wet periods. Local drainage flooding occurs on smaller streams, creeks, and drainage ways, and is more likely to result from heavy local storms and debris-clogged storm drain systems. This pilot project focuses on riverine flooding, which generally impacts larger areas at greater depths than drainage flooding.

Historic Frequency and Probability of Occurrence

Floods are a common and widespread hazard in Oregon. The Portland/Vancouver PMSA has been subject to major floods throughout recorded history. Flooding can be aggravated when heavy rains are accompanied by snowmelt and frozen ground. It was the combination of these factors that caused recent, disastrous floods in February and November 1996.

Flood risk or probability can be expressed by frequency of occurrence. It is measured as the average recurrence interval for a flood of a given magnitude and can be stated as the percent chance that a flood of a certain magnitude or greater will occur in any given year. FEMA's National Flood Insurance Program (NFIP) is based on the risk associated with a "100-year" or base flood; that is, a flood that has a one percent chance of occurring in any year.

Severity

Flooding can be a frequent, costly, and deadly hazard facing Portland; flash flooding also poses a significant danger. Many roads run through low-lying areas that are prone to sudden and frequent flooding during storms. Motorists often attempt to drive through barricaded or flooded roadways. Because it takes only 18 to 24 inches of water moving across a roadway to carry away most vehicles, this presents a significant potential cost and human health risk. The second largest impact on injuries results from people walking or playing in or near flooded areas. Warning times are short (0 to 3 hours, or less) depending on the nature of the flood event. Generally, floods kill people in two ways: when people ignore basic safety precautions (such as evacuations and warnings), or when a flash flood hits an area with no warning. Floods can be very damaging, and depend on the depth and velocity of the floodwaters. During a severe event, buildings can be washed off their foundations; however, most flood damage is caused by water saturating materials that are susceptible to loss (for example, wood, insulation, and furnishings).

Significant historic flooding has been recorded for the Willamette and Columbia River basins in 1861, 1880, 1881, 1894, 1909, 1913, 1927, 1928, 1942, 1946, 1948, 1961, 1964/1965, and 1996 (Oregon OEM 2000). Historic flood inundation levels for the Willamette River at Portland occurred in 1894 (35.1 feet above flood stage warning), 1948 (31.6 feet), 1964 (29.8 feet), 1974 (25.7 feet), and 1996 (30.2 feet) (Metro 1999). Major past events include floods in 1948 on the Lower Columbia River in the Portland/Vancouver PMSA that caused about 25 deaths; in December 1964 and January 1965 that forced the evacuation of thousands, destroyed scores of bridges and secondary roads, caused the Willamette River at downtown Portland to have a flood stage of 29.8 feet, caused $157 million in damages, and caused 17 deaths; and statewide floods in February 1996 that caused five deaths, forced thousands into shelter, destroyed hundreds of homes, caused damages in excess of $280 million, and forced the City of Portland to erect makeshift barriers to prevent flood waters from moving into the downtown area (Oregon State Police 2003). Twenty-seven counties, including Multnomah, were eventually covered by a disaster declaration due to the 1996 floods (Oregon OEM 2000).

Many residents who have suffered damage rebuild in the same vulnerable areas, only to be flooded again. These properties are termed repetitive loss properties, and are troublesome because they continue to expose lives and property to flooding (Clackamas County 2002).

Designated Hazard Areas

According to NFIP, Oregon has 256 flood-prone communities, including all 36 counties. Flood hazard areas are defined as areas that would be inundated by a flood of a given magnitude. The areas subject to riverine flooding have been mapped by FEMA under the NFIP and are illustrated on Figure 3-3 for the Portland study area for the 100-year and 500-year flood zones. These areas are determined using statistical analyses of flood discharge data and hydraulic and topographic analyses. A 100-year flood has a 1 percent chance of being equaled or exceeded in any one year. This flood event is also referred to as the base flood. A flood that has a 0.2 percent chance of being equaled or exceeded in any one year is called a 500-year flood.

Mitigation Plan Goals and Existing Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature, guidance from the Portland Natural Hazards Mitigation Steering Committee, and interviews with Portland stakeholders. Goals for this mitigation plan address four categories:

1. Identify risk level and evaluate Portland's vulnerability to natural hazards.
2. Implement activities to protect human life, property, and natural systems.
3. Promote public awareness, engage public participation, and enhance partnerships through education, outreach, and coordination of a diverse and representative group of the City's population.
4. Establish a disaster resistant economy.
5. Build and support the capacity and commitment to continuously become less vulnerable to hazards.

Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies or organizations. Personal stakeholder interviews were

conducted with several Portland agencies to obtain existing mitigation activity information.

City Programs

1996 Flood and Landslide Mitigation Plan

After the 1996 floods, a flood and landslide mitigation plan was developed by a key group of city bureaus. Actions outlined by this group allowed for reimbursement funding from the federal government due to the floods. The sub-committee reviewed these actions to develop implementation strategies and determine the progress needed. Many of the items are carried over into the 2004 plan, but the following were implemented. This plan included recommendations to add flood and landslide maps to the GIS permit center, consider the cost/benefit advantage of applying for the National Flood Insurance Program Community Rating System, and to upgrade the river gauging system throughout the State, among others. This plan served as a starting point for the action items in the flood section of this natural hazard mitigation plan.

River Elevation Conversion Tables

One issue raised in the 1996 Flood and Landslide Mitigation Plan was the variation in data systems used among local and federal agencies. Based on the work of an interagency, intra-bureau team, the following Conversion Chart was developed but no one datum was formally chosen as the main reference of flood level.

River Elevation Conversion Tables

All elevations in feet, round to nearest 0.1'

Columbia River	**NGVD/MSL**	**City of Portland**	**NAVD88**
NWS Vancouver	**MCDD, ODOT**	**PDOT, BES**	**Water Bureau Map**
0.0	+1.8	+3.2	+5.3
1.8	0.0	+1.4	+3.5
3.2	-1.4	0.0	+2.1
5.3	-3.5	2.1	0.0

Willamette River	**NGVD/MSL**	**City of Portland**	**NAVD88**
NWS Morrison	**MCDD, ODOT**	**PDOT, BES**	**Water Bureau Map**
0.0	+1.6	+2.9	+5.0
1.6	0.0	+1.4	+3.5
2.9	-1.4	0.0	+2.1
-5.0	-3.5	-2.1	0.0

Community Rating System

The Community Rating System (CRS) recognizes community floodplain management efforts that go beyond the minimum requirements of the

NFIP. Property owners within the City would receive reduced NFIP flood insurance premiums if the City implements floodplain management practices that qualify it for a CRS rating. For further information on the CRS, visit FEMA's website at http://www.fema.gov/nfip/crs.htm.

In Portland, the CRS program creates an incentive for the City to continue implementing proactive, long-term mitigation activities by bringing a discount to flood insurance policy holders. The City of Portland participates in this program and scored a #6 Rating within the CRS program, the highest rating in the State along with that of Tillamook County. A #6 rating delivers a 20% discount to flood insurance policy holders in the City. Through mitigation planning and the newly outlined actions, even more CRS points and therefore more deductions to homewners' flood insurance can be claimed.

City of Portland Codes

Chapter 24.50 Flood Hazard Areas

The purpose of this Chapter is to protect public health, safety, and welfare by restricting or prohibiting uses which are dangerous to health, safety, or property in times of flood or which cause increased flood heights or velocities, and by requiring that uses and structures vulnerable to floods be protected from flood danger at the time of initial construction. This code identifies flood hazard areas and limits or prohibits development where significant personal property loss can occur or where significant environmental damage can occur. The City of Portland currently:

1. Uses environmental zones to protect significant natural resources and limits the development impact by restricting the proximity of development to water bodies, minimizing the impervious footprint, retaining and restoring native vegetation.
2. Uses Plan District regulations to prohibit development within the Johnson Creek floodway, prohibit land divisions within the flood risk area, limit impervious surfaces within the 100-year floodplain, limit tree removal, and limit housing types in the multi-family zone that are within the 100-year floodplain.

Flood Management Projects

Kelley Creek

The Alsop-/Brownwood project was originally proposed as a single, 50-acre restoration project. The project involves removing fill and recreating historic meanders in Johnson Creek and Kelly Creek. Because of the complexity of the project and the cost of design, permitting, and construction, the project was broken into smaller projects and will be constructed in phases, as resources are available. The first phase, the Kelley Creek Floodplain Restoration Project, will cover the area between SE 159th and the Springwater Corridor where Kelley Creek meets Johnson Creek.[27] The Kelley Creek project was constructed during the summer of 2004 and provides more than 15 acre-feet of flood storage.

Johnson Creek

The "Willing Seller" program in the Johnson Creek area allows landowners in frequently flooded areas to sell their property at fair market price to the City.

In 1996, Portland Parks, Portland Environmental Services, Metro, and other federal partners began acquiring land and developing designs for large-scale floodplain, water quality, and habitat restoration projects in four target areas along Johnson Creek. These projects will provide flood management benefits while meeting open space, water quality, and habitat goals.

Columbia Slough Watershed

The Columbia Slough watershed in North and NE Portland is unique to Portland because it is protected from flooding by federally constructed levees and a series of pump stations managed by Multnomah County Drainage District #1, Peninsula Drainage District #1, and Peninsula Drainage District #2. The rest of the lower slough floodplain is not protected by levees. During the next five years, the City and the Drainage Districts will continue their partnership to re-grade, revegetate, and stabilize the slough banks.

Fanno Creek

Fanno Creek and its tributaries in Portland have steep slopes without a wide, well defined floodplain. Development, especially along the mainstem of Fanno Creek, has encroached extensively into the riparian corridors and in some cases into the floodway. About seven acres of riparian corridor in Fanno Creek and its tributaries are now permanently protected and are designated open spaces thanks to City of Portland and Metro acquisition programs.

Willamette River Corridor

The City has partially completed a five-year program partnering with public and private property owners to revegetate the Willamette River mainstream. These projects will reduce erosion along more than 7,000 feet of riverbank and bluffs and will restore 50-75 acres of riparian and oak habitat by removing invasive species and planting more than 75,000 native trees and shrubs. The City is also developing comprehensive plans to protect and enhance public and watershed health, while supporting multiple land uses in the river corridor and the watershed as a whole.[28]

Emergency Management Program

The Portland Office of Emergency Management (POEM) coordinates City departments, governmental agencies, and private networks to prepare, plan, equip, train, and exercise emergency response actions and to coordinate the implementation of mitigation and recovery plans.

The City has established POEM consistent with its authority under Oregon Revised Statutes (ORS) 401.305 to 401.335 and City Code 2.01.010 to 2.01.060 (cited as the "Emergency Management Code"). The Emergency Manager is part of the Mayor's Office and is responsible for managing the City's program in all four phases of Emergency Management.

State Programs

State of Oregon Floodplain and Floodway Removal/Fill Law

The Oregon Removal/Fill Law, which is administered by the Oregon Division of State Lands, requires a permit for activities that would remove or fill 50 or more cubic yards of material in state waters (e.g., streams, lakes, wetlands). Portland, Clean Water Services, and other partner cities must comply with the removal/fill laws when designing and building facilities and have related responsibilities when dealing with private development and other construction projects.[29]

Oregon's Wetlands Protection Program

Oregon's Wetlands Program was created in 1989 to integrate federal and state rules concerning wetland protection with the Oregon Land Use Planning Program. The Wetlands Program has a mandate to work closely with local governments and the Division of State Lands (DSL) to improve land use planning approaches to wetland conservation. A Local Wetlands Inventory (LWI) is one component of that program. DSL also develops technical manuals, conducts wetlands workshops for planners, provides grant funds for wetlands planning, and works directly with local governments on wetlands planning tasks.

Oregon Wetlands Joint Venture

The Oregon Wetlands Joint Venture is a coalition of private conservation, waterfowl, fishery, and agriculture organizations working with government agencies to protect and restore important wetland habitats.[30]

Federal Programs

National Weather Service

The National Weather Service provides flood watches, warnings, and informational statements for rivers throughout Washington County.

National Resources Conservation Service (NRCS), US Department of Agriculture

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance for clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and must generally benefit more that one property.

Federal Emergency Management Agency (FEMA) Programs

The Federal Emergency Management Agency (FEMA) resulted from the consolidation of five federal agencies that were dealing with different types

of emergencies. Since then, many states and local jurisdictions have accepted this approach and changed the names of their organizations to include the words "emergency management." Portland is one of those local jurisdictions.[31] FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance.

National Flood Insurance Program (NFIP)

Flood insurance is available to citizens in communities that adopt and implement NFIP siting and building standards. The standards are applied to development that occurs within a delineated floodplain, a drainage hazard area, an area subject to inundation during a base flood event, and properties within 250 feet of a floodplain boundary. These areas are depicted on federal Flood Insurance Rate Maps that are available through the City of Beaverton. Oregon's Department of Land Conservation and Development is the state's NFIP-coordinating agency.

Flood Mitigation Action Items

The flood mitigation action items provide direction on specific activities that organizations and residents in the City of Portland can undertake to reduce risk and prevent loss from flood events. Each action item includes an estimate of the timeline for implementation. *Short-term action items* (ST) are activities that state agencies may implement with existing resources and authorities. *Long-term action items* (LT) require new or additional resources and/or authorities.

Short-term Action Items

ST-FL#1: A covenant is recorded with the deed of new development in the floodplain to ensure that space below the BFE is not converted to habitable space. This should be codified to improve compliance.

Key Issues Addressed

- Many areas below the base flood elevation (BFE), over time, are converted to habitable space; this puts more people and property in harm's way. An "unfinished enclosure covenant" is used, but is not codified.

Ideas for Implementation

- No code specifically references this covenant. Recommendation for action plan is to codify the covenant. Floodplain ordinance 24.50 is currently in discussion for revision.

General Comments

- New construction in the floodplain with high crawl spaces are required to complete a covenant agreeing to not convert the area into habitable space. This covenant is recorded with Multnomah County prior to permit issuance.
- This action was also recommended in the *1996 Flood and Landslide Hazard Mitigation Plan.*

Coordinating Organization:	Bureau of Development Services
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1 yr.
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#2: Continue to co-fund improvements to river and stream gauges in the Portland metropolitan area with the United States Geological Survey.

Key Issues Addressed

- River stage gauges are needed to accurately monitor and predict flood danger along a specific river. Many jurisdictions around the state reported that in 1996 they needed earlier warning and better information. Many gauges have been deactivated and not replaced due to lack of funding.

Ideas for Implementation

- Continue partnerships with USGS; assure that funding is in place with each budget cycle.
- Upgrade the river gauging system throughout the state, finding ways to ensure stable and ongoing funding for maintenance. It is recommended that the State Water Resources Department be the lead agency to work with local jurisdictions.

General Comments

- This action was identified in the *1996 Flood and Landslide Hazard Mitigation Plan*.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	none
External Partners:	USGS, Oregon Fisheries, Other adjacent jurisdictions may also gain from this information and can also become partners
Level of Immediate Capability:	High
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#3: Convene an interagency committee to determine which datum will be used when the City is responding to a flood event. This decision will not preclude agencies from using their own datum during non-flood times.

Key Issues Addressed

- The levels of the Willamette and Columbia rivers are measured using at least four different datum depending on which agency presents the data (An example of the multiple datum conversion chart is included in the Existing Programs section of this section). This difference caused considerable confusion during the 1996 flood.

Ideas for Implementation

- Formally acknowledge, possibly via City Council resolution, that one datum will be used when Portland's Emergency Operation Center is operational. Reconvene a committee to select the emergency datum as soon as possible.
- Conversion charts will be distributed before as well as during a disaster, and will include instructions for use.

General Comments

- Per recommendations in the *1996 Flood and Landslide Hazard Mitigation Plan*, an inter-agency committee was set up to select a datum to use across all agencies in both emergency and non-emergency situations, but they were unable to reach consensus regarding which datum to use.
- FEMA and NOAA each have their own measurement system, which is imbedded within all of their maps and reporting systems. One possible solution is to find a method of working with existing systems; agencies need to discuss how this would work. Conversion chart is available in card format for easy access and use.

Coordinating Organization:	Harbor Master, Fire Bureau
Internal Partners:	Bureau of Development Services, Portland Office of Emergency Management
External Partners:	Northwest River Forecast Center- NOAA
Level of Immediate Capability:	Medium
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-FL#4: Secure the agreements necessary to design and implement the redevelopment of Freeway Land Company site (within the Lents Urban Renewal Area) to better manage floods.

Key Issues Addressed

- Freeway Land Company is a keystone parcel for flood management in the Lents area. Approximately one-quarter to one-third of the total area of this property needs to be available for flood storage and conveyance if long term plans for mitigation of the 10-year flood event in the Foster Road and 110th area are to succeed. Freeway Land Company is expected to redevelop this site in the next two to six years. These plans should include flood management in order to meet Lents area-wide goals.

Ideas for Implementation

- Portland Development Commission, Portland Office of Transportation, Portland Parks and Recreation, and Bureau of

Environmental Services collaborate with each other and developers via a development agreement; the City provides incentives to encourage developers to incorporate flood and open space plans for the site. The City should be prepared to do necessary design and construction to improve the open space for flood management and open space amenity value. This would combine the implementation of flood management goals with job-creation goals.

General Comments

- The current property owner and the Lents Urban Renewal Advisory Committee have endorsed a concept plan that includes flood management. However, since the property is currently for sale, the City must wait for an interested developer before detailed conversations can commence.
- Though there is a high level of interest from multiple internal agencies, the project will demand a high cost in both dollars and staff resources.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Portland Development Commission; Bureau of Planning, Portland Office of Transportation, Portland Parks and Recreation
External Partners:	Oregon Economic Development Department, site land owners
Level of Immediate Capability:	Medium
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#5: Acquire outside funding to lead the application process for a Class 5 rating the next time the City submits for the Community Rating System certification.

Key Issues Addressed

- More favorable ratings result in increased discounts to flood insurance policy holders and create an incentive for the City to continue implementing proactive, long-term mitigation activities.

Ideas for Implementation

- Given current staffing levels, it will be necessary to acquire grant funding to hire a consultant (1/4 FTE) to coordinate multi-bureau staff and the overall application process.

General Comments

- Reapplication for the Community Rating System will occur in 2006.

- The largest barrier to implementation is the lack of staff time to coordinate multiple bureaus and assemble the complicated application. The 2001 application was funded through a grant.

Coordinating Organization:	Bureau of Environmental Services, Community Rating System Coordinator
Internal Partners:	Bureau of Development Services; BoP; Parks; Portland Office of Emergency Management; Bureau of Maintenance
External Partners:	Federal Emergency Management Agency, Department of Land Conservation and Development, Insurance Services Office, Inc. (ISO)
Level of Immediate Capability:	Medium
Estimated Timeline:	2 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-FL#6: Support MCDD in the continued calibration and updating of hydraulic models for conveyance and internal flood impacts to the four managed floodplains managed by Multnomah County Drainage District # 1.

Key Issues Addressed

- The hydraulic model identifies development-related impacts to the water flow and capacity of watersheds. The models could be used in conjunction with flood inundation modeling to predict flood levels and identify measures that would reduce impacts. Measures could include identifying high-risk areas, critical facilities vulnerability, and measures to mitigate vulnerability.

Ideas for Implementation

- Partner with the City and acquire funding for the action.
- Address this need for protection of life and property as part of the ongoing characterization of the Columbia Slough watershed.

General Comments

- This type of modeling could also be used for other watersheds within the City of Portland

Coordinating Organization:	Portland Office of Emergency Management, Bureau of Environmental Services
Internal Partners:	Bureau of Planning
External Partners:	Multnomah County Drainage District
Level of Immediate Capability:	Medium
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

ST-FL#7: Develop a multiple-agency plan for evacuation of the managed Columbia River floodplain in Multnomah County in the event of a potential levee failure.

Key Issues Addressed

- In the unlikely (though possible) event of levee failure, evacuation may be necessary for the protection of life.

Ideas for Implementation

- Coordinate with Law Enforcement, Fire and Rescue, and other appropriate agencies.
- Build on existing evacuation plans for overlapping geographic areas.

General Comments

- Multnomah County Drainage District would rely on river forecasting, weather forecasting, and on technical assistance from the Army Corps of Engineers regarding the need for evacuation during a flood event.

Coordinating Organization:	Mitigation Program Coordinator, Portland Office of Emergency Management
Internal Partners:	Portland Office of Transportation
External Partners:	Multnomah County Drainage District, Multnomah County Sheriff, Army Corps of Engineers
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-FL#8: Identify funding for the design and construction of the Springwater Wetlands Complex, a 30-acre floodplain wetland restoration project in the Lents area of Johnson Creek.

Key Issues Addressed

- This project is located in the Lents Urban Renewal Area between SE 111th and SE 120th, an area that is known to experience problem flooding. Because it is near existing wetlands, the project has significant water and habitat quality benefits and would provide important flood storage. Between 15 and 20 homes adjacent to the project site will experience fewer floods, which have flooded three times since 1964. Without this project, these homes have a 71% chance of flooding over the course of a 30-year mortgage. This project can reduce that chance to 26%.

Ideas for Implementation

- Oregon Department of Transportation is a potential funder through their wetland mitigation bank program. The Corps of Engineers is a potential funder through their Section 206 Habitat Restoration Program.
- Continue discussions with these partners, package funding, finalize the predesign effort started through the Section 206 program, and design and construct the project.

General Comments

- This project was attempted previously but funding was eliminated in the middle of predesign due to changing federal priorities. It is currently on hold due to lack of available funding.
- Partnerships with Parks and Recreation will be important since the project is likely to also include passive recreation components such as interpretive signage and boardwalks.
- The project was identified as a high priority project in the Johnson Creek Restoration Plan, 2001.
- Implementation of this action also supports Urban Renewal objectives in the Lents area.

Coordinating Organization:	Johnson Creek Watershed Manager, Bureau of Environmental Services
Internal Partners:	Parks and Recreation, Portland Development Commission
External Partners:	Army Corps of Engineers, Oregon Department of Transportation
Level of Immediate Capability:	High, given the availability of funding
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#9: Secure funding to implement the passive flood management projects that are recommended in the Johnson Creek Restoration Plan. Coordinate with Portland Development Commission's urban renewal efforts in Lents and with other partners in other parts of the watershed.

Key Issues Addressed

- Four areas in Johnson Creek watershed flood frequently: Tideman-Johnson, West Lents, East Lents, and Lower Powell Butte. The most frequently flooded and highest priority area is East Lents along Foster road between SE 102nd and 112th. Flooding in this area impacts nearby residences and businesses.

Ideas for Implementation

- Secure more funding to complete willing seller land acquisitions.
- Secure funding for predesign and design of the flood management facilities recommended in the Johnson Creek Restoration Plan.
- Leverage outside funding and phase large projects into manageable pieces.

General Comments

- This action is an update of a recommendation that was included in the 1996 *Flood and Landslide Hazard Mitigation Plan*.
- In West and East Lents, all work has been coordinated through Portland Development Commission and the Lents Urban Renewal process. The Bureau of Environmental Services has completed a significant amount of flood analysis in the Lents area and has completed 10% designs for flood management. Design and construction of projects is pending funding and willing property sellers (approximately one-third of the property remains in private ownership).

Coordinating Organization:	Bureau of Environmental Services, Johnson Creek Watershed Manager
Internal Partners:	Portland Development Commission, Parks and Recreation
External Partners:	Army Corps of Engineers
Level of Immediate Capability:	High
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-FL#10: Improve definitions and refine standards for stormwater retention in the Stormwater Management Manual (SWMM).

Key Issues Addressed

- Stormwater retention assures that water does not leave the site, other than via infiltration and evapotranspiration. Detention holds back the water, but ultimately releases it. Detention and retention of stormwater on site will not prevent downstream flooding, but they will contribute to lessening flood impacts. Current SWMM standards require that stormwater is retained on the site to the "maximum extent practicable" (MEP) and the rest detained; this definition should be clarified through standards.

Ideas for Implementation

- Include this recommendation as part of the next 3-year update to the SWMM.
- Develop a stream map that identifies flashy streams where the regulations would apply.
- Clarify MEP standards to increase the amount of stormwater that is retained on site in those watersheds or sub watersheds.
- Additional funding may be necessary to assure that staff is assigned to focus specifically on this issue.

Coordinating Organization:	Development Services Division, Bureau of Environmental Services
Internal Partners:	Bureau of Development Services, Bureau of Planning
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards

ST-FL#11: Support development of a multiple-agency plan for Marine Drive closure coordination.

Key Issues Addressed

- During major flood events, it may be necessary to close Marine Drive so that flood fighting actions may be undertaken, and to reduce impact to the levee when it is saturated with flood waters**.**

Ideas for Implementation

- Coordinate with Law Enforcement and other appropriate agencies.

Coordinating Organization:	Portland Office of Emergency Management Mitigation Program Coordinator
Internal Partners:	Bureau of Water, Portland Office of Transportation
External Partners:	Multnomah County Sheriff; Oregon Department of Transportation, Army Corps of Engineers, Multnomah County Drainage District
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#12: Provide staff to participate in Flood Fight Trainings lead by the Multnomah County Drainage District.

Key Issues Addressed

- Readiness for levee monitoring and flood fight in the event of a high water event on the Columbia River.

Ideas for Implementation

- Multnomah County Drainage District has facilities for training and has trained US Army Corps of Engineers personnel, COP Water Bureau personnel, POP personnel, and private business personnel. Identify other relevant participants and encourage them to come to trainings.

General Comments

- Trainings are held annually. Other interested parties should contact the Drainage District.

Coordinating Organization:	Portland Office of Emergency Management, Mitigation Program Coordinator
Internal Partners:	Bureau of Maintenance, Police, Water Bureau
External Partners:	Multnomah County Drainage District, Army Corps of Engineers
Level of Immediate Capability:	High
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population. Build and support the capacity and commitment to continuously become less vulnerable to hazards.

.ST-FL#12: Install a river gauge in the vicinity of the bridge over Johnson Creek at 108th. The gauge should be able to send data to a remote monitoring site.

Key Issues Addressed

- This action provides an early warning system floods that occur in the right of way on both public and private property.

Ideas for Implementation

- Portland Office of Transportation and Bureau of Environmental Services should form a work team to research the following:
  - Determine proper instrumentation and compatibility with current systems.
  - Determine costs.
  - Determine remote telemetry configuration and site location.
  - Installation location of equipment to accomplish task.

General Comments

- The existing stream gauge that is closest to the one that is proposed is located at SE 148th. This location is not close enough to accurately predict whether and when Foster Road at SE 108th needs to be closed, or to provide warning to residents and businesses to prepare.

Coordinating Organization:	Bureau of Maintenance, Environmental Systems Division Manager
Internal Partners:	Bureau of Environmental Services; Portland Office of Transportation
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1 year once funding is secured
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#13 Install one-way valves on the outlet pipes of the storm inlets on SE Foster Road between 101st and 112th.

Key Issues Addressed

- This action would eliminate reverse flow in outlet pipes to street inlets to the right of way. This would significantly reduce the incidences of localized drainage system flooding before bank topping of Johnson Creek.

Ideas for Implementation

- Portland Office of Transportation and Bureau of Environmental Services team should research all potential sites and determine the most viable valve system for implementation.
- Determine installation costs.
- Prioritize identified sites.
- These should be engineered for optimum efficiency given the nature of inflow from the street and backflow from Johnson Creek when flow elevations reach a given point, even though creek banks have not been exceeded.

Coordinating Organization:	Environmental Systems Division Manager, Bureau of Maintenance
Internal Partners:	Bureau of Environmental Services
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1 year once funding is secured
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

Long-term Action Items

LT-FL#14: Increase funding for the Johnson Creek Willing Seller Program; establish willing seller programs in other watersheds where flood hazard and priority restoration areas coexist.

Key Issues Addressed

- Willing seller programs help restore the natural functions of floodplains while also permanently removing the risk of flood damages to acquired properties. These natural functions provide extra benefit such as water storage, water quality improvement, and rare open space amenities for urban dwellers.

Ideas for Implementation

- Continue and increase funding for existing programs such as Johnson Creek Willing Seller Program.
- In other watersheds, delineate target areas based on high-risk areas. This action can achieve multiple objectives when high-risk areas are also high quality habitat and/or water quality protection areas.
- Purchase properties on a willing basis only using consistent and equitable procedures and policies

General Comments

- This program exists in the Johnson Creek watershed
- Interest and institutional capability are high, but funding is low
- This action item was identified in the *1996 Flood and Landslide Hazard Mitigation Plan.*

Coordinating Organization:	Watershed Managers, Bureau of Environmental Services
Internal Partners:	Department of Parks and Recreation, Bureau of Planning, Water Bureau
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	long-term
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-FL#15: Review and amend City Code to require that all facilities that store or handle hazardous materials (including large tanks), and which are located in the 500-year floodplain or landslide hazard areas, develop

a hazardous materials inventory statement. This statement will be made available for Fire Bureau review. Require that these storage tanks are either adequately protected or relocated outside of the 500-year floodplain.

Key Issues Addressed

- Storage of hazardous materials in the floodplain can cause hazardous materials spills during flood events. This is particularly dangerous because the spills occur in environmentally sensitive areas.

Ideas for Implementation

- The existing SARA Title III database contains data that are a good starting place for developing a database of hazardous materials storage locations.
- The Fire Marshal could adopt fire code appendices requiring "hazardous materials inventory statements" and "hazardous materials management plans." The Fire Marshal could then implement a program to evaluate and mitigate potential hazards.
- Identify funding sources for implementation.
- Develop options for funding assistance to affected business or property owners in the floodplain.

General Comments

- Underground tanks are anchored to keep them from floating during floods. Above ground tanks typically have secondary containment such as a dyke that can hold the contents of the largest tank within the facility. Small tanks are considered portable and have no anchors or protection from flood damage.
- This action was also recommended in the *1996 Flood and Landslide Hazard Mitigation Plan.*

Coordinating Organization:	Chief Fire Marshal
Internal Partners:	Harbor Master, Fire Bureau, Portland Office of Emergency Management, Bureau of Development Services
External Partners:	State Fire Marshall Office
Level of Immediate Capability:	Low
Estimated Timeline:	3-5 years once funding has been identified
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#16: Develop a plan for addressing flooding in the Holgate Lake area.

Key Issues Addressed

- Localized groundwater flooding occurs after extensive periods of rain to the east of SE 128th and Holgate (called "Holgate Lake" although a lake only intermittently exists). Flooding occurs relatively infrequently, but has a high impact because of the amount of development that is located here. The area continues to develop, leaving more homes in harms way. Although finished floors of newer homes are protected from the flooding, access to and from the site can be a problem since the floods tend to have a long duration.

Ideas for Implementation

- Determine which agency would be most appropriate to take the lead on developing and implementing the plan.
- Secure funding for an area-specific plan. Establish a working committee. Gather Holgate-Lake specific data. Develop a plan that will be implemented through a combination of zoning code, building code, and land acquisition.

General Comments

- This action was also identified in the *1996 Flood and Landslide Hazard Mitigation Plan*.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Bureau of Development Services, Parks and Recreation, Bureau of Planning
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	5 + years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-FL#17: Improve hydraulic bottleneck that prevents discharge of chlorinated effluent to the Willamette River during high river levels.

Key Issues Addressed

- Currently, during high river levels, chlorinated effluent is discharged directly into the Willamette River. This situation is undesirable for public health and environmental reasons. When this situation occurs, the City is temporarily in noncompliance with its sanitary system discharge permit.

Ideas for Implementation

- Design and construct a chlorinated secondary effluent bypass pump station at the Tryon Creek Wastewater Treatment Plant (TCWTP).
- Design and construct outfall pipe improvements at the Tryon Creek Wastewater Treatment Plant (TCWTP).
- Secure internal Bureau of Environmental Services funding for one of these projects in order to leverage federal funding for the other.

General Comments

- This project is already in an approved BES plan- Project No. 12 in the Tryon Creek Wastewater Treatment Plant Facilities Plan, 1999. The project was estimated to cost $870,000 (1999 dollars). Funding has not yet been identified.

Coordinating Organization:	Operating Manager Tryon Creek Wastewater Treatment Plant, Bureau of Environmental Services
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	2 years once funding has been identified
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#18: As Waterfront Park remodeling is designed, ensure that Portland's downtown property and critical facilities remain protected from floodwaters.

Key Issues Addressed

- Without the seawall in place, downtown Portland will be exposed to catastrophic flooding. The redesign of Waterfront Park has the potential to impact the function of the seawall. These impacts would include floodwater, debris, floating structures and vessels.

Ideas for Implementation

- Conduct engineering studies to determine whether property protected by the seawall would remain protected under the proposed new designs.
- Make funding of the design and construction of the improvements contingent on the inclusion of engineering studies that ensure the continued function of the seawall.
- Ensure that Fire Bureau Harbor Master reviews and comments on redevelopment projects for Waterfront Park, as recommended in the 2002 Master Plan.

General comments

- A Master Plan was completed in 2002 that made recommendations for altering the seawall along Waterfront Park.

Coordinating Organization:	Parks and Recreation
Internal Partners:	Harbor Master/ Fire Bureau, Bureau of Planning, Bureau of Development Services
External Partners:	none
Level of Immediate Capability:	High, pending project funding
Estimated Timeline:	5-10 years, dependent on funding
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#19: Support Multnomah County Drainage District (MCDD) as they develop a multiple-agency plan for initiation of traffic closure on the Columbia River as advised by MCDD and the Army Corps of Engineers.

Key Issues Addressed

- During the 1996 floods, significant damage resulted from wave wash erosion. Closing the Columbia River to river traffic to prevent wave wash erosion to the levee of flood is longer than for a Johnson Creek overland flood.

Ideas for Implementation

- Coordinate with Fire Bureau, Harbor Master and other appropriate agencies.

General Comments

- Recommended in the Consolidated Drainage District Flood Emergency Plan, 2002.

Coordinating Organization:	Mitigation Program Coordinator, Portland Office of Emergency Management
Internal Partners:	Portland Office of Transportation
External Partners:	Captain of the Port, Coast Guard; Multnomah County Sheriff; U.S. Army Corps of Engineers; Multnomah County Drainage District
Level of Immediate Capability:	High
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-FL#20: Partner with Army Corps of Engineers to conduct modeling of the Willamette River upstream of Portland to identify areas that, if acquired or restored, would contribute to mitigation of peak flows in

Portland or result in significant reduction of flood damages.

Key Issues addressed

- Portland is subject to increased flood risks due to development on up-stream properties. This action will determine whether there are areas upstream of Portland that could be protected or restored to reduce the flood risk in Portland. It is difficult for the City to influence land acquisition priorities in upstream, rural areas without contributing funding. Until we have information about the benefits of upstream acquisition, expenditures will not occur.

Ideas for Implementation

- Secure funding for the study.
- Inventory work that has already been done to model the Willamette River.
- Develop contract and scope of work with the Army Corps of Engineers (COE).
- Participate with COE to check assumptions and assure that modeling output is translated to issues significant to Portland.
- If the information is compelling and points to possibilities for significant reduction of flood impacts, create a committee to formulate recommendations for next steps.

General Comments

- The City has the modeling capacity to work with the COE; however, the scale of the Willamette basin upstream of Portland will make it difficult to identify specific areas with significant impact. Also, it will be difficult for the City to be the driver on this effort alone; it needs the full participation of the COE or other entity that has more of a basin wide jurisdiction. Related to Recommendation #15 in the 1996 Flood and Landslide Hazard Mitigation Plan.

Coordinating Organization:	Bureau of Environmental Services Systems Analysis Group
Internal Partners:	none
External Partners:	Corps of Engineers, United States Geologic Survey
Level of Immediate Capability:	Medium
Estimated Timeline:	5+ years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

LT-FL#21: Develop citywide, watershed or sub- watershed specific goals, policies, and provisions for amount of impervious surface that should be reduced. Develop implementation tools to meet these goals.

Key Issues Addressed

- Reduction of impervious surfaces within a watershed can decrease flood levels. While impervious surface limits are enforced within the Johnson Creek area, they apply only within the 100-year floodplain. Impervious surfaces in upland areas also contribute to flooding. Impervious surfaces in upland areas in Johnson Creek and other watersheds could also benefit from citywide limits on effective impervious areas.

Ideas for Implementation

- Develop watershed plans that include target goals for maximum impervious surface percentages; amend the comprehensive plan, the zoning code, and/or the stormwater manual to address maximum percentages of allowed imperviousness on a property and to address cumulative impacts on a watershed scale.
- Include the impervious surfaces created by roads, sidewalks, and parking lots within subdivisions and other large developments; give stormwater fee credits to properties that remove impervious surfaces.
- Identify design elements for low-impact development.
- Develop non-regulatory tools to provide incentive to minimize new impervious surfaces and/or removal of existing.

General Comments

- Bureau of Environmental Services is developing a watershed plan that will provide existing effective impervious surface data and recommended targets for reduction; it will be complete in 2005. This plan includes mitigation goals, but not for all areas of the city. The goals will be guidelines rather than requirements.

Coordinating Organization:	Bureau of Planning, Bureau of Environmental Services
Internal Partners:	Bureau of Development Services, Portland Office of Transportation
External Partners:	none
Level of Immediate Capability:	Low; not in current budget
Estimated Timeline:	5 + years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#22: Upgrade trestles that carry the main conduits of the water delivery system.

Key Issues Addressed

- Some trestles are vulnerable to floods, and should be upgraded to protect Portland's water supply.

Ideas for Implementation

- Rebuild/ upgrade or replace existing trestles to increase natural disaster survivability.

General Comments

- Several of these trestles are located in the Bull Run Watershed, which provides all of Portland's drinking water.
- Currently defined in the Water Bureau's 5-year CIP Plan; However, this does not guarantee funding

Coordinating Organization:	Water Bureau
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	High, given availability of funding
Estimated Timeline:	3-8 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems. Establish a disaster resilient economy.

LT-FL#23: Create redundancy in the water delivery system at the three Sandy River crossings by burying conduits under the river.

Key Issues Addressed

- This action would remove the potential for flood-carried debris or water surges to damage or collapse existing trestles. The Sandy River has historically been the most problematic in terms of debris flow and landslide impacts to the conveyance system.

Ideas for Implementation

- Conduct an engineering feasibility study.
- Complete permitting, design and construction of the trestle.

General Comments

- This project is in the 5-year Capital Improvements Program, but funding is not guaranteed.

Coordinating Organization: Water Bureau, Operations and Support Manager

Internal Partners:	none
External Partners:	River users groups
Level of Immediate Capability:	High, with funding
Estimated Timeline:	5-10 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#24: Provide funding for and participate in the development of a flood inundation model for the managed floodplains and downtown seawall.

Key Issues Addressed

- The model would provide key information regarding impacts and inundation timing in the event of a Columbia River Levee or downtown sea wall breach at various flood stages. Information will be used to develop evacuation plans and assess impacts to critical facilities, develop action plans to protect critical facilities or remove them from harm's way.

Ideas for Implementation

- Hold presentations with interested partners to discuss the advantages to them for using the model. Incorporate other partners' requirements and adjust scope and budget.
- Determine funding sources and timeline.
- Construct model run.
- Review outputs with technical group to determine if the results meet the expected results.
- Write report on model findings.
- Develop action plan outline, scope of work and cost to implement.
- Fund and implement the project.

General Comments

- In September 2004, the Water Bureau developed a model presentation with scope of work and estimated budget.
- In the planning phase, the project needs commitment from other partners as well as funding.

Coordinating Organization:	Portland Office of Emergency Management Mitigation Program Coordinator
Internal Partners:	COP, Bureau of Environmental Services, Water Bureau
External Partners:	Multnomah County Drainage district
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

Flood Mitigation Resources

County Resources

Multnomah County Emergency Management

Multnomah County Emergency Management is the central contact point for county resources prior to and during a disaster. Multnomah County Emergency Management is responsible for the coordination of resources within the unincorporated county and the cities of Gresham, Fairview, Troutdale and Wood Village. This also includes public health, county justice system and certain road networks. The City of Portland reports to Multnomah County in a disaster through the disaster declaration process and works to coordinate programs as much as feasibly possible.

Contact 1:	Director, MCEM
Address:	501 SE Hawthorne Bldv, Room 600
Phone:	(503) 988-4233
Fax:	(503) 988-3093
Website:	http://www.comultnomah.or.us/dbcs/emergnecy_mgmt

Regional Resources

Metro Regional Government

Metro is the directly elected regional government that serves more than 1.3 million residents in Clackamas, Multnomah, and Washington counties and 24 cities in the Portland metropolitan area. Chapter 5 of Metro's Regional Framework Plan addresses natural hazards. Metro's Natural Hazards Program is a service of the Growth Management Services Department's Data Resource Center. Their web pages relate to natural hazards that may impact the Portland metropolitan area. Their links provide information about natural hazards in the Portland metropolitan area and suggest tools for reducing potential damages before disaster strikes. Metro produced the *Regional Hazard Mitigation Policy and Planning Guide* in 1999 to assist local governments in planning for future natural hazard events.

Contact 1:	Metro Regional Government
Address:	600 NE Grand Ave, Portland, OR 97232-2736
Phone:	(503) 797-1839

Fax: (503) 797-1911
Website: http://www.metro.dst.or.us/metro/growth/gms.html
Email: 2040@metro-region.org

Contact 2: Metro Data Resource Center
Website: http://storefront.metro.dst.or.us/drc/nathaz/nathaz.cfm

Email: drc@metro.dst.or.us

REMG/REMTEC

Emergency Management professional from a 5 county urban area (Multnomah Co., Clackamas Co., Washington Co. ,Columbia Co. , Oregon and Clark Co. Washington and the cities and major agencies within the area concerned with emergency management) coordinate regional planning resources and resolve regional issues through the "hands on" technical committee which proposes and reports to the "public official level", REMG. Sub-committee research and create position papers on such issues as regional emergency transportation routes, debris removal, school safety planning.

State Resources

Department of Land Conservation and Development (DLCD)

DLCD administers the state's Land Use Planning Program. The program is based on 19 Statewide Planning Goals, including Goal 7, related to flood and other natural hazards. DLCD serves as the federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide related mitigation activities. In order to help local governments address natural hazards effectively, DLCD provides technical assistance and conducts workshops, reviews local land use plan amendments, and works interactively with other agencies.

Contact: Natural Hazards Program Manager, DLCD
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html
Oregon Floodplain Coordinator: (503) 373-0050 ext. 255

Oregon State Police (OSP)-Office of Emergency Management (OEM)

OEM administers FEMA's Hazard Mitigation Grant Program to provide post-disaster monies for acquisition, elevation, relocation, and demolition of structures located in the floodplain. OEM also administers FEMA's Flood Mitigation Assistance Program. This program provides assistance for NFIP- insured structures only. OEM also helps local jurisdictions to develop hazard mitigation plans. OEM is heavily involved in flood damage assessment and works mainly with disaster recovery and hazard mitigation programs. OEM provides training for local governments through workshops on recovery and mitigation. OEM also helps implement and manage federal disaster recovery programs.

Contact: Office of Emergency Management

Address: 595 Cottage Street NE, Salem, OR 97310
Phone: (503) 378-2911
Fax: (503) 588-1378
Website: http://www.osp.state.or.us/oem/
OEM Hazard Mitigation Officer: (503) 378-2911 ext. 22247
Recovery and Mitigation Specialist: (503) 378-2911 ext. 22240

Oregon Department of Fish and Wildlife (ODFW)

ODFW's mission is to protect and enhance Oregon 's fish and wildlife and their habitats for use and enjoyment by present and future generations. ODFW regulates stream activity and engages in stream enhancement activities.

Contact: ODFW
Address: 2501 SW First Avenue, PO Box 59, Portland, OR 97207
Phone: (503) 872-5268
Website: http://www.dfw.state.or.us/
Email: Odfw.Info@state.or.us

Oregon Division of State Lands (DSL)

DSL is a regulatory agency responsible for administration of Oregon's Removal-Fill Law. This law is intended to protect, conserve, and make the best use of the state's water resources. It generally requires a permit from DSL to remove, fill, or alter more than 50 cubic yards of material within the bed or banks of state waters. Exceptions are in state scenic waterways and areas that are designated essential salmon habitat; in these areas, a permit is required for all in-stream activity regardless of volume.DSL and the US Army Corps of Engineers may issue these permits jointly.

Contact: Division of State Lands
Address: 775 Summer Street NE, Suite 100, Salem, OR 97301-1279
Phone: (503) 378-3805
Fax: (503) 378-4844
Website: http://statelands.dsl.state.or.us/
Assistant Director: (503) 378-3805, ext. 279
Western Region Manager: (503) 378-3805, ext. 244

Oregon Water Resources Department (WRD)

The WRD's mission is to serve the public by practicing and promoting wise long-term water management. The WRD provides services through 19 watermaster offices throughout the State. In addition, five regional offices provide services based on geographic regions. The Department's main administration is performed from the central office in Salem.

Contact: WRD
Address: 158 12th ST. NE, Salem, OR 97301-4172
Phone: (503) 378-8455
Website: http://www.wrd.state.or.us/index.shtml
http://www.co.washington.or.us/dptmts/wtr_mstr/wtr_mstr.htm

Federal Resources

Federal Emergency Management Agency (FEMA)

FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance. FEMA also operates the National Flood Insurance Program. FEMA's mission is "to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery." FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

Contact: FEMA, Federal Regional Center, Region 10
Address: 228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov

To obtain FEMA publications:
Phone: (800) 480-2520

To obtain FEMA maps:
Contact: Map Service Center
Address: P.O. Box 1038, Jessup, Maryland 20794-1038
Phone: (800) 358-9616
Fax: (800) 358-9620

United States Geological Survey (USGS)

The USGS website provides current stream flow conditions at USGS gauging stations in Oregon and throughout the Pacific Northwest. The Oregon USGS office is responsible for water-resources investigations for Oregon and part of southern Washington. Their office cooperates with more than 40 local, state, and federal agencies in Oregon. Cooperative activities include water-resources data collection and interpretive water-availability and water-quality studies.

Contact: USGS Oregon District Office
Address: 10615 S.E. Cherry Blossom Dr., Portland, OR 97216
Phone: (503) 251-3200
Fax: (503) 251-3470
Website: http://oregon.usgs.gov
Email: info-or@usgs.gov

Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. The Bureau of Reclamation owns Scoggins Dam in Washington County and prepares emergency action plans for events at the dam.

Contact: Bureau of Reclamation, Pacific Northwest Region
Address: 1150 N. Curtis Road, Boise, ID 83706
Phone: (208) 378-5012
Website: http://www.pn.usbr.gov/contact/index.shtml

Army Corps of Engineers

The Corps of Engineers administers a permit program to ensure that the nation's waterways are used in the public interest. Any person, firm, or agency planning to work in waters of the United States must first obtain a permit from the Army Corps of Engineers. In Oregon, joint permits may be issued with the Division of State Lands. The Corps is responsible for the protection and development of the nation's water resources including navigation, flood control, energy production through hydropower management, water supply storage, and recreation.

Contact: US Army Corps of Engineers-Portland District, Floodplain Information Branch
Address: P.O. Box 2946, Portland, OR 97208-2946
Phone: (503) 808-4874
Fax: (503) 808-4875
Website: http://www.nwp.usace.army.mil/

National Weather Service, Portland Bureau

The National Weather Service provides flood watches, warnings, and informational statements for rivers in Washington County. The majority of the County falls in the NWS "Willamette Tributary" region. The far western and northwestern portions of the County fall in the "SW Washington/NW Oregon" region. The NWS Portland office provides river level information online and by phone.

Contact: National Weather Service, Portland Bureau
Address: P.O. Box 2946, Portland, OR 97208-2946
Phone: (503) 261-9246 or (503) 261-9247
Fax: (503) 808-4875
Website: http://www.wrh.noaa.gov/Portland/public_hydro/

Washington County Soil and Water Conservation District (SWCD)

The SWCD works in partnership with the Natural Resource Conservation Service to promote soil and water conservation in Washington County. SWCD works with agricultural interests and landowners to provide information on natural resource conservation practices. The partnership blends individual member resources to offer technical and financial assistance in planning and applying natural resource conservation practices and systems. Areas of focus include: erosion management, wetlands preservation and restoration, resource inventories, watershed assessments, and conservation education.

Contact: Washington County Soil and Water Conservation District
Address: 1080 SW Baseline Building B, Suite B-2, Hillsboro, OR 97123
Phone: (503) 681-0953
Fax: (503) 640-1332
Website: http://www.swcd.net/

National Resources Conservation Service (NRCS), US Department of Agriculture (USDA)

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The

Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource or experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance for clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under the EWP must be environmentally and economically sound and generally benefit more that one property.

Contact: USDA-NRCS
Address: 1080 SW Baseline, Bldg B, Suite B-2, Hillsboro 97123-3823
Phone: (503) 648-3174
Fax: (503) 640-1332
Website: http://www.swcd.net/

Additional Resources

The National Flood Insurance Program

The National Flood Insurance Program (NFIP) Website is a subsection of the Federal Emergency Management Agency (FEMA) site (http://www.fema.gov). The NFIP information is intended for both the general public and the many organizations and agencies participating in the program. It includes information about the NFIP and other flood disaster assistance available from the Federal Government. It also provides access to the newly revised NFIP booklet: *Answers to Questions about the National Flood Insurance Program*.

Contact: The National Flood Insurance Program
Phone: (888) FLOOD29 or (800) 427-5593
Website: http://www.fema.gov/nfip

The Association of State Floodplain Managers

The Association of State Floodplain Managers is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning, and recovery. ASFPM fosters communication among those responsible for flood hazard activities, provides technical advice to governments and other entities about proposed actions or policies that will affect flood hazards, and encourages flood hazard research, education, and training. The ASFPM Web site includes information on how to become a member, the organization's constitution and bylaws, directories of officers and committees, a publications list, information on upcoming conferences, a history of the association, and other useful information and Internet links.

Contact: The Association of State Floodplain Managers
Address: 2809 Fish Hatchery Road, Madison, WI 53713
Phone: (608) 274-0123
Website: http://www.floods.org

USGS Water Resources

This web page offers current US water news; extensive current (including real-time) and historical water data, numerous fact sheets and other publications, various technical resources, descriptions of ongoing water survey programs, local water information, and connections to other sources of water information.

Contact: USGS Water Resources
Phone: (503) 251-3200
Website: http://water.usgs.gov or http://water.usgs.gov/public/realtime.html
Email: info-or@usgs.gov

Office of Hydrology, National Weather Service

The National Weather Service's Office of Hydrology (OH) and its Hydrological Information Center offer information on floods and other aquatic disasters. This site offers current and historical data including an archive of past flood summaries, information on current hydrologic conditions, water supply outlooks, an Automated Local Flood Warning Systems Handbook, Natural Disaster Survey Reports, and other scientific publications on hydrology and flooding.

Contact: Office of Hydrology, National Weather Service
Website: http://www.nws.noaa.gov/oh or http://www.nws.noaa.gov/oh/hic/

The Floodplain Management Association

The Floodplain Management website was established by the Floodplain Management Association (FMA) to serve the entire floodplain management community. It includes full-text articles, a calendar of upcoming events, a list of positions available, an index of publications available free or at nominal cost, a list of associations, a list of firms and consultants in floodplain management, an index of newsletters dealing with flood issues (with hypertext links if available), a section on the basics of floodplain management, a list of frequently asked questions (FAQs) about the Website, and, of course, an extensive catalog of Web links.

Contact: Floodplain Managers Association
Website: http://www.floodplain.org
Email: admin@floodplain.org

Northwest Regional Floodplain Managers Association (NORFMA)

This site is a resource for floodplains, fisheries, and river engineering information for the Northwest. This site provides technical information, articles, and Internet links in the field of floodplain and fisheries management.

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Contact: Northwest Regional Floodplain Managers Association
Website: http://www.norfma.org/

FEMA's List of Flood Related Websites

This site contains a long list of flood related Internet sites from "American Heritage Rivers" to "The Weather Channel" and is a good starting point for flood information on the Internet.

Contact: Federal Emergency Management Agency.
Phone: (800) 480-2520
Website: http://www.fema.gov/nfip/related.htm

Publications

Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local government employees and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides, including: flooding, wildfires, landslides, coastal hazards, and earthquakes. This document is available online. You can also write, call, or fax to obtain this document:

Contact: Natural Hazards Program Manager, Department of Land Conservation and Development
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

NFIP Community Rating System Coordinator's Manual. FEMA/NFIP. Indianapolis, IN.

This informative brochure explains how the Community Rating System works and what the benefits are to communities. It explains in detail the CRS point system and the activities communities can pursue to earn points. These points then add up to the "rating" for the community, and flood insurance premium discounts are calculated based upon that "rating." The brochure also provides a table on the percent discount realized for each rating (1-10). Instructions on how to apply to be a CRS community are also included.

Contact: NFIP Community Rating System
Phone: (800) 480-2520 or (317) 848-2898
Website: http://www.fema.gov/nfip/crs.htm

Floodplain Management: A Local Floodplain Administrator's Guide to the NFIP. FEMA-Region 10. Bothell, WA.

This document discusses floodplain processes and terminology. It contains floodplain management and mitigation strategies as well as information on the NFIP, CRS, Community Assistance Visits, and floodplain development standards.

Contact: National Flood Insurance Program
Phone: (800) 480-2520
Website: http://www.fema.gov/nfip/

Flood Hazard Mitigation Planning: A Community Guide, (June 1997), Massachusetts Department of Environmental Management.

This informative guide offers a ten-step process for successful flood hazard mitigation. Steps include: map hazards, determine potential damage areas, take an inventory of facilities in the flood zone, determine what is or is not being done about flooding, identify gaps in protection, brainstorm alternatives and actions, determine feasible actions, coordinate with others, prioritize actions, develop strategies for implementation, and adopt and monitor the plan.

Contact: Massachusetts Flood Hazard Management Program
Phone: (617) 626-1250
Website: http://www.magnet.state.ma.us/dem/programs/mitigate

Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials, (February 1987), FEMA-116.

This guidebook offers a table of actions that communities can take to reduce flood losses. It also offers a table with sources for floodplain mapping assistance for the various types of flooding hazards. There is information on various types of flood hazards with regard to existing mitigation efforts and options for action (policy and programs, mapping, regulatory, non-regulatory). Types of flooding which are covered include alluvial fan, areas behind levees, areas below unsafe dams, coastal flooding, flash floods, fluctuating lake level floods, ground failure triggered by earthquakes, ice jam flooding, and mudslides.

Contact: Federal Emergency Management Agency
Phone: (800) 480-2520
Website: http://www.fema.gov

Oregon Model Flood Damage Prevention Ordinance, (January 1999), FEMA/DLCD.

This is an example of how to write an ordinance that complies with NFIP/FEMA standards. Communities can simply adopt this ordinance, word for word, filling in the blanks specific to their community or jurisdiction.

Contact: Department of Land Conservation and Development
Phone: (503) 373-0050
Website: http://www.lcd.state.or.us/hazards.html

Flood Endnotes

[1] The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, June 2000).

[2] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 4.

[3] Ibid.

[4] Flood and Landslide Mitigation Work Group, Portland Bureau of Buildings. "Flood and Landslide Hazard Mitigation Plan: Based on lessons learned in February, 1996". October, 1996.

[5] Ibid.

[6] Federal Emergency Management Agency. (June 2003). http://www.fema.gov/fhm/fq_term.shtm#frequt4

[7] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 4.

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[11] Ibid.

[12] February 1996 *Flooding and Landslides and Stream Erosion in the State of Oregon*. The Interagency Hazards Mitigation Team (1996) Oregon State Police – Office of Emergency Management.

[13] Ibid

[14] Ibid.

[15] Ibid.

[16] Ibid

[17] Ibid.

[18] Ibid.

[20] Portland Office of Emergency Management, "Portland, Oregon Hazard risk Assessment Using Hazus-MH." March, 2004.

[21] Portland Office of Emergency Management, "Portland, Oregon Hazard risk Assessment Using Hazus-MH." March, 2004.

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[23] Title 3, Metro Regional Framework Plan, www.multnomah.lib.or.us/metro/growth/tfplan/funcsum.html (July 2001).

[24] Burby, R. (Ed.) *Cooperating with Nature* (1998) Washington D.C.: Joseph Henry Press.

[25] Burby, R. (Ed.) *Cooperating with Nature.* (1998) Washington D.C.: Joseph Henry Press.

[26] Ibid

[27] Kelley Creek Project Takes Off, Skendarian, Maggie; Johnson Creek Watershed Council, Within Your Reach, Volume XII,No. 2; Summer/Fall 2004

[28] Portland Floodplains 2003, past Present & Future, Living in a flood hazard area. What you can do. ; Environmental Services ; Dan Saltzman, Commissioner

[29] *Surface Water Management Framework*. (January 2001). Clean Water Services (formerly Unified Sewerage Agency.)

[30] Oregon Wetlands Joint Venture, Website: http://www.dfw.state.or.us/ODFwhtml/Wetlands/about.htm (May 2001).

[31] www.ci.Portland.or.us/departments/emergency/emergency_whatis.html