



CITY OF NORTH BEND

KING COUNTY, WASHINGTON

FLOODPLAIN MANAGEMENT PLAN



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PREPARED BY
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CHAPTER 1

INTRODUCTION

PURPOSE

The purposes of this Flood Hazard Management Plan Amendment are to incorporate areas annexed to the City of North Bend from King County into the plan, address recent changes to the Regulatory Floodplain, and to update the plan in accordance with new Federal, State, King County and City regulations.

The City of North Bend has increased in area through annexations since the original Floodplain Management Plan was adopted in 2005. The Federal Emergency Management Agency (FEMA) has recently redrawn the 100-year floodplain for the Middle and South Forks of the Snoqualmie River through North Bend. Recently annexed areas to be added to the Plan include:

- Forest Service/Mount Si
- Tanner Area
- East North Bend Way- Edgewick Employment Area
- Maloney Grove/Thrasher Annexation
- Stilson Area

Maps from the North Bend Comprehensive Plan indicate that Silver Creek, Forest Service/Mount Si and Maloney Grove neighborhoods have significant areas within the 100-year floodplains of either the Middle Fork or South Fork of the Snoqualmie River. Extending Floodplain Management Plan (FMP) coverage to these areas will allow them to be included in the Community Rating System (CRS), which will maintain North Bend's consistency with the requirements of the National Flood Insurance Program (NFIP) and potentially reduce the costs of flood insurance in flood prone areas. Extension of the FMP will help to maintain the City's eligibility for FEMA Public Assistance, Individual Assistance and Hazard Mitigation Grant Programs (HMPG). North Bend is a participating jurisdiction in the King County All Hazards Plan and as such remains eligible for FEMA Public Assistance, Individual Assistance and HMPG.

Until 2004 the City of North Bend managed the development of its floodplain by the adoption of various ordinances, regulations and practices, and by incorporation of floodplain management goals into the City's Comprehensive Plan. The City compiled all of these management tools using guiding principles of the FEMA into the 2005 FMP. The

2005 FMP laid the framework and provides guidance for flood protection activities for the future and addressed annexations as of that date, including Si View and Maloney Grove. It also guides North Bend to implement flood related activities that are most effective and appropriate for the situation and to better prepare North Bend for future flooding events. The 2005 FMP has provided a balanced approach that looks at both structural and non-structural solutions to reducing potential flood damage for both life and property, natural resource protection such as wetland, erosion and sediment control, environmental enhancement, water quality, emergency services, land development and public education.

The North Bend FMP focuses on the floodplains of the South and Middle Forks of the Snoqualmie River and their tributaries within the City limits of North Bend. Ribary, Gardiner, and Silver Creeks drain into the South Fork of the Snoqualmie River to the west. The Department of Ecology's Flood Control Account Assistance Program (FCAAP) funded the original flood plan with the appropriate match being made by the City of North Bend. A Washington State Dept. of Emergency Management Flood Mitigation Assistance (FMA) Grant was also obtained to update the flood plan for compliance with the Disaster Mitigation Act of 2000 (DMA2K), new CRS requirements, and update the repetitive loss section if needed. The original FMP was adopted by the City of North Bend on May 17, 2005.

BACKGROUND

There have been 13 damaging floods from the Snoqualmie River in the North Bend vicinity since 1975. The City of North Bend, like many other jurisdictions in King County, was founded close to the banks of a river because the river environment provided opportunities for navigation, commerce, fishing, logging, and agriculture. Thus, older and in some cases historical portions of the City, including North Bend's downtown core, are located in areas that are vulnerable to flooding. Approximately 42 percent of North Bend's land area is mapped or identified as 100-year floodplain.

Flood damage to public infrastructure in all of King County associated with major federally-declared disasters during the winter of 1990 totaled approximately \$7,000,000 and damages associated with the winter storms of 1995-1996 totaled approximately \$12,600,000. Damages to homes and businesses are not included in these totals. In response to flooding in the Snoqualmie Valley, FEMA and the US Army Corps of Engineers (USACE) have provided assistance to King County and the City of Snoqualmie in the form of Hazard Mitigation Grants for elevation and relocation of flood-prone structures and a 205 Grant modifications to levees in the City of Snoqualmie below the confluence of the three forks to reduce flood elevations.

While severe floods in recent years have closed roads, damaged bridges and impacted the levee systems on the Snoqualmie River, North Bend has been spared the worst of the flooding in the upper Snoqualmie Valley. The majority of flood damage has occurred in King County downstream of the North Bend City limits and in the City of Snoqualmie.

For the most part, the existing levee system has effectively protected the North Bend downtown core. North Bend has four (4) repetitive loss properties. Additional repetitive loss properties are located outside of the North Bend City limits, but within the designated Urban Growth Area.

Minor flooding has occurred in the vicinity of the Senior Center and in a portion of the parking lot at the Outlet Mall and at the South Fork Interchange; a portion of this flooding has been addressed by recent flood and stormwater projects along Ribary Creek. The Silver Creek, Si View and Maloney Grove neighborhoods experience minor stormwater and localized flooding, generally only lasting a few hours.

The levee system along the South Fork that protects the historic downtown portion of North Bend from flooding does not meet FEMA's criteria¹ for flood protection for Flood Insurance Study recognition. This in essence assumes that no levees exist when modeling the 100-year flood. During 1997, FEMA initiated a remapping of the special flood hazard area (SFHA) in the City of North Bend and unincorporated King County. Draft FEMA maps of August 2000 first showed historical downtown North Bend in the 100-year floodplain. This area includes downtown businesses, City Hall and Community Services buildings, the Fire Station, many single- and multi-family structures, Two Rivers Alternative School, North Bend Elementary School, the City's sewer treatment plant, King County Library, and the historical North Bend Community Church.

Over the years, North Bend has implemented measures to protect its residents and businesses from flooding impacts and from financial losses due to floods.

These include:

- Joining the NFIP in 1984 so that property owners could purchase flood insurance to protect their properties from financial losses due to flooding. As a condition of joining the NFIP, North Bend adopted floodplain development regulations.
- These regulations were strengthened and enhanced in later years to exceed the minimum requirements of the NFIP.
- Adopting Growth Management Policies for floodplain management ensuring consistency with King County and the City of Snoqualmie. The overall objective is to "prevent significant adverse flooding and erosion impacts from affecting other jurisdictions."
- Participation in FEMA's Community Rating System since 1995. Under the CRS, flood insurance premiums for properties in participating communities

¹ 44CFR 65.10

are reduced to reflect the flood protection activities that are being implemented.

- Adopting the City's first Stormwater Management Plan in 2001 and updating that plan in 2011-2012.
- Adopting the FMP in 2005 and updating the FMP in 2011-2012.

CITIZEN'S ADVISORY COMMITTEE

The 2005 FMP was developed under the guidance of a Citizen's Advisory Committee (CAC). A resolution was passed in 1999, by the City Council that formally recognized the planning process. The resolution named the committee members, ensuring that at least half of them represented residents and stakeholders from the flood prone area.

The committee met between 1999-2004. It reviewed the flood problems, considered a variety of ways to reduce and prevent flood damage, and recommended the most appropriate and feasible measures for implementation. Since adoption of the Plan on May 17, 2005, the role of the CAC has been taken up by the City of North Bend Planning Commission.

PLANNING APPROACH

The CAC followed a standard 10-step process for development of the original plan, based on guidance and requirements of the FEMA CRS and DMA2K, and Washington State Department of Ecology FCAAP Grant requirements. This process is summarized in Figure 1-1 shown below. The 2005 FMP was updated by Gray and Osborne, Inc., with assistance from City staff and King County. Additional public input was solicited through the SEPA process, an open house and input from the Community Development and Public Works Departments.

PUBLIC INVOLVEMENT

Because of the limited area being added to North Bend's regulatory oversight of floodplain development, a draft of the amendments to the Plan was posted on North Bend's website and a public meeting was advertised for November 10, 2011. The hearing was conducted at a Planning Commission meeting. The completed deliberations and recommendations were forwarded to the City Council, which adopted the update in 2012.

FIGURE 1-1

Floodplain Management Planning Process

The Planning Process



COORDINATION

During the planning/updating process for the 2005 FMP, contacts were made with agencies and organizations to determine how their programs affect or could support the

City's flood mitigation efforts. These agencies included the Washington Department of Ecology (Washington State's NFIP Coordinating Agency), FEMA Region X, King County, City of Snoqualmie, King County Emergency Management and WA Emergency Management. At the end of the planning process, each of these agencies was sent a copy of the draft plan and asked to comment in time for the pre-adoption public meeting.

GOALS

Goals and objectives for the 2005 FMP were developed at the beginning of the planning process through public meetings with the CAC that included federal, state, local agencies and North Bend residents. A large number of issues raised at these meetings were then reviewed and broken into categories that became the goals and objectives for the plan. The goals are discussed in Chapter 3.

MITIGATION STRATEGIES

Many strategies that could help to minimize flood damage in North Bend were considered in 2005. The technical support experts ensured that time was not wasted on irrelevant activities, and the process was not limited to just a few alternatives such as a levee or acquisition projects.

The subsequent plan document explored six general strategies for reaching the goals.

- Preventive measures (e.g., zoning, floodplain, stormwater, and other ordinances)
- Structural Projects (e.g., levees, channel improvements)
- Property Protection (e.g., relocation, floodproofing, insurance)
- Emergency Services (e.g., warning, sandbagging, evacuation)
- Natural Resource Protection (e.g., wetlands protection, best management practices)
- Public Information (e.g., outreach projects, technical assistance)

An "action plan" was drafted that specifies recommended projects that best meet the goals and objectives of the FMP, who is responsible for implementing them, and when they are to be done. The 2005 action plan is included in Chapter 10. Implementation of these recommendations depended on adoption of this plan by the City and the cooperation and support of the county, state, and federal offices designated as responsible for each action item.

Recommendations in the flood plan for new projects to mitigate potential flood hazards were made only through proposed policy recommendations. Funding opportunities for the City to study major capital flood projects as part of the 2005 FMP were not available. Since 2005, consideration was made for a potential USACE 205 project related to the levees and possible home buy-outs. North Bend had completed a flood benefit/cost analysis in 2005 for possible acquisition, elevation, relocation of existing buildings, and/or structural flood protection projects for the City. Also, since 2005, the King County Flood Control Zone District was formed, funded by a county-wide property levy/tax of \$0.10 per \$1,000 assessed value. The projects undertaken by the District include some of those discussed in Chapter 10.

PLANNING AREA

Figure 1-2 has been updated to include the newly annexed areas and the new City limits. It shows all of North Bend's mapped floodplains as they appear on FEMA's current Flood Insurance Rate Map (FIRM), April 19, 2005. The plan addresses flooding problems within the City limits of North Bend, including the newly annexed areas in the Forest Service/Mount Si, and Maloney Grove neighborhoods. Many of the specific recommendations in the plan are consistent with King County and the City of Snoqualmie. It is, therefore, intended that this plan provide solutions that can be used with, benefit from, and be implemented in close cooperation with these other jurisdictions.

Because of the river locations, the scope of the plan focuses on the South and Middle Forks of the Snoqualmie River and their floodplains as shown on Figure 1-2.

The South and Middle Forks have associated floodplains through various parts of the City. The northern portion of the floodplain in the City limits includes mostly single-family homes and one City park. Much of the floodplain in the western portion of the City is in preserved open space including 204 acres at Meadowbrook Farm and 215 acres at Tollgate Farm (both figures include only those portions within North Bend's City limits). Open space is defined as land that is free from buildings, filling, or other encroachment to flood flows.

King County has completed a study of three tributaries to the Snoqualmie River, Ribary, Gardiner, and Clough creeks. The King County study is known as the South Fork Tributaries Action Plan (SoFTAP). SoFTAP identifies potential problems and solutions for these three tributaries both inside and outside the North Bend City limits.

This FMP touches on other natural hazards. Because these hazards are not limited to a particular locale, the planning area for them is the entire City.

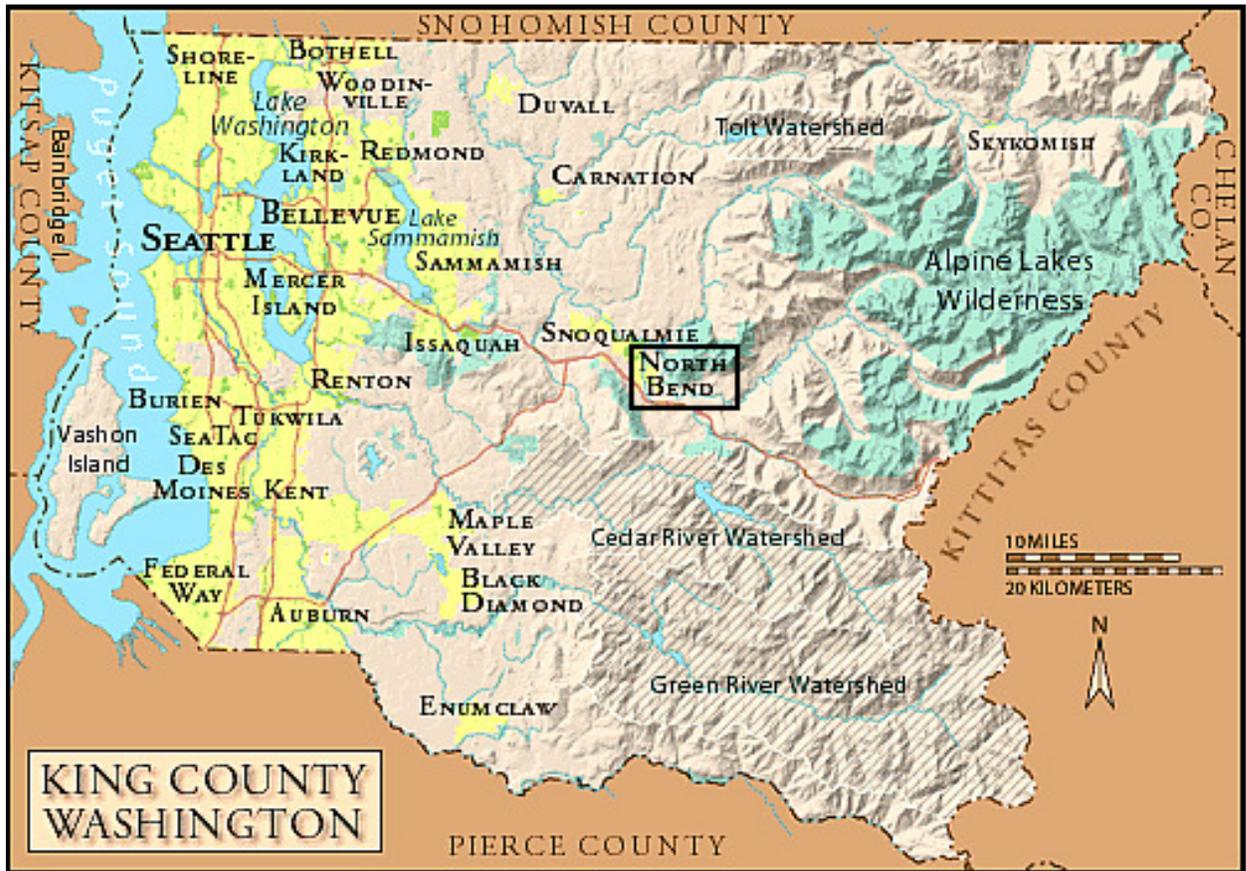
COMMUNITY DESCRIPTION

LOCATION

The study area is in the City of North Bend, Washington, which is in King County, approximately 31 miles southeast of Seattle via Interstate 90 (see Figure 1-3). The City is situated at the entrance to the Cascade Mountains at the foot of Mount Si, near the confluence of the Snoqualmie River's Middle and South Forks.

FIGURE 1-3

North Bend, Washington Location Map



GEOGRAPHY

The City of North Bend is located in the upper Snoqualmie Valley, and lies at the foot of imposing Mt Si. Much of the land is relatively flat, but then rises in a gentle slope to the foot of the mountain to the northeast. To the southwest and west, Rattlesnake Mountain makes a natural boundary for the valley. The Snoqualmie River forms from three forks that begin in the foothills of the Cascade Range. Interstate 90 defines the current southern boundary of the City as it sweeps up toward Snoqualmie Pass.

Much of the soil is agricultural quality, but serious drainage and flooding problems combine with a wet climate have discouraged commercial farming. Some wetlands/marshlands and peaty bogs are found, while highlands overlooking the valley are solid rock or glacial deposits. The City's Comprehensive Plan, land values, and the Growth Management Act have discouraged the use of commercial farming in the City as well. The climate is wet and cool. Average summer temperature is 74 degrees F while the average winter temperature is 33 degrees F. Annual precipitation is approximately 100 inches and annual snowfall averages 17 inches. Prevailing winds come from the southeast.

POPULATION

North Bend is a small but rapidly growing rural city. As of 2011, the City of North Bend reached a population of 5,830, which includes the 2007 Malony Grove-Thrasher Annexation, the 2009 Tanner Annexation, and the 2010 Stilson Annexation. These three annexations have increased the planning area to approximately 4.4 square miles. Between 2006 and 2011, Forest Service/Mount Si, Tanner Area, East North Bend Way – Edgewick Employment Area and Maloney Grove neighborhoods were annexed into the City. Figure 1-4 shows the neighborhoods and added floodplains in these annexed areas.

The City faces recognizable pressure for change, older development seeking renewal, and new development seeking to assert its presence on the landscape. The City's Comprehensive Plan seeks to balance these pressures for change without sacrificing the quality of life that makes North Bend so unique. The FMP is a balanced plan recognizing the pressure for change. However, conservation of the natural environment will be a guiding theme to ensure the quality of life that North Bend residents treasure will be preserved.

HISTORIC GROWTH AND LAND USE PATTERNS

The City of North Bend has a historical development pattern based on its natural resource utilization including agriculture, timber harvest, and mining. The location between the Middle and South Forks of the Snoqualmie River has been the focus for the City's development. The results of this natural setting, however, now affects the majority of the City, leaving residents vulnerable to major flooding.

The historic development pattern of the City was along a northwest-southeast axis, paralleling the old Highway 10 corridor and major railroad grades. Early residential developments clustered around the downtown employment center. The City has generally been platted along a standard grid layout. Other, more rural land uses were scattered throughout the upper valley.

With the completion of Interstate 90 (I-90) south of the City, the old highway became more of a local access route. Bendigo Boulevard (SR 202) links North Bend to the City of Snoqualmie and on into Redmond and Kirkland. The relative ease of access to the Eastside and Seattle made possible by the I-90 corridor has significantly increased the rate of growth in the North Bend area. The South Fork Interchange (I-90 and Bendigo Boulevard) zoning encouraged development of new commercial and light industrial uses within the City, changing the land use from farming and floodplain storage to high intensity uses.

THE COMMUNITY RATING SYSTEM

In 1990, FEMA launched a program that would provide incentive to local communities to exceed the minimum programmatic requirements of the NFIP. This incentive was a reduction in the cost of flood insurance in participating communities. The objective of the CRS program was to:

1. Reduce flood losses.
2. Facilitate accurate flood insurance rating.
3. Promote the awareness of flood insurance.

As part of the NFIP, flood insurance premiums for properties in participating communities are reduced to reflect the flood protection activities that are being implemented.

The CRS is a voluntary program because it rewards communities that have *taken the initiative to exceed the minimum requirements* of the NFIP. A community receives a CRS classification based upon the credit points it receives for its activities. It can undertake any mix of activities that reduce flood losses through better mapping, regulations, public information, flood damage reduction and/or flood warning and preparedness programs.

There are ten CRS classes: Class 1 requires the most credit points and gives the largest premium reduction; Class 10 receives no premium reduction. A community that does not apply for the CRS or that does not obtain the minimum number of credit points is a Class 10 community and, therefore, receives no premium reduction.

There are now 1,174 communities nationally that receive flood insurance premium discounts based on their implementation of local mitigation, outreach, and educational activities that go well beyond minimum NFIP requirements (see Table 1-1 below). While premium discounts are one of the benefits of participation in CRS, it is more important that these communities are carrying out activities that save lives and reduce property damage. These 1,174 communities represent a significant portion of the Nation’s flood risk as evidenced by the fact that over 66 percent of the NFIP’s policy base is located in these communities. Communities receiving premium discounts through the CRS cover a full range of sizes from small to large, and a broad mixture of flood risks including coastal and riverine.

TABLE 1-1

National CRS Communities by Class as of May 1, 2012

Rate Class	Number of Communities Nationally by Class	CRS Credit Points Required	Discount for Special Flood Hazard Areas
10	141	0 – 499	0%
9	214	500 – 999	5%
8	445	1,000 – 1,499	10%
7	281	1,500 – 1,999	15%
6	176	2,000 – 2,499	20%
5	66	2,500 – 2,999	25%
4	7	3,000 – 3 499	30%
3	0	3,500 – 3,999	35%
2	3	4,000 – 4,499	40%
1	1	4,500 +	45%

According to the *May 1, 2012 – October 2011 (CRS Bulletin)*, 33 Washington communities participate, including North Bend. North Bend is currently a Class 6 and the citizens receive up to a 20 percent reduction in flood insurance premiums for structures within Special Flood Hazard Areas and a 10 percent reduction for structures outside Special Flood Hazard Areas. It should be noted that King County has a CRS Rating of 2, and that flood insurance rates for residents within newly annexed areas will therefore likely increase significantly.

There are over 19,000 communities in the NFIP. At first glance, having only 6 percent in the CRS looks like a low participation rate; however, these 1,174 cities and counties represent over 66 percent of all flood insurance policyholders. CRS communities have the bulk of the nation’s flood problems.

PROGRAM INCENTIVE

The CRS provides an incentive not to just start new programs but also to keep those programs going. There are two requirements that “encourage” the City to implement flood mitigation activities.

First, North Bend would receive CRS credit for this plan when it is adopted. To retain this credit; however, the City has submitted a progress report on the implementation of this plan to FEMA by October 1st. This report has been made available to the media and the public.

Second, the City has recertified to FEMA that it is continuing to implement its CRS credited activities, which has resulted in an improvement of the City’s CRS Rating from Class 7 in 2004 to Class 6 in October 2011. Failure to maintain the same level of involvement in flood mitigation/protection can result in a loss of CRS credit points and; therefore, an increase in flood insurance rates to the citizens of North Bend.

Appendix B provides a summary document from FEMA and additional detail on the CRS titled *Community Rating System: A Local Official’s Guide to Saving Lives, Preventing Property Damage and Reducing the Cost of Flood Insurance, FEMA 573*.

In 2005 North Bend had a rating of 2,077 points and in 2010 the City attained a rating of 2,321. Both of these scores place the City in a Class 6. North Bend would need an additional 200 points to be rated as Class 5 in order to achieve the 25 percent discount on NFIP insurance for structures in a Special Flood Hazard Area (SFHA).

Table 1-2 lists the various activities a CRS Community can undertake to improve their CRS Score and lower the community’s flood insurance premiums. This table provides the maximum number of points available for specific CRS activities numbered from 310 to 630. It also shows North Bend 2010 score and the average number of points for communities in the CRS System.

TABLE 1-2**National CRS Credit Categories**

Credit Series	Description	Maximum Points	2010 North Bend Points	National Average Points
310	Elevation Certificates	162	70	69
320	Map Information Service	140	140	138
330	Outreach Projects	380	210	90
340	Hazard Disclosure	81	10	19
350	Flood Protection Information	102	70	24
360	Flood Protection Assistance	71	35	53
410	Additional Flood Data	1,346	0	86
420	Open Space Preservation	900	306	191
430	Higher Regulatory Standards	2,740	382	166
440	Flood Data Maintenance	239	93	79
450	Stormwater Management	670	371	98
510	Floodplain Management Planning	359	165	115
520	Acquisition and Relocation	3,200	0	213
530	Flood Protection	2,800	0	93
540	Drainage System Maintenance	330	315	232
610	Flood Warning Program	255	75	93
620	Levee Safety	900	0	198
630	Dam Safety	175	69	66

The average CRS Community, which is rated around a 7 manages to score only about 14 percent of the available points. In order for North Bend to score the additional 200 points required to move up to Class 5 there are a number of activities that could help to accomplish this, including:

- Improvements in levee safety (North Bend's levees are not Corps certified);
- Improvements to the Flood Warning Program; NB recently updated the flood warning system (Public Works and the Fire Department);
- Floodplain Management Planning (e.g., current plan should maintain or improve the City point score);
- Flood protection activities/acquisition and relocation or other types of flood protection (many points available);

- Stormwater Management Planning (City will continue to receive points for latest Stormwater Management Plan);
- Open space preservation (City has previously received points for farm preservation activities);
- Adopting Regulatory Standards in excess of the minimum required (many points available).
- Many other means for obtaining lesser numbers of CRS points.

THE DISASTER MITIGATION ACT OF 2000

In the past, federal legislation has provided funding for disaster relief, recovery, and hazard mitigation planning. The Disaster Mitigation Act of 2000 is the latest legislation to improve this planning process and was put into motion on October 10, 2000, when the President of the United States signed the Act (Public Law 106-390). This legislation reinforces the importance of mitigation planning and emphasizes planning for disasters *before* they occur. Communities *must* comply with these requirements to qualify for funding opportunities.

- Mitigate: To cause to become less harsh or hostile, to make less severe or painful.
- Planning: The act or process of making or carrying out plans, the establishment of goals, policies, and procedures for a social or economic unit.
- Hazard Mitigation (as defined by the Disaster Mitigation Act of 2000): Any sustained action taken to reduce or eliminate the long-term risk to humane life and property from hazards.

The Disaster Mitigation Act of 2000 is intended to facilitate cooperation between state and local authorities, prompting them to work together. It encourages and rewards local and state predisaster planning and promotes sustainability as a strategy for disaster resistance.

To implement the Disaster Mitigation Act of 2000 requirements, FEMA prepared an Interim Final Rule, published in the Federal Registry on February 26, 2002, 44 CFR Parts 201-206, which establishes planning and funding criteria for state and local governments.

The primary purpose of hazard mitigation is to identify community policies, actions, and tools for implementation over the long-term that will result in a reduction in risk and

potential for future losses community-wide. This is accomplished by using a systematic process of learning about the hazards that can affect the community, setting clear goals, identifying appropriate actions, following through with an effective mitigation strategy, and keeping the plan current. The FMP must be reviewed, revised if appropriate, and resubmitted for approval within 5 years of adoption in order to continue to be eligible for HMGP project grant funding and Predisaster Mitigation Funding.

1. What is Natural Hazard Mitigation?

Natural hazard mitigation is the development and implementation of activities designed to reduce or eliminate losses resulting from natural hazards.

2. Why Develop a Natural Hazards Mitigation Strategy?

This plan serves to establish a floodplain management foundation for coordination and collaboration between North Bend, City of Snoqualmie, King County, WS Dept. of Ecology and FEMA. This plan will identify flood mitigation strategies and possible future flood mitigation projects as a means to assist in meeting the requirements of various federal assistance programs.

The rising cost of responding to and recovering from natural disasters such as a major flood event, has led to a renewed interest in identifying effective ways to reduce the vulnerability to natural hazards and the disasters these hazards can create.

3. What are the Benefits of Hazard Mitigation?

- **Save lives and property** – Communities can save lives and reduce property damage from natural hazards through mitigation actions, such as moving families and their homes out of harm's way or by limiting development and/or regulating the type of construction or structures allowed in certain areas.
- **Reduce vulnerability to future hazards** – By having a mitigation strategy in place, communities are better prepared to take the proper steps that will permanently reduce the risk of future losses.
- **Facilitate post-disaster funding** – By identifying mitigation strategies and projects before the next disaster, communities will be in a better position to obtain post-disaster funding because much of the background work necessary for funding assistance will already be in place.

- **Speed recovery** – By developing a mitigation strategy, communities can identify post-disaster mitigation opportunities in advance of a disaster.
- **Demonstrate commitment to improving community health and safety** – Developing a mitigation strategy demonstrates a community’s commitment to safeguarding its citizens and protecting its economic and environmental well-being.

The North Bend FMP was written using the best available information obtained from a wide variety of sources. Throughout the plan development process, a concerted effort was made to gather information from neighboring jurisdictions, staff, as well as stakeholders/business owners and local citizens of North Bend. *A concerted effort was made to solicit information from local agencies and individuals with specific knowledge of flood hazards and past historical events, as well as planning and zoning codes and ordinances and recent planning decisions.*

CHAPTER 2

PROBLEM DESCRIPTION

INFLUENCES ON FLOODING

TYPES OF CONCERNS

The City of North Bend is located within the Upper Snoqualmie River Valley floodplain, upstream from Snoqualmie Falls. The Upper Snoqualmie River basin drains an area of approximately 300 square miles. The frequency and extent of flooding in North Bend depends on these and other factors; heavy rains, rain on snow events, stormwater runoff, the conditions of the watershed, obstructions in the river channel and floodplain, earthquakes, and possible failure of Chester Morris Dam.

What is a Floodplain? Any land area susceptible to being inundated by floodwaters from any source. A Flood Insurance Rate Map (FIRM) identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area.

What is the Base Flood? The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the NFIP are protected to the same degree of flooding.

What is the Base Floodplain? Any land area susceptible to being inundated by the base flood.

What is a Floodway? The floodway is typically the channel of the river or stream and the overbank areas adjacent to the channel. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest and most destructive. NFIP regulations require that mapped floodways be kept open so that the flood flows are not obstructed or diverted onto other properties and that the impact of the development will not cause an increase in the 100-year flood elevation of more than 1 foot.

Topography

North Bend is located along the western flank of the Cascade Mountains where the three major forks of the Snoqualmie River spill out of deep glacially carved valleys into the Upper Snoqualmie basin. During the past 2 million years, (most recently from 20,000 to 15,000 years ago) both the Puget lowland and mountain valleys were repeatedly scoured and filled by glaciers. The glaciers that flowed down the valley from the Cascade Mountains approximately 14,000 years ago are called alpine glaciers. The Puget lowland was filled by a vast mass of ice flowing out of Canada called the Puget Lobe glacier or

ice sheet. The action of these glaciers and their associated rivers built the landscape we see today by substantially altering the preglacial bedrock-controlled drainage system and leaving behind a massive and complex sequence of glacial and river sediments.

This segment of the river where North Bend is located can be characterized as having a high potential for rapid channel migration as well as flooding mainly due to the relatively low gradient of the river and its wide floodplain. The location of Mount Si to the east-northeast of the City constrains the Middle Fork of the river and forces both channel migration and flooding toward the west where much of the City's current single-family development is concentrated.

Approaching the rivers' confluence (Three Forks), the Middle and South Forks are somewhat constrained. This can result in upstream flooding in the relatively flat valley floor between the Middle and South Forks where the City is located. Therefore, the location of North Bend and the configuration of the Upper Snoqualmie River system make the City vulnerable to major flooding events. Upon leaving the mountains, the Three Forks of the Snoqualmie River flow onto a broad, relatively flat, alluvial floodplain area northwest of North Bend. The three forks deposit most of their sediment load in the broad gravel bars that are characteristic of the rivers in the North Bend area. This sediment deposition can cause the river to shift laterally within the floodplain (channel avulsion) during major flooding events.

Climate

The climate in the Upper Snoqualmie River basin varies from moist alpine conditions in the headwaters to moist temperate conditions in the lower valley in and around North Bend. The Cascade Mountains form a barrier to the easterly movement of moist air from the Pacific Ocean and thus result in significant rainfall during the late fall and winter months. Winter snowfall and subsequent snowmelt also result in elevated spring runoff conditions in the river, as well as frequent flooding events.

The North Bend area receives an average of 90 to 100 inches of rain each year. Most precipitation by the headwaters falls as snow from October through March and as rain thereafter. Rainfall dominates the lower elevations of the upper river basin between October and June. However, it is not spread out evenly over the year. The amount of rain that falls varies from storm to storm and varies over an area. When these heavy warm rains occur, much of the snow pack can melt and add significantly to flooding in the valley. The typically robust spring snow pack commonly experiences rain on snow after March, but it stores water and melts in steps rather than catastrophically as can happen when a "Pineapple Express" hits in October or November.

Hydrology

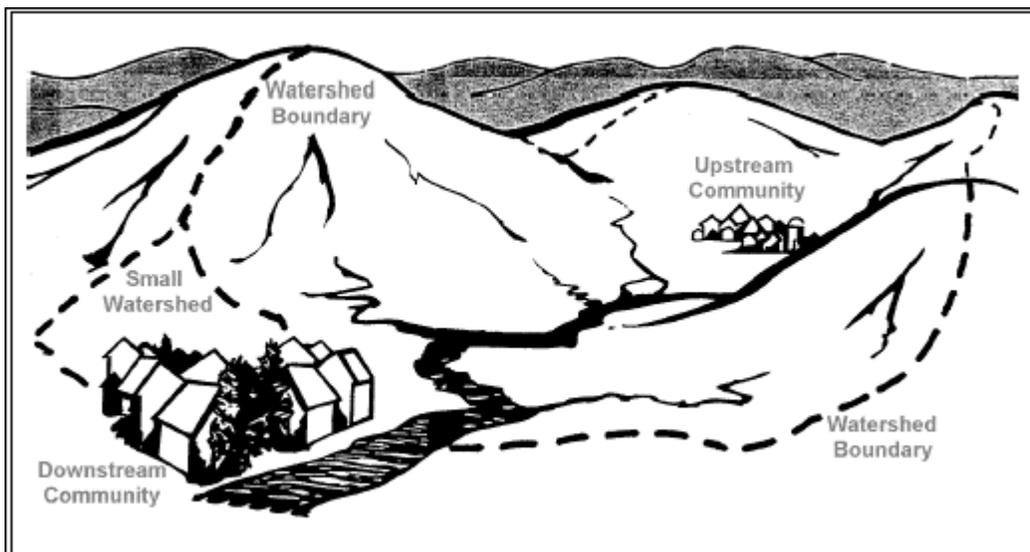
The Three Forks of the Snoqualmie River form the principal drainage features in the upper valley. Several smaller streams also exist within the North Bend area. The most prominent streams are 1) Ribary Creek, which runs off of Rattlesnake Ridge into the City and then parallels the South Fork just south of the downtown area and 2) Gardiner Creek which runs off of Rattlesnake Ridge, through the Forster Woods Developments, under I-90 behind the Factory Stores and Nintendo, and finally empties into the South Fork north of the City.

These creeks exhibit similar characteristics and flooding problems. Each has very steep headwater areas along Rattlesnake Mountain, which descend into steep alluvial fans characterized by rare, but potentially damaging, debris flows, shallow landslides, and channel shifting. Both creeks flatten considerably near I-90 as they enter and cross the large floodplain of the South Fork Snoqualmie River. This causes the creeks to deposit sediment (sand and gravel) in broad, shallow alluvial fans, which historically filled and shifted the channels back and forth over time. These creeks would also be significantly influenced by overflow from the South Fork Snoqualmie River during large floods, resulting in as much as a tenfold increase in flow. This and additional creek information is located in the SoFTAP report.

The US Geological Survey (USGS) and King County have collected long-term flow data on the Middle and South Forks of the Snoqualmie River since 1961 and on the North Fork since 1930. The main sources of flow in the Upper Snoqualmie River are winter rainfall and spring snowmelt.

FIGURE 2-1

Typical Watershed



Watershed

A watershed, also called a drainage basin or catchment area, is the geographic area where the water for a river or lake originates. All lands in a watershed drain downhill towards a stream, lake, bay or other body of water. The boundary of a watershed is also called a divide. Stormwater runoff on one side of the divide drains to one body of water and runoff on the other side drains to another different body of water. Most communities are in several watersheds. These may include a large watershed that drains to a large stream and a number of smaller watersheds that drain into creeks or ditches that enter the community from other locations.

North Bend is subject to flooding from the South Fork and Middle Forks of the Snoqualmie River. The watershed for South Fork River upstream of North Bend at the USGS 12143400 gage near Garcia is 81.70 square miles. The watershed for the Middle Fork River upstream of North Bend at the USGS 12141300 gage near Tanner is 154.00 square miles. The North Fork drainage area is 64.00 square miles.

The condition and characteristics of the watershed affect what happens to the rain. For example, more rain will run off if the terrain is steep, if the ground is already saturated from previous rains, if the watershed is covered with lots of impervious surfaces, or if depressional storage areas have been filled in.

The headwaters of the Middle Fork of the Snoqualmie River lie in the Cascade Mountains. The headwaters include portions of the Snoqualmie National Forest and an extensive network of tributaries. Timber harvest has been a major land use in the upper basin. The lower segment of the Middle Fork has several feeder creeks that flow off Mount Si. The headwaters of the South Fork of the Snoqualmie River are located in the Cascade Mountains near Snoqualmie Pass. The headwaters of the South Fork run parallel to I-90 for much of its length, picking up runoff from this major highway corridor. After crossing under I-90, the South Fork flows through downtown North Bend before joining with the Middle and North Forks downstream of the City limits. Upstream of the Three Forks area, the river is characterized by its relatively narrow floodplain, steep gradient, and stable channel typical of Cascade streams. The headwaters of all three forks of the river are mountainous, forested terrain.

Geology and Soils

The Three Forks area of the Snoqualmie River is located in an embayment in the Cascade Range. The three forks of the river emerge from the mountains in this area and deposit their coarse sediment load on the broad, relatively flat valley floor between North Bend and Snoqualmie Falls (Booth et al., 1991). The sediment deposited by rivers and streams is termed *alluvium*. In the North Bend area, the three forks of the river flow primarily through alluvial deposits of unconsolidated gravel, sand, and silt that have been laid down and reworked by surface water flows in the active floodplain. In most of the area,

the alluvium is underlain by hundreds of feet of Quaternary glacial deposits, which in turn overlie bedrock. In places, the rivers have also cut down through their alluvial deposits and left the former floodplain behind as evidenced by the remaining terraces. These terraces are subject to lateral erosion and channel avulsion during flood events. In other places, the older, underlying geologic features are exposed. These include glacial till deposits as well as the *bedrock* escarpment of Mount Si. The bedrock of Mount Si is classified as a “pretertiary melage.” This bedrock consists of a matrix of varying lithologies including a hard, erosion-resistant metagabbro and metavolcanic rock (Booth, 1990). The valley wall materials found on the Mount Si side of the river are less erodible than the alluvium that makes up the majority of the valley, and limits the rivers’ lateral migration to the east.

Alluvial Fans

Every time the waters of the rivers flow deep and fast enough to carry gravel, the process of filling the valley that has operated for thousands of years, is renewed. So each flood is another shovel full of earth that nature is using to achieve its long-term plan for North Bend.

Even though the majority of the City is mapped as floodplain, the City is built on an alluvial fan. It is important to understand this distinction because the causes of flooding, flood hazards, protection of the public and the long-term strategy for protecting the City are different in these hydro-geologic settings.

Upper reaches of rivers or streams are generally steep and flows are fast. These flows are confined to narrow channels and, due to their velocities, are very erosive. Sediment from channels is carried with the water downstream to a point where the forces of the water can no longer push it on. This is usually where the lower reaches of the river flatten out and the stream velocities decrease. The sediment is then deposited in the stream channel during normal flows or spread out into a fan shaped formation across floodplains during floods.

In the upper Snoqualmie Valley, floodplain environments occur mainly west of the South Fork Snoqualmie River, i.e., the Tollgate and Meadowbrook Farm areas where the terrain is relatively flat and stream velocities are low. Coarse sediment carried as bed load from the upper reaches of the South and Middle Fork Snoqualmie Rivers are encroaching on this floodplain. Alluvial fans have also built up on the sides of the upper Snoqualmie Valley where streams cascade down the bedrock ridges of Rattlesnake Mountain and Mount Si. These areas are in transition from floodplains to an alluvial fan.

Areas included in the floodplain are relatively flat, lowland areas adjacent to rivers and streams. Floodplain lands and adjacent waters combine to form a complex, dynamic physical and biological system that supports a multitude of water resources, living resources, and societal resources. They benefit North Bend with natural flood storage that helps reduce the flood peak down river. Dense vegetation rooted in the cohesive

soils of the floodplain provides erosion control and natural water filtering processes. Connections between presently occupied channels and past channels, such as oxbows, create a wide variety of habitat for flora and fauna, places for recreation and scientific study, and contain historic and archeological sites. North Bend's floodplains are also the focus of a variety of human activities including homes, recreation, infrastructure, and some agriculture.

Alluvial fans are among the most active hydro-geologic environments. North Bend is mainly built on an overlapping sequence of alluvial fans, some of which are very large and active. As noted in the King County DNR report "Channel Migration in the Three Forks Area of the Snoqualmie River, January 1996," "the floodplain between the Middle and South Forks is a large alluvial fan, a fan shaped form deposited by a stream where it issues from a relatively steep narrow valley onto a broad plain. The apex of the fan is located near the Mount Si Bridge on the Middle Fork." The Middle Fork flows along the eastern boundary of the fan.

The most recent fan is set inside the terraces of larger and steeper fans than the Middle Fork that extend up the valley to the great embankments of glacial sediments that once dammed both the Middle and South Fork valleys. It was incision through these 700-foot-high delta moraines (Mackin 1956) that provided the millions of cubic yards of sediment necessary to fill Lake Snoqualmie, now North Bend, at an average rate of more than 6 feet per century for the past 80 centuries.

The behavior of floodwaters on an alluvial fan differs considerably from that of floodwaters on a floodplain. On an alluvial fan, relatively steep gradients cause high velocity overbank flows that in a natural condition would result in the cutting of entirely new channels for the rivers. The migration of channels is also regularly forced by the accumulation of coarse sediment in the bed or the development of bars that concentrate flows against an opposing riverbank. Thus, on an alluvial fan, the coarser grain size of the sediment contributes to aggradation and channel migration, while on a floodplain, fine silt settles out during relatively low velocity overbank flow and this builds a relative flat and stable platform.

Alluvial fan flooding can be quite severe, powerful, and exhibit unpredictable flow paths and high velocities that are life-threatening and develop with little advance warning time. Relatively slow-moving flood waters that overflow the floodplain on the alluvial fan may result in isolation of areas of higher ground, and flows of water between drowning highlands that are too fast to drive, walk, and perhaps even safely boat through. Early evacuation will be essential for safety of the public from portions of the alluvial fan during floods any larger than the 1990 flood.

The difference in the size of the sediment found in an alluvial fan versus a floodplain results in another critical difference between the two hydrogeologic environments and that is the movement of groundwater. Groundwater moves rapidly through the coarse sediments of the North Bend alluvial fan. Thus levees, which may contain elevated water

levels in floodplain cities like North Bend and New Orleans, are only superficial barriers to rising water levels where extensive flow can occur in the ground beneath a levee. The alluvial fan model for the long-term fate of North Bend also predicts that growth of the fan may eventually bury the City under sand, gravel, and boulders. This aggradation of the valley floor will occur until the valley floor is steep enough to carry such coarse sediment over Snoqualmie Falls and out of the upper valley.

Prior to the summer of 2000, a reasonably accurate estimate of the rate of aggradation of the North Bend alluvial fan was not possible. However, a test well drilled by the East King County Regional Water Association (EKCRWA) during the spring of 2000, encountered wood at 495 feet below the ground surface at a site just east of Torguson Park. Golder Associates, supervising the project for the EKCRWA, had a sample of the wood radiocarbon dated. The age of the wood is about 8000 years BP (Before Present – about 6000 years BCE).

Therefore, given this scientific find, the average rate of sediment accumulation since 8000 BP has been about 6 feet per century. Given the large volume of gravel that has been excavated from the South Fork Snoqualmie River, and then reappeared after flooding, that rate may be a reasonable expectation for the twenty-first century. Such a rate of aggradation on either the Middle Fork or the South Fork would profoundly increase the destructiveness of flooding through North Bend even from events experienced during the 1990s. It should be noted that the aggradation would not be uniform along the riverbed, and could contribute to local changes in hydraulics and cause channel migration typical of natural alluvial fans.

Stream and Groundwater Flood Hazard

A common flood occurrence in North Bend other than stream flooding is when runoff exceeds the conveyance capacity of manmade drainage systems as a result of an extremely high ground water table. This typically occurs with moderate-to high-intensity storms that can last for several days or occur in succession over a period of weeks. These events are characterized as rainfall of 3 inches or more in a 24-hour period. In normal rainfall occurrences, water has some opportunity to infiltrate into the ground along ditches or landscaped areas. During extended rainfall periods, the ground becomes saturated and unable to absorb more water, consequently placing a greater burden on the conveyance system. This type of flooding generally occurs gradually and allows time for property owners to identify an impending flood situation and prepare for it. These events during the winter months usually result in widespread flooding along conveyance corridors like streets, streams, ditches, culvert systems, and storm drains. Conditions can change rapidly and the onset of flooding can occur at an accelerated rate.

Channel Migration

Channel migration is the process of a river channel moving horizontally or vertically across or within its floodplain. Horizontal channel movement can occur as a river erodes one bank and deposits sediment along the other, resulting in a net lateral migration of the channel. Though channel migration by bank erosion may occur gradually over time, a channel can migrate great distances over long timeframes. Channel migration can also occur as an abrupt shift of the channel to a new location, called an avulsion. Floodplain areas affected by channel migration are called Channel Migration Zones (CMZs).

The Three Forks area of the upper Snoqualmie River is one of several rapidly migrating river systems in King County, as identified by King County.²⁻¹ Channel migration behavior between 1865 and 1993 was determined from aerial photographs and maps showing successive channel positions. Rates and types of channel migration have varied dramatically during the last century. The highest migration rates were associated with large floods such as that of 1959. Except in the North Fork, average channel migration rates were higher between 1942 and 1961 than between 1961 and 1993.

Dramatic changes in channel pattern suggest that pre-1942 channel migration rates were higher still, although rates were not calculated due to the poor resolution of early maps. The post-1961 decline in migration rates was attributed to several factors, including levee and revetment construction, flood history, gravel removal, and channel pattern changes probably related to sediment load. Rapid bank erosion and channel changes continue to occur in several reaches. Differences in channel migration behavior between river reaches are attributed to floodplain slope and width, and locally to the extent of bank protection. The highest channel migration rates occur in zones of rapid sediment deposition and meander bend growth in each of the three forks.

During large floods, overbank flows could erode and enlarge existing channels between the Middle Fork and the South Fork, and potentially cause the Middle Fork to switch channels to a new course through North Bend. The probable future limits of channel migration were defined using historic meander belt widths and bend amplitudes. Land within these limits was classified according to the relative degree of hazard from channel migration, based upon historic rates of channel migration and the presence of major bank protection structures that protect arterial roads and subdivisions as shown on Channel Migration Map.

Obstructions

Obstructions can be channel obstructions, such as small bridge openings or log jams, or floodplain obstructions, such as road embankments, fill and buildings. Channel obstructions will cause smaller, more frequent floods, while floodplain obstructions

²⁻¹ Channel Migration in the Three-forks area of the Snoqualmie River, January 1996

impact the larger, less frequent floods where most of the flow is overbank, outside the channel.

Obstructions can be natural or manmade. Natural obstructions, like log jams, can be cleared out or are washed away during floods. The greater problem is manmade obstructions that tend to be more permanent.

The Bendigo (Highway 202) bridge section that crosses the South Fork constricts the levee channel resulting in head loss (backwater) of up to 5.5 feet during high flow events. This intrusion has resulted from at least three changes in the bridge and approach road over time. King County constructed two of these changes. The most recent change occurred in 1976 and was designed by Washington State Department of Transportation (WSDOT) with a bridge that is narrower than the original bridge.²⁻² A modification is proposed to these bridge abutments to relocate them upland several feet to accommodate high flows. However, no funding has been secured to accomplish this modification. The project is on the list of projects to be considered by the King County Flood Control Zone District in the future.

NATURAL AND BENEFICIAL FLOODPLAIN FUNCTIONS

Floodplain lands and adjacent waters combine to form a complex, dynamic physical and biological system found nowhere else. Undisturbed floodplains or restored floodplains back to their natural state provide a wide range of benefits for both humans and natural ecosystems. Some are static conditions such as providing aesthetic pleasure and some are active processes, such as reducing the number and severity of floods, helping handle stormwater runoff minimizing non-point water pollution, and providing wildlife food and habitat. Such natural processes cost far less money than it would take to build facilities to correct flood, stormwater, and water pollution. In addition to the values and functions mentioned, the Meadowbrook and Tollgate Farm properties represent a scenic resource important to the natural and rural character of North Bend as well as providing migratory corridors relative to the river, streams, floodplain and riparian wetlands. Over 150 acres of significant emergent, wet meadow, scrub shrub and forested wetlands occur on the Meadowbrook site.

The Middle and South Forks of the Snoqualmie River, its tributaries and associated wetlands support many species of birds including the bald eagle, peregrine falcon, and waterfowl species. The bald eagle is state listed as “threatened.” Many types of mammals are also observed. The Middle Fork Snoqualmie River, South Fork Snoqualmie River, Ribary, Gardiner and Clough creeks provide habitat for resident salmonid species, including cutthroat, rainbow and brook trout. The *Literature Review & Recommended Sampling Protocol for Bull Trout in King County, Final Draft*, June 12, 2000 indicated that no evidence of a self-sustaining bull trout population in the

²⁻² Kato Warren Report for WSDOT, dated June 23, 2000

Snoqualmie Watershed. See Figure 2-1: *Current Known Distribution of Self-Sustaining Sub-Populations and Isolated Observations of Native Char in King County.*

FIGURE 2-2

Native Char Distribution in King County

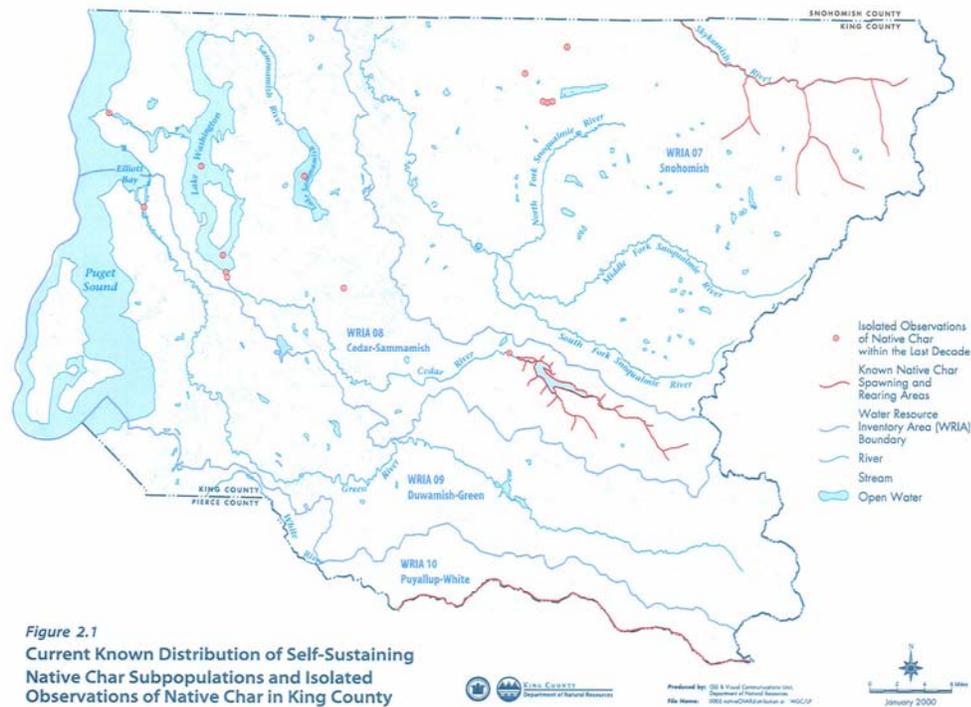


Figure 2.1
Current Known Distribution of Self-Sustaining Native Char Subpopulations and Isolated Observations of Native Char in King County

Floodplain properties such as portions of the Meadowbrook and Tollgate Farms can provide the following resources:

WATER RESOURCES

Values and functions beneficial to both surface and ground water include:

Natural Flood and Erosion Control

- Provide floodwater retention and detention
- Reduce flood velocities
- Reduce flood peaks

- Reduce sedimentation

Water Quality Maintenance

- Filter nutrients and impurities from surface water runoff

Process Organic Wastes

- Moderate temperature fluctuations
- Decrease water turbidity

Groundwater Recharge

- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows

BIOLOGICAL RESOURCES

Values and functions supporting high diversities of plants and animal life include:

Biological Productivity

- Support high rate of plant growth
- Maintain biodiversity
- Maintain health and integrity of the ecosystem

Fish and Wildlife Habitat

- Provide breeding and feeding grounds
- Create and enhance waterfowl habitat
- Protect habitats for rare/endangered species

SOCIETAL RESOURCES

Values and functions beneficial to human society include:

Harvest of Wild and Cultivated Products

- Provide sites for aquaculture
- Restore and enhance forest lands

Recreational Opportunities

- Provide areas for active and passive uses

- Provide open space
- Provide aesthetic pleasure

Areas for Scientific Study and Outdoor Education

- Contain cultural resources (historic and archaeological sites)
- Provide opportunities for environmental and other studies

FLOODPLAIN NATURAL RESOURCES, WETLANDS AND RIPARIAN CORRIDORS

The term “natural resources” often brings to mind products, such as timber or fossil fuels that may be extracted from their natural environments and sold as commodities for profit. However, the natural resources of floodplains, wetlands and riparian corridors are different; their value lies not in their removal and sale, but in the functions and values that they perform within the natural environment. These may include 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 the flood-prone areas. These areas are considered important to the natural “infrastructure.”

Wetlands are those areas inundated or saturated by surface water or groundwater at a frequency and duration to support vegetation typically adapted for life in hydric soils. Wetlands include natural swamps, marshes, bogs, and constructed wetlands created as mitigation for conversion of wetlands for other land uses. Jurisdictional wetlands do not include those constructed for the treatment of stormwater or wastewater.

Wetlands are important to flood hazard management because they serve natural retention and detention functions. Wetlands store water above and below ground, reducing the volume and velocity of floodwaters downstream. Wetlands also improve water quality and provide habitat for a wide array of biota. Wetlands are typically an integral part of the natural riverine floodplain environment. Maintaining wetlands, particularly those located within the riparian/floodplain zone, is one of the most cost-effective ways to reduce the adverse effects of flooding and to support a healthy river ecosystem. Wetlands represent some of the most diverse and productive ecological communities in the Pacific Northwest. In addition, wetlands provide many social benefits such as aesthetics and recreation.

The City of North Bend has mapped wetland areas within its jurisdiction (see the Wetlands Map). These delineated wetlands are based on aerial photographic analysis, USGS data, national Wetland Inventory maps, and the King County Wetlands Inventory (1981).

Riparian corridors provide beneficial sources of food and habitat for migratory waterfowl, other birds and mammals. This intrinsic value increases the diversity of animal species and enhances the overall health of the biota.

As our understanding of these resources grows, we increasingly recognize the importance of conserving, restoring, and regulating these areas. Building consensus among all affected individuals, however diverse, best provides an opportunity to establish mutually supportive partnerships. It also offers the obvious benefits of commitment to basic goals and objectives, and a more meaningful implementation.

BIOLOGICAL RESOURCES (FISH AND WILDLIFE HABITAT)

A healthy river ecosystem is an important component of the high quality of life found in the North Bend area. The preservation and protection of sensitive areas for habitat use is critical in sustaining native fish and wildlife, as well as retaining the City's rural character. The Growth Management Act (GMA) mandates the preservation of fish and wildlife habitat through jurisdictional goals, policies, and regulations. The City's Sensitive Areas Ordinance (SAO) addresses these issues and integrates habitat protection with the rights of private property owners.

The City of North Bend is located upstream of Snoqualmie Falls, a complete barrier to the upstream migration of riverine fish. As such, no anadromous salmonids use the upper river basin. However, resident fish are found throughout the Three Forks area of the river and in their many tributary streams. In general, watershed development has been shown to degrade aquatic ecosystem integrity, especially in small streams and wetlands. Two of the most significant reasons for the loss and/or degradation of riverine fish habitat are the loss of off-channel-rearing habitat due to floodplain encroachment and construction of levees. The loss of riparian forests, wetlands, and floodplain areas also has had a significant impact on fish and wildlife habitat in the Upper Snoqualmie River Valley.

ENDANGERED SPECIES ACT (ESA)

The Endangered Species Act provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered in the U.S. or elsewhere. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions. The Endangered Species Act also is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the Act and the Convention.

The purposes of the Act are to provide a means of conserving the ecosystems upon which endangered and threatened species depend; provide a program for conserving those

species; take steps necessary to achieve the purposes of the international treaties and conventions. The policy of Congress is that federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the Act's purposes.

On March 9, 1998, the West Coast Chinook Salmon were listed as threatened by the Department of Commerce, National Oceanic and Atmospheric Administration.²⁻³ On June 10, 1998, the Bull Trout was listed by the Department of the Interior, Fish and Wildlife Service as "threatened" species.²⁻⁴ The listing of these species invoked the full protection where their critical habitats have been identified. The Puget Sound Steelhead was listed as "threatened" by the National Marine Fisheries Service on May 7, 2007, and a 5-Year Review completed on August 15, 2011, confirmed this listing; designation of critical habitat is under development. As with Puget Sound Chinook, Puget Sound Steelhead in the Snoqualmie River are limited to the stream reaches downstream of Snoqualmie Falls. It is important to remember that anadromous fish cannot move upstream beyond Snoqualmie Falls as they act as a natural migration barrier. Thus, flood hazard reduction projects in the upper Snoqualmie Basin will not directly impact the migration or spawning of Chinook or other salmon species.

Bull trout require the coldest water temperatures with the lowest fine sediment levels for spawning, incubation and the rearing of juveniles. The bull trout juveniles typically would occur in the smaller tributaries and headwater streams of the upper river basin. *The Current Known Distribution of Self-Sustaining Native Char Subpopulations and Isolated Observations of Native Char in King County* (January 2000), indicates that a self-sustaining population of bull trout is not present in the Snoqualmie River, especially upstream of Snoqualmie Falls.

WATER QUALITY

In addition to contributing significantly to the natural aesthetics and quality of life, the rivers, streams, and wetlands of the Upper Snoqualmie Valley store, purify, and convey surface water runoff from developed areas. Stormwater runoff from residential, commercial, and industrial developments is a significant source of water pollution entering the Snoqualmie River. In addition, agricultural activities and timber harvesting have been a major source of water quality degradation in the upper river basin. Water quality continues to be a concern.

²⁻³ Federal Register, Vol. 63, No. 45/ Monday March 9, 1998

²⁻⁴ Federal Register, Vol 63, No.111,/ Wednesday June 10, 1998

FLOOD LEVELS

FLOOD BOUNDARIES ADOPTED BY THE NATIONAL FLOOD INSURANCE PROGRAM

The Flood Insurance Study (FIS) is a report published by the Federal Insurance and Mitigation Administration (FIMA) for a community in conjunction with the community's Flood Insurance Rate Map (FIRM). The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. The FIRM and the corresponding FIS aid in the administration of the National Flood Insurance Program (NFIP). This study developed flood risk data for North Bend that will be used to establish actuarial flood insurance rates and to assist North Bend in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations (CFR) at 44 CFR, 60.3. North Bend's floodplain management regulations are more restrictive than the minimum federal requirements. In such case, the more restrictive criteria take precedence.

The Flood Insurance Study was originally completed for the City of North Bend by the Federal Emergency Management Agency (FEMA) and adopted on August 1, 1984, which mapped the 100- and 500-year floodplain boundaries.

In order to provide a national standard without regional discrimination, the Base Flood has been adopted by FEMA as the purposes of floodplain management. The 500-year flood is employed to indicate additional areas of potential flood risk in the community.

The boundaries of the 100-year and 500-year floods are shown on the FIRM. On this map, the 100-year boundary corresponds to the areas of Special Flood Hazards (Zone AE, AH, AO, F-AE). For areas studied using detailed engineering methods base flood elevations have been established in the AE zone. These elevations are based upon the height above mean sea level vary based on topography and hydrology.

The floodplains on the City of North Bend's FIRM are segregated into the following zones:

Zone AE

Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations determined.

Zone AH

Special Flood Hazard Areas inundated by the 100-year flood, with flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

Zone AO

Special Flood Hazard Areas inundate by types of 100-year shallow flooding with flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

Floodway areas in AE (F-AE)

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1 percent annual chance flood can be carried without substantial increases in flood heights.

Zone X (Shaded)

Areas of 0.2 percent annual chance flood; areas of 1 percent annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1 percent annual chance flood.

Flood Insurance Study Revision (FIS), 2005

The FIS has been revised to incorporate the results of detailed hydrologic and hydraulic analyses for the Middle and South Forks Snoqualmie River performed by the USACE, Seattle District, for FEMA, and as revised by King County and Harper Righellis, Inc. through a Cooperative Technical Contract (CTC) with FEMA in December 2000. The restudy covers the main stem of the Snoqualmie River from Meadowbrook Bridge to the confluence of the Middle and South Fork and the Middle Fork Snoqualmie River from its mouth to the I-90 Bridge. Harper Righellis, Inc., initially performed the hydraulic analysis for the South Fork Snoqualmie River upstream of I-90, for King County Surface Water Management Division. This data was incorporated into the latest analysis.

What are the odds of a flood?

The term "100-year flood," or Base Flood, has caused much confusion for people not familiar with statistics. Another way of looking at it is to think of the odds that a base flood will happen sometime during the life of a 30-year mortgage (26% chance).

Chance of Flooding over a Period of Years

<u>Time Period</u>	<u>10-yr</u>	<u>25-yr</u>	<u>50-yr</u>	<u>100-yr</u>
1 year	10%	4%	2%	1%
10 year	65%	34%	18%	10%
20 year	88%	56%	33%	18%
30 year	96%	71%	45%	26%
50 year	99%	87%	64%	39%

Even these numbers do not convey the true flood risk because they focus on the larger, less frequent, floods. If a house is low enough, it may be subject to the 10-or 25-year flood. During the proverbial 30-year mortgage, it may have a 26% chance of being hit by the 100-year flood, but the odds are 96% (nearly guaranteed) that the 10-year flood will occur during the 30-year period. Compare those odds to the only 5% chance that the house will catch fire during the same 30-year mortgage.

The restudy was required for several reasons. A recent restudy done by Harper Righellis, Inc., for King County, identified possible mixed flows between the lower Middle and South Fork. In addition, the USACE, Seattle District, determined that the levees on the South Fork do not meet FEMA's current standards for providing protection from the 100-year flood. This is primarily based on the lack of adequate freeboard as specified in the Code of Federal Regulations (CFR).²⁻⁵ Significant changes to the maps include four overflow channels through the Silver Creek neighborhood that flows from the Middle Fork Snoqualmie River to the South Fork Snoqualmie River. These overflow channels may have great impacts on the homeowners in this area.

Flood Risk

Past floods are indications of what can happen in the future, but flood studies and mitigation plans are based on the *risk* of future flooding. Flood studies extrapolate from historical records to determine the potential that storms and floods of certain magnitude will recur. Such events are measured by their "recurrence interval," i.e., a 10-year storm or a 50-year flood.

These terms are often misconstrued. Commonly, people interpret the 50-year flood definition to mean "once every 50 years." This is wrong. A 50-year flood could occur two times in the same year, 2 years in a row, or four times over the course of 50 years. It is possible to not have a 50-year flood over the course of 100 years.

The Snoqualmie River has been subject to several flood studies. The official floodplain study for insurance and regulatory purposes is the *Flood Insurance Study* for North Bend by FEMA published April 19, 2005.

FEMA uses the "base" flood as the basis for its regulatory requirements and flood insurance rate setting. This plan uses the same base flood. The base flood is the one percent chance flood, i.e., the flood that has a 1 percent (one out of 100) chance of occurring in any given year. The one percent chance flood has also been called the 100-year flood.

Another term used is the "500-year flood." This has a 0.2 percent chance of occurring in any given year. While the odds are more remote, it is the recommended standard used for protecting critical facilities, such as hospitals, schools, and power plants.

South Fork Snoqualmie River USGS Garcia Gage

Flood levels on the South Fork have been recorded on the "Garcia Gage" since 1961. This gage is located upstream of I-90. It is operated and maintained by the U.S. Geological Survey (USGS).

²⁻⁵ 44CFR, 65.10: Mapping areas protected by levees

The gage measures water levels starting from an arbitrary “stage” but they can be converted to elevation above sea level. The state of zero equates to an elevation of 447.67 feet above sea level. Water that reaches a state of 13 feet at the Garcia Gage is 460.67 feet above sea level.

The “flood of record,” or highest flood in recorded history of the river, was 17.84 feet on November 29, 1995.

Middle Fork Snoqualmie River USGS Tanner Gage

Flood levels on the Middle Fork have been recorded on the “Tanner Gage” since 1961. This gage is located upstream of Tanner. It is operated and maintained by the USGS.

The gage measures water levels starting from an arbitrary “stage” but they can also be converted to elevation above sea level. The state of zero equates to an elevation of 780.00 feet above sea level. Water that reaches a state of 13 feet at the Tanner Gage is 793.00 feet above sea level.

The “flood of record,” or highest flood in recorded history, was 14.97 feet on November 24, 1990.

100-Year or Base Flood Elevations

The 100-year or base flood levels are:

Based on the 1984 FIS

South Fork at North Bend:	15,000 cfs peak discharge
Middle Fork above confluence with North Fork:	43,800 cfs peak discharge

Based on the 2005 FIS

South Fork at the North Bend Gage:	15,000 cfs peak discharge
Middle Fork at the Mt Si Bridge:	55,800 cfs peak discharge
Middle Fork Upper South Overflow at divergence from MF:	7,400 cfs peak discharge
Middle Fork Upper North Overflow:	3,700 cfs peak discharge
Middle Fork Lower Overflow at divergence from MF:	4,200 cfs peak discharge
Middle Fork Middle Overflow:	1,600 cfs peak discharge

The newest study of the South and Middle Forks of the Snoqualmie River concluded that the 1984 Flood Insurance Study underestimated the true risk.

HISTORICAL FLOODING

Climatic and topographic conditions of the upper Snoqualmie valley create two distinct high-flow periods each year. In the spring or early summer, the seasonal rise in temperature melts snow in the headwaters and causes increased flow. The other high-flow period, the winter flood, is the most damaging. Winter storms bring in moisture-laden air from the Pacific Ocean and mild temperatures causing snowmelt, combined to cause floods of high magnitude and short duration. Most of the major floods have occurred during November, December, January, and February.

1959

The largest known flood in the Snoqualmie-North Bend area occurred on November 23, 1959. As the rivers in the basin swelled on that November day, there occurred a classic example of how wildly a river can change its course. About 9 miles east of North Bend, the South Fork cut a new channel on the opposite side of its valley through what was a section of the main cross state arterial, the Snoqualmie Pass Highway (North Bend Way). Atop the newly cut southerly bank, described as a steep clay cliff, remained the former riverbed. The torrent on the South Fork left countless homes damaged in North Bend and contiguous areas.

The violent turbulence of the Middle Fork washed out principal bridges and left other spans badly damaged. This misfortune left over 50 families stranded for over a week. Some residents on necessary business, some school children, and carriers of mail and milk, treaded lightly by foot across the listing bridges that continued to slip on their supports after the flood. Other large floods were November 1990, November 1995 and February 1996. The highest recent flows occurred during flooding between January 7 and 8, 2009 (King County On-Line Snoqualmie River Flooding Information).

1990

In late November 1990, North Bend was hit by one of the worst floods disasters in its history. On November 9th, flooding had swelled major rivers throughout Western Washington. Then, on November 23rd, a heavy downpour of warm rain referred to by local weather forecasters as the “Pineapple Express” because of its origins in the southern Pacific Ocean began to fall on a recent snowfall in the Cascades. The resulting runoff from melting snow and rain hit the already saturated floodplain soils on November 24th – 25th, leading to the highest flows ever recorded on most of the rivers and streams in western Washington draining the western slopes of the mountains.

The Thanksgiving Flood, as it has come to be known, will not be forgotten. Flood damages from the storm were estimated to exceed \$15 million in King County. Damage amounts in North Bend were unknown. Sixteen counties in Western Washington were declared disaster areas by the federal government, with total damages of more than \$200 million. In King County, nearly 900 homes were damaged or destroyed, and two men drowned. Agricultural areas experienced heavy losses, as hundreds of cattle and other livestock drowned. In King County and North Bend, dozens of roads were

impassable during the flood, and numerous streets, bridges, levees and other public property were damaged.

Along with the damage, destruction, and tragedy it left behind; however, the Thanksgiving Flood also taught some valuable lessons. It demonstrated clearly that living in the floodplain is dangerous, even for residents who thought they were fully protected by a levee or bank stabilization project. The left bank of the South Fork overtopped as designed to do at very high flows, although landward residents were not all aware of that fact. It became clear that structural flood control, no matter how well designed and built, always carries a risk of failure. Unfortunately, it also became clear that the presence of these projects creates a false sense of security among landowners, often encouraging development in hazardous areas because there is insufficient understanding of the risk.

For the first time, the fundamental, and entirely avoidable, risk associated with the floodplain became the primary focus of attention. Newspaper editorials did not call for bigger and better flood control; they proposed banning most types of construction in the floodplain, relocating or elevating people who were in harm's way, and restoring the storage and conveyance of functions of the natural floodplain (Seattle Post-Intelligencer 1990).

1995-1996

Rainfall was widespread throughout the basin for 6 days beginning on February 4, 1996, peaking on February 8, 1996 and ending on February 9, 1996. Precipitation totals were significantly higher at higher elevations as is typically observed; however, there was also a trend of lower rainfall in a northerly direction as evidenced by smaller rainfall totals at Monroe compared to Patterson Creek or SeaTac sites.

Based on the maximum 72-hour period at stations from the headwaters of the basin to the mouth of the river, the storm ranged from a 10 to 30-year peak annual event (see Table 2). Storm totals were higher than the November 1995 event in all interval categories at all representative gauging sites and occurred on soils that were already saturated by preceding above-average winter rainfall. The superposition of rainfall, saturated soils, and snowmelt at higher elevations caused widespread flooding.

Basin-wide, the floods of February 8th and 9th, and November 29, 1995, were superficially similar, producing approximately 8-year flood peaks (51,000 cfs) at Snoqualmie Falls and near 40-year flood peaks (62,000 cfs) at Carnation. Both of which were dwarfed in magnitude by the flooding in November 1990, which had a 63-year peak (78,800 cfs) at Snoqualmie Falls and a 50-year (64,300 cfs) peak at Carnation. In 1990, the peak at Carnation was 18 percent lower than at Snoqualmie Falls, while in the recent flood, it was 22 percent higher. There are several possible explanations for this contrast, but it is likely that the 1990 event involved a more rapidly rising flood hydrograph at the falls that subsequently subsided more dramatically as it moved downstream through the floodplain. The recent flood was probably less flashy and therefore did not attenuate as

much as it proceeded downstream. The November 1990 and the 1996 storms are characterized by rain on snow events. In addition, the February 1996 storm was preceded by extensive rainfall, causing saturated conditions, which resulted in greater than normal runoff.

TABLE 2-1

Record of Recent Large Storm Events

24-hour Peak Precipitation Depths in Inches and Return Periods in Years									
Gage Name	Gage #	February 1996		November 1995		November 1990		January 1990	
		Depth	R.P.	Depth	R.P.	Depth	R.P.	Depth	R.P.
Snoqualmie Pass	NWS 7781	5.40*	~7	5.80*	~15	6.80*	~30	5.20*	~6
Snoqualmie Falls	NWS 7773	2.22*	NDA	2.95*	NDA	3.27*	NDA	2.58*	NDA
Patterson Creek	KC 48U	3.45	25	1.95	2	2.96	10	NDA	
Monroe	NWS 5525	2.55*		1.29*		2.20*		2.75*	
Seatac	NWS 7473	3.02	10	2.39	5	3.58	25	3.00	10
72-hour Peak Precipitation Depths in Inches and Return Periods in Years									
Gage Name	Gage #	February 1996		November 1995		November 1990		January 1990	
		Depth	R.P.	Depth	R.P.	Depth	R.P.	Depth	R.P.
Snoqualmie Pass	NWS 7781	12.50*	~90	12.90*	~100	12.50*	~70	9.00*	~7
Snoqualmie Falls	NWS 7773	6.07*	NDA	6.64*	NDA	6.09*	NDA	6.34*	NDA
Patterson Creek	KC 48U	4.72	20	3.48	5	3.48	5	NDA	
Monroe	NWS 5525	3.30*		2.94		2.96*		4.15*	
Seatac	NWS 7473	5.10	30	3.12	2	4.15	10	4.60	20
Snoqualmie Pass	NWS 7781	14.60*	~9	14.00*	~7	15.50*	~15	14.00*	~7
Snoqualmie Falls	NWS 7773	7.91*	NDA	9.05*	NDA	6.09*	NDA	6.34*	NDA

TABLE 2-1 – (continued)

Record of Recent Large Storm Events

168-hour Peak Precipitation Depths in Inches and Return Periods in Years									
Gage Name	Gage #	February 1996		November 1995		November 1990		January 1990	
		Depth	R.P.	Depth	R.P.	Depth	R.P.	Depth	R.P.
Patterson Creek	KC 48U	6.11	15	4.93	5	4.16	2	NDA	
Monroe	NWS 5525	3.84*		3.70		4.14*		6.18*	
Seatac	NWS 7473	5.92	15	4.53	3	4.53	3	5.96	15

*Derived from daily totals, hourly data not available.

NDA - No data available.

Data may be available from NWS, Seattle, Doug McDonnal 526-6091

TABLE 2-2

Record of Recent Large Flood Events

168-hour Peak Precipitation Depths in Inches and Return Periods in Years									
Gage Name	USGS #	February 9, 1996		November 29, 1995		November 24, 1990		January 9, 1990	
		Peak	R.P.	Peak	R.P.	Peak	R.P.	Peak	R.P.
NF Snoqualmie nr Snoq. Falls	12142000	12,600 (2/8/96)	12*	14,500	27*	12,000	8.5*	5,890	<2*
MF Snoqualmie nr Tanner	12141300	25,300 (2/8/96)	10	27,400	~18	30,100	28	12,700	<2
SF Snoqualmie at North Bend	12144000	10,300 (2/8/96)	25	9,960	19	10,100	20	5,310	<2
Snoqualmie R nr Snoqualmie	12154500	51,800	8.8	50,200	7.5	78,800	63	43,300	4
Raging River nr Fall City	12154500	4,110 (2/8/96)	14*	3,500	9.5*	6,220	53*	4,640	20*
SF Tolt R nr Carnation	12148000	1,190	3	2,000	7.5	5,380	375	1,110	2
Tolt R nr Carnation	12148500	10,300	5*	11,400	9.5*	11,200	9.5*	7,630	<2*
Snoqualmie R nr Carnation	12149000	61,500	37	62,400	40	64,300	50	48,900	10

Return period based on Gringorten plotting position, except for values that are marked with an *, which use the Weibull plotting position.

Snoqualmie River Basin Background Information.

REPRESENTATIVE PRECIPITATION GAGE SITES

The gage sites chosen to represent conditions in the Snoqualmie River include the following:

- Snoqualmie Pass (NWS 7781) – Located at the summit of Snoqualmie Pass this location is representative of rainfall depths in the headwaters of the Snoqualmie River.
- Snoqualmie Falls (NWS 7773) – Located near the confluence of the forks of the Snoqualmie River, this gauge is assumed to be representative of rainfall depths across the upper-middle basin.
- Patterson Creek (KC 48U) – This gauge is located along the western boundary of the middle Snoqualmie Valley, several miles east of the divide.
- Monroe (NWS 5525) – Not located in the county, this gauge is assumed to represent rainfall amounts in the lower Snoqualmie Valley.
- Seatac (NWS 7473) – This NWS gage is not within the basin, but it is the gage of record for the Seattle metropolitan area. It is included for comparison purposes.

DEVELOPMENT OF FREQUENCY CURVES FOR REPRESENTATIVE PRECIPITATION GAGE SITES

Frequency quantiles were determined for the NWS gage sites using hourly precipitation records. Hourly records were available for all three representative sites. Annual maxima for each time interval were extracted and plotted using the Gringorten plotting position. A semilog line was fit to all points with greater than a 1.5-year return period. Fits were generally excellent with r^2 values above 0.95. Record lengths were variable, but were generally several decades or longer. Frequency quantiles for shorter term King County gages sites were assigned quantiles based on their geographic position relative to NWS gage sites.

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TABLE 2-3

Precipitation Frequency Estimates for Representative Gage Sites

Return Periods of Maximum Annual 24-Hour Events							
Gage Name	Gage #	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Snoqualmie Pass	NWS 7781	4.04	4.94	5.62	6.53	7.21	7.89
Snoqualmie Falls	NWS 7773	NDA	NDA	NDA	NDA	NDA	NDA
Patterson Creek	KC 48U	2.0	2.6	3.0	3.5	4.0	4.4
Monroe	NWS 5525	NDA	NDA	NDA	NDA	NDA	NDA
SeaTac	NWS 7473	2.0	2.6	3.0	3.5	4.0	4.4
Return Periods of Maximum Annual 72-Hour Events							
Gage Name	Gage #	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Snoqualmie Pass	NWS 7781	7.27	8.56	9.54	10.83	11.81	12.79
Snoqualmie Falls	NWS 7773	NDA	NDA	NDA	NDA	NDA	NDA
Patterson Creek	KC 48U	2.9	3.6	4.2	4.9	5.5	6.1
Monroe	NWS 5525	NDA	NDA	NDA	NDA	NDA	NDA
SeaTac	NWS 7473	2.9	3.6	4.2	4.9	5.5	6.1
Return Periods of Maximum Annual 168-Hour Events							
Gage Name	Gage #	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Snoqualmie Pass	NWS 7781	10.72	13.28	15.22	17.78	19.71	21.65
Snoqualmie Falls	NWS 7773	NDA	NDA	NDA	NDA	NDA	NDA
Patterson Creek	KC 48U	4.2	5.1	5.7	6.5	7.2	7.8
Monroe	NWS 5525	NDA	NDA	NDA	NDA	NDA	NDA
SeaTac	NWS 7473	4.2	5.1	5.7	6.5	7.2	7.8

REPRESENTATIVE FLOW GAGE SITES

PEAK RIVER FLOWS

Similar to rainfall, flood peaks on the Snoqualmie River can be characterized and compared historically using USGS gauging records for a set of locations (see Figure 2-3 below). Data from the following locations are presented:

- Middle Fork Snoqualmie River near Tanner (USGS #12141300) – Measures flows from 154 square miles of the forested upper watershed. The gauge is approximately 11 river miles above the confluence of the forks at North Bend. The largest floods are often caused by a combination of rainfall and melting snow. Granite Creek and the Pratt River are the bigger tributaries.

- North Fork Snoqualmie near Snoqualmie Falls (USGS #12142000) – At river mile 9.2, this gauge measures the discharge from 64.0 square miles of the forested upper basin. Largest flows are often caused by rain on melting snow.
- South Fork Snoqualmie River at North Bend (USGS #12144000) – This tributary drains from the crest of the Cascades, as the previous two also do. The gauge, at river mile 2.0 measures the discharge from 81.7 square miles of forested terrain. Boxley Creek, a tributary, is partially fed during flood events by seepage from Chester Morse Lake in the headwaters of the Cedar River.
- Snoqualmie River at Snoqualmie (USGS #12144500) – At river mile 40.0 this gauge is 0.3 miles downstream of Snoqualmie Falls. The basin above this point is largely forested in its 375 square miles. This gauge is the first gauge that represents the flow of the Snoqualmie River below the confluence of the three forks.
- Raging River near Fall City (USGS # 12145500) – This is a relatively small tributary with 30.6 square miles of basin above the gauge, which is located approximately 2.0 miles southwest of the town of Fall City.
- South Fork Tolt River near Carnation (USGS # 12148000) – Another smaller tributary, this one is of interest, as it has been regulated since 1963. In addition, it provides an average of 79 cubic feet per second, which is diverted into the Seattle Water supply. The drainage basin is 19.7 square miles. The gauge is located at river mile 6.8, approximately 9.8 miles east of Carnation.
- Tolt River near Carnation (USGS #12148500) – Found at river mile 8.7, this gauge measures the flow from 81.4 square miles of largely forested land.
- Snoqualmie River near Carnation (USGS #12149000) – This gauge, located at river mile 23.0 is approximately 1.9 miles downstream of the Tolt River. It gauges the flow from 603 square miles of largely agricultural and forest production lands.

Note: King County also maintains gages on some of the major tributary creeks draining both urbanized and relatively undeveloped basins. Information for all King County gauges is available in the Hydrologic Monitoring Report, Volume 1 for the years 1988 to 1994.

TABLE 2-4**Estimated Peak Annual Flow Exceedance Levels in CFS**

Gage Name	USGS #	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
NF Snoqualmie near Snoqualmie Falls	12142000	8,650	10,450	12,300*	13,650	16,300*	18,000*
MF Snoqualmie near Tanner	12141300	18,000	22,200	24,900	29,400	32,600	35,800
SF Snoqualmie at North Bend	12144000	5,600	7,350	8,700	10,500	11,900	13,200
Snoqualmie R near Snoqualmie	12144500	34,100	40,550	54,000	65,000	73,900	82,500
Raging River near Fall City	12145500	1,750	2,850	3,790*	4,800	5,910*	6,970*
SF Tolt R near Carnation	12148000	850	1,625	2,250	3,000	3,625	4,250
Tolt R near Carnation	12148500	7,100	9,700	11,900*	15,200	16,700*	18,800*
Snoqualmie R near Carnation	12149000	35,000	43,500	49,500	58,000	64,000	70,500

Flow quantities developed from USGS historical data using the Gringorten or Weibull plotting position and curve fitting. Weibull derived values marked with *.

This flow information from the King County website at [/1996-snoqualmie-flood.htm](http://1996-snoqualmie-flood.htm)

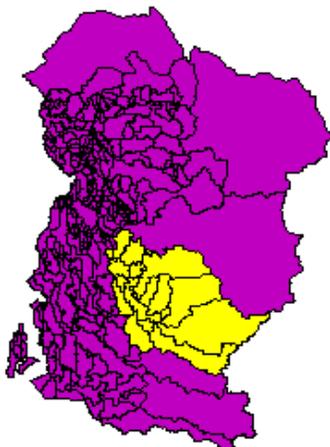
FIGURE 2-3

Snoqualmie River Basin

Snoqualmie River Basin



Vicinity Map



Legend

- Usgs_rel.shp
- Usgs.shp
- Gauges.shp
- ▬ Sirm_kc.shp
- ▬ Sirm_sno.shp
- ▭ Basins.shp

Flow information from the King County website at: <http://dnr.metrokc.gov/hydrodat/FloodReports/1996-snoqualmie-flood.htm>

TABLE 2-5

Historic Flood Peak Summary

Date	Sum of the South and Middle Forks⁽¹⁾	Snoqualmie River near Snoqualmie Falls
November 1990	50,100 cfs	78,800 cfs
November 1995	49,350 cfs	50,200 cfs
February 1996	44,430 cfs	51,700 cfs
November 2006	53,500 cfs	55,000 cfs
January 2009	54,110 cfs	60,700 cfs

(1)

FLOOD ANALYSIS

FLOODPLAIN

The Snoqualmie River 100-year floodplain is shown on the floodplain map. The FEMA flood studies cited herein calculated flood elevations for the North Bend area. The elevations were then transferred to maps, based on the best available topographic, hydraulic and hydrologic information. Two primary issues influenced the results generated by this study. The first and most significant was the lack of certification of the levees on the on the South Fork. FEMA study criteria require that the influence, or protection, available from non-certified levees not be included in the analysis. Basically, these levees do not exist in the eyes of the model. The second issue deals with topographic information utilized in the analysis. Where the information on ground elevations was inaccurate due to the base mapping utilized in the study, the corresponding floodplain boundaries were not accurate. During the associated field survey work, three areas were identified where the floodplain boundaries did not match the existing ground contours of the City's recent base maps:

1. The Silver Creek area is flooded by stormwater and localized flooding. The new draft FEMA maps show overflow flood channels from the Middle Fork and King County has mapped areas as channel migration. This area is a neighborhood that was built in the 1950s and has had some infill since then.
2. Downtown is shown with possible flooding from the Middle Fork overflows connecting with flows from the South Fork. Levees line this portion of the South Fork. These levees are not certified by the USACE and; therefore, the maps show them as not providing protection from the base flood.

3. The South Fork Interchange floods from multiple sources. Seepage from the South Fork levees, overflows from the South Fork, overflows from Ribary and Clough Creeks.
4. Levees along the Middle and South Forks in the vicinity of the newly annexed areas are not certified. Significant portions of the Maloney Grove/Thrasher Annexation (Silver Creek Area), Forest Service/Mount Si and the Shamrock Park neighborhoods are within the 100-year floodplain.

FLOODWAY

The central part of the floodplain is called the “floodway.” The floodways in the North Bend area were determined with a computer program that calculates the effects of development in the floodplain. Beginning at both edges of the floodplain, the computer model starts “filling” the floodplain. This “squeezes” the floodwater toward the main flow channel and causes the flood level to rise. At the point where this causes a 1-foot rise, the floodway boundaries are drawn.

RATE OF RISE

An important flood mitigation concern is how fast floodwaters rise. Fast rising floods are known as flash floods. Flash floods occur in hilly areas and in areas where large parts of the watershed are covered with pavement and other impervious surfaces. In these areas, stormwater runs off quickly and can cause a stream to go overbank in a few hours. This should be considered with future land use planning efforts by North Bend.

DURATION

Another concern is how long floodwaters remain up (“duration”). The longer the duration, the more damage will be done to property and the longer businesses and roads will stay closed. Floods can take several days to rise and fall on both the South and Middle Forks of the Snoqualmie River. Street and yard flooding from local storms typically last only a few hours.

SAFETY AND HEALTH HAZARDS

SAFETY

The City of North Bend has not experienced any fatalities during past floods. Floods on King County’s major rivers, which can generate deep, fast-flowing water and debris over wide areas, are an obvious threat to life and limb. Fortunately, despite the potential for injury and death, there have been very few flood-related fatalities in King County. Newspaper accounts indicate that approximately a dozen people have been killed by

flood in King County since the turn of the century; most drowned while trying to cross-inundated roadways.

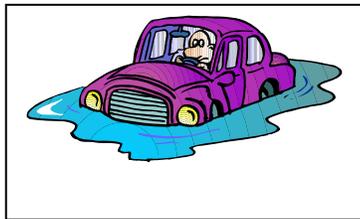
It is important to note that the majority of these fatalities occurred before 1960, when King County began its flood warning system. In fact, there were no flood-related fatalities in the County for almost 30 years after that system went into effect. Then, during the 1990 to 1991 flood season, three people drowned in floods on the Snoqualmie River or its tributaries: a boater during a minor October 1990 flood, a motorist who tried to cross the river on the Woodinville-Duvall Bridge during the Thanksgiving 1990 Flood, and a motorist whose car was swept off the Tolt River Road in a February 1991 flood.²⁻⁶

A car will float in less than 2 feet of moving water and can be swept downstream into deeper waters. This is one reason floods kill more people trapped in vehicles than anywhere else. Victims of floods have often put themselves in perilous situations by ignoring warnings about travel or mistakenly thinking that a washed-out bridge is still there.

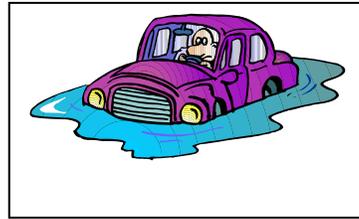
Electrocution is the second most frequent cause of flood deaths, claiming lives in flooded areas that carry a live current created when electrical components short out. Floods also can damage gas lines, floors, and stairs, creating secondary hazards such as gas leaks, unsafe structures, and fires. Fires are particularly damaging in areas made inaccessible to firefighting equipment by high water or flood-related road or bridge damage.

FIGURE 2-4

Effects of Flooded Roadways



Water weighs 62.4 lbs. per cubic foot and typically flows downstream at 6 to 12 miles and hour.

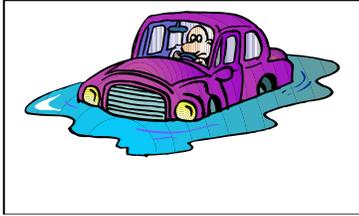


When a vehicle stalls in the water, the water's momentum is transferred to the car. For each foot the water rises, 500 lbs. Of lateral force are applied to the car.

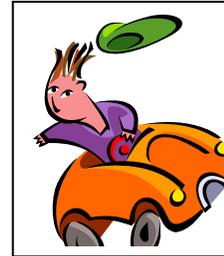
²⁻⁶ King County Flood Hazard Reduction Plan, November 1993

FIGURE 2-4 – (continued)

Effects of Flooded Roadways



But the biggest factor is buoyancy. For each foot the water rises up the side of the car, the car displaces 1,500 lbs. of water. In effect, the car weighs 1,500 lbs. less for each foot the water rises.



Two feet of water will carry away most automobiles.

Source: Flash Floods and Flood. The Awesome Power, National Weather Service
Effects of shallow water on cars.

HEALTH

There is no available data on health problems caused by floods in North Bend. While such things are not reported, three general types of health problems accompany floods. The first comes from the water itself. Floodwaters carry whatever was on the ground that the upstream runoff picked up, including dirt, oil, animal waste, and lawn, farm and industrial chemicals. Pastures and areas where cattle and horses are kept can contribute polluted waters to the receiving streams. So can inundated sewer systems and wastewater treatment plants.

The second type of health problem can come after the floodwaters have receded. Isolated pools become breeding grounds for mosquitoes, and wet areas of a building that have not been cleaned, breed mold and mildew. A building that is not thoroughly and properly cleaned becomes a health hazard, especially for small children and the elderly. Also, when heating ducts in a forced-air system are not properly cleaned after inundation and the furnace or air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants, potentially resulting in chronic respiratory problems, aka “sick-building syndrome.”

The third problem and many times the *worst* of all, is the long-term psychological impacts of having been through a flood and seeing one’s home damaged and irreplaceable keepsakes destroyed. The cost and labor needed to repair a flood-damaged home puts a severe strain on people, especially the unprepared and uninsured. There is potentially a long-term problem for those who know that their homes can be flooded again. The resulting stress on floodplain residents can take its toll in the form of aggravated physical and mental health problems.

FLOODPRONE BUILDINGS

BUILDING DAMAGE

Damage to buildings, especially residences, is usually a city's largest single flood problem. In a few situations, deep or fast flowing waters will push a building off its foundation, but this is rare. More often, structural damage is caused by the weight of standing water; known as "hydrostatic pressure."

Foundation walls and floors are particularly susceptible to damage by hydrostatic pressure. Not only is the water acting on foundation walls deeper, a foundation is subjected to the combined weight of water and saturated earth. In addition, water in the ground underneath a building can result in uplift forces that can break a concrete floor.

Due to the relatively shallow flood depths in the Snoqualmie River floodplain, soaking causes the most common type of damage inflicted by a flood. When soaked, many materials change their composition or shape. Wet wood will swell and, if dried too quickly, will crack, split or warp. Plywood can come apart. Gypsum wallboard will fall apart if it is bumped before it dries out.

The longer these materials are exposed to flood waters, the more moisture, sediment and pollutants they will absorb. Walls present a special problem: a "wicking" effect pulls water up through wood and wallboard, soaking materials several feet above the actual high-water line.

Soaking can also cause extensive damage to household goods. Wooden furniture may become so badly warped that it cannot be used. Other furnishings such as upholstery, carpeting, mattresses, and books usually are not worth drying out and restoring. Electrical appliances and gasoline engines will not work safely until they are professionally dried and cleaned.

In short, while a building may look sound and unharmed after a flood, the waters can cause a lot of damage. To properly clean a flooded building, the walls and floors should be stripped, cleaned, and allowed to dry before being recovered. This can take weeks and is expensive.

BUILDING COUNT

In 2002, as a part of the preparation of a Flood Cost/Benefit Study, a field survey was conducted of each building in Special Flood Hazard Areas shown on the structures map. This survey determined that there were 753 buildings in the floodplain, 610 of which

were residential structures²⁻⁷. This survey identified that the downtown and Silver Creek reaches contain the greatest number of properties susceptible to flood damage.

Flood-prone public buildings included City-owned buildings such as: City Hall, Fire Station, Sewer Treatment Plant, Community Services Building, and the Police Station. Other buildings in the public category include but not limited to the North Bend Elementary School, Two Rivers Alternative School, Mt Si Senior Center, and the historical North Bend Community Church.

FLOOD DEPTHS

The three major factors in damage to buildings are flood depth, velocity, and duration. As noted earlier, velocities vary throughout the City with four new floodways and channel migration areas in an older neighborhood of the City, Silver Creek. Duration can vary from flood to flood, but floodwater will stay longer in the lower buildings.

Therefore, in North Bend a key determinant of flood damage to buildings is flood depth, and in the new floodways, the depth and velocity of the floodwaters. Deeper and faster moving water means:

- Greater hydrostatic pressure on walls and floors;
- More of the building gets wet;
- Water will soak materials and contents for a longer time;
- Velocities may not be safe for families or their pets; and
- Velocities may be dangerous to the buildings.

Residential areas most exposed to flood damage are shown on the flood maps.

FLOOD INSURANCE PAYMENTS/POLICY BASE

A readily available source of building damage and exposure data is flood insurance claim payments and policy counts. As of December 2011, FEMA has paid 78 claims for a total \$985,054 via NFIP flood Insurance policies. This is an average of \$12,628.90 per claim paid. As of December of 2011, there were 540 flood insurance policies in force.

REPETITIVE LOSSES

A “repetitive loss property” is one, which has received two or more flood insurance claim payments of at least \$1,000 in any rolling 10-year period since 1978. These properties are important to the National Flood Insurance Program and its Community Rating System because they account for one-third of the country’s flood insurance claim payments. There are several FEMA programs that encourage communities to identify the

²⁻⁷ City of North Bend Flood Damage Assessment Benefit Cost Analysis, August 20, 2002 (Appendix A)

causes of their repetitive losses and develop a plan to mitigate the losses (this *Flood Mitigation Plan* meets FEMA's repetitive loss planning criteria).

Since the City's entrance into the National Flood Insurance Program in 1984, six properties have been identified and documented by FEMA as having sustained as single property damage from flooding. In each case, the damage was relatively minor. North Bend has four repetitive loss properties currently within the City limits.

The general cause of loss in all cases has been from rain on snow events with unusually high runoff in excess of the capacity of the channels and Pre-FIRM construction of buildings that were built too low to avoid localized creek flooding. Multiple repetitive losses have also occurred just outside of the current City limits in un-incorporated King County. Some of these areas are included in the City's Urban Growth Area.

To strengthen protective measures, reduce flood insurance premiums, and to continue to insure that the City has very few repetitive losses, the City had instituted more than the minimum protective measures within SFHA's. The City may continue to adopt new and higher standards if supported by local officials.

Such efforts may include, but are not limited to:

- Maintenance of the drainage system;
- Storm drainage improvements;
- Support of major flood improvements by others, such as the Army Corps of Engineers and King County;
- Complete an Emergency Preparedness Plan for flooding and have the procedures incorporated into the King County Flood Warning System if possible;
- Educating residents of these areas of concern and measures they can personally take to mitigate flood damage;
- Development and implementation of higher regulatory standards;

In addition to these direct protective measures, the City may also:

- Annually request from FEMA a list of areas of known flood losses;
- Revise the FIRM as necessary to reflect new information;
- Identify and document the sources and frequency of flooding of all claimed loss areas; and
- Continue to formulate near- and long-term methods for mitigating losses.

CRITICAL FACILITIES

“Critical facilities” are not strictly defined by any agency. Generally they fall into two categories:

1. Buildings or locations vital to the flood response and recovery effort, such as police and fire stations and telephone exchanges; and
2. Buildings or locations that, if flooded would create secondary disasters, such as hazard materials facilities and nursing homes.

The following sites are critical during a flood in North Bend.

- Fire Station
- Police Station
- Public Works Complex/the EOC
- North Bend Sewer Treatment Plant
- Mt Si Spring Plant (City's water source)
- South Fork Sewer Lift Station
- Senior Center Stormwater Lift Station
- Opstad Force Main/Sewer Pump Station
- Snoqualm Force Main/Sewer Pump Station
- Nintendo Force Main/Sewer Pump Station

While the public works complex is not in the floodplain and stays dry, the fire station, city hall, and the sewer treatment plant had water lapping at the doors in 1990. Five additional sites have been identified as critical facilities because they are in the floodplain and they store large amounts of gasoline or other hazardous materials.

- North Bend Drycleaners
- Michael's Fine Drycleaning
- Chevron Gas Station (Exit 31)
- Texaco Gas Station (Exit 31)
- Shell Gas Station (Exit 31)
- Tesaro Gas Station & Propane Tank
- Sunbelt Rentals - Commercial Propane Tank

If schools were flooded, there would be an adverse impact on both education and shelter options for disaster assistance. Local public schools located in the floodplain include:

- North Bend Elementary School
- Two Rivers Alternative School

North Bend has one nursing home in the downtown floodplain that began to flood in 1990 and one assisted living apartment located in the floodplain on the east side of downtown. Additional senior housing and the Mt Si Senior Center are also located in the downtown floodplain.

There are no critical facilities located within the recently annexed areas.

There are three bridges across the South Fork Snoqualmie River in North Bend. None of the bridges have been overtopped by floodwaters. There are three bridges over Ribary Creek, which have also not been overtopped by floodwaters. However, sediment did accumulate under the bridge on Mt Si Boulevard and was cleaned out after the flood of 1990 to ensure adequate capacity. The Ribary Creek culvert under Bendigo Boulevard is under capacity. Department of Transportation installed an additional culvert in 2000.

ECONOMIC IMPACT

BUSINESS

Floods cause other problems that are not as easy to identify as damage to buildings and critical facilities. Businesses that are disrupted by floods often have to be closed (in 1990 some businesses closed for a few days). Businesses lose their inventories, customers cannot reach the businesses, and employees may be cleaning up their own homes.

Most businesses are not fully insured for flood damage. A review of the 31 flood insurance claims concluded that businesses filed claims at about the same level

IMPACT ON TAXES

As with flooded roads, public expenditures on flood fighting, sandbags, fire department calls, clean up and repairs to damaged public property affect all residents of North Bend. In 1990, 1995, 1996, 2003, 2006, February 2007, December 2007, December 2008 and January 2009, there were presidential disaster declarations that provided disaster assistance to local governments and non-profit organizations in King County. However, federal government handouts cannot be counted on in the future for all flood events. Further, a law now requires that public agencies also purchase flood insurance. The amount of insurance that *should* be carried, if the structures are not insured, will be deducted from disaster assistance payments.

Even with Federal disaster assistance and public agency insurance, public agencies incur many expenses that must be paid with local taxes, which ultimately have an impact on annual City budgets and services.

TRANSPORTATION

Loss of road access is a major flood impact that can affect all residents and businesses in North Bend, not just those that own property in the floodplain. In 1990, Bendigo Boulevard at South Fork Avenue was closed and Mt Si Blvd. was closed due to the amount of water flowing over the road and Mt Si Boulevard has deep water as well affecting those businesses and travelers. Many other local roads also had water flowing

over them limiting access. This required detouring of traffic, and caused delays in the delivery of goods, and restricted access to some businesses and homes, etc.

OTHER IMPACTS

In addition to lost income, there are costs for fighting the floods, finding temporary housing, and cleaning up. Repetitively flooded areas tend to deteriorate over time and property values go down.

OTHER NATURAL HAZARDS

The City of North Bend is a planning partner with King County Emergency Management in the King County Multi-jurisdictional Regional Hazard Mitigation Plan. This plan was prepared pursuant to the requirements of the Disaster Mitigation Act, which ties federal pre and post disaster mitigation funding to planning requirements. This plan addresses multiple natural and man-made hazards that include severe weather, flood, earthquake, civil disorder and terrorism in a defined planning area that includes North Bend. The risk and vulnerability assessments, and mitigation strategies for the flood hazard in North Bend directly reference this plan. This plan will be viewed and used as a supplement to the regional plan. The regional plan can be viewed at the King County Emergency Management website

FUTURE TRENDS

THE PROBLEM

Flood problems can become more severe when buildings and other forms of development are located in the floodplain. North Bend's flooding problems can become worse if new development is allowed that does not account for the flood hazard. As development occurs near channels, overbank flood flows are obstructed. As a result, flood levels rise upstream. Development that fills in floodplains means less area to store floodwaters. If there is no compensation for this loss of storage, water surface levels will rise downstream.

Development in the watershed also has an impact on flooding. Stormwater runoff increases when vacant land is replaced with rooftops, pavements and storm sewers. Unconstrained watershed development often will aggravate downstream flooding and overload the drainage system.

GROWTH POTENTIAL

Growth potential is determined in the City's Comprehensive Plan required by the Growth Management Act.

IMPACTS

The greatest increase in flood damage caused by new development will probably occur along the South Fork Snoqualmie River due to the projected land uses and vacant land available. Existing development around Ribary and Gardiner Creeks increases the potential for flooding in these areas due to the lack of development standards required at the time of development.

The magnitude of future flooding along the Snoqualmie River in North Bend will depend on how well future development avoids and protects floodplains and wetlands. Planning, regulatory authority, and acquisition are the three tools that will have the strongest influence on wetlands and floodplain protection.

Impacts new developments have on flood damage in North Bend will largely depend upon four primary factors:

1. How well wetlands and floodplains are protected and managed;
2. How much more of the landscape is covered by impervious surface;
3. How well new development sites are designed to minimize runoff;
4. Future development trends in the watershed.

If land continues to be developed as it has in the past with little attention given to the amount of impervious surface, new development will almost certainly result in increased flood heights on the Snoqualmie River and its tributaries. On the other hand, if through the use of development site designs and best management practices (discussed in Chapters 4 and 8), the volume and rate of runoff from developed areas are significantly reduced; localized flood damage should be minimized.

CAC IDENTIFIED CONCERNS

During the FMP planning process, Citizen Advisory Committee (CAC) members identified a variety of flooding concerns and considered a range of potential solutions. This chapter presents identified flooding issues and potential mitigating alternatives. The site-specific alternatives identified in this chapter are a preliminary list, *and may need further study* before alternatives can be selected for implementation. The focus of this FMP is on identifying policy measures to be applied City-wide. As additional funding becomes available, the City can study and choose alternatives to address site-specific flooding problems and/or provide FEMA with a revised flood study updating the FEMA maps, if needed.

It should be noted that any structural flood-control activities could impact the mapped floodway boundaries and could potentially change the floodplain area. Both the City and King County require compensatory storage measures for structural improvements that decrease floodplain storage volumes or raise flood elevations. Structural alternatives should be evaluated using a hydraulic computer model such as HEC-RAS, the computer model used by King County to define the regulatory floodplain for FEMA and North Bend. The HEC-RAS data files can be obtained from King County and modified to reflect changes in river hydraulics caused by structural modifications. Several scenarios should be simulated to determine the impact on flood elevations and floodplain boundaries in addition to weighing the costs and benefits to determine the best set of solutions for implementation.

It should also be noted that hazard identification and mapping are key tools that are utilized in hazard mitigation. These tools can be used to identify or predict probable vulnerability of life and property to the hazard. However, mapping is rarely viewed as a mitigation action because it has no impact on reducing the impact of the hazard on life or property.

For flood-based hazards, the default tools for hazard identification are the FIRM's produced by FEMA. These maps are produced for two reasons: (1) to determine where flood insurance is required; and (2) to delineate an area subject to regulation. When prioritizing mitigation actions that weigh the cost vs. the benefits, mapping rarely generates favorable ratios. This is primarily because removing a property from the flood insurance purchase requirement is not considered mitigation and is therefore not viewed as a "benefit." Therefore, the scope of this plan will not identify and prioritize mapping as a mitigation action. It will strive to utilize the best available information and technology (i.e., mapping) as a tool to identify mitigation actions that are consistent with the goals and objectives of this plan, and are consistent with King County and the City of Snoqualmie flood planning efforts. The City can determine at a later date if it wants to do a restudy of the area, not as a mitigation strategy, but to ensure the best available information.

River reach issues identify specific areas that continually experience flood damage or that have been identified as flooding concerns. Each flooding issue was given a label indicating a geographic area and issue number (see Table 2-6). For example, SF2 refers to issue two in the South-Fork of the Snoqualmie River; MF2 refers to issue two in the Middle-Fork.

TABLE 2-6

Flooding Issues on the Upper Snoqualmie River

ID	Flooding Issue
MF1	Flooding/channel avulsion downstream of Mount Si bridge
MF2	Flooding throughout the Middle Fork floodplain corridor
SF1	Flooding/channel migration in North Bend
SF2	Flooding in downtown North Bend
SF3	Flooding problems from Clough Creek
SF4	Drainage under Bendigo for Ribary Creek and South Fork overflows
SF5	Floodplain loss/degradation upstream of Bendigo Blvd.
SF6	Flooding throughout the South Fork floodplain corridor
RL1	Repetitive loss sites on the South Fork

MF1-FLOODING AND POTENTIAL CHANNEL MIGRATION ON THE WEST SIDE OF THE MIDDLE FORK, DOWNSTREAM OF THE MOUNT SI BRIDGE

Problem Definition

Since 1990, the area downstream of the Mount Si Bridge has experienced significant flooding several times. This area is also highly vulnerable to channel migration and avulsion. The existing levee system (*around RM 2, or 47 on channel migration map*) extends along the left bank upstream of the location of most probable flooding/avulsion, and as such provides some protection to the Forest Service and Silver Creek neighborhoods. The current Flood Insurance Study dated April 19, 2005, indicates four floodway channels through the Silver Creek area. The 2011 North Bend Comprehensive Plan calls for a north-south extension of Pickett Avenue North/428th Avenue to connect the Silver Creek and Forest Service neighborhoods. This should be carefully considered in that it will bisect one of these mapped floodways. Basic concerns associated with this problem area include:

- Potential channel migration into residential areas of North Bend.
- Flooding of existing property, structures, and roads in the Silver Creek and Forest Service neighborhoods.
- Maintaining the natural and beneficial functions of the floodplain (includes storage)

Discussion of Alternatives

Possible alternatives (which may be implemented individually or in combination) for dealing with both the flooding and channel migration problems on the Middle Fork of the Snoqualmie River, downstream of the Mount Si Bridge include:

1. No modifications to the existing levee system or structures located within the floodplain boundaries. This is the no cost, no improvement (status quo) alternative.
2. Reinforce the existing levees/revetments at their current position and elevation to prevent migration (structural mitigation only).
3. Reinforce existing riverbank levees/revetments to provide 100-year protection as required by 44CFR 65.10 and construct additional levees/revetments to include 100-year protection along the entire west bank of the Middle Fork between RM 1 and 4.
4. Prohibit any development within the mapped floodway boundaries and elevate any existing structures or roads within the floodway to reduce potential flood damage. This development exclusion area should include all lands to the east of Pickett Ave N/428th along the Middle Fork (RM 1-3).
5. Maintain current open space parcels as open space. Consider using this area as a combined park and stormwater treatment area. This parcel lies directly within the mapped floodway and the potential channel migration path, making any development vulnerable to potential flood-related damage.
6. Construct a 100-year setback levee parallel to the old BN railroad grade; extending from the intersection of North Bend Way in the south to the extension of Pickett Avenue North in the north. In addition, this setback levee system could extend along the east side of Pickett Avenue North to the vicinity of RM 1. As part of this plan, Pickett Avenue North could be raised to act as the setback levee.
7. Develop a routine inspection plan for gravel/sediment deposition in the Middle Fork and periodically remove excess gravel to increase flood storage volume.

HEC-RAS computer modeling should be used to evaluate levee alternatives. Objectives of these computer simulations are as follows:

- Determine how high the existing riverbank levee must be raised to provide 100-year protection.
- Determine the level of protection provided by the existing levee.
- Examine changes in floodplain boundaries and flood elevations if a 100-year levee system was extended downstream of Mount Si Bridge.
- Examine changes in floodplain boundaries and flood elevations if a 100-year setback levee was constructed along the BN railroad grade and/or along Pickett Avenue North.

Compensatory storage and mitigation for other impacts would be considered before selecting an alternative.

MF2-FLOODING THROUGHOUT THE MIDDLE FORK FLOODPLAIN CORRIDOR

Problem Definition

Flooding is common throughout the floodway/floodplain corridor of the Middle Fork of the Snoqualmie River. Most of this flooding has been caused by the Middle Fork starting to migrate upstream of its confluence with the North Fork (King County, 1996). An existing levee/revetment is located along the left bank near the location of most probable flooding/avulsion, and as such provides some protection to this area. The current Flood Insurance Study dated April 19, 2005 also indicates a floodway channel through the heart of this area. Basic concerns associated with this problem area include:

- Potential channel migration.
- Flooding of existing property, structures, and roads.
- Loss of flood storage volume.
- Maintaining the natural and beneficial functions of the floodplain (includes storage)

Discussion of Alternatives

Possible alternatives for dealing with both the flooding and channel migration problems on the Middle Fork of the Snoqualmie River include:

1. No modifications to the existing levee system or structures located within the floodplain boundaries. This is the no cost, no improvement (status quo) alternative.

2. Reinforce the existing levees/revetments at their current position and elevation to prevent channel migration.
3. Reinforce existing riverbank levees/revetments to provide 100-year protection as required by 44CFR 65.10 and construct additional levees/revetments to include 100-year protection along the entire west bank of the Middle Fork.
4. Prohibit any development within the mapped floodway boundaries and elevate any existing structures or roads within the floodway to reduce potential flood damage. This development exclusion area should include all lands within the regulatory floodway.
5. Construct a 100-year setback levee along the mapped floodway; parallel to the Middle Fork, extending from the Mount Si Bridge to the confluence of the Middle and North Forks.

SF1-FLOODING AND POTENTIAL CHANNEL MIGRATION IN THE SE AREA OF NORTH BEND

Problem Definition

The SE portion of the City of North Bend includes the Opstad, Maloney Grove, and Si View neighborhoods. During recent years, this area located along the northeast bank of the South Fork, has experienced significant flooding. The exact cause of this flooding is not known, but is probably due to the cumulative effects of multiple factors including leakage from levees, stormwater runoff, and rising groundwater (King County, 1996).

North Bend's Comprehensive Stormwater Management Plan (2001) identified two local drainage issues in the Si View neighborhood; debris accumulation at the trunk storm drain outfall to the South Fork in the Si View development, and flooding of a drainage swale in the Si View Park area off Meadow Drive SE. An existing levee system lines both banks of the South Fork, and as such provides some protection to these neighborhoods. The current Flood Insurance Study dated April 19, 2005 indicates a floodway channel through a portion of this area. Basic concerns associated with this area include:

- Maintaining the South Fork within the levee system and mapped floodway area.
- Maintaining the natural and beneficial functions of the floodplain (includes storage).
- Enhancing or maintaining flood storage volume for the South Fork.
- Identifying and correcting drainage problems related to flooding in this area.

- Potential flooding of existing property, structures, and roads in the Si View and Maloney Grove neighborhoods.

Discussion of Alternatives

Possible alternatives for dealing with both the flooding problems on the South Fork of the Snoqualmie River, in the Si View/Maloney Grove/Opstad areas include:

1. No modifications to the existing levee system or structures located within the floodplain boundaries. This is the no cost, no improvement (status quo) alternative.
2. Reinforce the existing levees/revetments at their current position.
3. Reinforce and elevate existing right bank levees to provide 100-year protection as required by 44CFR 65.10 along the entire South Fork between I-90 and Bendigo Boulevard (SR-202).
4. Prohibit any development within the mapped floodway boundaries and elevate any existing structures or roads within the floodway to reduce potential flood damage. This development exclusion area should include all undeveloped riparian forest between the river and SE 136th Street/420th Avenue SE.
5. Elevate existing structures within the 100-year floodplain boundary.
6. Construct a 100-year setback levee along the mapped floodway on the northeast bank of the river; extending from the I-90 underpass of Maloney's Grove Road northwest towards the Si View area near RM 3.5.
7. Stormwater improvements as recommended by the Stormwater Comprehensive Plan.
8. Modification of the Si View outfall storm drain to include a man-way access through the bar screen to improve access for maintenance/debris removal.
9. Develop a routine inspection plan for gravel/sediment deposition in the South Fork and periodically remove excess gravel to increase flood storage volume, if allowed by current regulations.

SF2-FLOODING IN THE DOWNTOWN CORE OF NORTH BEND

Problem Definition

In previous years, the downtown area of the City has experienced significant flooding. The exact cause of this flooding is not known, but is probably due to the cumulative effects of multiple factors including leakage from levees, stormwater runoff, and rising groundwater (King County, 1996). An existing levee system lines both banks of the South Fork, and as such provides some protection to this area. The current Flood Insurance Study dated April 19, 2005 indicates a 100-year channel through a portion of this area. Basic concerns associated with this problem area include:

- Flooding of existing property, structures, and roads in the downtown core.
- Reduction of access to public facilities.
- Maintaining the South Fork of the river within the levee system and mapped floodway area.
- Maintaining the natural and beneficial functions of the floodplain (includes storage).
- Identifying and correcting drainage problems related to flooding in this area.

Numerous stormwater related flooding problems were identified in the City's recently completed Comprehensive Stormwater Management Plan for this area.

Discussion of Alternatives

Possible alternatives for dealing with flooding problems on the South Fork of the Snoqualmie River, in the downtown area include:

1. No modifications to the existing levee system or structures located within the floodplain boundaries. This is the no cost, no improvement (status-quo) alternative.
2. Reinforce the existing levees/revetments at their current position.
3. Reinforce and elevate existing riverbank levees to provide 100-year protection as required by 44CFR 65.10 along the entire South Fork between I-90 and Bendigo Boulevard (SR-202).
4. Identify funding sources for and implement the Comprehensive Stormwater Management Plan's (CSMP) recommended capital improvements. See CSMP for priority ranking.

5. Develop a routine inspection plan for gravel/sediment deposition in the South Fork and periodically remove excess gravel to increase flood storage volume, if allowed by current regulations.

SF3-FLOODING PROBLEMS FROM CLOUGH CREEK

Problem Definition

During recent years, the area around the confluence of Clough Creek and the South Fork of the Snoqualmie River, between I-90 and the South Fork has experienced significant flooding. The problem is mainly due to the inability of flows from Clough Creek to enter the South Fork during high-flow periods and subsequent levee seepage, as well as lack of floodplain area. Concerns associated with this problem area include:

- Providing additional flood protection to existing property, structures, and roads in this area.
- Reducing the flood impacts of Clough Creek on properties behind the South Fork levee.
- Maintaining the natural and beneficial functions of the floodplain (includes storage).

Discussion of Alternatives

Possible alternatives for dealing with both the flooding problems on Clough Creek and the South Fork of the Snoqualmie River include:

1. No modifications to the existing levee system or structures located within the floodplain boundaries. No modifications to the Clough Creek drainage.
2. Replacement of the Clough Creek outfall structure.
3. Prohibit any development within the mapped floodway boundaries. This development exclusion area should include all undeveloped land between the river and I-90 in the Clough Creek area.
4. Remove or relocate all existing structures between the river and South Fork Avenue SE. This would include homes on South Fork Avenue SE and SE 130th Street (approximately 15 residences). In addition, a setback levee would need to be constructed along the east side of I-90 and South Fork Avenue. The levees along the west bank of the South Fork between I-90 and the end of South Fork Avenue could then be removed to allow the river and Clough Creek access to its natural floodplain area.

SF4-IMPROVED DRAINAGE AND FLOOD FLOW UNDER BENDIGO BOULEVARD SOUTH (SR-202)

Problem Definition

During the last two major flood events, flood flow from the South Fork (overtopping and leakage from levees) and Ribary Creek has resulted in a significant backwater condition as this flow is routed under Bendigo Blvd. S. Redesign of the drainage under Bendigo Boulevard South for both Ribary Creek and flood flows from the South Fork may be required. The current Flood Insurance Study dated April 19, 2005 indicates that there is a potential bottleneck for flood flows draining out of the Shamrock Park area under Bendigo Boulevard South. The existing culvert system may not be adequate to handle both flood flows and stormwater runoff from the commercial/retail area centered on the I-90 interchange. Coordination between King County, WSDOT, and the City of North Bend will be required to resolve this problem. Concerns associated with this problem area include:

- Integrating floodplain management into the overall development planning process.
- Maintaining the natural and beneficial functions of the floodplain (includes storage).
- Provisions for emergency access.
- Providing additional flood protection to existing property, structures, and roads in this area.
- Improving flood flow routing under Bendigo Blvd S/SR202
- Reducing the flood impacts of Ribary Creek.

Discussion of Alternatives

Possible alternatives for dealing with flooding problems due to drainage system design under Bendigo Boulevard South include:

1. No modifications to the existing levee system or structures located within the floodplain boundaries. This is the no cost, no improvement (status quo) alternative.
2. Installation of additional/larger-capacity culvert(s) under Bendigo Boulevard South.
3. Replacement of the current Bendigo Boulevard South configuration/bridge with a larger bridge or elevated roadway that would accommodate both normal and flood flows from Ribary Creek and the South Fork of the Snoqualmie River. This is anticipated to be a joint project between WSDOT, the City, and King County Flood Control Zone District.

SF5-IMPROVED FLOODPLAIN FUNCTION FOR THE SOUTH FORK UPSTREAM OF BENDIGO BOULEVARD NORTH (SR-202)

Problem Definition

Currently, the floodplain area upstream of Bendigo Boulevard is largely undeveloped. A portion of this area (the west bank) is currently designated neighborhood business and public open space. Concerns associated with this problem area include:

- Integrating flood hazard management into the overall development planning process.
- Maintaining riparian function.
- Maintaining structural integrity of the existing levee system.
- Providing additional flood protection to existing property, structures, and roads in this portion of the City.
- Reducing the flood impacts of Ribary Creek.
- Maintaining the natural and beneficial functions of the floodplain.

Discussion of Alternatives

Possible alternatives for dealing with flooding problems on the South Fork of the Snoqualmie River upstream of Bendigo Boulevard (SR-202) include:

1. No modifications to the existing levee system or structures located within the floodplain boundaries. This is the no cost, no improvement (status quo) alternative.
2. Reinforce and elevate existing riverbank levees to provide 100-year protection along the entire South Fork.
3. Elevate existing structures within the floodway boundary.
4. Reinforce existing riverbank levees to provide 100-year protection along the South Fork downstream of Bendigo Boulevard.
5. Preserve or enhance riparian forest areas within the 100-year floodplain on both sides of the South Fork downstream of Bendigo Boulevard.
6. Prohibit any development within the mapped floodway boundaries. This development exclusion area should include all undeveloped land on both sides of the river (includes some portions of Meadowbrook and Tollgate).

7. Remove or relocate all existing structures in the mapped floodway area upstream of Bendigo Boulevard.
8. Construct a setback levee along both sides of the South Fork upstream of Bendigo Boulevard. The existing levees along the west bank of the South Fork upstream of Bendigo Boulevard could then be removed to allow the river access to its natural floodplain area. This floodplain would include that of Ribary Creek as well. Existing floodplain areas and wetlands surrounding the Nintendo complex would need to be incorporated into this plan. This would necessitate some formal agreement between the City of North Bend and Nintendo in the form of conservation easement or other similar arrangement.
9. Develop a routine inspection plan for gravel/sediment deposition in the South Fork and periodically remove excess gravel to increase flood storage volume, if allowed by current regulations.
10. Any development proposed for the 100-year floodplain of the South Fork upstream of Bendigo Boulevard could be located and/or transferred to other non-constrained lands within the City. For example, a transfer of development rights from a property located in a hazardous area and a non-hazardous area may be a feasible alternative to building new homes in the floodplain.
11. Development in this area, if built, should be designed and constructed using the latest, innovative “low-impact” development techniques so as to minimize the effects on the river and floodplain area, as well as reducing the potential for flood damage.

SF7-FLOODING THROUGHOUT THE SOUTH FORK FLOODPLAIN CORRIDOR

Problem Definition

Flooding is common throughout the floodway/floodplain corridor of the South Fork of the Snoqualmie River. In addition, the area surrounding the South Fork is prone to localized flooding due to levee seepage, stormwater runoff, and elevated groundwater levels. An existing levee system is located along the entire length of the South Fork, within the North Bend Urban Growth Area (UGA), and as such provides some level of protection to this area. The April 19, 2005 Flood Insurance Study indicates there is potential for significant flooding in some parts of this area. Basic concerns associated with this problem area include:

- Flooding of existing property, structures, and roads.

- Maintaining the natural and beneficial functions of the floodplain (includes storage).
- Integrating flood hazard management into the overall development planning process.
- Maintaining riparian function.
- Maintaining structural integrity of the existing levee system.
- Providing additional flood protection to existing property, structures, and roads in this portion of the City.

Discussion of Alternatives

Possible alternatives for dealing with both the flooding and channel migration problems on the Middle Fork of the Snoqualmie River include:

1. No modifications to the existing levee system or structures located within the floodplain boundaries. This is the no cost, no improvement (status quo) alternative.
2. Reinforce the existing levee system at the current position and elevation.
3. Reinforce existing riverbank levees to provide 100-year protection as required by 44CFR 65.10 and construct additional levees to include 100-year protection along both banks of the South Fork.
4. Prohibit any development within the mapped floodway boundaries and elevate any existing structures or roads within the floodway to reduce potential flood damage. This development exclusion area should include all lands within the mapped floodway (P-FIS, March 2003).
5. Construct a 100-year setback levee along the mapped floodway; parallel to the South Fork, extending throughout the North Bend UGA including the joint planning area known as River Bend.
6. Develop a routine inspection plan for gravel/sediment deposition in the South Fork and periodically remove excess gravel to increase flood storage volume, if allowed by current regulations.

FW1-FORSTER WOODS

Problem Definition

The potential for flooding in the Forster Woods area, comes from local streams known as Ribary and Gardiner Creeks. The headwaters begin high within Rattlesnake Ridge. This

area has not been included in the FEMA FIRM maps and was studied by King County. The SoFTAP report generates additional information (see Appendix B).

Discussion of Alternatives

1. Public education should be initiated in this area and recommend that property owners purchase flood insurance.

RL1-REPETITIVE LOSS SITES ON THE SOUTH FORK

Problem Definition

The City currently contains 4 repetitive loss properties. As part of this Floodplain Management Plan and Repetitive Loss Plan, the City will annually review and correct any errors on the NFIP Repetitive Loss Correction worksheets provided by FEMA.

The City will also maintain, through our digitized/overlay mapping system, a map of repetitive loss properties. The current map of North Bend's repetitive loss area identifies these properties.

There are no repetitive loss areas on the Middle Fork associated with the areas annexed to the City since 2004.

Discussion of Alternatives

The scope of these potential flood damage reduction alternatives could focus on targeting individual structures or could be expanded to include neighboring structures that may not be covered by the NFIP, but may also be sustaining repetitive losses. Potential non-structural and structural measures include the following:

1. No modifications to the structure or property. This is the no cost, no improvement alternative.
2. Elevate structure(s) above BFE.
3. Wet-flood proof structure(s) above BFE. Wet floodproofing allows water to enter a structure during flooding and requires that all construction and finishing materials below the flood protection elevation (i.e., basement, crawlspace) be made resistant to flood damage.
4. Relocate structure on new property or in another location outside the SFHA on the same property.
5. Acquire property and demolish existing structure. Property owner purchases new property outside the SFHA.

6. Construct a cut-off or ring levee or floodwall around structure. Levees or floodwalls can be built around individual buildings to provide a barrier between floodwaters and the structure. Floodwalls are structures constructed of concrete, masonry, or both and are usually built to a maximum height of 4 feet. Levees and floodwalls can be tied into higher ground such as a roadway embankment (cutoff levees), or completely surround the structure with openings for driveways (ring levees). Openings are sealed off during a flood.
7. Construct a setback levee along the mapped floodway; parallel to the South Fork.

CONCLUSIONS

Chapter 2 summarizes North Bend's flood problems. The summary is based on available information. While some of the data may be incomplete, the information does show some patterns that are important to the design of a flood mitigation plan. The key considerations are:

1. The major flooding problems facing North Bend is in the base floodplain of the South and Middle Forks of the Snoqualmie River, which encompass 42 percent of the City.
2. While past flooding has been minor, the latest studies show that the base flood elevations would be higher than the 1990 flood event.
3. The severity of the next flood cannot be predicted. To provide a sufficient level of protection, North Bend prepared a plan based on both historic flood levels and the risk of higher floods in the future.
4. The base floodplain boundaries shown on the April 19, 2005 draft Flood Insurance Rate Map show the best available ground contour information.
5. Floods present a variety of safety and health hazards to people. As of 2002, there are 753 structures subject to the base flood. Of these, 610 are residences.
6. The area subject to the greatest flood damage potential is Silver Creek.
7. Several critical facilities are affected by flooding, including city hall, fire station, police station, Mt Si Spring Plant (City's water source) NB Sewer Treatment Plant, North Bend Elementary and Two Rivers Alternative Schools.

8. Flooding impacts the entire community by closing roads, affecting businesses and costing all taxpayers.
9. North Bend is subject to damage and threats to public health and safety from flooding, winter storms, earthquakes, wind, fire, and drought.
10. Additional investigations could be conducted of those buildings where an earthquake would most threaten lives and safety.
11. Floodplains provide natural and beneficial functions and improve the recreational opportunities for North Bend residents.
12. Future development can aggravate the City's flooding problems. Additional higher regulatory standards are needed to prevent or minimize the impact new development has on flood heights, water quality and habitat.

REFERENCES

1. Comprehensive Land Use Plan Update, North Bend, 2002.
2. Field survey by City staff, and Tetra Tech/KCM Consultants, 2002.
3. Flood insurance policy records, Federal Emergency Management Agency.
4. King County Flood Hazard Reduction Plan, November 1993.
5. Flood Insurance Study, North Bend, FEMA, April 19, 2005.
6. South Fork Tributaries Action Plan, July 2001
7. *Literature Review & Recommended Sampling Protocol for Bull Trout in King County, Final Draft*, June 12, 2000 and Figure 2.1 Current Known Distribution of Self-Sustaining Sub-Populations and Isolated Observations of Native Char in King County.
8. National Marine Fisheries Service, Northwest Regional Office, Threatened & Endangered Salmonids WebSite entries for Puget Sound Steelhead and Puget Sound Chinook Salmon.
9. King County On-Line Flood Information for the Snoqualmie River.

CHAPTER 3

GOALS

FINDINGS

In preparing the 2005 Floodplain Management Plan, the Citizen's Advisory Committee (CAC) conducted several exercises to reach a consensus on the goals and objectives for flood mitigation planning. These exercises brought out members' concerns about the planning area and the problems residents and businesses face. They also identified the strong points about the area and the community that should be preserved and built on. The Planning Commission continues to review and revise as needed the goals for the Floodplain Management Plan. The City's Public Works Director manages the City's activities related to floodplain management

These concerns, plus the previous chapter's description of the flood problems sets the stage for what the City should do to reduce flood hazards. The City's approach is based on the following findings.

1. The primary natural hazard threatening North Bend is flooding from the South and Middle Forks of the Snoqualmie River, Ribary, Gardiner and Clough Creeks, and localized stormwater conveyance systems.
2. Past floods have shown the threats to life and health, damage to property and disruption of commerce that can occur within the City and in unincorporated King County. Flooding in the future may be worse.
3. Flooding can potentially occur to more than 600 residences and more than 150 non-residential properties. These are not just floodprone buildings. They are people's homes, businesses that form part of the economic base of the City, roads that are used by everyone, and schools and municipal services that are vital to the community. The area exposed to the greatest potential damage is the Silver Creek neighborhood and to the historic downtown.
4. Flooding in the planning area impacts all residents of North Bend and also non-residents who need to use a business or a road that has been flooded.
5. Living and working in the planning area have real advantages. It means proximity to natural areas and recreational opportunities, good schools and North Bend services, and ready access to local businesses and other destinations in the region. There is a real sense of community and a goal to remain rural in character.

6. Residents and property owners need to be assured that the flood problems will be addressed, mitigation alternatives will be pursued, and that new development will not aggravate current problems.

TECHNICAL CONCERNS

The following technical concerns were kept in mind when setting goals and designing a mitigation program:

1. Goals are long-range targets that the City's flood mitigation program aims for. The goals established by the CAC were considered when they proposed the mitigation measures outlined in this plan.
2. People should not expect 100 percent protection from the forces of nature or expect that the 100-year flood "will not happen here" because it has not happened yet. Mitigation does not mean eliminating all the threats, it means reducing the impact of those threats.
3. To be successful, flood mitigation must account for both the natural and human facets that comprise the floodplain. Mitigation measures need to minimize disruption to the community and the environment.
4. It makes sense to select mitigation tools that can address multiple hazards.
5. Mitigation measures need to be effective and affordable. This means they will take time to plan, fund, and implement.

EXISTING POLICIES, PLANS AND CODES THAT IMPACT FLOODPLAIN MANAGEMENT

The Washington State Growth Management Act requires local governments, including North Bend, to designate and protect critical areas including frequently flooded areas. In 1995 the GMA was amended to require local governments "to include best available science when developing policies and development regulations to protect the functions and values of critical areas."

Washington State adopted comprehensive flood legislation in 1991 that makes the GMA requirements for coordination and consistency on flood hazard regulations much more explicit. Under the law counties are to develop flood hazard control management plans with the full participation of jurisdictions in the planning area. Once plans are adopted by the County, cities within flood hazard planning areas must comply with the management plan (RCW 86.12.210). The Countywide Flood Hazard Reduction Plan for

King County was reviewed by affected jurisdictions including North Bend, and adopted by the King County Council on November 15, 1993.

King County Countywide Planning Policy CA-12 adopted pursuant to the GMA guides implementation of the state flood legislation by directing that the cities and the County should closely plan and coordinate implementation of their flood hazard reduction activities within the Snoqualmie, and other major river basins. Comprehensive plan policies, regulations and programs of jurisdictions in the major river basins should be consistent with the King County Flood Hazard Reduction Plan policies. Each jurisdiction's policies, regulations, and programs should effectively prevent new development and other actions from causing significant adverse impact on major river flooding, erosion and natural resources outside their jurisdiction.

FLOODPLAIN MANAGEMENT POLICY IN KING COUNTY

Both the Washington State Growth Management Act (36.70A RCW) and Title 86 RCW, Flood Control requires inter-local consistency and coordination for effective floodplain management. Counties have been directed to prepare comprehensive floodplain management plans with participation of the cities. Under the King County Countywide Planning Policies (CPPs), comprehensive floodplain management plans, regulations, and programs within all jurisdictions in any of the major river basins in King County must be consistent with the King County Flood Hazard Reduction Plan. As such, King County is a regional service provider for floodplain management. King County has established the following policies concerning floodplain management:

- F-258 King County should participate with cities to prepare, update and implement comprehensive flood hazard reduction plans that meet or exceed standards established by the National Flood Insurance Program.³⁻¹
- F-259 King County shall maintain a regional flood-warning program for the major river basins in King County.³⁻¹
- F-260 Maintenance of flood protection facilities on the main stem rivers in King County should reflect a prioritized approach, based upon the Flood Hazard Reduction Plan policies, within available funding levels. Additional funding and floodplain management partnerships in support of maintaining and improving flood protection facilities should be sought whenever possible.³⁻¹
- CP-904 King County will oppose annexations to Snoqualmie Valley cities that currently contain designated floodplain lands until inter-local

³⁻¹ King County 2004 Comprehensive Plan

agreements have been enacted to advance the policies and standards set forth in the Comprehensive Plan. (SQP-27)

NORTH BEND COMPREHENSIVE PLAN POLICIES ON FLOODPLAIN MANAGEMENT

The goals and policies in the North Bend Comprehensive plan provide a foundation for development of land use regulations that are consistent with the FMP, because it seeks to discourage development in the floodway and its natural systems and preserve the flood storage function and conveyance in the 100-year floodplain. These goals and policies are referenced herein and hereby incorporated as additional goals and policies of this Floodplain Management Plan. Please refer to the Comprehensive Plan to view these goals and policies.

FLOOD PLAN GOALS AND OBJECTIVES

Goals and objectives for the FMP were developed at the beginning of the planning process through public meetings between the Citizen's Advisory Committee (CAC) and federal, state, local agency's and North Bend residents and business owners. A large number of issues raised at these meetings were then reviewed and broken into categories that became the goals and objectives for the plan.

GOALS

- G-1 – Reduce flood hazards.
- G-2 – Preserve the natural resources and functions of the floodplains.
- G-3 – Encourage a pattern and program of land use and development, which reduces the likelihood of flooding and its consequences, protects environmental quality and enhances community character.
- G-4 – Minimize expenditure of public funds.

OBJECTIVES

- O-1 – Integration of zoning, development regulations and environmental enhancement activities, which reduce flood hazards, preserve the scenic, aesthetic, and ecological qualities of the Snoqualmie River and its tributaries.
- O-2 – Prevent or reduce the impacts of flooding to human life, existing development, public health, property, and disruption of vital services.
- O-3 – Encourage use of nonstructural measures for flood prevention and flood damage reduction measures to the extent possible.
- O-4 – Manage floodplains, rivers, streams and other water resources for multiple beneficial uses including flood and erosion hazard reduction,

open space, preserve fisheries resources and wildlife habitat, recreation, water quality, and water supply.

- O-5 – Continue interagency coordination and promote regional consistency.
 - O-6 – Improve public education and awareness of flood hazards emergency response.
 - O-7 – Provide adequate warning using the King County Flood Warning System.
 - O-8 – Preserve and enhance the socio-economic values of the city.
 - O-9 – Develop solutions and a means to fund them.
 - O-10 – Ensure that further development will minimize the need for flood assistance or cause additional flooding.
 - O-11 – Encourage King County to maintain the levee(s) in a manner that will provide continuing flood protection.
 - O-12 – Minimize the need for emergency services.
- O-13 – Minimize the need and cost for flood projects

CHAPTER 4

PREVENTIVE MEASURES

Preventive measures are designed to keep the impacts of flooding from occurring or getting worse. Their objectives are to ensure that future development does not increase the damage caused by a flood or other hazard and that new construction is protected from those hazards. Preventive measures are usually administered by building, planning, zoning, public works, and/or code enforcement offices. They include the following:

- 4.1 Planning
- 4.2 Zoning
- 4.3 Open space preservation
- 4.4 Building codes
- 4.5 Floodplain development regulations
- 4.6 Stormwater management

The first three measures, planning, zoning, and open space preservation, work to keep damage-prone development *out* of the hazardous or sensitive areas.

The next two measures, building codes and floodplain development regulations, impose construction standards on what is allowed to be built *in* the floodplain. They protect buildings, roads, and other projects from flood damage and prevent development from aggravating the flood problem.

Stormwater management addresses the increase in runoff generated from new development that can impact properties and increase flood heights.

PLANNING

“Planning” can cover a variety of community plans including, but not limited to, comprehensive plans, land use plans, transportation plans, capital improvement plans, and economic development plans. While plans generally have limited authority, they reflect what the community would like to see happen in the future. Plans also guide other local measures such as capital improvements and the development of ordinances.

Comprehensive land use plans generally identify how a community should be developed and are the most likely tools for hazard mitigation. Use of the land can be tailored to match the hazards on that land, typically by reserving flood prone areas for low intensity development, parks, recreational trails, open space, golf courses, or similar compatible uses.

North Bend's capital improvement programs state where major public expenditures will be made over 5 to 20 years. Capital expenditures may include acquisition of land for public uses, such a parkland, wetlands, or natural areas, and extension or improvement of roads, utilities, channels, and drainage structures.

LOCAL IMPLEMENTATION

North Bend's first Comprehensive Land Use Plan prepared under the Growth Management Plan was adopted in 1995. The current *Comprehensive Plan* was recently updated in 2007. Its objective is to "guide the location of future land uses" within North Bend and its urban growth area.

The *Comprehensive Plan* identifies where certain types of development should go and sets goals, objectives and policies for those developments. This plan is broken down into nine elements:

1. The Land Use Element
2. The Critical Areas Element
3. The Housing Element
4. The Transportation Element
5. The Utilities Plan Element
6. The Capital Facilities Element
7. The Natural Resources Element
8. The Parks and Open Space Element
9. The Economic Development Element

Goal 2 of the Critical Areas element guides the City to "protect the public safety by discouraging development within the river floodway and its natural systems and by preserving the flood storage function of floodplains." The zoning adopted to implement the Comprehensive Plan does not differentiate between floodplain/floodway areas and non-floodplain/floodway areas.

CAPITAL IMPROVEMENT PROGRAM

The City regularly adopts and implements a 6-Year Capital Facilities Program. It addresses the needs and plans for water, sanitary sewer, stormwater management, streets, fire, schools, police, and libraries. The stormwater element of the CFP includes a multi-year drainage improvement and maintenance program. This has a major impact on the local drainage problems caused by heavy storms.

CRS CREDIT

Generally, the CRS does not credit a community for developing a comprehensive plan. It does require these plans to be reviewed for consistency and probable incorporation, when preparing a CRS Floodplain Management Plan. Policies and recommendations from

these plans can result in CRS credits under other activities such as Open Space, Low Density Zoning and Higher Regulatory Standards.

ZONING

A zoning ordinance regulates development by dividing a community into zones or districts and setting development criteria for each zone or district. Zoning ordinances are considered the primary tool to implement a comprehensive plan's guidelines for land development.

There are two ways that a zoning ordinance can address floodplain development.

1. The floodplain can be designated as one or more separate zoning districts created to permit only those uses or activities that are less susceptible to damage by flooding, such as conservation areas, passive recreation areas and agricultural uses.
2. The floodplain can be shown as an "overlay" district with higher development standards to prevent development that would contribute to or cause increased flood damage, regardless of the use in the underlying zone.

LOCAL IMPLEMENTATION

The "North Bend Zoning Ordinance" implementing the current Comprehensive Plan was originally adopted in 1997 and has since been periodically updated.

The North Bend Zoning Ordinance specifically avoids consideration of the floodplain development requirements deferring instead to the City's floodplain management ordinance. This is a common approach, used by many communities have conflicting requirements in different ordinances.

Development such as plats and/or planned unit developments (PUDs) are required to set aside open space in usable areas, preserve natural vegetation, respect natural topography adversely affecting flooding, soil drainage, and other natural ecologic conditions, giving more imaginative and effective ways to manage stormwater runoff.

Large undeveloped properties such as the Meadowbrook and Tollgate farms have been preserved in public ownership. This will not have a major impact on overbank flood protection.

CURRENT LAND USE

The table below shows the existing land use zoning. The incorporated area of the city is comprised of about 2,820 acres, of which close to 47 percent is developed.

TABLE 4-1

Existing Land Uses in the City of North Bend (Excluding UGA)

Zoning Category	Area (Acres)	% Of Total City Area	Area within 100-year Special Flood Hazard Area (Acres)	% of the Special Flood Hazard Area
Low-density, Residential (LDR)	873.0	31%	259.0	21.5%
Cottage Residential (CR)	63.1	2.2%	15.5	1.3%
High-Density Residential (HDR)	51.3	1.9%	16.2	1.3%
Downtown Commercial (DC)	58.3	2.1%	57.7	4.8%
Interchange Commercial (IC)	76.7	2.7%	9.8	0.8%
Interchange Mixed Use (IMU)	37.2	1.3%	24.7	2.0%
Neighborhood Business (NB)	168.7	6.0%	105.9	8.8%
Employment Park-1 (EP-1)	353.7	12.5%	115.3	9.6%
Employment Park-2 (EP-2)	132.5	4.7%	0.0	0.0%
Parks/Open Space/Pub. Fac. (POSPF)	634.2	22.5%	483.7	40.1%
Right of Way/Railroad	371.7	13.2%	119.1	9.9%
Total	2820.5	100%	1206.9	100%

Residential development spreads throughout the City limits with multi-family in or near the downtown core, suburban residential developments in the surrounding areas and into outlying rural areas. The historic downtown core and the newer South Fork area at the I-90 interchange have concentrations of retail and commercial land uses. The I-90 interchange area is the location of the factory outlet stores, fast food restaurants, the Safeway complex, gas stations, and the Nintendo distribution facility. The Employment Park zoning is the principle industrial zone in the northwest corner of the City. Much of this area remains vacant. Together with land identified as environmentally sensitive areas, parks and open-space provide access to the river corridor, provide wildlife habitat, and buffer these sensitive areas from the impacts of development.

FUTURE LAND USE AND ZONING

The UGA defines the City's growth boundary for the next twenty years. The table below summarizes future land use within the UGA.

TABLE 4-2

Future Land Uses in the City of North Bend UGA (Outside City Limits)

UGA Zoning Category	Area (Acres)	% of UGA Area	Area within SFHA (Acres)	% of the SFHA Area
Low-Density Residential (LDR)	643.8	63.4%	270.5	78.2%
Cottage Residential	0	0	0	0
High-Density Residential (HDR)	0	0	0	0
Downtown Commercial (DC)	0	0	0	0
Interchange Commercial (IC)	0	0	0	0
Interchange Mixed Use (IMU)	0	0	0	0
Neighborhood Business (NB)	0	0	0	0
Employment Park-1 (EP-1)	0	0	0	0
Employment Park-2 (EP-2)	0	0	0	0
Parks/Open Space/Public Facilities (POSPF)	32.6	3.2%	27.5	8.0%
Right of way/Railroad (ROW/RR)	339.8	33.4%	47.7	13.8%
Total	1016.2	100%	345.8	100%

OPEN SPACE PRESERVATION

Keeping the floodplain open and free from development is the best approach to preventing flood damage. Preserving open space is beneficial to the public in several ways. Preserving floodplains, wetlands, and natural water storage areas maintains the existing stormwater storage capacities of an area. These sites can also serve as recreational areas, greenway corridors and provide habitat for local flora and fauna. In addition to being preserved in its natural landscape, open space may also be maintained as a park, golf course, or in agricultural use.

Open space preservation should not be limited to floodplains, as some upland areas within a watershed may be key to limiting runoff that will worsen flooding problems in adjacent or downstream lowlands. A significant increase in runoff from surrounding uplands will raise the base flood elevation and enlarge the floodplain boundary. Therefore, the amount of land maintained as open space will directly affect the level of flood hazard.

Comprehensive and capital improvement plans should identify areas to be preserved by acquisition and other means, such as purchasing an easement. With an easement, the owner is restricted from developing within that easement area. However, the owner might receive a benefit of reduced property taxes.

Although there are Federal programs that can help acquire or reserve open lands, open space lands and easements do not always have to be purchased. Developers can be encouraged to dedicate park land and be required to dedicate easements for drainage purposes. These are usually linear parcels along property lines or channels. Streamside property owners in return for a community channel maintenance program can also donate maintenance easements.

GREENWAYS

Greenways are protected corridors of open space along natural features, such as streams and ridges. Greenways provide two key flood mitigation benefits.

1. First, they preserve some floodplain from damage-prone development. While these may be narrow strips of open space, they are usually the area closest to the channel, i.e., the most dangerous area during a flood and that part of the floodway where the most water is carried.
2. Second, they draw people to the rivers for recreational purposes where they can learn to appreciate the benefits of open space and become more familiar with the rivers and creeks in the City. This second benefit is discussed more in Chapter 9: Public Information.

LOCAL IMPLEMENTATION

As shown on the open space map, approximately 624.56 acres, 21.54 percent of land area in the City limits is preserved as public open space in the Snoqualmie River floodplain. The largest owners of floodplain property are the City of North Bend, the City of Snoqualmie, and King County.

These public lands account for a much of the undeveloped parcels in the Snoqualmie River floodplain. The agencies have prevented many dollars in flood damage through the foresighted acquisition of these floodplains by not allowing future development.

Existing Parks, Open Space, and Facilities within Special Flood Hazard Areas

City-owned parks, recreation, open space and wildlife habitat areas and facilities located in the Special Flood Hazard Areas are depicted on open space map. Open space does include parking lots used with City parks and parking lots within the City located in the floodplain for CRS purposes. The protected open space in many of the parks located within the floodplain provides benefits for flood storage and conveyance. For a summary of the sizes and features of each of these parks, see the Parks and Recreation Element of the Comprehensive Plan.

CRS Credit

North Bend received a score of 306 points during its 2010 verification for activity 420, Open Space. This credit was based on documentation that approximately 19 percent of North Bend's floodplain (as depicted on the FIRM in effect at the time of the verification) was in an open space use. Additional credit was provided to recognize those open space parcels that have a formal deed restriction keeping them in an open space use in perpetuity, and those parcels that provide a natural and beneficial floodplain function. Credit for this activity could be increased under future verifications as the City creates additional open space uses within the floodplain

BUILDING CODES

Hazard protection standards for all new and improved or repaired buildings can be incorporated into the local building code. These standards should include criteria to ensure that the foundation will withstand flood forces and that all portions of the building subject to damage are above, or otherwise protected from flooding.

Communities in Washington have adopted the International Building Code (IBC), which contains provisions for natural hazard protection including floodplain management provisions that will meet the minimum requirements of the NFIP. Most communities however adopt a separate floodplain management ordinance, which makes it easier to adopt and apply higher regulatory standards to floodplain development. Prior to the evolution of the IBC, this was the preferred approach by FEMA for NFIP compliance.

Just as important as the code standards is the enforcement of the code. Adequate inspections are needed during the course of construction to ensure that the builder understands the requirements and is following them. Making sure a structure is properly anchored requires site inspections at each step.

The Building Code Effectiveness Grading Schedule (BCEGS), administered by the Washington State Survey and Rating Bureau, assesses the building codes in effect in a community and how that community enforces them, with special emphasis on mitigation of losses from natural disasters. This assessment is utilized by the Insurance Industry to underwrite property insurance. Under the BCEGS program, communities are rated similarly to the Community Rating System on a scale of 1 (best) to 10 (not rated). This rating can impact the cost of property insurance with discounts in premiums up to 25 percent, based on how well a community scores under its evaluation. The BCEGS program can be an excellent measure of a code enforcement program against an applied National Standard. The Community Rating System recognizes the importance of code enforcement by establishing prerequisites for classifications to BCEGS ratings.

LOCAL IMPLEMENTATION

North Bend adopted the IBC July 2004 as mandated by Washington State law. North Bend's code enforcement program was last evaluated under the BCEGS program on March 15, 2003. The resulting classification from that review was a Class 4 (out of 10) for dwelling properties and Class 4 (out of 10) for commercial properties. A future evaluation will be needed once some history of code enforcement is established for the recently annexed areas.

CRS CREDIT

North Bend is currently receiving 30 points under the CRS program for its class 4 BCEGS rating. This rating is also sufficient to meet the CRS classification prerequisites for CRS 7 or better. According to the CRS Bulletin from May 2012, North Bend currently has a CRS Rating of 6. Should BCEGS classifications improve under future evaluations, North Bend could earn up to 60 points for its BCEGS classification. North Bend is eligible for up to an additional 60 points with the adoption of the IBC.

FLOODPLAIN DEVELOPMENT, SENSITIVE AREAS AND SHORELINES REGULATIONS

A system of plans and regulations that support the recommendations proposed by a FMP is a critical component of effective floodplain management. These recommendations may include regulatory plans and programs affecting land use, floodplain management, engineered projects, as well as shoreline management, resource management, and stormwater management. The need for engineered projects to prevent or mitigate flood hazards can often be eliminated if complementary and forward looking regulatory programs are initiated before extensive development occurs. A general public understanding of existing regulations can help prevent the waste of time and money on projects that will never be permitted.

This chapter provides an overview of existing federal, state, and local plans, regulatory and permitting requirements that relate to floodplain management, surface water management, sensitive areas, water quality, and shorelines protection. New studies currently completed or underway are also discussed.

SUMMARY OF EXISTING REGULATIONS/PROGRAMS

Many laws that address floodplain management directly or indirectly have been enacted at the federal, state, and local levels. Most federal laws are implemented at the state and local levels. For example, the National Flood Insurance Program (NFIP), which offers affordable flood insurance to property owners, is a national program administered by FEMA, but requires cities and counties to adopt minimum floodplain regulations.

With the exception of the NFIP, the laws most relevant to floodplain management originate at the state level. Most of these begin with state legislation that enables local governments to adopt regulations promoting public health, safety, and general welfare. Environmental laws that affect floodplain management through habitat, shoreline, and other critical-area protection measures also exist at the state level, but the majority of enforcement is the responsibility of local governments. State Growth Management requirements contain additional recommendations regarding land use and development near wetlands and in frequently flooded areas, with regulatory implementation largely in the hands of local jurisdictions.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

Determines floodplain boundaries, floodways, and flood hazard areas associated with the 100-year flood via a Flood Insurance Study and Flood Insurance Rate Map (FIRM). The NFIP provides federally subsidized flood insurance to all property owners in exchange for the City's adoption of a local floodplain ordinance that meets minimum standards.

COMMUNITY RATING SYSTEM (CRS) PROGRAM

This program rewards communities that are doing more than meeting the minimum NFIP requirements to help citizens prevent or reduce flood losses. The CRS also provides an incentive for communities to initiate new flood protection activities.

NORTH BEND MUNICIPAL CODE, CHAPTER 14.12 – FLOODPLAIN MANAGEMENT

This ordinance is required for participation in the NFIP, by setting minimum standards and regulations for development in Special Flood Hazard Areas (SFHA). Floodplain boundaries were originally defined in the August 1, 1984 Flood Insurance Study for North Bend. Subsequent revisions have been made to the FIRM maps and the latest revisions were adopted on April 19, 2005. Special flood hazard areas are areas subject to the base-flood as shown in the above-mentioned maps. This chapter of the NBMC establishes a development permit application, review procedures, and new development standards for proposed development in special flood hazard areas and currently includes regulatory standards that exceed the minimum requirements of the NFIP.

The provisions for flood hazard protection in designated floodways are considerably more stringent than for those in the 100-year floodplain. Designated floodways are shown on the FIRM map. The City is currently preparing updates to the Floodplain Management Regulations as necessary for conformance with the updated NFIP Floodplain Management Requirements, following from the National Marine Fisheries Service Biological Opinion on the impact of the NFIP on listed species (described further under Section 4.8, below). The City anticipates adoption of those updates in early 2012.

NORTH BEND MUNICIPAL CODE, TITLE 14 - CRITICAL AREAS

Establishes development regulations for designated critical areas within North Bend, satisfying requirements of the GMA. North Bend's current ordinance designates the Middle and South Fork of the Snoqualmie River, Gardiner Creek, and Ribary Creek as stream corridors as well as a portion of the Silver Creek network and an unnamed creek\swale that flows through the Stow-Si View addition. The current CAO was adopted in 2006. These critical areas include:

- Wetlands
- Areas with a critical recharging effect on aquifers used for potable water
- Fish and wildlife habitat conservation areas
- Frequently flooded areas
- Geologically hazardous areas

NORTH BEND MUNICIPAL CODE, CHAPTER 14.20 - SHORELINE MANAGEMENT

This program implements requirements of Washington's Shoreline Management Act at the local level. The City has substantially completed an update to its Shoreline Master Program for conformance to the State Shoreline Master Program Guidelines, and anticipates adoption by City Council and approval by the Department of Ecology in 2012. The area within shoreline jurisdiction per the City's Shoreline Master Program includes the floodway plus 200 feet, and all wetlands within the floodplain of the Middle Fork and South Fork Snoqualmie Rivers. For more information on the different Shoreline Environments and allowed uses within each environment, please refer to the Shoreline Master Program.

STORMWATER MANAGEMENT, CLEARING AND GRADING

In 2001, the City adopted a Comprehensive Stormwater Management Plan which is being updated in 2012. "This plan consists of a comprehensive examination of the existing surface water management system, the primary focus on correcting flooding and erosion problems, improving water quality, and preserving and enhancing valuable environmental resources such as wetlands, riparian corridors, and fish habitat." Under this plan, a Citizen's Advisory Committee was formed to oversee the preparation of the plan. It formulated a list of stormwater program goals and objectives of which the following flood related goals were included:

- Incorporate Community Rating System requirements for stormwater
- Preserve the natural and beneficial functions of the drainage system
- Make sure the city drains properly

The stormwater management plan recognizes the interrelationship between localized drainage and river flows noting that direct river flooding results from periodic overflows of the local river channels or backwater effects up tributary creeks or drainage courses. The recommended capital improvement program for stormwater does not include any facilities for conveying river overflows since, per the plan, “it is not practicable to design improvements to these local creek systems to carry the larger river-induced flows.”

However, the proposed improvements in the Silver Creek and Ribary/Gardiner Creek areas will speed up the lowering of flood levels and evacuation of flood waters after large flooding events, thus reducing impacts of flooding in specific areas. The other improvements recommended in the plan will help to reduce the localized flooding (not river-induced) caused by the inadequate and undersized drainage infrastructure.

NORTH BEND MUNICIPAL CODE, SECTION 19 - DEVELOPMENT STANDARDS

Provides design and construction standards for development in the City. Standards for sanitary sewer systems, water systems, storm sewers, streets, electrical and street lighting, and underground cable television are included.

Chapter 19.04, Design and Construction Standards for Storm Sewers, adopts the design and construction standards for storm sewers contained in the current edition of the King County Surface Water Design Manual.

The standards by which new drainage facilities are designed are based on not increasing impacts of 100-year runoff events on downstream properties. This is not to say that properties won't flood. However, the rates of runoff from developments built since the adoption of these standards are to be no greater than those runoff rates experienced prior to development. Additionally, conveyance courses are now to be designed to handle 25-year runoff events instead of the past practice of using a 10-year event for design. Thus, as the existing storm system infrastructure is upgraded, the period floodwaters retained may be reduced.

These design standards also address the control of sediments caused by erosion effects of runoff on exposed soils during construction activities. The control of sediments has a direct relationship to capacity of downstream drainage courses. The deposition of silts in conveyance courses reduces the capacity of those courses to convey runoff. This has an affect of causing localized flooding during more frequent storm events. The standards are designed to avoid this effect by controlling the sediments at their sources. A second benefit to control of sediments at their sources is to avoid endangering riparian aquatic life and their habitats.

Chapter 19.10, Clearing, Grading, Filling and Drainage contains the requirements for erosion and sedimentation control. This section contains general requirements for

temporary erosion and sediment control for construction sites, and requirements for plan review.

PERMITTING REQUIREMENTS

A project may require one or more permits, depending on its nature and location. At least five permits are typically required for in-stream, shoreline, floodplain, and river engineering projects. These include a Hydraulic Project Approval from the Washington State Department of Fish and Wildlife, a Shoreline Substantial Development Permit from the City of North Bend, a Floodplain Development Permit from the City of North Bend, an Army Corps of Engineers 404 Permit, and a critical areas review and mitigation plan. State Environmental Policy Act (SEPA) review is generally required. SEPA review may consist of completing a checklist for a Determination of Non-Significance or, if the project is expected to have significant impact, an environmental impact statement (EIS).

Many permit requirements depend on the project location in relation to the river, shoreline jurisdiction, and floodplain boundary. Only work in and adjacent to the Middle Fork or the South Fork of the Snoqualmie River would require an Clean Water Act, Section 404 permit administered by the Corps of Engineers.

Some permits are issued following acquisition of other permits. The WSDOT right-of-way permit process, required whenever work is proposed within a state right-of-way, can have the longest processing time. The USACE, Shorelines, and floodplain permit processes require procurement of most other required permits and approvals before issuance. Sensitive area review and mitigation can be coordinated with SEPA or performed independently. SEPA compliance may be accomplished by preparing an environmental checklist, but if an EIS is found to be necessary, this can substantially delay procurement of all permits that require completion of the SEPA process.

The Hydraulic Project Approval (HPA) application (JARPA Form) can be submitted before the SEPA process is finished, but it will not be issued until SEPA review has been completed. Ecology will not issue the Water Quality Modification/Certification until the HPA has been issued. The grading and filling permit requires SEPA compliance prior to issuance.

RELEVANT STATE AND FEDERAL REGULATIONS AND PROGRAMS

WASHINGTON STATE DEPARTMENT OF ECOLOGY FLOODPLAIN REGULATIONS

Chapter 86.16 RCW establishes statewide authority through regulations promulgated by Ecology for coordinating the floodplain management regulation elements of the National Flood Insurance Program (NFIP). Under Chapter 173-158 WAC, Ecology requires local

governments to adopt and administer regulatory programs compliant with the minimum standards of the NFIP. Ecology provides technical assistance to local governments for both identifying the location of the 100-year (base) floodplain and for administering their floodplain management ordinances.

Ecology also establishes land management criteria in the base floodplain area by adopting the federal standards and definitions contained in 44 CFR, Parts 59 and 60, as minimum state standards.

North Bend Municipal Code Chapter 15.40 adopts floodplain regulations equal to and in some sections of the code, more restrictive than the Washington Model Flood Damage Prevention Ordinance.

WASHINGTON STATE DEPARTMENT OF FISH AND WILDLIFE/HYDRAULIC PROJECT APPROVAL

The Washington State Department of Fish and Wildlife (WSDFW) requires a Hydraulic Project Approval (HPA) for construction activities that use, divert, obstruct, or change the natural flow or bed of any waters of the state (RCW 75.20.100). The purpose of the requirements, which are administered through the JARPA process, is to protect fisheries habitat in stream channels and prevent erosion, and to protect freshwater and near-shore marine aquatic life.

Any construction activity such as channel widening or culvert improvements within the ordinary high water of any stream would fall under the HPA permit requirements. In some instances, WSDFW is also extending their permitting authority to include developments creating new impervious surfaces in excess of 5,000 square feet even if the project does not include work within the ordinary high water mark. The rationale for extending their permit authority is that such a project will affect the hydrologic regime of downstream stream habitats.

GROWTH MANAGEMENT ACT

A general discussion of the Growth Management Act (GMA) is provided in this section regarding its requirements for designating and protecting critical areas, including frequently flooded areas. North Bend, as a city in King County, is required to plan under the GMA. North Bend complies with the GMA through adoption and implementation of its Comprehensive Plan. The City's Comprehensive Plan and development regulations were reviewed and evaluated by September 1, 2002, and are reviewed at least every five years after initial publication, pursuant to RCW 36.70A.130, using "best available science" (RCW 36.70A.172).

Development Regulations - Natural Resource Lands and Critical Areas

Cities and counties subject to the Act must:

- Inventory and designate natural resource lands and critical areas
- Adopt development regulations to ensure the conservation of agricultural, forest, and mineral resource lands.
- Adopt development regulations precluding land uses or development that are located on: wetlands; areas with a critical recharging effect on aquifers used for potable water; fish and wildlife habitat conservation; frequently flooded areas; or geologically hazardous areas

The City, with the adoption of NBMC Title 14, Critical Areas, has completed this. Critical areas regulations adopted pursuant to the GMA must be reviewed and periodically updated pursuant to RCW 36.70A.130 using “best available science” (RCW 36.70A.172).

BEST AVAILABLE SCIENCE

A criterion for determining which information is considered to be the “best available science” is based upon WAC 365-195-900 through 365-195-925. North Bend must include the “best available science” when developing policies and development regulations to protect the functions and values of critical areas and must give “special consideration” to conservation or protection measures necessary to preserve or enhance anadromous fisheries. The rules in WAC 365-195-900 through 365-195-925 are intended to assist cities in identifying and including the best available science in newly adopted policies and regulations and in the periodic review and evaluation and in demonstrating they have met their statutory obligations under RCW 36.70A.172(1).

Endangered Species Act – 4(d) Rule

In 1973 Congress authorized the Endangered Species Act. Section 9 prohibits the “take” (which includes harass, harm, pursue, hunt, shoot, wound, kill, trap, or collect; or to attempt any of these things) of threatened or endangered species, including 14 groups of salmon and steelhead listed as threatened under the Endangered Species Act (ESA). NMFS adopted the take rule under section 4(d) of the ESA. This rule prohibits anyone from taking a listed salmon or steelhead, except in cases where the take is associated with an approved program. The 4(d) rule approves some specific existing state and local programs, and creates a means for NMFS to approve additional programs if they meet certain standards set out in the rule. The 4(d) rule for salmon took effect 180 days after it was published in the Federal Register (January 2001). The 4(d) rule for steelhead took effect 60 days after it was published in the Federal Register (September 25, 2008).

In addition to the 4(d) rule, the ESA provides a variety of tools for saving species threatened with extinction. Under section 7 of the ESA, no federal agency may fund, permit or carry out any activity that will jeopardize their continued existence. That is why projects that require a federal permit or have federal funding must go through a “consultation” with NMFS (for salmon and (steelhead) or the U.S. Fish and Wildlife Service (for bull trout). This “consultation” is to make sure that the project will adequately limit any impacts and qualify for an “incidental” take of listed species. Another tool is under Section 10 of the ESA that allows NMFS to issue incidental take permits for specific activities like research that usually do not apply to a municipality. Back under Section 4(d), the ESA requires that activities of state and local governments, tribes, and private citizens be controlled so they do not lead to extinction of listed species. To comply with this, NMFS has established protective rules for threatened species. However, the rules need not prohibit all “take”.

The 4(d) rule can “limit” the situations to which the take prohibitions apply. But NMFS offers 4(d) “limits” only for those programs or activities that will not impair properly functioning habitat of listed species. In accordance with this provision, NMFS has established 13 general categories of programs that can qualify for 4(d) limits on the take prohibitions. NMFS will evaluate programs under these 13 categories that wish to be granted a 4(d) limit on take prohibitions. Limit No. 12 – Municipal, Residential, Commercial, and Industrial Development and Redevelopment (MRCI) is the category where a municipal program could be evaluated by NMFS for a 4(d) limit on take prohibitions. The Tri-County Effort described below is working to obtain NMFS approval of a MRCI program so that any jurisdiction that adopts the program would then be eligible for the 4(d) limit on take prohibition.

The ESA does not directly require jurisdictions to change their practices to conform to the take limits described in the final rule. The take limits provide a way for jurisdictions to make sure an activity or program does not violate the take prohibitions. Without this assurance, jurisdictions would risk ESA penalties when an activity in question is determined to result in a take of a listed fish.

The 4(d) rule also provides a list of activities that have a high risk of resulting in a “take” of the listed threatened or endangered salmonids. The following list includes items that could be included in design standards that would prohibit activities that the 4(d) rule has determined are likely to result in injury or harm to listed salmonids. City design standards should prohibit:

- Constructions of structures like culverts, berms, or dams that eliminate or impede a listed species’ ability to migrate or gain access to habitat.
- Removal, addition, or alteration of rocks, soil, gravel, vegetation or other physical structures that are essential to the integrity and function of a listed species’ habitat.

- Removal of water or otherwise altering stream flow in a manner that significantly impairs spawning, migration, feeding, or other essential behavioral patterns.
- Construction of dams or water diversion structures with inadequate fish screens or passage facilities.
- Construction of inadequate bridges, roads, or trails on stream banks or unstable hill slopes adjacent to or above a listed species' habitat.
- Operations that substantially disturb soil and increase the amount of sediment going into streams.

The following list includes items that should be included in the City's regulations so that these activities that the 4(d) rule has determined are likely to result in injury or harm to listed salmonids would be illegal.

- Discharge of pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water (including sewage water) into a listed species' habitat is prohibited.
- The release of non-indigenous or artificially propagated species into a listed species' habitat or into areas where they may gain access to that habitat is prohibited.

The 4(d) rule has determined that the following list of maintenance related items are likely to result in injury or harm to listed salmon. The City's maintenance program should not:

- Discharge of pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water (including sewage water) into a listed species' habitat is prohibited.
- Maintain structures like culverts, berms, or dams if maintenance eliminates or impedes a listed species' ability to migrate or gain access to habitat.
- Remove, poison, or contaminate plants, fish, wildlife, or other biota that the listed species requires for feeding, sheltering, or other essential behavioral patterns.
- Remove, add, or alter rocks, soil, gravel, vegetation or other physical structures that are essential to the integrity and function of a listed species' habitat.
- Remove water or otherwise alter stream flow in a manner that significantly impairs spawning, migration, feeding, or other essential behavioral patterns.

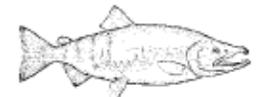
**ENDANGERED
SPECIES
ACT**



CHINOOK
Proposed Listing as
Threatened for Puget Sound



BULL TROUT
Proposed Listing as
Threatened for Puget Sound



CHUM
Depressed; Proposed Listing
as Threatened for Hood Cana



SEA-RUN CUTTROT
Status Determination
December 1998



COHO
Status Determination
Mid-1999



STEELHEAD/RAINBOW
At Risk of Future Listing



SOCKEYE
Depressed; Listing Unlikely



PINK
Some Runs Extinct;
Others Still Healthy

- Operate dams or water diversion structures with inadequate fish screens or passage facilities.
- Maintain or operate inadequate bridges, roads, or trails on stream banks or unstable hill slopes adjacent to or above a listed species' habitat.

ESA AS IT RELATES TO NORTH BEND

As stated in Section 2.5, the listing of Puget Sound Chinook salmon, Puget Sound steelhead and Puget Sound bull trout does not directly affect the City of North Bend, as Snoqualmie Falls is an impassible barrier to the upstream migration of anadromous fish in the Snoqualmie River. However, water quality and quantity related impacts to the Snoqualmie River resulting from activities in the City of North Bend could contribute to cumulative impacts on Chinook downstream of the falls. Knowledge about bull trout is less certain since comprehensive data is not available. The *Literature Review & Recommended Sampling Protocol for Bull Trout in King County, Final Draft*, June 12, 2000 indicated no evidence of a self-sustaining bull trout population in the Snoqualmie Watershed. See Figure 2.1: *Current Known Distribution of Self-Sustaining Sub-Populations and isolated Observations of Native Char in King County in Appendix.*

COUNTY AND LOCAL EFFORTS TO RESPOND TO ESA

In response to the federal listings of Chinook salmon and bull trout under the federal Endangered Species Act, the Snohomish Basin Salmon Recovery Forum, of which the City of North Bend is a part, created a Salmon Conservation Plan to guide protection and restoration actions in the Snohomish River Basin. This Salmon Conservation Plan was a part of the larger Tri-County Effort to respond to the National Marine Fisheries Service in a coordinated manner. The Salmon Conservation Plan proposes targeted project actions and recommended policy updates to support the healthy habitat conditions necessary to begin recovery of the species.

The Snohomish Basin Salmon Conservation Plan was approved by the Snohomish Basin Salmon Recovery Forum in 2005, and approved by the National Marine Fisheries Service in 2007, as a part of the Puget Sound Chinook Recovery Plan. The City of North Bend provided a letter of commitment to the Snohomish Basin Salmon Conservation Plan in 2005 through Resolution 1074, committing the City to implementing applicable portions of the plan. Through the City's commitment to the plan, the City is eligible for the section 4(d) rule limit on take prohibition under the Endangered Species Act.

THE NATIONAL FLOOD INSURANCE PROGRAM (NFIP) BIOLOGICAL OPINION

The NFIP was created in 1968 to offer an alternative to disaster assistance for properties subject o flood damage. In return for federally supported flood insurance, local

governments had to agree to regulate floodplain development in accordance with the Program's criteria.

The NFIP is administered by the Federal Emergency Management Agency and has proved very effective at shifting the costs of flood damage from tax payers to insurance policy holders. It has also steered development away from floodplains and set construction standards for development that is allowed.

While the minimum requirements of the NFIP protect the public health, safety, and welfare of the community by protecting buildings from the 100-year, or 1 percent chance flood, the program was not intended to address other floodplain management concerns, such as riparian habitat for listed salmonids.

In 2008, the National Marine Fisheries Service issued a Biological Opinion, which noted that continued implementation of the NFIP in Puget Sound adversely affects the habitat of certain threatened and endangered species. This Biological Opinion required changes to the implementation of the NFIP in order to meet the requirements of the Endangered Species Act in the Puget Sound Watershed.

FEMA offers two ways to meet this ESA requirement:

1. Prohibit all development in the floodway and other areas specified by "Reasonable and Prudent Alternatives" in the Biological Opinion.
2. Enact regulations that allow development that meets the criteria specified in the Biological Opinion by either:
 - a. Adopting a Model Ordinance approved by NMFS and FEMA, or
 - b. Enforcing the same requirements in other regulations, such as the growth management, zoning, or critical areas regulations.

If a community chooses not to enact regulations under the two options described above, then a third option of showing compliance with ESA on a permit by permit basis will be required. This would typically involve requiring applicants for floodplain development permits to develop in the Special Flood Hazard Area to submit permit applications to NMFS. If option 3 is chosen, NFIP communities must ensure that permit applicants have demonstrated ESA compliance through consultation with the National Marine Fisheries Service before issuing a floodplain development permit.

A community may choose to demonstrate that their local ordinances, processes, and written procedures meet or exceed the performance standards of the Biological Opinion Reasonable and Prudent Alternative (RPA) elements 2 and 3 and Appendix 4 in addition to the performance standards of the minimum NFIP program. NMFS and FEMA have developed a National Flood Insurance/Endangered Species Act Model Ordinance.

To assist floodplain communities with NFIP Biological Opinion Compliance, the NMFS has developed a Biological Opinion Checklist for the ESA/Biological Opinion criteria (April 2011). The City of North Bend is currently reviewing its ordinances, processes and written procedures to determine whether they meet the “no adverse effect” standard of the RPAs. Biological Opinion Provisions include:

1. Activities Affected
2. Mapping Criteria
3. Administrative Procedures
4. General Development Standards
5. Habitat Protection Standards

The NFIP Ordinance Checklist includes:

1. Model Ordinance (MO) 3.2.A: Basis for establishing the areas of Special Flood Hazard;
2. MO 4.1: Development permit required;
3. MO 4.2.F, 4.5.B, 4.7.A.3: Permit review;
4. MO 3.3.F: Use of other Base Flood Data;
5. MO 4.2.C, 4.5.F, 4.7.A.1: Information to be obtained and maintained;
6. MO 7.9.B: Alteration of Water Courses (alteration);
7. MO 7.9.C: Alternation of Water Courses (capacity);
8. MO 6.2.C: Anchoring (new construction);
9. MO 6.2.4.B: Anchoring (mobile homes);
10. MO 6.2.D: Construction materials & methods (flood damage resistance);
11. MO 6.2 – 6.6: Construction materials & methods (practices & methods to minimize flood damage);
12. MO 6.2.E: Construction Materials & Methods (elevation/floodproofing);

13. MO 6.7: Utilities;
14. MO 5.1: Subdivision proposals;
15. MO 6.2: Residential construction;
16. MO 6.3: Non-residential construction;
17. MO 6.4: Manufactured homes;
18. MO 6.5: Recreational vehicles;
19. MO 3.5, 7.5.B: AE and A1-30 Zones with BFE but no floodways;
20. MO 7.5.A: Floodways;
21. MO 3.3.B & others: Standards for shallow flooding areas (AO Zones);
22. MO 6.2.G & others: Coastal High Hazard Areas;

- reduction of sedimentation and other pollutants in the South Fork Snoqualmie River.
- Alternatives attempted to maximize riparian habitat preservation as well as mitigating flood impacts to the existing built environment.

SOFTAP

The SoFTAP project is an analysis prepared by Northwest Hydraulic Consultants of three streams that flow into the South Fork Snoqualmie River near North Bend. The three stream systems are Ribary Creek, Gardiner Creek, Clough Creek and their watershed boundaries. SoFTAP is a surface water project planning effort that is intended to help guide flood hazard reduction work in these three basins that might be done with new surface water utility programs both within the City of North Bend and in unincorporated King County. This project was funded through a Disaster Recovery Initiative (DRI) grant from the U.S. Department of Housing and Urban Development.

USACE 205 PROJECT

This project is a Hydrologic Engineering Management Plan (HEMP) developed for the flood damage reduction feasibility study for the lower Middle and South Forks of the Snoqualmie River. The primary objective of this study is to identify alternatives that could reduce flood damage in and near North Bend. The “HEMP” describes the hydrologic and hydraulic assumptions, techniques, and methodologies that are recommended to formulate potential flood damage reduction measures. Benefit cost issues associated with proposed levee improvements downstream of North Bend have precluded implementation of a 205 Project to date within North Bend. A 205 Project was recently completed in the City of Snoqualmie that widened the mouth of the river near the falls with a resulting reduction in the Base Flood Elevation in Snoqualmie of approximately one half foot.

KING COUNTY’S CHANNEL MIGRATION IN THE THREE-FORKS AREA OF THE SNOQUALMIE RIVER

Published in 1996, the Channel Migration Study was conducted by King County Surface Water Management Division following the floods of 1990. This study looks at the historical channel migration in the North Bend area and discusses the potential for future migration due to flooding events. Pursuant to NBMC Chapter 14.10, Channel Migration Zones, the City will consider the potential impacts of channel migration on development proposals within Channel Migration Hazard Areas through the SEPA process and provide mitigation as appropriate.

CONCLUSIONS

This chapter has reviewed preventive measures currently being implemented and available to the City of North Bend's floodplain management program. It has looked at preventive measures in terms of land use regulations, building codes and stormwater management regulations while also looking at federal and state programs and mandates that can impact these measures. Conclusions that can be formed from this review are as follows:

- Current programs and policies in effect within North Bend provide a strong foundation for the use of preventive measures in the mitigation of its flood hazard.
- There are opportunities through federal and state mandates such as the Endangered Species Act and Growth Management Act to enhance these measures to provide multi-objective mitigation for the current and future flood hazard in North Bend.
- There are other tangible benefits to enhanced preventive measures in North Bend under programs such as the Community Rating System (CRS) and the Disaster Mitigation Act (DMA).

CHAPTER 5

PROPERTY PROTECTION

Property protection measures are used to modify buildings or property subject to damage. Property protection measures fall under three approaches to protect buildings and other property. While flood hazards are discussed here, as noted later, most of these measures can also protect from other hazards.

The property owner normally implements property protection measures, although in many cases technical and financial assistance can be provided by a government agency such as FEMA or Washington State Department of Ecology.

The first nine sections of this chapter review the property protection measures.

- 5.1 Building relocation
- 5.2 Building acquisition
- 5.3 Building elevation
- 5.4 Barriers
- 5.5 Dry floodproofing
- 5.6 Wet floodproofing
- 5.7 Sewer backup protection
- 5.8 Insurance
- 5.9 Measures for other hazards

There are two subsequent sections that discuss the building-by-building survey and the measures that are recommended for the buildings in North Bend's floodplain, and the use of Transfer of Development Rights for floodplain management.

- 5.10 Property protection criteria
- 5.11 Transfer of Development Rights

BUILDING RELOCATION

Moving a building to higher ground is the surest and safest way to protect it from flooding. While almost any building can be moved, the cost goes up for heavier structures, such as those with exterior brick and stonewalls, and for large or irregularly shaped buildings. In areas subject to deep and/or fast flowing waters or other high hazard, relocation is often the only safe approach. The City encourages relocation for those persons willing to sell their property and incur the relocation expenses. Relocation is also preferred for buildings on large lots that include buildable areas outside the floodplain.

Relocation can be expensive. For a house to be picked up and moved successfully, it must be structurally sound. Costs for relocation range from \$30,000 for a small wood frame building to over \$60,000 for masonry and slab on grade buildings. Two story houses are more expensive to move because of the need to temporarily relocate wires along the moving route and avoid underpasses. Additional costs may be necessary for acquiring a new lot on which to place the relocated building and for restoring the old site. Larger buildings may have to be cut and the parts moved separately.

LOCAL IMPLEMENTATION

While buildings have been moved in downtown North Bend, it was only for road width purposes. There are no known examples as of May 2012 of moves for protection from floods or other hazards.

CRS CREDIT

The Community Rating System provides the most credit points for acquisition and relocation because this measure permanently removes insurable buildings from the floodplain. The Community Rating System does not differentiate between the modes of clearing buildings out of the floodplain.

ACQUISITION

Like relocation, acquisition of buildings in the floodprone areas ensures that they will no longer be subject to claims for damages. The major difference is that acquisition results in the purchase of the property and the conversion of the use of that property to open space in perpetuity.

Acquiring buildings and removing them from the floodplain is not only the most effective flood protection measure available, it is also a way to convert a problem area into a community asset and obtain environmental benefits.

Occasionally acquisition and relocation projects are undertaken jointly. Under one scenario, the purchasing agency sells the building for salvage to a third party willing to relocate it. In another scenario, the original owner relocates the building and sells the land. The advantage of this approach is that the owner relocates the building rather than demolishes it. This way, the owner gets to keep the building and may have enough money from the sale of the land to pay for a new lot and moving expenses. There is a further savings in that the local government does not have to pay for demolition of the building.

While acquisition is appropriate for any type of flood hazard, it is more cost-effective in areas subject to deep and/or fast flowing waters, or repetitive flooding where other property protection measures are not feasible. Acquisition, followed by demolition, is

most appropriate for buildings that are difficult to move such as larger, slab foundation or masonry structures and for dilapidated structures that are not worth protecting.

An acquisition budget should be based on the median price of similar properties in the community, plus fees for appraisals, abstracts, title opinions, relocation benefits, and demolition. If the purchase occurs immediately after a flood, the community may have to pay only the difference between the full price of a property and the amount of the flood insurance claim if received by the owner.

LOCAL IMPLEMENTATION

North Bend has purchased large parcels of open space in SFHA's as they've become available for sale such as Meadowbrook and Tollgate farms. However, the City has not purchased any occupied properties for the purpose of flood protection.

CRS CREDIT

The Community Rating System provides the most credit points for acquisition and relocation because this measure permanently removes insurable buildings from the floodplain. However, the score is adjusted based on the percentage of buildings remaining in the floodplain. A city that removes 12 out of 100 floodprone buildings will receive a higher score than one that removes 12 out of 1,000. As of May 2012, North Bend has not received any credit for this activity.

BUILDING ELEVATION

Next to acquisition or relocation, raising an existing structure to a flood-protection level is the next best solution to protecting a structure from flood damage. Water flows under the building, causing little or no damage to the structure or its contents. Alternatives are to elevate on continuous foundation walls (creating a non-livable enclosed space below the building) or elevation on compacted earthen fill.

Although elevating on compacted fill is sometimes the most desirable elevation solution for new construction, it is a complicated alternative for retrofitting an existing structure. The building has to be temporarily moved, so that the fill can be placed and properly compacted, then replaced. This adds to the cost of the project often outweighing the overall benefits. Current codes in effect within the City of North Bend may require compensation for the net impact of the fill on storage capacity at the site, further inflating the cost of this alternative. Fill is not encouraged in North Bend due to the detrimental effect of displacing floodwaters onto other property owners.

Elevating the habitable portion of a building will change its appearance. If the required amount of elevation change is small, the result is similar to having a building with a 2-foot-high crawlspace. If the building were raised 2 feet, the front door would be three

steps higher than before. If the habitable portion has to be raised 8 or more feet, the lower area can be wet floodproofed and used for parking and for storage of items that are not subject to damage by floodwaters.

Raising a building above the flood level is cheaper than moving it and can be less disruptive to a neighborhood and the family. Elevation has proven to be an acceptable and reasonable means of complying with NFIP regulations that require new, substantially improved, and substantially damaged buildings to be elevated above the base flood elevation. A substantially damaged or improved building is defined as a structure where the costs of improvements or repairs to a structure equal or exceed 50 percent of the market value of the structure.

As with relocation, the cost depends on the construction type (e.g., frame or masonry) and type of existing foundation (e.g., crawlspace, or slab-on-grade).

PRECAUTIONS

During a flood, the utilities and other infrastructure that serve an elevated building will still be exposed to potential flood damage. If damaged, the building may become isolated and unusable. Another problem arises when newly created lower stories are used for storage of vulnerable items, which puts them at risk of flood damage.

LOCAL IMPLEMENTATION

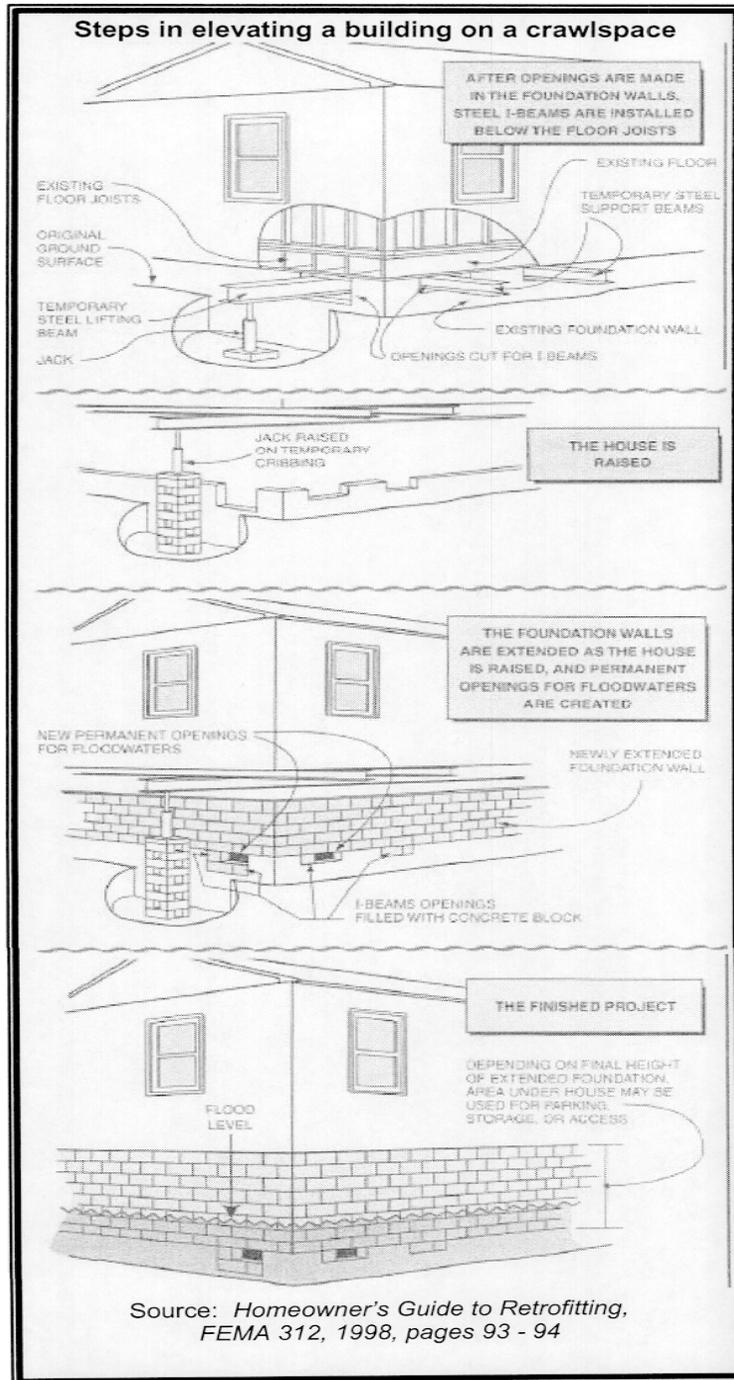
Homes have not yet been elevated in North Bend for flood protection. It is a recommendation of this plan that the City promotes the benefits and encourages elevation of those homes at risk in the floodplain. King County and the City of Snoqualmie use this method when possible.

CRS CREDIT

The Community Rating System provides credit points for elevating buildings to at least one foot above the base flood elevation, Activity 530 (Retrofitting). Elevating a building above the flood level will also reduce the flood insurance premiums on that individual building. As of May 2012, North Bend has not received credit for this activity.

FIGURE 5-1

Steps in Elevating a Building on a Crawlpace



BERMS AND FLOODWALLS

Barriers such as berms and floodwalls keep surface floodwaters from reaching a building. A barrier can be built *of* soil ("berm" or "levee"), or concrete or steel ("floodwall"). Levees and floodwalls that protect more than one structure are considered as structural flood control projects and are addressed under Chapter 7 of this plan. For the purposes of this chapter, discussion will focus on small-scale barrier options that can be utilized to protect a single property.

The typical design slope for earthen berms is three horizontal feet for each vertical foot (3:1). As a result, an area six feet wide is the minimum needed for each foot in height. Floodwalls need less room but can be more expensive. Barriers must be placed so as not to create flooding or drainage problems on neighboring properties, nor can they be constructed in the floodway. Barriers are also less effective if human intervention (such as placement of flood shields which are removed for access to the property) is required for their functionality.

Berms also may be contrary to a community's floodplain mitigation objectives because they require the placement of fill in the floodplain that can have a net impact on flood storage. However, there may be site-specific situations where these alternatives offer the best means of property protection and should be promoted as an option. It should also be noted the small-scale property protection berms or floodwalls will not make a property eligible for removal from the floodplain. These measures are also not intended as flood-protection measures for new construction. They are options for existing construction that were not built to flood protection standards and are typically pre-FIRM buildings.

PRECAUTIONS

A barrier can only be built so high. A flood higher than expected can overtop it. Berms or levees made of earth are susceptible to erosion from rain and floodwaters if not properly sloped, covered with grass, and maintained. A berm can also settle over time after its initial construction, lowering its protection level. With respect to floodwalls, they can crack, weaken, and lose their watertight seals allowing water to migrate through to the so-called protected properties. For the construction of these floodwalls or levees, compensatory storage requirements relative to floodplain displacement need to be met so as not to impact other properties.

Some barriers have openings for driveways and sidewalks. Closing these openings is dependent on someone being timely, available and capable of putting the closure in place. Another precaution is to account for water in the sewer lines that may back up under the barrier and flood inside the building (see Section 5.7 on sewer backup protection).

LOCAL IMPLEMENTATION

Walls to protect individual structures against surface flooding have not been used in North Bend. While there are no known examples in North Bend, there are a few buildings including the City's wastewater treatment plant where sump pumps are used to manage high ground water levels in crawlspaces.

CRS CREDIT

Credit for floodwalls, levees and berms that are located entirely on the owner's property would be provided under Activity 530 (Retrofitting). Because this property protection measure is less secure than elevation, not as many points would be provided.

DRY FLOODPROOFING

Dry floodproofing is completely sealing the exterior of a building to prevent the entry of floodwaters. One of the primary considerations and greatest limitations is the effect of hydrostatic pressure. Because dry floodproofing prevents water from entering the house, an equal force from water inside the house does not counter the external hydrostatic pressure exerted by floodwaters. This external pressure results in two significant problems: heavy un-equalized loads on the walls of the house and buoyancy, or uplift force, which acts on the entire house.

There are several techniques for sealing up a building to ensure that floodwaters cannot get inside it. All areas below the flood protection level are made watertight. Walls are coated with waterproofing compounds or plastic sheeting. Openings (doors, windows, vents, and sewer lines) are closed, either permanently with removable shields or constructed with automatically closing valves or vents. Because the walls are exposed to floodwaters and the pressures they exert, dry floodproofing is practical only for houses with walls constructed of flood-resistant materials and only where flood depths are low, no more than 2 to 3 feet. Successful dry floodproofing involves the following:

- Sealing the exterior walls of the house
- Covering openings below the flood level
- Protecting the interior of the house from seepage
- Protecting the service equipment outside the house

Many dry floodproofed buildings do not look any different from those that have not been modified. Dry floodproofing is only appropriate for buildings on concrete slab floors (without basements) and with no cracks. To ensure that the slab is watertight and sound, an engineering analysis is recommended. The maximum flood protection level for dry floodproofing is three feet above the slab.

Dry floodproofing of new and existing nonresidential buildings in the regulatory floodplain is permitted under State, FEMA and County regulations. Dry floodproofing of *existing* residential buildings in the floodplain is also permitted as long as the building is not substantially damaged or being substantially improved. However, this type of floodproofing is not allowed for new residential construction. Owners of buildings located outside the regulatory floodplain can always use dry floodproofing techniques. It should also be noted that eligible structures that employ this flood protection technique might be eligible for reduced flood insurance premiums when a floodproofing certificate is provided.

PRECAUTIONS

During a flood, the streets, utilities, and other infrastructure that serve a building will still be exposed to potential flood damage. The building may become isolated and unusable.

Another precaution is to account for water in the sewer lines that may back up under a barrier and flood inside the building (see Section 5.7 on sewer backup protection).

It may be very tempting for the owner, trying to keep the flood waters out of the building, to dry flood proof the building more than two or three feet high. During a flood, this can result in collapsed walls, buckled floors, and danger to the occupants.

LOCAL IMPLEMENTATION

North Bend has one commercial structure that is designed for dry floodproofing techniques; the owners install shields for their windows and doorways during a flood event.

CRS CREDIT

Credit for dry floodproofing is provided under Activity 530 ~ (Retrofitting). Because this property protection measure is less secure than elevation, not as many points are provided.

WET FLOODPROOFING

Wet floodproofing means letting the water in to minimize water pressure on a structure's foundation. Damage is avoided by taking simple measures like moving furniture and appliances to areas above the flood level, or by elevating vulnerable equipment, electrical controls, furnaces and water heaters. There are several ways to modify a building so that floodwaters are allowed inside, but minimal damage is done to the building and its contents. These techniques range from moving a few valuable items to rebuilding the floodprone area.

Structural components below the flood level are replaced with materials that are not subject to water damage. For example, concrete block walls are used instead of wooden studs and gypsum wallboard. The furnace, water heater, and laundry facilities are permanently relocated to a higher floor. Where the flooding is not deep, these appliances can be raised on blocks or platforms.

Wet floodproofing is not feasible for one-story houses because the flooded areas are the living areas. However, many people wet flood proof their basements, crawlspaces, garages, and accessory buildings simply by relocating all hard-to-move valuables, such as the furnace, heavy furniture and electrical outlets. Light or moveable items, like lawn furniture and bicycles, can be moved if there is enough warning. Fuse and electrical breaker boxes should be located high and near a door in order to safely turn the power off to the circuits serving floodprone areas.

Wet floodproofing has one advantage over the other approaches, no matter how little is done, flood damage is reduced. Simply moving furniture and electrical appliances out of a basement can prevent thousands of dollars in damage.

PRECAUTIONS

During a flood, the streets, utilities, and other infrastructure that serve a building will still be exposed to potential flood damage. The building may become isolated and unusable.

Moving contents is dependent on adequate warning and the presence of someone who knows what to do. Flooding a basement or garage where there is electricity, paint, gasoline, pesticides, or other hazardous materials creates a safety hazard. There will still be a need for cleanup, with its accompanying health problems.

LOCAL IMPLEMENTATION

North Bend's outreach projects suggest moving things out of the basement or garage or otherwise elevate damage-prone contents.

CRS CREDIT

Credit for wet floodproofing is provided under Activity 530 - (Retrofitting). Because this property protection measure is less secure than elevation, not as many points are provided.

SEWER BACKUP PROTECTION

Even though a property may appear to be protected from floods by means of floodwalls or levees, they may still become flooded. Sewer pipes can act as a conduit for floodwaters that may get into the sewer system and flow backwards through the system. If the water level in the sewer system due to inflow of floodwaters is higher than the floor

drain in the basement or garage, or if it is higher than the drain in the bathtub or toilet bowl, polluted waters could backflow into the building and cause flood damage. Other impacts may be exposure to viruses and bacteria in the sewage.

A means of avoiding this potential problem is to install a flap valve (check valve) in the side sewer in the yard. This is best done when new construction is occurring. However, existing facilities can easily be retrofitted.

LOCAL IMPLEMENTATION

All new construction or substantial improved structures must install a backflow prevention device.

CRS CREDIT

Credit for sewer backup protection is provided under Activity 530 (Retrofitting). Because this property protection measure is less secure than elevation, not as many points are provided.

INSURANCE

Flood insurance has the advantage that, as long as the policy is in force, the owner is protected from damages and no human intervention is needed for the measure to work. The standard homeowner's insurance policies do not cover property from flood damage. An owner can insure a building from flood damage through the National Flood Insurance Program (NFIP) and their local insurance agent.

Flood insurance coverage is provided for insurable buildings and their contents damaged by a "general condition of surface flooding". Building coverage is for the structure. This includes all things that typically stay with the building when it changes ownership, including:

- Utility equipment, such as a furnace or water heater
- Wall-to-wall carpeting
- Built-in appliances
- Wallpaper and paneling

Ten percent of a residence's building coverage may apply to a detached garage or carport. Other appurtenant structures must be insured under a separate policy.

Contents coverage is for the removable items inside an insurable building. A renter can take out a policy with contents coverage, even if there is no structural coverage. Certain items are not insurable. These include:

- Items outside a building, such as fences, carports, landscaping and driveways
- Jewelry, artwork, furs and similar items valued at more than \$250.
- Finished structural parts of a basement, such as paneling and wall-to-wall carpeting
- Animals and livestock
- Licensed vehicles
- Money or valuable papers
- Contents in a basement

Some people have purchased flood insurance because the lender required it when they got a mortgage or home improvement loan. The Standard Flood Insurance Policy (SFIP) covers physical losses to the structure and its contents caused by "floods". A "flood" as defined by the NFIP is:

- A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder's property), or
- Overflow of inland or tidal waters, or
- Unusual and rapid accumulation or runoff of surface waters from any source; or
- Mudflow; or
- Collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood

Also covered are losses resulting from flood-related erosion caused by waves or currents of water activity exceeding anticipated cyclical levels, or caused by a severe storm, flash flood, abnormal tidal surge, or the like, which result in flooding, as defined. Damage caused by mudslides (i.e., mudflows), as specifically defined in the policy forms, is covered. Currently these policies can cover a single-family residence up to \$250,000 and non-residential structures up to \$500,000. Contents coverage is \$100,000 for single-family and \$500,000 for non-residential structures.

In most cases, a 30-day waiting period follows the purchase of a flood insurance policy before it goes into effect. The objective of this waiting period is to encourage people to keep a policy at all times. People cannot wait for the river to rise before they buy their coverage.

Basements: There is limited coverage for basements and the below grade floors of bi-levels and tri-levels. The NFIP defines a "basement" as "any area of the building, including any sunken room or sunken portion of a room, having its floor below ground level (sub grade) on all sides.

Cost: Rates are lower for buildings that are elevated above the base flood level. Properties outside of the mapped floodplain with no history of flooding can be covered by an even less expensive “preferred risk policy.”

Many insurance policies will only pay to repair the damage incurred. If damage is severe enough, the owner may have additional costs to bring the building up to current codes. Flood insurance now covers these costs (up to \$20,000) when there is a flood. This is called “Increased Cost of Compliance” coverage and is automatically included in all policies.

LOCAL IMPLEMENTATION

Flood insurance has been available in North Bend since 1984. As of January 31, 2011 there are 540 flood insurance policies in the City, compared with just 377 policies in 2002. This represents a substantial increase, as the number of structures within the floodplain has not increased proportionally during that same period..

BASEMENT/CRAWLSPACE BACKUP INSURANCE

The NFIP will cover seepage and sewer backup for an additional deductible provided there is a general condition of flooding in the area that was the proximate cause of the basement getting wet.

Several insurance companies have sump pump failure or sewer backup coverage that can be added to a homeowner's insurance policy. Each company has different amounts of coverage, exclusions, deductibles, and arrangements. Most are riders that cost extra. Most exclude damage from surface flooding that would be covered by a National Flood Insurance policy. The cost varies from \$0 up to about \$75 for a rider on your homeowner's insurance premium.

OTHER HAZARD INSURANCE

Private insurance companies cover the other hazards that threaten North Bend property owners. Wind and winter storm coverage is part of most homeowner's policies. Separate endorsements are usually needed for earthquake coverage. Unlike flood insurance, there are no readily available statistics on how many homeowners' policies or special hazard endorsements are in force in North Bend.

CRS CREDIT

There is no CRS credit for purchasing flood or basement insurance, but the Community Rating System does provide credit for local public information programs that explain flood insurance to property owners. The CRS also reduces the premiums for those people who do buy NFIP coverage.

MEASURES FOR OTHER HAZARDS

Property protection measures can be taken against hazards other than flooding and sewer backup. *Here are the more common ones:*

DROUGHT/HEAT

- Adding insulation
- Installing water saver appliances, such as shower heads and toilets

EARTHQUAKE

- Relocation out of known areas susceptible to severe ground shaking (i.e. type “E” soils)
- Retrofitting structures to better withstand shaking bolting foundations and strengthening walls with shear-wall protection
- Anchoring appliances, water heaters, bookcases and fragile furniture so they won't fall over during a quake

WINTER STORMS

- Adding insulation
- Relocating water lines from outside walls to interior spaces
- Sealing windows
- Burying utility lines
- Installing/incorporating backup power supplies

THUNDERSTORMS

- Installing lightning rods and lightning surge interrupters
- Installing storm shutters and storm windows
- Burying utility lines
- Installing/incorporating backup power supplies

COMMON MEASURES

From the above lists, it can be seen that certain approaches can help protect from more than one hazard. These include:

- Strengthening roofs and walls to protect from wind and earthquake forces.
- Bolting or tying walls to the foundation protect from wind and earthquake forces and the effects of buoyancy during a flood.
- Adding insulation to protect for extreme heat and cold.

- Anchoring water heaters and tanks to protect from ground shaking and flotation.
- Burying utility lines to protect from wind, ice and snow.
- Installing backup power systems for power losses during storms (especially important for those basements that depend on sump pumps to prevent flooding).

LOCAL IMPLEMENTATION

Many residents have improved their homes' ability to withstand extremes in heat and cold with extra insulation, window sealing and other measures. The Washington State Emergency Management Agency has funded several projects to retrofit schools and other public buildings for earthquake protection.

CRS CREDIT

There is no CRS credit for property protection measures to protect a building from hazards other than flooding, local drainage, and sewer backup.

PROPERTY PROTECTION CRITERIA

The Citizen's Advisory Committee recommended property protection measures based on known local building types and anticipated ranges in flood depths. These recommendations are for planning purposes and different approaches may work for site-specific situations, after a closer review of its condition. Some examples of the structural issues associated with flood protection on which the recommendations are based are:

1. **Slab Foundation:** If the first floor is above the base flood elevation (depth is "< 0 feet"), then no measures are recommended (other than insurance for floods that exceed the base flood). If the base flood is less than 2 feet over the first floor ("<2 feet"), then a barrier to keep the shallow floodwaters away from the structure is the preferred approach. If there is no room for the barrier, then dry floodproofing would work.

For floods deeper than 2 feet over the first floor, an in-place retrofitting measure is not recommended. The most cost-effective flood protection approach will be to relocate the structure (or acquire and demolish it).

2. **Crawlspace Foundation:** Because ductwork and sometimes furnaces and air conditioning equipment are located in the crawlspace, a safety factor of two feet is used. The first floor must be two feet above the base flood elevation before the building is considered "above BFE" or everything below one foot above the BFE must be pressure treated and completely water tight.

If the base flood does not go over the first floor, the crawlspace should be wet floodproofed (i.e., the furnace, ductwork, etc., should be moved to a higher level and the insulation should be made of water resistant material, such as Styrofoam). A less secure alternative is to construct a barrier, such as a berm, to keep water out of the crawlspace as long as it isn't displaced to the neighbor.

If the depth of flooding is deeper, that is, over the first floor, elevating the entire building is the recommended approach. This is the most effective way to protect a building and it is most economical for buildings on crawlspaces.

3. Basements: In *older* neighborhoods some homes may have basements. If the flood level does not go over the first floor, a building can usually be protected with a barrier or basement protection berm. This assumes that the barrier will not have to be more than 3 or 4 feet high. A less desirable alternative is to let the water into the basement, but wet floodproof the area. The only way to protect a building with a basement from flooding over the first floor is to elevate or relocate it. If elevated, the only safe thing to do is to fill in the basement.
4. Bilevels/Trilevels: These buildings are treated the same as buildings with full basements with one exception. It is assumed that valuables and contents can be evacuated from a basement and the area can be wet floodproofed. In the case of bi-level and triplexes, the area below grade level is not "expendable." It is the living area that will not survive intentional flooding. Therefore, if the water is expected to be over the first floor, relocating it out of the floodplain can only protect the building.

"Retrofitting" includes those property protection measures that alter a building in place. It does not include acquisition, relocation or insurance.

The 2004 CAC's recommendations on retrofitting type measures were as follows:

FLOOD PROTECTION OF STRUCTURES ENCOURAGED

This option would encourage property owners to voluntarily protect existing structures to at least two feet above the BFE. The City would provide information on good techniques to use and where residents might go to obtain financial assistance.

Advantages

- Reduces flood damage and the cost of flood insurance

- Voluntary program that might be funded by outside sources

Disadvantages

- Added program for City staff
- Protecting existing structures in the floodplain does not remove the need for flood warning, evacuation and the hazard to personal safety

The 2004 CAC recommended this measure begin immediately and remain an ongoing property protection measure.

ELEVATE EXISTING STRUCTURES AT RISK

Elevating an existing structure requires raising the structure until the lowest habitable floor is above the predicted flood level by a desired factor of safety (freeboard). FEMA recommends raising structures so that the finished floor is at least 1 foot above the predicted 100-year flood level to account for uncertainties in the analysis and the possibility of debris dams or blockages. Elevating can be accomplished by either elevating the entire house on a higher foundation, or by constructing a new floor on top of the existing structure and moving the living area to the upper floor. Methods of elevating vary based on the type of foundation.

Advantages

- The risk of damage to the structure and its contents is greatly reduced
- Elevation eliminates the need to move vulnerable contents during flooding except where the lower floor is used for storage
- Elevation often reduces flood insurance premiums

Disadvantages

- This method may be too costly to implement.
- The appearance and ease of access to the building may be adversely affected.
- The house will still need to be evacuated during a flood.
- This method is not appropriate in areas with high-velocity flows, fast moving debris, ice-jams, erosion or potentially avulsions.
- Additional costs may be involved if the building needs to be brought into compliance with local building or plumbing codes.
- Potential wind and earthquake loads must be considered.

The 2004 CAC recommended that this measure be an ongoing property protection measure.

As noted in Chapter 2's discussion on flood depths, the most severely affected areas are Silver Creek, Downtown, and the South Fork. Those areas also have the most buildings that need this more expensive and disruptive property protection measure.

In downtown, for example, the majority if not all buildings are on slab foundations, making in-place retrofitting inappropriate where flood depths are greater than two feet. These buildings would also be technically appropriate for acquisition, but other factors must be considered before an acquisition decision is made. One concern is funding.

Another key concern is that there is a desire by the Committee as well as the City's plans to preserve the downtown core. Either flood mitigation measures other than acquisition will be needed for this area or the acquired sites would be used to build new, flood protected commercial structures. State and Federal funds could not be used for the latter approach; these programs require that the acquired lots be kept forever as open space.

The 2004 CAC established the following criteria for determining whether a property should be purchased. They are listed in priority order.

1. The owner must be willing to sell
2. Repetitively flooded properties
3. Buildings that are deteriorating or in an unsafe condition
4. Properties in the floodway
5. Properties with the deepest flooding over the first floor
6. Public properties (e.g., school)

Except for the priorities related to willingness to sell, public buildings and the downtown core, the priorities set by the Committee are related to the flood threat. Those facing the greatest hazard (repetitive flooding, floodway and deepest flooding) should be purchased first. Those in a deteriorating condition are also those that should not be protected through an in-place retrofitting approach.

A recommended priority list would be for planning purposes only. It would be most useful if North Bend were able to obtain enough funds to buy several properties. The list would then be used by the City to determine which properties should receive the first offers. Until such funds become available, the current program of offering to purchase properties as they come up for sale should be followed. In either case, all acquisition projects should be voluntary.

Two other factors must be considered. The first is the criteria of outside funding agencies. The Washington State Emergency Management Agency and FEMA for example, has given priority funding to residential and repetitively flooded properties through the Flood Mitigation Assistance Grant Program (FMA), the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation Program (PDM).

The other factor is economy. If one building remains surrounded by public open space, it makes sense to purchase it (assuming the owner is willing), even though it may not be one of the properties appropriate for acquisition.

The impact of flooding on North Bend is not just property damage related. A flooded school has an adverse impact on the students, their education and their health, as well as the emotional devastation people live with after a flood.

The 2004 CAC recommendations on acquisition and relocation type measures were as follows:

RELOCATION OF HIGH RISK STRUCTURES BY WILLING SELLERS

This option permanently removes homes and businesses located in the SFHA. Structures at the highest risk of flooding should be highest on the priority list. These would be frequently flooded structures and those located in areas of deep and/or fast flowing water or in identified avulsion zones. In some cases, relocation can be beneficial to all parties, especially when the cost is shared with the property owner and the local government with assistance from federal grants.

Advantages

- Permanently reduces flood damages and the potential for loss of life
- Preserves or increases storage and conveyance capacity
- Creates more open space within the City
- May restore the natural and beneficial functions of the floodplain
- CRS highly encourages and supports this effort providing large points toward lowering the CRS rating, which reduces flood insurance premiums

Disadvantages

- May require large amounts of money from the property owner if grants or outside funding is not available
- May require land acquisition if there is no good relocation site on the lot

The 2004 CAC recommended that this measure be a long-term property protection measure.

WILLING LAND ACQUISITION (FOCUS ON HIGH RISK AREAS)

This option is essentially the same as the relocation option except that the land is acquired by the City and the property owner uses the money to rebuild elsewhere on the property or on newly purchased property outside the floodplain. The existing structure can be torn down and disposed of and the site restored. The vacant area can then be used

for park space, pasture, agriculture or open space. Demolition of structures normally includes purchase of the property for use by the public, but not always.

Advantages

- Creates more flood storage and conveyance capacity
- Eliminates the possibility of future at risk construction and therefore, reduces the potential for future flood damages
- Could provide permanent riparian area
- Additional open space within the community
- May restore the natural and beneficial functions of the floodplain
- CRS highly encourages and supports this effort providing large points toward lowering the CRS rating, which reduces flood insurance premiums

Disadvantages

- High capital costs when not assisted by federal grants
- Neighbors may not approve

The 2004 CAC recommended that this measure be an ongoing property protection measure.

The final 2004 CAC recommendation on insurance was as follows:

FLOOD INSURANCE

Encourage property owners in the SFHA to purchase flood insurance. This option requires that the property owner participate in the National Flood Insurance Program. Although federally backed loans require the purchaser to buy flood insurance if they are within a SFHA, property owners with non-federally backed loans or who bought the property before the establishment of the NFIP may not have flood insurance. Through the City's outreach program, flood insurance education is a large part of the project.

Advantages

- Provides for the availability of flood insurance
- Monetary benefits in case of flood damage to insured structures
- Potentially provides additional money to help elevate the structure if it is substantially damaged
- If a high percentage of structures are insured, FEMA may be more willing to help finance mitigation projects

Disadvantages

- Requires community to adopt and enforce floodplain regulations
- Flood insurance premiums are frequently perceived of as costly

The 2004 CAC recommended that this measure continue as part of the City's outreach projects and remain an ongoing property protection measure.

TRANSFER OF DEVELOPMENT RIGHTS

The City adopted a voluntary Transfer of Development Rights (TDR) program in 2002 for certain properties. Designated "sending sites" where development rights may be transferred from includes sensitive areas (rivers, streams, floodways and channel migration zones but not the floodplain) and land within the Meadowbrook/Tollgate Urban Separator Overlay District (Figure 1-6 of the 2007 Comprehensive Plan), much of it is located in the floodplain. The designated receiving site is confined to the downtown area, which is all located in the floodplain.

The choice to designate the downtown as a receiving site was made with full knowledge of the potential flood problems as a measure to strengthen the downtown economy. The designation of the downtown as the only TDR receiving site suggests there may be a need to examine ways to collectively address the compensatory storage requirements that may accompany the increased building that can occur in the downtown.

The TDR program as it is presently written will provide a tool to help protect the properties that are severely constrained by floodways or channel migration zones. The TDR program could be revised in the future to include floodplain properties in the sending sites if receiving sites were designated outside of the floodplain.

NORTH BEND'S ROLE

Property protection measures are usually considered the responsibility of the property owner. However, the City should be involved in all strategies that can reduce flood losses, especially acquisition. There are various roles the City can play in encouraging and supporting implementation of these measures. The City collects a storm and flood fee from each property in the City to be used toward projects to reduce the hazards.

PUBLIC INFORMATION

Providing basic information to property owners is the first step in supporting property protection measures. Owners need general information on what can be done. They need to see examples, preferably from nearby. Public information activities that can promote and support property protection are covered in Chapter 9 of this *Plan*.

FINANCIAL ASSISTANCE

Communities can help owners by helping to pay for retrofitting projects, just like they pay for flood control projects. Financial assistance can range from full funding of a project to helping residents find money from other programs. Some communities assume responsibility for sewer backups and other flood problems that arise from an inadequate public sewer or drain system. Others might provide rate incentives for building owners to retrofit their side sewers for protection against the potential of backed up systems.

Less expensive community programs include low interest loans, forgivable low interest loans and rebates. A forgivable loan is one that does not need to be repaid if the owner does not sell the house for a specified period, such as five years. These approaches don't fully fund the project but they cost the community treasury less and they increase the owner's commitment to the flood protection project. Often, small amounts of money act as a catalyst to pique the owner's interest to get a self-protection project moving.

The more common outside funding sources are listed below. Unfortunately the first five are only available after a disaster, not before, when damage could be prevented. Following past disaster declarations, FEMA and/or the Washington State Department of Emergency Management can provide advice on how to qualify and apply for these funds.

Post-Disaster Funding Sources

- Flood insurance claims
- The National Flood Insurance Program's Increased Cost of Compliance provision (which increases the claim payment to cover a flood protection project required by code as a condition to rebuild the flooded building)
- FEMA's disaster Public Assistance (for public properties) FEMA's disaster Individual Assistance (for private properties associated with some disasters)
- Small Business Administration disaster loans (for non-governmental properties)
- FEMA's Hazard Mitigation Grant Program
- Community Development Block Grant

Grant Resources Not Tied to a Disaster

- Predisaster Mitigation Program (PDM) established under the Disaster Mitigation Act of 2000
- Washington States Flood Control Account Assistance Program (FCAAP)
- Flood Mitigation Assistance Grant Program (FMA)
- USACE's 205 Program

OTHER INCENTIVES

Sometimes only a little funding is needed to motivate a property owner to implement a retrofitting project. A flood insurance premium reduction will result if a building is elevated above the flood level. The savings of this type of mitigation on flood insurance premiums over the life of a 30-year mortgage can be significant, but often is not enough to totally offset the cost of the project. Often, property owners can be encouraged down this path to property protection with small impact incentives such as permit fee waivers, property tax credits, or low interest rate loans for hazard mitigation projects. Other forms of floodproofing are not reflected in the flood insurance rates for residential properties, but they may help with the Community Rating System, which provides a premium reduction for all policies in the City.

There are many other personal but non-economic incentives to protect a property from flood damage such as peace of mind, and increased value at property resale.

MANDATES

Mandates are considered a last resort if information and incentives aren't enough to convince a property owner to take protective actions.

There is a mandate for improvements or repairs made to a building in the mapped floodplain. If the project is worth more than 50% of the market value of the original building it is considered a "substantial improvement". The building must then be elevated or otherwise brought up to current flood protection codes and other possible building and planning regulations may also be required. This is a minimum requirement of the National Flood Insurance Program (NFIP).

Another possible mandate is to require less expensive flood protection steps as a condition of a building permit. For example, many communities require upgraded plumbing and heating as a condition of a home improvement project. If a person were to apply for a permit for either plumbing or heating, North Bend could require that these improvements be moved/placed above the base flood elevation.

LOCAL IMPLEMENTATION

Public information programs are discussed in Chapter 9. The City has a large education outreach program. This program could include information to help property owners understand the various federal disaster assistance programs and property protection measures.

North Bend has not acquired properties due to flood damage. However, King County and the City of Snoqualmie have been very successful completing acquisition projects within their jurisdictions. The CAC strongly supports acquisition efforts as long as all purchases are from willing sellers.

The City has or could fund sewer backup protection measures and a rebate program to help property owners fund retrofitting projects to protect against surface flooding. As an example, if a project is approved, installed, and inspected, the City would reimburse the owner a percentage of the cost up to a maximum dollar amount. Perhaps not surprisingly, contractors would become some of the best agents to publicize this program.

Some suburban communities have resale inspections that provide the buyer and the seller a list of recommended and/or required changes. North Bend could consider this option. All communities in the National Flood Insurance Program have the 50 percent substantial improvement requirement for floodplain properties.

CRS CREDIT

Except for public information programs, the Community Rating System does not provide credit for efforts to fund, provide incentives or mandate property protection measures. The CRS credits are provided for the actual projects, after they are completed (regardless of how they were funded or who instigated them).

CONCLUSIONS

1. There are several ways to protect individual properties from flood damage. Each is appropriate in certain situations and each has advantages and disadvantages.
2. There are many ways to protect properties from other hazards. There are several measures that can protect properties from the effects of more than one hazard.
3. Property owners can implement some property protection measures at little cost, especially for sites in areas of low flood hazard. For other measures, such as relocation and elevation, the owners may need financial assistance.
4. Many people are not aware of the various ways they can protect their own property. There is a low level of awareness of the availability and coverage provided by flood insurance. There is probably a similar level of awareness of other hazard insurance.
5. Those buildings that are below the base flood elevation should be retrofitted in place or relocated, depending upon the difference in elevation.

6. The City can promote and support property protection measures through several activities and funding programs listed above

RECOMMENDATIONS

1. Property owners should be advised of the property protection measures that can help them reduce flood losses and the effects of other hazards. This should be done through the existing education outreach program.
2. All acquisition projects should be voluntary. The City should use its powers of eminent domain only when there are extenuating circumstances, such as code violations or the property is a health or safety threat to others.
3. As funds become available, the City should acquire properties in the priority order recommended by the CAC. In most cases the acquired properties should be cleared and kept as public open space. However, in the downtown core, reuse of the land should be consistent with the City's Land Use Comprehensive and Downtown Revitalization Plans.
4. When proposed for other purposes such as development or redevelopment, all new and existing utility lines could be buried to protect them from damage by wind, ice and snow.
5. The City should pursue the following activities to encourage and support property protection measures taken by property owners:
 - a. Public information (reviewed in more detail in Chapter 9).
 - b. Outside funding sources that can assist property owners fund property protection measures, especially after a disaster declaration.
6. The City's floodplain management regulations, the building code, and zoning code should be revised to mandate simple and inexpensive property protection measures, such as moving the heating and hot water tank above the base flood elevation as a condition of a building permit for non-substantial improvement or at the time of resale and/or as a condition of financial assistance if possible.
7. The City should publicize projects that have been implemented by property owners in the past, if there are any.

REFERENCES

1. *Disaster Mitigation Guide for Business and Industry*, Federal Emergency Management Agency, FEMA-190, 1990
2. *Engineering Principles and Practices for Retrofitting Flood Prone Residential Buildings*, Federal Emergency Management Agency, FEMA-259, 1995.
3. *Flood Proofing Techniques, Programs and References*, U.S. Army Corps of Engineers National Flood Proofing Committee, 1991.
4. *Flood Proofing: How to Evaluate Your Options*, U.S. Army Corps of Engineers, 1993.
5. *Hazard Mitigation Guidebook for Northwest Communities*, Federal Emergency Management Agency, Region 10, 1998
6. *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding*, Federal Emergency Management Agency, FEMA-312, 1998.
7. *Multi-Hazard Identification and Risk Assessment*, Federal Emergency Management Agency, 1997, 2000.

CHAPTER 6

EMERGENCY SERVICES

Emergency services measures protect people during and after a disaster. A good emergency services program addresses all hazards, not just flooding. At the state level, the Washington State Department of Emergency Management coordinates emergency response with the County and local authorities and the Department. North Bend's Emergency Operations Center, when activated, is staffed by various city employees and housed in the Public Works Department Building.

Emergency services measures include the following:

- 6.1 Threat recognition
- 6.2 Warning
- 6.3 Response
- 6.4 Critical facilities protection
- 6.5 Post-disaster recovery and mitigation

THREAT RECOGNITION

Threat recognition is the key. The first step in responding to a flood, storm, or other natural hazard is knowing that one is coming. Without a proper and timely threat recognition system, adequate warnings cannot be disseminated.

A flood threat recognition system provides early warning to emergency managers. A good system will predict the time and height of the flood crest. This can be done by measuring rainfall, soil moisture, and stream flows upstream of the community and calculating the subsequent flood levels.



On large rivers, including the Snoqualmie Rivers, the National Weather Service, which is part of the National Oceanographic and Administration (NOAA) does the measuring and calculating weather and stream parameters that are component parts of the overall flood threat and issues predictions.. Flood threat predictions are disseminated on the NOAA Weather Wire or NOAA Weather Radio. The federal government considers NOAA Weather Radio to be the official source for weather information.

King County provides funding to the United States Geological Survey (USGS) to support the operation and maintenance of river and stream gages and related systems on the Snoqualmie and other rivers in the County.

KING COUNTY FLOOD WARNING PROGRAM

The King County Flood Hazard Reduction Services Section of the Department of Natural Resources is responsible for carrying out programs and implementing projects that reduce flood damages and protect public safety along King County's major rivers. This includes a flood-warning program that impacts the North Bend area. When high water conditions are imminent, King County activates its Flood Warning Center.

Operation of the Center is based on a four-phase warning system, issued independently for each river. The thresholds for each phase are based on river gages, which measure the flow and stage (depth) of the major rivers in various locations. King County staff monitors the gages on a 24-hour basis, so that actions can be taken depending on river conditions. King County (KC) works closely with the National Weather Service to obtain forecast information used to make flood predictions. Close coordination occurs with the KC Office of Emergency Management, KC Roads, and other agencies such as North Bend's Emergency Operations Center to obtain up-to-date information about problems sites, road closures, evacuations and other emergency services. Coordination also occurs with the U.S. Army Corps of Engineers and Seattle Public Utilities regarding dam operations.

TABLE 6-1

Flood Warning Center Action

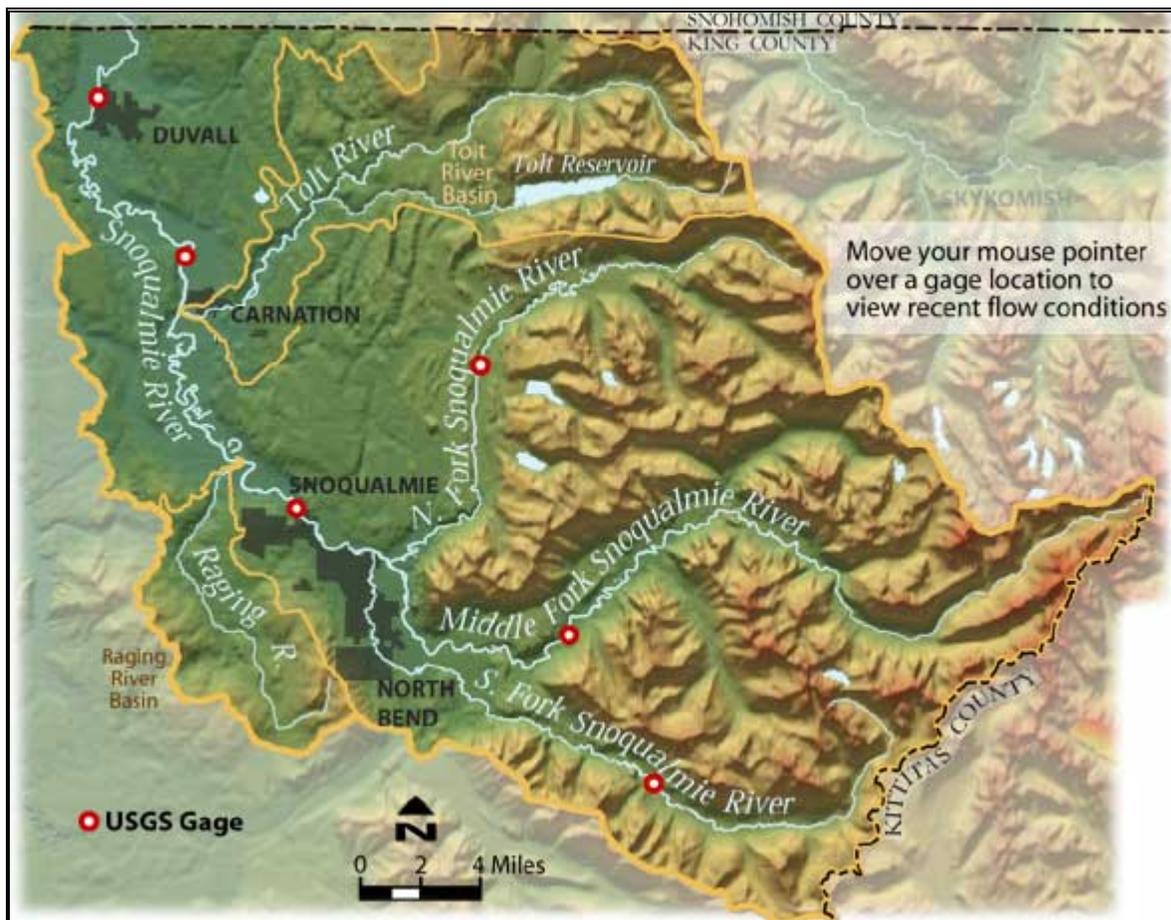
Flood Phase	Phase Threshold (Sum of the Forks)	Action
Phase 1	6,000 cfs	County personnel are put on alert, and preparations are made to open flood warning center
Phase 2	12,000 cfs	Flood warning center is opened. Staff monitor river gages around the clock and gage information is updated hourly on a recorded message (call (206) 296-8200 or (800) 945-9263
Phase 3	20,000 cfs	Investigation crews are sent out to monitor flood control facilities (such as levees
Phase 4	38,000 cfs	Warnings are issued to police, fire departments, schools, other agencies, and the public through news media and in some neighborhoods through volunteer telephone trees.

LOCAL IMPLEMENTATION

On the Snoqualmie Rivers, the U.S. Geological Survey maintains the Garcia and Tanner gages. The Garcia gage is located on the South Fork above Alice Creek near Garcia. The Tanner gage is located on the Middle Fork near Tanner.

FIGURE 6-1

USGS Gage locations



Real time stream data is reported on the Geological Survey's web site. This tells the user *current* conditions. In addition, at these two gages, the Weather Service is able to issue a specific *prediction* of when and how high the river will crest. The warning system provides at least 2 hours lead time before floodwaters reach damaging levels.

The NOAA Weather Wire is monitored by King County's Flood Warning Center for weather forecast and river crest predictions. The County relies on the U.S. Army Corps of Engineers and City of Seattle Public Utilities for dam operations, King County Department of Transportation for road closures, and flood patrols, local community and

citizen's observations for field conditions. The City relies on King County Flood Warning Center for up to date monitoring starting at Phase II flood levels.

The National Weather Service does not issue flood statements on smaller streams such as Gardiner, Ribary or Clough creeks. It may be hard to justify the expense of setting up a gage network to provide flash flood warnings on these streams. In the absence of a gaging system on small streams such as Ribary, Gardiner and Clough creeks, the best threat recognition system is to have local personnel monitor rainfall and stream conditions. While specific flood crests and times will not be predicted, this approach provides advance notice of potential local flooding.

CRS CREDIT

Up to 40 points could be received for the flood threat recognition. North Bend currently receives 75 points for using the King County Flood Warning System.

WARNING

After the threat recognition system tells the King County Flood Warning Center (KCFWC) that a flood or other hazard is imminent, the next step is to notify the public and staff of other agencies and critical facilities. The earlier and the more specific the warning, the greater the number of people who can implement protection measures. The National Weather Service issues notices to the public using two levels of notification:

Watch: conditions are right for flooding, storms, etc.

Warning: a flood, storm, etc. has started or has been observed.

The community in a variety of ways may disseminate a more specific warning. The following are the more common methods:

- Outdoor warning sirens
- Sirens on public safety vehicles
- NOAA Weather Radio
- Commercial or public radio or TV stations
- Cable TV emergency news inserts
- Telephone trees
- Door-to-door contact
- Mobile public address systems

Multiple or redundant systems are most effective: if people do not hear one warning, they may still get the message from another part of the system. Each has advantages and disadvantages. Outdoor warning sirens can reach the most people quickly, but they do not explain what hazard is coming and cannot be sounded unless a timely means of threat recognition exists. Radio and TV provide a lot of information, but people have to know to

turn them on. Telephone trees are also fast, but can be expensive and do not work when phones lines are down.

Just as important as issuing a warning is telling people what to do. A warning program should have a public information aspect. People need to know the difference between a winter storm warning and a flood warning and what to do in each type of hazard.

LOCAL IMPLEMENTATION

The City of North Bend Emergency Operations Center (EOC) disseminates warning information to the public and notifies key response personnel during an emergency. Communications are maintained with the county for the receipt of situation reports and monitoring the effects of, and response to, the emergency. King County provides flood warning information through a 24-hour telephone support system, press releases, a recorded information telephone line, the media, and the Internet.

The cities of North Bend and Snoqualmie jointly operate/share an AM radio station that normally broadcasts tourism information but is used during disasters to broadcast warning information to its citizens. Emergency alert signs are stationed in the cities at strategic locations to let people know when emergency information is being broadcast and the numbers of the station to tune into. The station can be used for live broadcasts or pre-programmed messaging.

RESPONSE

The protection of life and property is the most important task of emergency responders. Concurrent with threat recognition and issuing warnings, a community should respond with actions that can prevent or reduce damage and injuries. Typical actions and responding parties include the following:

- Closing streets or bridges (Police or Public Works)
- Activating the emergency operations center (Emergency Management)
- Shutting off power to threatened areas (Utility Company)
- Holding children at school/early release of children from school (School District)
- Passing out sand and sandbags (Public Works)
- Ordering an evacuation (Mayor/City Administrator)
- Opening evacuation shelters (Red Cross)
- Monitoring water levels (Public Works)
- Security and other protection measures (Police & Fire)

An emergency action plan ensures that all bases are covered and that the response activities are appropriate for the expected threat. These plans are developed in coordination with the agencies or offices that are given various responsibilities.

Planning is best done with adequate data. One of the best tools is a flood stage forecast map that shows what areas would be under water at various flood stages. Emergency management staff can identify the number of properties anticipated to be flooded, which roads will be under water, which critical facilities will be affected, etc. With this information, an advance plan can be prepared that determines what resources will be needed to respond to the predicted flood level.

Emergency response plans should be updated periodically to keep contact names and telephone numbers current and to make sure that supplies and equipment that will be needed are still available. They should be critiqued and revised after disasters and exercises to take advantage of the lessons learned and changing conditions. The end result is a coordinated effort implemented by people who have experience working together so that available resources will be used in the most efficient manner.

LOCAL IMPLEMENTATION

The *City of North Bend's Emergency Operations Plan* adopted in April of 1999 and updated September 2007, is set up as a multi hazard functional plan promoted by FEMA under its Civil Planning Guidance (FEMA CPG 1-8A). This plan establishes procedures to be followed for all types of natural and technological hazards. It establishes the Incident Command System, which sets up command structure and assigns responsibilities during a disaster, such as communications, evacuation, public health and safety, and media relations.

North Bend has the basis for preparing a flood stage forecast map that utilizes the best available data such as: topography, areas of historical flood inundation, updated hydrology, and GIS base mapping. The data reflected on a flood stage forecast map can be related to the elevations at the Tanner and Garcia gages in order to quickly identify which properties are affected at different flood forecasts issued by the National Weather Service. This allows for timely response on the part of North Bend's City services, and thus reduces the vulnerability to the flooding situation.

CRITICAL FACILITIES PROTECTION

The term "critical facilities" is not strictly defined by any agency but may include the following:

- Fire station
- Police station
- Hospital
- Schools
- Emergency operation center
- Water supply

- Treatment facilities
- Telephone exchanges and
- Hazardous materials facilities.

Protecting critical facilities during a disaster is the responsibility of the facility owner or operator. Providing that owner/operator notice that a flood is coming is the community's responsibility. If critical facilities are not prepared for an emergency, the rest of the community could be impacted. If a critical facility is damaged, workers and resources may be unnecessarily drawn away from other flood response efforts. If the owner or operator adequately prepares such a facility, it will be better able to support the community's emergency response efforts.

Most critical facilities have full-time professional managers or staff who are responsible for the facility during a disaster. These people often have their own emergency response plans. Washington State law requires hospitals, nursing homes, and other public health facilities to develop such plans. Many facilities would benefit from early flood warning, flood response planning, and coordination with community flood response efforts.

LOCAL IMPLEMENTATION

North Bend's critical facilities during a flood are those found in the following table. The EOC keeps an up to date list of major facilities (schools, public facilities, etc.) and their contacts and phone numbers.

TABLE 6-2

Critical Facilities (Flood)

Facility	Concern	Owner/Operator
Fire Station	Public Safety	City of North Bend
Police Station	Public Safety	City of North Bend?
Water Source Pump Station	Public Health	City of North Bend
Wastewater Treatment Plant	Public Health	City of North Bend
Bendigo Blvd. South	Transportation	City of North Bend/WSDOT
Two Rivers Alternative School	Public Safety	Snoqualmie Valley S. D.
North Bend Elementary	Public Safety	Snoqualmie Valley S. D.
North Bend Drycleaners	Chemicals	Private
Michael's Fine Drycleaning	Chemicals	Private
Texaco Gas Station	Gasoline	Private
Shell Gas Station	Gasoline	Private
Tesaro Gas Station	Gasoline	Private

Several of the private facilities, such as the Factory Stores, Mt Valley, and QFC may have their own emergency response plans. Frequent contacts are made between the Fire

Department and the facilities' owners. The Fire Department inspects all critical facilities at least annually.

POST-DISASTER RECOVERY AND MITIGATION

After a disaster, communities should undertake activities to protect public health and safety facilitate recovery and help prepare people and property for the next disaster. Throughout the recovery phase, everyone wants to get “back to normal.” The problem is, “normal” means the way they were before the disaster, exposed to repeated damage from future disasters.

Appropriate measures include the following:

RECOVERY ACTIONS

- Providing safe drinking water
- Clearing streets
- Cleaning up debris and garbage
- Patrolling evacuated areas to prevent looting
- Apply for post-disaster recovery funds
- Regulating reconstruction to ensure that it meets all current code requirements as necessary

MITIGATION ACTIONS

- Conducting a public information effort to advise residents about mitigation measures they can incorporate into their repair and reconstruction work
- Evaluating damaged public facilities to identify mitigation measures that can be included during repairs
- Acquiring substantially or repeatedly damaged properties from willing sellers
- Planning for long term mitigation activities
- Applying for post-disaster mitigation funds

Requiring permits, conducting inspections, enforcing the National Flood Insurance Program's (NFIP) substantial improvement/substantial damage regulations (see Section 4.5), and applying to FEMA and WEM for Public Assistance and Hazard Mitigation funding after declared disasters can be very difficult for local, understaffed overworked offices. If these activities are not carried out properly, not only does the municipality miss a tremendous opportunity to redevelop and improve damaged facilities or clear out a hazardous area, it may be violating its obligations under the NFIP.

CONCLUSIONS

1. The flood threat recognition system for the Snoqualmie Rivers works, as do the threat recognition procedures for the other quick onset hazards, such as winter storms.
2. The warning procedures and media are effective for the hazards faced by the City. Every warning should be accompanied by information on what people should do.
3. The slow onset of flooding in the past has allowed the North Bend to determine and implement response activities as the flooding occurs. A flood stage forecast map could be very helpful in identifying areas and facilities affected by a flood and in preparing pre-flood response plans.
4. The Emergency Operations Plan is a multi-hazard response plan and will provide specific guidance for individual hazards.
5. Emergency response planning should include those critical facilities that will be affected by various types of hazards. Floodprone critical facilities may need additional preparation for flooding by the Snoqualmie Rivers.
6. The Emergency Operations Plan will have guidance on North Bend recovery and reconstruction activities to be undertaken after a disaster. Detailed plans and procedures that coordinate these activities with public information activities and inspections of building repairs would better prepare North Bend and property owners to quickly take advantage of post-disaster mitigation opportunities.

RECOMMENDATIONS

1. North Bend should use its geographic information system (GIS) capabilities to prepare a formal flood stage forecast map for the Snoqualmie River floodplain. It should tie site elevations to predicted flood levels at the Tanner and Garcia gages.
2. North Bend should update and enhance its *Emergency Operations Plan* to include:
 - a. Maps that show areas and facilities affected at various flood levels;
 - b. Procedures that clarify when and how to issue a local flood warning;
 - c. A specific list of flood response activities by agency or department that will be utilized in the response and recovery effort;

- d. What critical facilities do various flood levels affect;
 - e. Procedures for providing early warning to threatened critical facilities;
 - f. What support is needed by the critical facilities;
 - g. Procedures and public information materials for post-disaster building inspections and identification of mitigation opportunities;
 - h. Resources needed to implement the planned actions.
3. Given the relatively small area, the City of North Bend could initiate a procedure of door-to-door warnings of predicted river flooding at phase IV. Only those properties threatened by the predicted flood level need be warned. The procedure should include handouts on appropriate safety, health and property protection steps.
 4. The City has implemented a public information program to encourage residents and businesses to advise them of the warning procedures and messages and what to do when warnings are issued.

REFERENCES

1. *CRS Coordinator's Manual, Community Rating System, FEMA, 2002.*
2. *CRS Credit for Flood Warning Programs, FEMA, 2002.*
3. *King County Flood Warning Center Procedures, 2002.*
4. *North Bend's Emergency Operations Plan, 4/99.*

CHAPTER 7

STRUCTURAL PROJECTS

BACKGROUND

Communities have traditionally used structural projects to control floodwaters. Structural projects keep floodwaters away from an area. They are usually designed by engineers and managed or maintained by public works staff. This section will review alternatives viable within the City of North Bend and identify structural approaches that meet the goals and objectives of this plan. It should be noted that it is the recommendation of the CAC to emphasize non-structural solutions in this plan. However, they do recognize that structural solutions can be the most cost-beneficial. This section will attempt to identify such projects.

Structural projects offer advantages not provided by other measures, but as shown below, they also have major shortcomings. The appropriateness of using structural flood control depends on individual project area circumstances.

TABLE 7-1

Pros and Cons of Structural Flood Control Projects

Advantages	Shortcomings
May provide the greatest amount of protection for land area used.	They disturb the land and disrupt natural water flows, often destroying wildlife habitat.
Because of land limitations, may be the only practical solution in some circumstances.	They require regular maintenance, which if neglected, can have disastrous consequences.
Can incorporate other benefits into structural project design such as water supply and recreational uses.	They are built to a certain flood protection level that can be exceeded by larger floods, causing extensive damage.
Regional detention may be more cost-efficient and effective than requiring numerous small detention basins.	They can create a false sense of security as no flood can ever reach them.
	Although it may be unintended, in many circumstances they promote more intensive land use and development in the floodplain.

Since structural flood control is generally the most expensive type of mitigation measure in terms of installation costs, maintenance requirements and environmental impacts, a thorough alternative assessment should be conducted before choosing a structural project.

In some circumstances smaller flood control measures may be included in a package of several recommended measures for a project area where non-structural measures would not be practical or effective.

Larger structural flood control projects have regional or watershed-wide implications and can be very expensive. Because of this, they are often planned, funded and implemented at a regional level by agencies or joint agencies, such as King County, Army Corp. of Engineers, FEMA, the Department of Transportation and the local communities. Over the years, numerous studies that reviewed structural alternatives have been conducted. Those reports that had recommendations impacting North Bend are as follows:

- King County Flood Hazard Reduction Plan, King County, 1993
- Channel Migration in the Three-Forks Area of the Snoqualmie River, King County, January 1996
- South Fork Tributaries Action Plan, June 15, 2001
- Draft City of North Bend Flood Damage Assessment, Benefit Cost Analysis, June 2003
- City of North Bend Comprehensive Stormwater Management Plan, currently being updated -2011.King County South Fork Snoqualmie River Gravel Removal Study, January 2011

REVIEW OF STRUCTURAL ALTERNATIVES

Under this section, review of structural alternatives available to reduce the impacts of flooding in North Bend is performed. The advantages, disadvantages, and local implementation are discussed under the following categories:

- Reservoirs/ Regional Detention
- Levees and Floodwalls
- Channel Improvements
- Bridges, Culverts and Roadways
- Drainage and Stormwater Improvements
- Drainage System Maintenance

RESERVOIRS/DETENTION

Reservoirs control flooding by holding high flows behind dams or in ponds. After a flood peaks, water is released or pumped out slowly at a rate that the river can accommodate downstream.

- Reservoirs are suitable for protecting existing development downstream from the project site. Unlike levees and channel modifications, they do not have to be built close to or disrupt the area to be protected.

- Reservoirs are most efficient in deeper valleys where there is more room to store water, or on smaller rivers where there is less water to store. Building a reservoir in flat areas and on large rivers may not be cost-effective, because large areas of land have to be purchased.
- Groundwater may also reduce storage capacity. Desirable site characteristics include, but are not limited to: attainability by floodwaters, impervious soil conditions, and a low water table.

On the other hand, reservoirs and detention basins can have the following disadvantages:

- There is a constant expense for management and maintenance of the facility
- They may fail to prevent floods that exceed their design levels.
- Sediment deposition may occur and reduce the storage capacity over time
- They can impact water quality, as they are known to affect temperature, dissolved oxygen and nitrogen, and nutrients
- If not designed correctly, they may cause backwater-flooding problems upstream
- Reservoirs rarely provide environmental/riparian benefit
- Depending on their location in the watershed, reservoirs and regional detention facilities can negatively impact downstream flows due to release timing and rate
- Topography, sedimentation and level of development may make it difficult to locate enough storage to consistently provide a 100-year level of protection

Local Implementation

At this time there are no regional flood control reservoirs upstream or in North Bend. This structural approach has not been recommended in any existing study or analysis. With the regional impact of the Endangered Species Act (ESA) and concerns regarding critical habitat for listed salmonids, this structural approach is an unlikely flood mitigation strategy at this time.

LEVEES AND FLOODWALLS

Probably the best-known flood control measure is a levee (barrier of earth) or floodwall (concrete) erected between the watercourse and the property to be protected. Levees and floodwalls confine water to the stream channel by raising its banks. They must be well designed to account for large floods, underground seepage, pumping of internal drainage, and erosion and scour.

Key considerations when evaluating use of a levee include:

- Provision of compensatory storage (compensating for the floodwater storage that will be displaced by the levee)
- Internal drainage of surface flows from the area inside the levee
- Cost of construction
- Cost of maintenance
- Regulatory issues associated with maintenance dredging
- Impacts to riparian habitat
- Barrier to river access and views
- The impact on riparian habitat
- Creating a false sense of security (while levees may reduce flood damage for smaller more frequent rain events, they may also overtop or breach in extreme flood events and subsequently create more flood damage than would have occurred without the levee)

Levees placed along the river or stream edge can degrade the aquatic habitat and water quality of the stream. They may push floodwater onto other properties upstream or downstream. To reduce environmental impacts and provide multiple use benefits, a setback levee (set back from the floodway) is a better option. The area inside a setback levee can provide open space for recreational purposes and access sites to the river or stream.

Floodwalls perform like levees except they are vertical-sided structures that require less surface area for construction. Floodwalls are constructed of reinforced concrete, which makes the expense of installation cost prohibitive in many circumstances. Floodwalls also degrade adjacent habitat and can displace erosive energy to unprotected areas of shoreline downstream.

Local Implementation

Flood protection by a levee has been a common approach in the City of North Bend. In the late 1960s and early 1970s, King County constructed a system of levees at various locations along the South Fork and Middle Fork of the Snoqualmie Rivers to protect the City of North Bend from frequent flooding. Recent analysis of these levees has determined that they do not meet FEMA's criteria for certification of flood protection specified under section 65.10 of 44CFR.

This recent analysis combined with the fact that there has been significant new development since the levees were constructed has drawn into question, their reliability for providing flood protection from the larger flood events typical of the Snoqualmie system. There is no question that these levees can provide a degree of flood protection. The question lies in the degree of flood protection they can provide, and the benefits versus the cost of enhancing that degree of protection.

There are various studies that have been performed on the South Fork levee system that have provided recommendations for this system. The City, King County and the Corp of Engineers have looked at the potential feasibility of maximizing flood protection at the least cost, with the least environmental and social impacts within the limits of a Section 205 authority. The proposed project selectively protects several housing developments on the left bank of the South Fork, and would remove or raise the homes, which may be the most severely flooded in the floodway of the Middle Fork Snoqualmie River. It does not alleviate all flooding for North Bend. Limiting the proposed project scope was predominately required to keep project costs within the limits of North Bend and King County's capabilities (Section 205 versus a General Investigation project). To date, the proposed project has not been implemented due to cost concerns.

Another potential alternative that has not yet been evaluated is to construct a set-back levee to replace the existing levee along the left bank of the South Fork Snoqualmie River between Bendigo Boulevard and North Bend Way. Such a setback levee could be constructed in conjunction with a new connector road that would extend South Fork Avenue SW north to North Bend Way, and would allow an expanded area of flood storage capacity between the new setback levee and the river. A challenge to this approach would be the relocation of Ribary Creek in this area. .

There are many unanswered questions regarding enhancement of the existing levee system, or the construction of new levee systems (i.e., set back levees) as a primary source of flood protection for North Bend. These questions will need to be answered by further study and analysis once the City's overall floodplain management policies and objectives are established by this plan.

CHANNEL IMPROVEMENTS

By improving channel conveyance, more water can be carried away at a faster rate. Improvements generally include making a channel wider, deeper, smoother or straighter. Some smaller channels in urban areas have been lined with concrete or put in underground pipes. This structural approach may allow the removal of some properties from the regulatory requirements of the NFIP.

Dredging/Sediment Removal

Is often viewed as a form of conveyance enhancement. However, it has the following problems:

- On the larger stream systems, removing a foot or two from the bottom of the channel will have little effect on flood heights given the large volume of water conveyed during flood event

- Dredging/sediment removal can sometimes be cost prohibitive because the dredged material must be disposed of somewhere
- This approach is maintenance intensive to preserve the increased conveyance capacity created
- If the channel has not been disturbed for many years, dredging will destroy habitat that has developed
- To protect the natural values of the stream, federal law requires a Clean Water Act--Section 404 Permit from the US Army Corps of Engineers and associated Endangered Species Act consultation with the National Marine Fisheries Service and US Fish & Wildlife Service. Other permits are also required such as an HPA from Fish and Wildlife, Shoreline Permit and any related King County permits before dredging could proceed. This can be a very lengthy process that requires much advance planning and many safeguards to protect critical habitat downstream of Snoqualmie Falls for species protected under the authority of the Endangered Species Act; i.e. Puget Sound Chinook, Steelhead and Bull Trout.

Straightening, deepening and/or widening a stream or river channel, commonly referred to, as “**channelization**” has traditionally been the common remedy for local drainage or flooding problems. Here are the concerns with this approach that need to be kept in mind:

- Channelized streams can create or worsen flooding problems downstream as larger volumes of water are transported at a faster rate
- Channelized streams rise and fall faster. During dry periods the water level in the channel is lower than it should be, which creates water quality problems and degrades habitat
- Channelized streams tend to be unstable and experience more stream-bank erosion. The need for periodic reconstruction and silt removal becomes cyclic, making channel maintenance very expensive
- On the other hand, channelization can be performed in a way that can provide significant environmental/riparian enhancement along with improved flood conveyance. However, these types of projects are often very costly and the extra cost for the environmental enhancement can result in an unfavorable benefit-cost ratio.

A **diversion** is a new channel that sends floodwaters to a different location, thereby reducing flooding along an existing watercourse. Diversions can be surface channels or overflow weirs. During normal flows, the water stays in the old channel. During flood flows, the floodwaters spill over to the diversion channel or overflow weirs, which carry the excess water to the receiving stream or river.

Diversions are limited by topography; they will not work in some areas. Unless the receiving water body is relatively close to the floodprone stream and the land in between is low and vacant, the cost of creating a diversion can be prohibitive. Where topography

and land use are not favorable, a more expensive channel or another mitigation measure may be needed.

Local Implementation

Varying degrees of structural approaches have and will be utilized in the City of North Bend. The South Fork Tributaries Action Plan (SoFTAP) identifies projects that utilize varying degrees of this approach (see 7.3.1). The Comprehensive Stormwater Management Plan, currently under revision (2011-12) also looks at utilization of these techniques in providing flood protection for localized flooding. The city has utilized sediment removal in some of the tributary streams to the Middle Fork since implementation of the 2004 edition of this plan.

In 2011, King County prepared a South Fork Snoqualmie River Gravel Removal Study. This study characterized sediment accumulation and related flooding conditions in the South Fork of the Snoqualmie River from the Bendigo Boulevard Bridge upstream approximately 1.6 miles to the 1-90 bridges. The study evaluated the potential effectiveness of removing alternative selected gravel bars that have accumulated within this reach. Depending on the outcome of further cost/benefit analysis of these alternatives, the County may decide to pursue a gravel removal project as a part of a broader flood damage reduction strategy in the North Bend vicinity.

The deciding factor for each of these types of projects will always be the availability of funding and the net cost of the project including permitting and maintenance costs versus the net benefits the project provides. These factors will be evaluated within the goals and objectives of this plan.

BRIDGES, CULVERTS, AND ROADWAYS

In some cases buildings may be elevated above floodwaters but access to the building is lost when floodwaters overtop local roadways, driveways, and culverts or ditches. Depending on the recurrence interval between floods, the availability of alternative access, and the level of need for access, it may be economically justifiable to elevate some roadways and improve crossing points.

For example, if there is sufficient downstream channel capacity, a small culvert that constricts flows and causes localized backwater flooding may be replaced with a larger culvert to eliminate flooding at the waterway crossing point such as Silver Creek and Ballarat Avenue N. The potential for worsening adjacent or downstream flooding should be considered before implementing any crossing or roadway drainage improvements.

Local Implementation

The City of North Bend completed replacing the culvert under Ballarat crossing Silver Creek to increase conveyance in 2004. This stream channel is also considered a floodway

on the April 2005 FIRMs. modeling of flood flows identified constricted flow on this stream. This project has had a favorable impact on flood conveyance. SoFTAP also identifies culvert enhancement projects in its recommendations.

There are two bridges crossing the South Fork Snoqualmie River within the city limits. DOT did a study on the Bridge over the South Fork at Exit 31 that determined conveyance capacity was decreased at this location during recent repair/replacement projects. Detailed studies have not been done to provide what the impacts may or may not be on the 10-25-50-100- and 500-year floods for each bridge across the South Fork, Ribary Creek or other culvert crossings. Further study of the bridges is needed to determine the viability of mitigating their impacts on flooding in North Bend. Widening of the opening beneath the Exit 31 Bridge over the Middle Fork Snoqualmie by moving the abutments landward has been identified as a priority project by the King County Flood Control Zone District and the City of North Bend.

It is a recommendation of this plan that the city considers/requires projects to elevate road surfaces above the base flood elevation.

DRAINAGE AND STORMWATER IMPROVEMENTS

Man-made swales and storm sewers help drain areas where the surface drainage system is inadequate, or where underground drainage ways may be safer or more practical. Stormwater improvements include installing new storm improvements, enlarging small pipes, and preventing backwater flows. Particularly appropriate for depressions and low spots that will not drain naturally, drainage and storm sewer improvements usually are designed to carry the runoff from smaller, more frequent storm events.

Because drainage swales and storm sewers convey water faster to other locations, improvements are only recommended for small local problems where the receiving stream or river has sufficient capacity to handle the additional volume and flow of water.

A combination of restored wetland functions, vegetated swales, infiltration trenches and other best management practices that increase infiltration (reducing runoff), and improve water quality have been implemented in conjunction with stormwater system improvements.

Local Implementation

The City of North Bend has developed and adopted a Comprehensive Stormwater Management Plan, currently under revision (2011-12) that will utilize varying aspects of this structural approach in its implementation (see 7.3.2)

DRAINAGE SYSTEM MAINTENANCE

The drainage system may include detention ponds, stream channels, swales, ditches and culverts. No two drainage systems are alike. Each drainage system has its own nuances that rely on topography, conveyances and development in need of a drainage system. Each jurisdiction can define its own drainage system by looking how stormwater is conveyed through its area. These conveyances may be streets, creeks, streams, irrigation canals, roadside ditches, or a combination of them all. Drainage system maintenance is an ongoing program to clear conveyance obstructions that prevent a defined drainage system from operating properly. It is the intent of maintenance to maintain a level of functionality of a drainage system such that property is not flooded. Maintenance is often impacted by state and federal regulations such as the Endangered Species Act.

“Debris” refers to a wide range of blockage materials that may include tree limbs and branches that accumulate naturally, or large items of trash or lawn waste accidentally or intentionally dumped into channels, drainage swales or detention basins. Maintenance of detention ponds may also require re-vegetation or repairs of the berm or overflow structure.

Maintenance activities normally do not alter the shape of the channel or pond, but they may affect how well the drainage system can do its job. It can be a very fine line that separates debris that should be removed from natural material that helps maintain habitat.

Government agencies usually accept responsibility for maintaining facilities on public property. However, in North Bend the responsibility for drainage system maintenance on private property, when no easements have been granted, is with the individual private property owner or homeowners associations. This generally often results in very little maintenance being accomplished. The city has the authority to respond to maintenance needs if there is an emergency or health/safety issue.

Local Implementation

North Bend maintains all public facilities and has responsibility over drainage systems under their jurisdiction. In the case of private detention ponds, a property owners' association or the owner is responsible for maintenance in residential developments or commercial properties.

North Bend’s Public Works Department inspects known “hot spots” at least bi-annually and after major storm events. Crews also respond to citizen complaints. There are formal maintenance procedures for open channels. These are updated as needed to comply with local, state, and federal requirements. The Comprehensive Stormwater Management Plan established an on-going maintenance program for its defined drainage system. Private property owners own most of the riverfront along the South and Middle Forks of the Snoqualmie River. Levee maintenance is the responsibility of King County.

STRUCTURAL RECOMMENDATIONS

The structural recommendation of this chapter will focus on two sources:

- South Fork Tributaries Action Plan
- City of North Bend Comprehensive Stormwater Management Plan (currently under revision in 2012)

These two programs have identified alternatives that can be implemented and are affordable. The resources to implement these recommendations have been identified and targeted. Two other sources of information will be sighted under this section: the Flood Damage Assessment and Benefit-cost Analysis, and the USACE North Bend 205 project. Both of these reports analyze alternatives dealing with the existing levees on the South Fork Snoqualmie River.

SOFTAP

The South Fork Tributaries Action Plan (SoFTAP) is a planning effort sponsored by King County Department of Natural Resources (DNR), in close coordination with the City of North Bend. The purpose of the study was to identify alternatives to reduce flooding impacts along 3 creeks, all tributaries to the South Fork of the Snoqualmie River in the North Bend vicinity: Clough Creek, Ribary Creek and Gardiner Creek. The recommendations in this report are based upon review of previous reports, field investigations, hydrologic and hydraulic analyses, sediment analysis, environmental review, public input and City and County staff input.

In general, all three creeks exhibit similar characteristics and flooding problems. Each has very steep headwater areas along Rattlesnake Mountain, which descend into steep alluvial fans characterized by rare, but potentially damaging, debris flows, shallow landslides, and channel migration. Recent residential development of the lower portions of these fans has prompted concerns over plugged culverts and channel shifting—particularly in Ribary and Gardiner Creeks.

SoFTAP identifies recommendations on all 3 creeks, summarized as follows:

- *Clough Creek:* Construct, operate, and monitor an 800-foot sediment trap along 415th Way. Several actions to avoid, minimize and/or mitigate aquatic impacts are recommended. Increase conveyance under I-90 with an additional culvert and/or reduce impacts due to a beaver dam/debris jam in the culvert through the King County levee downstream of I-90.
- *Ribary Creek:* In 2007, the existing sediment trap west of Ribary Way was modified with a more circuitous route to reduce the frequency of maintenance and to decrease the amount of sand and fine gravel

transported downstream of I-90. Channel capacity was increased between the two culverts under Bendigo Boulevard in 2011 by the excavation of approximately 1 foot of accumulated sediments between Mt. Si Boulevard and South Fork Avenue. Not yet implemented, the Plan also recommends the replacement and enlargement of two box culverts under Bendigo Boulevard and the consideration of a regulatory provision that requires new developments upstream of I-90 to provide a Professional Geologists or Engineering report and recommendation on the potential for debris flow, sediment transport, and channel instabilities.

- *Gardiner Creek:* In 2008, the City constructed a sediment trap immediately downstream of I-90. It is currently maintained and monitored by the City. Additionally, the downstream channel was restored, reshaped and increased in capacity in lieu of constructing two channels to switch back and forth over an estimated 5-year cycle. Not yet completed, the Plan also recommends the replacement/enlargement of culvert at NW 8th St. and the consideration of a regulatory provision that requires new developments upstream of I-90 to provide a professional Geologists or engineering report and recommendation on the potential for debris flow, sediment transport, and channel instabilities.

CITY OF NORTH BEND STORMWATER MANAGEMENT PLAN CURRENTLY UNDER REVISION

This plan consists of a comprehensive examination of the existing surface water management system, with primary focus on correcting local flooding and erosion problems, improving water quality, and preserving and enhancing valuable environmental resources such as wetlands, riparian corridors, and fish habitat. Through the use of field observations, results of past studies, hydrologic/hydraulic computer modeling, and input from City staff and a citizens advisory committee, the plan identifies existing problems and potential future problems within the study area. A combination of regulatory requirements, public education, increased maintenance activities, and capital improvements are recommended to solve the problems identified. The focus of this plan is limited to addressing flooding caused by localized storm events and inadequate and undersized stormwater conveyance systems. The major plan elements include the following:

- “Continued Implementation of the City’s Stormwater Management Ordinance.”
- Development of public education opportunities to inform the community of water quantity/quality issues
- Hydrologic and hydraulic computer modeling analysis of 6 major drainage basins in the City to simulate existing flows, project future flows, and evaluate system needs/requirements.

- Analysis of localized flooding and water quality problems and solutions, and development of a ranked list of drainage improvement needs
- Development of a prioritized Capital Improvements Program
- Development of program engineering, public education and program management activities
- Description/development of the overall program costs
- Analysis of funding options and the recommendation for implementing a new Stormwater utility

DRAFT FLOOD DAMAGE ASSESSMENT, BENEFIT-COST ANALYSIS

A cooperative study to assess flood damage potential in North Bend and to analyze the benefits versus the costs of alternatives was performed jointly by the City of North Bend, and the King County Conservation District. This study was adopted by the City of North Bend on August 20, 2002. The objectives of this study were:

- To estimate the annualized costs associated with flood damages under current conditions in the City.
- To develop flood mitigation alternatives and related conceptual designs.
- To conduct a preliminary benefit-cost analysis of each flood mitigation alternative, measuring their “relative” cost-effectiveness of each alternative.
- To attempt to maximize riparian habitat preservation, restoration or creation as well as mitigate flood impacts to the existing built environment.

Four alternatives were examined:

1. Relocation of structures to locations outside the floodplain.
2. Elevation of structures above the predicted 100-year flood elevation.
3. Construction of a levee to protect the downtown area from flooding by the Middle Fork of the Snoqualmie River.
4. Construction of an overflow channel to protect the Silver Creek neighborhood and the downtown area from flooding on the Middle Fork.
5. Expanded analysis to include the annexed areas.

The results of the 2004 analysis are summarized in Table 7-2.

TABLE 7-2

Benefit-Cost Analysis Summary

Alternative	Annualized Benefit (\$1,000s)	Annualized Cost (\$1,000s)	B/C Ratio
Remove Structures	110	394	0.28
Elevate Structures	98	67	1.47
Construct Levee	327	123	2.66
Construct Channel	900	929	0.97

It was the conclusion of this analysis that it appears there are economically viable flood protection options for North Bend. It also found that there were many parameters not reflected in this analysis that could impact the result either in a favorable way or a negative way. It was the recommendation of the CAC that these alternatives needed further study and analysis once policies and recommendations of this plan were identified.

NORTH BEND 205 PROJECT

This project has been a cooperative flood damage reduction project among the Corps of Engineers (USACE), King County and the City of North Bend. The project has evaluated the costs of the various flood reduction options along the South and Middle Fork Snoqualmie Rivers in and around the City. The Corps completed reconnaissance level studies with feasibility and preliminary design work in 2004. Flood hazard mitigation projects ranging from levee repairs and enhancements to building acquisitions and elevations were identified. As of May 2012 To date, none of these projects have been implemented by North Bend through the 205 program, due to cost-benefit issues. King County would be the primary local sponsor of the Corps project and would share local project costs with the City of North Bend in the event that a cost-effective project alternative is developed.

Completion of the City's FMP has helped to establish City policy and preferences for flood reduction alternatives to be studied in more detail in the feasibility and design phases. The project was to be cost shared 50/50 between the Corps/locals in the feasibility phase and 65/35 in the design and construction phase. The project would provide significant flood damage reduction to areas along the South and Middle Fork Snoqualmie Rivers. Many of these areas have experienced significant flood damages, since. The 1990s high flow events have resulted in federally-declared disasters in King County on ten separate occasions.

CONCLUSIONS

The existing data evaluating structural alternatives impacting North Bend (especially those dealing with levees) are dated and do not reflect programmatic changes that could significantly impact the benefits and costs of structural alternatives. Program mandates such as: The Endangered Species Act, the NMFS National Flood Insurance Biological Opinion, King County Flood Hazard Reduction Plan Policies, and even the policies recommended by this plan could impact a structural alternative such that it will no longer be cost-beneficial. There are structural recommendations that are sound and are based on currently available science and technology (i.e., SoFTAP, Comprehensive Stormwater Management Plan). With these facts in mind, the CAC recommended the following:

- Emphasize non-structural solutions in this plan;
- Implement those structural recommendations that are based on best available science, are cost-beneficial, and meet the goals and objectives of this plan;
- Perform further analysis of those alternatives not based on best available data, reflecting all appropriate parameters that may impact their benefits and costs once they are established.

RECOMMENDATIONS

With these conclusions in mind, the following structural alternatives are recommended:

1. Implement the recommendations identified in the SoFTAP as funding becomes available;
2. Implement those capital projects identified in the Comprehensive Stormwater Management Plan and subsequent updates;
3. Re-evaluate levee alternatives once policies have been established by this plan if deemed viable and appropriate;
4. Work with King County and the USACE to implement a flood protection program consistent with the recommendations of this plan under the Corp 205 program if a cost effective project and an affordable funding plan can be devised.

CHAPTER 8

NATURAL RESOURCES PROTECTION

Natural resource protection activities are generally aimed at preserving (or in some cases restoring) natural areas. In so doing, these activities enable the naturally beneficial functions of floodplains and watersheds to be better realized. These natural and beneficial floodplain functions include the following:

- Storage of floodwaters
- Absorption of flood energy
- Reduction in flood scour
- Infiltration that absorbs overland flood flow
- Groundwater recharge
- Removal/filtering of excess nutrients, pollutants, and sediments from floodwaters
- Habitat for flora and fauna and wildlife
- Recreational and aesthetic opportunities

These measures are implemented by a variety of public and private parties ranging from local park districts, forest preserves and regulatory agencies to land developers and farmers. This section reviews six natural resource protection activities. Integrating these activities into mitigation programs will not only reduce the community's susceptibility to damage, but will also improve the overall environment and help North Bend to meet goals of Federal and State mandated environmental laws such as the Endangered Species Act, the National Marine Fisheries Service (NMFS) 2008 Biological Opinion regarding implementation of the National Flood Insurance Program in Washington, and the Clean Water Act.

1. Wetland protection
2. Erosion and sedimentation control
3. River restoration
4. Best management practices
5. Dumping regulations
6. Urban forestry

WETLAND PROTECTION

Wetlands are often found in floodplains and depressional areas of a watershed. Many wetlands receive and store floodwaters, thus slowing and reducing downstream flow rates. They also serve as a natural filter, which helps to improve water quality, and provide habitat for many species of fish, wildlife, and plants.

The U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency under Section 404 of the Clean Water Act regulate wetlands. Before a "404" permit is issued, the applications are reviewed by several agencies, including the Corps, NMFS and the U.S. Fish and Wildlife Service (USFWS). Each of these agencies must sign off on individual permits. There are also nationwide permits that allow small projects that meet certain criteria to proceed without individual permits.

Generally, preventing development that will adversely affect them protects wetlands. If a permit is issued, the impact of the development must be mitigated. Wetland mitigation can include creation, restoration, enhancement or preservation of wetlands. The appropriate type of mitigation is addressed in each permit depending on the nature of the impact.

Selection of the mitigation is important to avoid drawbacks if the mitigation action is to develop an equivalent or larger wetland on a different site or enhance another wetland. First, it takes many years for a new wetland to approach the same quality as an existing one, thus temporarily depleting the functional benefits of having a wetland. Second, a new wetland in a different drainage basin will reduce the flood protection benefits provided by the impacted wetland in the original basin.

- Wetlands**
- Store large amounts of floodwater
 - Reduce downstream flood peaks
 - Reduce flood velocities
 - Protect shorelines from erosion
 - Filter water making it cleaner
 - Are groundwater recharge and discharge sites
 - Provide habitat for species that cannot live or breed anywhere else

LOCAL IMPLEMENTATION

The identified wetlands in the city are shown on the wetlands map (Figure 1 of the Critical Areas Ordinance).

There are other ways to protect wetlands besides development regulations. Educating property owners and local officials on the benefits and methods of protecting wetlands pays off through public support in later land use decisions that address their protection. There are some excellent public information materials, such as "Living with Wetlands". Also, the City has purchased environmentally sensitive tracts of land for the purpose of preservation of wetlands and sensitive riparian and floodplain habitat. This has come about with the assistance of Conservation Futures grants from King County.

CRS CREDIT

The Community Rating System focuses on activities that directly affect flood damage to insurable buildings. However, there are credits for preserving or restoring creditable open space parcels in their natural or beneficial state. The City's acquisition of Meadowbrook Farm qualified for this credit.

EROSION AND SEDIMENTATION CONTROL

Farmlands, clear-cut areas, and construction activities typically contain large areas of bare exposed soil. Surface water runoff can erode soil from these sites, sending sediment into downstream waterways. Erosion also occurs along stream banks as the velocity of flow or wave action destabilizes and washes away the soil.

Sediment suspended in the water tends to settle out where flowing water slows down. Similarly, in urban areas, it can clog storm sewers, drain tiles, culverts and ditches and reduce their conveyance capacity. As sediment builds up, the conveyance and storage capacities of the rivers, streams, piped systems, and wetlands are reduced causing backflow and greater flooding.

Not only are the streams, creeks, and drainage channels less able to do their job, but also the sediment in the water also reduces light, oxygen, and water quality and often brings along other pollutants. Sediment has been identified as the nation's number one non-point source pollutant for aquatic life⁸⁻¹. Suspended sediment results in turbid water that can harm fish. Deposited silt and sediment can also be harmful to fish habitat.

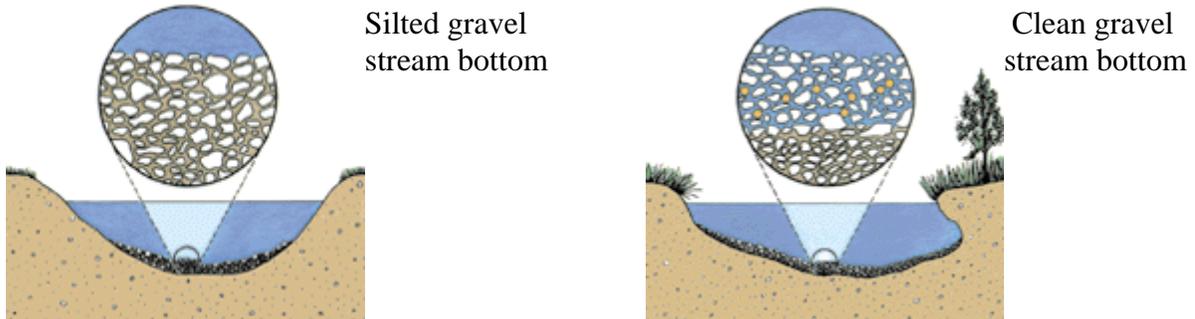
Some of the harmful impacts of silt and sediment deposits are:

- The small spaces between gravel particles become clogged, preventing the free flow of oxygenated water and the removal of waste products from developing eggs deposited in the gravels. This often suffocates the eggs and results in their death. In fact, it may even make gravel beds unsuitable for the future incubation of eggs.
- The habitat of bottom dwelling organisms such as crayfish and insects is destroyed. Fish rely on these organisms for food.
- The sheltered areas between boulders and gravel particles are eliminated. Young fish need these areas to survive.

⁸⁻¹ EPA-841-f-94-005, 1994

FIGURE 8-1

Sediment Impacts on Streams



There are two principal strategies to address these problems: minimize erosion and control sedimentation.

- Techniques to minimize erosion include phased construction, restricting the timeframe for construction to dry periods such as May thru September, minimizing land clearing, and stabilizing bare ground as soon as possible with vegetation and other soil stabilizing practices, and/or change erosion and sedimentation control regulations to decrease those construction activities that are exempt from regulation.
- If erosion occurs, other measures are used to capture sediment before it enters a drainage course. Silt fences, sediment traps/basins and vegetated filter strips are commonly used to control sediment transport.

Erosion and sedimentation control regulations mandate that these types of practices be incorporated into construction activities. Plans for such construction practices are generally required to be developed along with development plans and submitted for review and approval by the permitting agencies.

LOCAL IMPLEMENTATION

The City has adopted the most recent King County Surface Water Design Manual (most recently updated in 2009) as minimum standards for soil erosion and sediment control.

These standards require that cleared/graded areas must be temporarily covered if the areas are to remain un-worked for more than 7 days during the dry season and 2 days during the wet season. Areas to remain un-worked for more than 30 days are to be seeded or sodded. Steep areas such as embankments, stockpiles, and slopes with more than 10 feet vertical drop must be covered if they are to remain un-worked for more than 12 hours during the wet season.

Enforcement is important therefore on-going inspections are required. The city may require the developer to agree to more stringent performance standards depending on the complexity of the site.

CRS CREDIT

The Design and Construction Standards, erosion and sedimentation control provisions currently qualify for 30 points.

RIVER RESTORATION

There is a growing environmental movement that has several names, such as “stream conservation,” “bioengineering” or “riparian corridor restoration.” The objective of this movement is to return streams, stream banks, and adjacent land to a more natural, pre-developed condition, including natural meanders. Another term is "ecological restoration" which restores native indigenous plants and animals to the disturbed area.

A key component of these efforts is to use appropriate native plantings that deter erosion along the banks of streams. This may involve “retrofitting” the streambank or shoreline with willow cuttings, wetland plants, and/or landscape material covered with a natural fabric that decomposes after the banks are stabilized with plant roots. In all, restoring the right vegetation to a stream has the following advantages:

- Reduces the amount of sediment and pollutants entering the water
- Enhances aquatic habitat by shading and cooling water temperature
- Provides food and shelter for all types of wildlife
- Can reduce flood damage by slowing the velocity of water
- Increases the scenic characteristics that North Bend values
- Increases property value
- Prevents property loss due to erosion
- Provides recreational opportunities (hunting, fishing, bird watching)
- Reduces long term stream bank maintenance costs

Streambank Vegetation Zones, based on the frequency of submersion, identify various sections and functional areas of a stream bank. Different types of plants are used in these different buffer zones along a channel. Zone 1 plants are normally submerged. Zone 2 plants are inundated during much of the growing season. Zone 3 plants are water tolerant, but are flooded only during high water. By using the proper plants in each zone, stream enhancement projects can stabilize stream banks, filter polluted runoff, and provide habitat. Source: *A Guide to Selecting Native Plants for Stream banks and Shorelines*.

LOCAL IMPLEMENTATION

There have been several stream bank restoration projects completed in the North Bend area.

- Ribary Creek and Forster Woods Sediment Pond were initiated as streambank stabilization and sediment pond projects.
- The City has sponsored streambank stabilization projects along Ribary Creek at Tollgate Farm, along Gardiner Creek at Meadowbrook Farm, and
- South Fork Snoqualmie River at Riverfront Park and at Tollgate Farm.
- King County has also done bank restoration and stabilization projects on the South and Middle Fork Snoqualmie River.

The restoration objectives were to stabilize eroding channel banks and to remove excessive debris and non-native trees and shrubs that were shading out under-story vegetation and blocking flows. After clearing undesirable woody vegetation, combinations of “soil bio-engineering” techniques were installed to stabilize the stream banks. Treatments ranged from vegetative stabilization in the least severe erosion zones, to the installation of evolving techniques in combination with native vegetation and erosion blankets on more severely eroded banks. All of the stabilized sites have successfully withstood severe flooding conditions.

BEST MANAGEMENT PRACTICES

Point source pollutants come from pipes such as the outfall of a municipal wastewater treatment plant. The U.S. and Washington Environmental Protection Agencies regulate them. *Non-point source* pollutants come from non-specific locations, such as sheet flow off of yards, meadows, pastures, and forestlands, and are harder to regulate.

Examples of non-point source pollutants are lawn fertilizers, pesticides, and other farm chemicals, animal wastes, oils from street surfaces and industrial areas and sediment from agriculture, construction, mining and forestry. These pollutants are washed off the ground's surface by stormwater and flushed into receiving storm sewers, ditches and streams.

The term “best management practices” (BMP's) refers to construction and maintenance practices that minimize the impact of stormwater runoff rates and volumes, prevent erosion, protect natural resources and capture non-point source pollutants (including sediment). In addition to preventing increases in downstream flooding and minimizing water quality degradation, BMPs preserve beneficial natural features onsite, maintain natural base flows, minimize habitat loss, and provide multiple uses of drainage and storage facilities.

BMP's can be implemented during construction activities and as part of a project's maintenance to permanently address non-point source pollutants. There are three general ways do this:

- Avoidance: Setting construction projects back from the stream and implementing pollution prevention practices for activities on a project site.
- Reduction: Eliminating existing sources of pollutants or re-vegetating existing stream banks to enhance stream protection functions.
- Cleanse: Stopping pollutants after they are en-route to a stream, such as using grass drainage ways that filter the water and retention and detention basins that let pollutants settle to the bottom before they are drained.

In addition to improving water quality, BMPs can have flood related benefits. By managing runoff, they can attenuate flows and reduce the peaks during a storm. Combining water quality and water quantity measures can result in more efficient multi-purpose stormwater facilities. This is an example of a newer approach called "alternative site design."

CRS CREDIT

The CRS provides credit for regulations that require developments of 1 acre or larger to include in the design of their Stormwater facilities appropriate "best management practices" that will include the quality of surface water. North Bend is currently receiving points for this element.

DUMPING REGULATIONS

BMPs usually address pollutants that are liquids or suspended solids in day-to-day storm water runoff. Dumping regulations address heavier solid matter, such as shopping carts, appliances and landscape waste that can be accidentally or intentionally thrown into channels or wetlands. Such materials may not pollute the water, but they can obstruct even low flows and reduce the channels' and wetlands' abilities to convey stormwater.

Many cities have nuisance ordinances that prohibit dumping garbage or other "objectionable waste" on public or private property. Waterway dumping regulations need to also apply to "non-objectionable" materials, such as grass clippings or tree branches, which can kill ground cover or cause obstructions in channels. Regular inspections to catch violations should be scheduled.

Many people do not realize the consequences of their actions. They may, for example, fill in the ditch in their front yard not realizing that it is needed to drain street runoff. They may not understand how regrading their yard, filling a wetland, or discarding leaves or branches in a watercourse can cause a problem to themselves and others.

Therefore, a dumping enforcement program should include public information materials that explain the reasons for the rules as well as the penalties.

LOCAL IMPLEMENTATION

Other than a nuisance provision, the City of North Bend does not have specific ordinance language prohibiting dumping in channels, drainage ways or wetlands. In the update to the regulations following this plan completion, additional language to these effects will be added.

CRS CREDIT

The CRS provides up to 30 points for enforcing a regulation that prohibits dumping in the drainage system.

CONCLUSIONS

1. Improving water quality and natural habitats, expanding open space, and improving the quality of life in North Bend are goals of this *Plan*. Protecting natural resources, including wetlands, are important and effective measures to reach those goals.
2. A flood mitigation program can include protecting wetlands and natural floodplain functions and utilize natural resource protection programs to support flood protection.
3. The current regulations on wetland protection, erosion and sediment control, and best management practices, have effective standards are effective in meeting minimum state and Federal mandates. However, there is room to enhance these regulations as better science and new model programs evolve. These programs can be enhanced with multiple environmental objectives in mind, and as always, there is a need to ensure that they are properly enforced.
4. There are excellent examples of wetland protection and river and shoreline restoration in the area that demonstrate the benefits of these measures.
5. The City has an ordinance that prohibits dumping in wetlands or other parts of the drainage system.

RECOMMENDATIONS

1. The City should monitor and publicize area wetland and river restoration projects as a public outreach program for flood mitigation.

2. The City has stream and wetland dumping regulations. These should be reviewed and updated as needed.
3. The City should review its development ordinances and/or standards for best management practices to see if they should be strengthened in response to the NMFS NFIP Biological Opinion.
4. City procedures should be reviewed to close any gaps in enforcement of existing ordinances, such as ESA 4(d) coverage for maintenance programs.
5. The City should continue to enforce all development ordinances. Inspections for stream dumping, protection of buffers, and erosion and sediment control regulations should be incorporated into other code enforcement and drainage system maintenance inspections and procedures.

REFERENCES

CRS Coordinator's Manual, Community Rating System, FEMA, 2002
North Bend Municipal Code

2008 National Marine Fisheries Service Biological Opinion regarding implementation of the National Flood Insurance Program in Washington State; R10-08-132

CHAPTER 9

PUBLIC INFORMATION

A successful flood mitigation program involves both the public and private sectors. Public information activities advise property owners, renters, businesses, and local officials about flood hazards and ways to protect people and property. These activities can motivate people to take steps to protect the natural and beneficial functions of floodplains and watersheds. Six activities are covered in this chapter:

1. Map Information
2. Library and web sites
3. Outreach projects
4. Technical assistance
5. Real estate disclosure
6. Educational programs

MAP INFORMATION

Many benefits stem from providing map information to local property owners. Residents and businesses that become aware of the potential flood hazards can take steps to avoid flooding problems and/or reduce their exposure to flooding. Real estate agents and house hunters can find out if a property is floodprone and whether flood insurance may be required.

Flood maps have a wealth of information about past and potential flood hazards. However, they can be hard to obtain and many people have trouble reading maps. Therefore, communities like North Bend that provide map information from FEMA's Flood Insurance Rate Maps (FIRM's) and Flood Insurance Study provide a valuable public information service.

North Bend has aerial photography available from 1995 (Original upper Snoqualmie FIS imagery), 2004, 2007, and 2009 to use in conjunction with the current FEMA supplied Digital FIRM's (DFIRM) and the individual hardcopy FIRM panels for regulatory and informational purposes. Digital mapping data has been extracted and prepared from this aerial photography library in registration with the Washington State Plane Coordinate System. This allows the use of Geographic Information Systems (GIS) technology to accurately analyze and display (map) the relationships between structures, parcels, and many other physical environment features in relationship to FEMA FIRM maps. The city and its citizens benefit from having accurate mapping data available along with GIS abilities to use this data. Public safety is the greatest benefit provided by mapping and map related services.

North Bend may also assist residents in submitting requests for map amendments and revisions when they are needed to show that a building is outside the mapped floodplain.

North Bend may supplement what is shown on the April 19, 2005 FIRM with maps that complement and clarify the FIRM and information on additional hazards, flooding outside mapped areas and zoning. When the information is provided, city staff may also explain insurance, property protection measures and mitigation options that are available to property owners.

Users and inquirers need to remember that the flood maps are not perfect; they display only the larger floodprone areas that have been studied. North Bend maps were based on data that is more than 6 years old. In some areas, watershed developments render even recent maps outdated. City staff and map information service needs to remind inquirers that being outside the mapped floodplain is no guarantee that a property will never get wet.

In April 2005, FEMA, produced new Flood Insurance Rate Maps that show reported flood problems, including those not in the mapped floodplain. This updated floodplain information is presented in the City of North Bend's 2007 Comp Plan in Figure 2-2. The City's Comprehensive Plan also contains the North Bend Wetlands Inventory, King County's Channel Migration Area maps, and topographic maps from King Count, which are also available for public access.

LOCAL IMPLEMENTATION

Current and historical FIRM's are available to the public at all City of North Bend offices. The Public Works Department will help inquirers read the maps and obtain needed information, such as base flood elevations. The Community & Economic Development office staff will respond to development related inquires and understanding of the FIRMs. Additionally, the Mapping Technician can assist the public in creating individual Firmette Maps via the Internet.

CRS CREDIT

The Community Rating System provides 140 points for providing map information to inquirers. The service must be publicized and the community must keep the maps up to date.

LIBRARY AND WEB SITES

The community library and local websites are obvious places for residents to seek information on hazards, hazard protection, and protecting natural resources. Historically, libraries have been the first place people turn to when they want to research a topic. Interested property owners can read handbooks or other publications that cover their

situation. Libraries also have their own public information campaigns with displays, lectures, and other projects, which can augment the activities of the local government.

Today, websites are becoming much more popular as research tools. They provide quick access to a wealth of public and private sites and sources of information. Through links to other websites, there is almost no limit to the amount of up-to-date information that can be accessed by the user.

LOCAL IMPLEMENTATION

A branch of the King County Library is located in downtown North Bend. The library's catalog is available on their website (www.kcls.org) making searches for references easily accessible from home.

A search under the subject heading of "flooding" found many references. Some of them are pertinent to North Bend, and there are many listed that are educational references on property protection measures. There are many books on all hazards North Bend residents face such as flooding, winter storms, and earthquakes.

North Bend's website is used to keep users updated on the progress of the Flood Plan, the flood newsletter, flood outreach topics, and a link to King County's flood warning system. It also provides information on City offices and activities, frequently asked questions, codes and ordinances, and links to other agencies.

Another useful feature is that users can enter a street name and find where it is on a City map. When there's a current floodplain overlay available, users can quickly determine if a property is in or out of the floodplain. This could reduce staff time on map information in those instances when a site is close to the floodplain boundary.

The City of North Bend's website (www.northbendwa.gov) has information on flooding, stormwater management issues, property protection measures and other flood related information.

CRS CREDIT

The Community Rating System provides points for having a variety of flood references in the local public library.

OUTREACH PROJECTS

Outreach projects are the first step in the process of orienting property owners to property protection and assisting them in designing and implementing a project. They are designed to encourage people to seek out more information in order to take steps to protect themselves and their properties.

The most effective types of outreach projects are mailers or other forms of information distributed to both non-floodprone and floodprone property owners in the city. Other approaches include the following:

- Articles and special sections in newspapers
- Radio and/or TV news releases
- Hazard protection video for cable TV programs or to loan to organizations
- Presentations at meetings of neighborhood, civic or business groups
- Displays in public buildings or shopping malls
- Flood and other hazard open houses

Research has proven that outreach projects work. However, awareness of the hazard is not enough; people need to be informed as to what they can do about the hazard. So, projects should include information on safety, health and property protection measures. Research has also shown that a properly run local information program is more effective than national advertising or publicity campaigns. Therefore, outreach projects locally designed and tailored to meet local conditions are more beneficial.

LOCAL IMPLEMENTATION

The Fire Department has booklets that cover the basics on protection from fires and other hazards. The American Red Cross has a variety of brochures and publications on safety measures to take for fires, floods, winter storms, earthquake, etc. Their publications are tailored for different age groups. The Red Cross also conducts specialized programs on topics such as "home alone safety," first aid and CPR, and what to do during a disaster.

The City of North Bend has sponsored an annual "Flood Awareness Month" since 1999. This includes activities that were co-sponsored with the City of Snoqualmie and King County and others involved in flood hazard awareness and response. Half-day workshops on Elevation Certificate Training have been held for city staff, realtors, insurance agents, and surveyors.

Future events may include an evening open house program for the general public that include an overview of the City's flood hazard; an introduction of all of the local players in flood response, flood protection and mitigation; and "where to go" or "who to call" for help. As we progress into the electronic age, e-mail has become a viable method of public outreach in North Bend. Also, posting information on the city's web site can assist self-help citizens and reduce the City staff workload.

CRS CREDIT

The Community Rating System provides up to 380 points for outreach projects on flood topics. 125 of those points are for having a public information program strategy. This *Plan* qualifies for the strategy credit.

TECHNICAL ASSISTANCE

While general information helps, most property owners do not feel ready to retrofit their buildings without help or guidance. The city's building department staff can be a source of knowledge for construction techniques. They can provide free advice and steer the owner in the right direction. Because the staff must be independent reviewers of plans for any permitting process, staff cannot provide design services. Another party such as an architect or engineer must do this.

Building department or public works staff can visit properties and offer suggestions. Most can identify qualified or licensed companies for design or construction, an activity that is especially appreciated by owners who are unsure of the project or the contractor.

Technical assistance can be provided in one-on-one sessions with property owners or can be provided through seminars. For instance, seminars or "open houses" can be provided on retrofitting structures, selecting qualified contractors, and carrying out preparedness activities.

Public Works Department staff can make site visits to review local flooding or drainage problems and make recommendations on how they can be rectified.

LOCAL IMPLEMENTATION

The City of North Bend works closely with King County and the City of Snoqualmie in areas that experience flooding on a watershed or regional scale. The King County Health Department provides technical guidance related to septic system failure and well contamination.

CRS CREDIT

Up to 65 points are available for providing one-on-one flood protection assistance to residents and businesses and making site visits. This service must be publicized.

REAL ESTATE DISCLOSURE

Many times after a flood or other natural disaster, people say they would have taken steps to protect themselves if only they had known they had purchased property exposed to a flood hazard. Two regulations, one federal and one state require that a potential buyer of

a parcel be informed of the presence of a flood hazard prior to the purchase or the need for flood insurance.

Flood insurance is required for buildings located within the base floodplain if the mortgage or loan is federally insured. However, because this requirement has to be met only 10 days before closing, often the applicant is already committed to purchasing the property when he or she first learns of the flood hazard.

FEDERAL LAW

Federally regulated lending institutions must advise applicants for a mortgage or other loan that is to be secured by an insurable building that the property is in a floodplain as shown on the Flood Insurance Rate Maps (FIRM).

WASHINGTON STATE LAW

RCW 64.06.020 Washington Real Property and Conveyances, Seller's duty – format of disclosure Statement – Minimum information. This law, which went into effect on July 1, 1996, requires a seller to tell a potential buyer if the seller is aware of any settling, soil, standing water, or drainage problems, fill material on the property or if the property is located in a designated floodplain.

This State law is not wholly reliable because the seller must be aware of a problem and willing to state it on the disclosure form. Due to the sporadic occurrence of flood events, a property owner may legitimately not be aware of potential flooding problems with a property being sold or purchased.

Practices by local real estate boards can overcome the deficiencies of these laws and advise newcomers about the hazard earlier.

LOCAL IMPLEMENTATION

Local North Bend realtors follow the legal requirements. The shortcoming of this approach is that it is dependent on the seller, not on an independent check of the flood map. All Multiple Listing Service (MLS) entries read, "Flood insurance may be required." This does not provide any help in disclosing the flood hazard.

The City of North Bend requires that all subdivision plats must show whether any part of the subdivision is located in a Special Flood Hazard Area and be recorded as such. The same information is required for issuance of permits for construction of new buildings or "substantial improvements" for all properties in the floodplain. Existing elevation certificate information is also available.

CRS CREDIT

Up to 81 more points are available if real estate agents implemented a program that checked the FIRMs before a property was listed and provided the flood hazard information to house hunters. Ten points would be provided if local real estate agents gave out brochures that advised people to check out a property's hazards before they commit to a purchase.

EDUCATIONAL PROGRAMS

A community's most important natural resource is its children. These future generations will inherit the resources, infrastructure and development left to them. They will also be facing the same natural forces that cause periodic flooding, storms and other hazards. These watersheds and floodplains will be theirs to farm, build on and care for.

Environmental education programs can teach children about natural hazards, the forces that cause them, the factors that cause problems, and the significance of protecting the natural and beneficial functions of watersheds and floodplains. These programs can be undertaken by schools, park and recreation departments, conservation associations, and youth organizations such as the Boy Scouts, Campfire Girls and summer camps. An activity can be as involved as course curriculum development or as simple as an explanatory sign near a river.

There are many programs that provide support and curriculum materials for school and other educational programs. These include websites ("FEMA for Kids," USGS' "Water Science for Schools," etc.), posters, coloring books, games, and references.

Youth educational programs are not limited to children. Often adults learn about innovative concepts or new ideas from their children. If the children come home with an assignment for their new water quality-monitoring project, the parents become interested in finding out about water quality monitoring.

The Institute for Building and Home Safety is a nonprofit organization sponsored by insurance companies interested in reducing property losses from natural hazards. It has joined with the National Geophysical Data Center to sponsor a website (www.ibhs.org) that covers all hazards in addition to flooding.

CRS CREDIT

The Community Rating System credits educational activities under the outreach projects previous listed.

PUBLIC INFORMATION PROGRAM STRATEGY

After reviewing the possible and locally implemented public information activities covered in the previous sections, a Public Information Program Strategy was developed in cooperation with King County. Following the Community Rating System format, the strategy consists of the following parts:

1. The local flood hazard - discussed in Chapter 2 of this plan.
2. The flood safety and property protection measures appropriate for that hazard - discussed in Chapters 2 and 5 and on the previous page.
3. The flood-related public information activities currently being implemented within the community including those by non-government agencies - discussed in the previous paragraphs.
4. Goals for the community's public information program are covered in Chapter 3.
5. The outreach projects that will be done each year to reach the goals outlined.
6. The process that will be followed to monitor and evaluate the projects.

The last two parts of the strategy are in Chapter 10. By incorporating all of the parts into this plan, the City can implement a CRS-credited strategy with all of its other mitigation activities. Several exercises were conducted to identify the topics and media appropriate for North Bend's situation. The results of these are in the Recommendations section below.

CRS CREDIT

The Community Rating System provides 102 points for a public information program strategy.

CONCLUSIONS

1. There are many ways that public information programs can be used so that people and businesses will be more aware of the hazards they face and how they can protect themselves.
2. Most public information activities can be used to advise people about all hazards, not just floods.

3. City staff can implement some of the public information activities. By making a few changes and formalizing its activities, the City can earn nearly 500 points under the Community Rating System.
4. Other public information activities require coordination with other organizations, such as schools and real estate agents.
5. There are several area organizations that can provide support for public information and educational programs.

RECOMMENDATIONS

1. The following topics should be covered in public information activities. They are listed in priority order as recommended by the Staff/CAC.
 - a. Status of projects and what the City and other agencies are doing
 - b. Retrofitting a house or a business to protect it from floods and other hazards
 - c. Impact of flooding on the community, safety and health hazards
 - d. Emergency measures, evacuation, safety precautions for all hazards
 - e. Rules on building in the floodplain
 - f. Benefits of preserving and protecting wetlands and open space, beautifying the riverfront
 - g. Sources of assistance
 - h. Why it floods, history of flooding
 - i. Educating the public on the flooding problems facing Gurnee Grade School and the limitations of the flood protection alternatives.

The following media should be used to convey these messages. They are listed in priority order as recommended by the Citizen's Advisory Committee.

- a. City-wide newsletter
- b. Homeowner's flood protection handbook
- c. Technical advice from City staff
- d. Mass mailing to all floodplain residents
- e. Visits to a home by City staff
- f. Newspaper articles
- g. References available in the public library
- h. Park, Forest Preserve and School District educational programs
- i. The City's web site has been developed to include information and links to other sites to cover as many of the topics relevant to flooding issues as possible.

- j. Figure 2-2 of the City's 2007 Comprehensive Plan provides information regarding flood hazards throughout North Bend.

The City should develop these projects in close coordination with the other local jurisdictions, the School Districts, and the Red Cross.

REFERENCES

CRS Coordinator's Manual, Community Rating System, FEMA, 2002

CRS Credit for Outreach Projects, Federal Emergency Management Agency, 2003

CHAPTER 10

MITIGATION/ACTION PLAN

The culmination of this *Floodplain Management Plan* is this Mitigation/Action Plan. The general direction of the overall program is outlined here. Specific activities pursuant to the general direction are detailed in the following sections. These sections assign recommended projects and deadlines to the appropriate City offices.

A plan is worthless if there is no instrument for ensuring that it is carried out. Accordingly, City staff will need to periodically monitor the implementation of the *Plan*, report to the City Council on its progress, and recommend revisions to this *Plan* as needed.

The directions North Bend should follow to reduce its exposure to losses from floods are spelled out in this *Floodplain Management Plan*. This plan, in turn, will be linked to the King County Regional Hazard Mitigation Plan by reference as the flood element to the multi-hazard plan, North Bend Annex, developed pursuant to the requirements of the Disaster Mitigation Act. The overall directions of this Action Plan can be summarized under four general approaches:

1. Improve and administer regulations on new construction throughout the community, with special emphasis on floodplain development and protection of natural resources.
2. Implement appropriate measures such as acquisition, elevation, retrofitting and relocation, to protect human life and structures from flooding by the Snoqualmie Rivers and their tributaries.
3. Respond to floods and other natural hazards before they reach threatened areas.
4. Inform and involve the public in the implementation of this *Plan* and in protecting their health, safety and property.

It should be noted that these approaches and activities focus on the natural hazards faced by the City of North Bend. There are other activities planned and underway in North Bend and in the Snoqualmie River floodplain, such as supporting improvements to the downtown core. These activities should incorporate hazard mitigation measures and they should be coordinated with the action items recommended in this chapter.

This chapter summarizes the recommended floodplain management policies and programs that were developed by the Advisory Committee, City Staff, and adopted by City Council, and as reviewed and amended during the 2011 update to the Floodplain

Management Plan. The goal of these recommendations is to reduce current and future flood damages by regulating land use activities and development in flood hazard areas, by increasing public awareness and education, by improving emergency services, preserving natural resources, and by protecting existing structures from additional risk.

ACTION PLAN

General recommendations appear at the end of Chapters 4-9 for each of the six mitigation strategies. This section converts those general recommendations to specific action items. This section is organized based on the categorical strategy each initiative addresses. Under each action is a review of the advantages, disadvantages, time line, lead agency(s) to administer the action and the potential sources of funding. This action plan will then be further enhanced in the Action Plan Matrix below, which will list each initiative and establish a priority for its implementation. This matrix will be used to guide future policy decisions, plans, and regulations pertaining to floodplain management in North Bend.

PREVENTIVE ACTIVITIES

Increased Maintenance of Existing City Facilities

Description

This option reduces flooding by maintaining storage and flow capacity in detention facilities and the defined drainage system within North Bend. The City currently maintains a defined drainage system and this option would involve a program enhancement of the existing on-going program. Policies and procedures for maintenance should strive to adhere to guidelines established in the Routine Road Maintenance Program developed by the Washington State Department of Transportation (WSDOT) in collaboration with National Marine Fisheries Service and 24 local jurisdictions within the State of Washington.

Advantages

- Reduces flood loss
- Reduces impact on habitat
- If the maintenance plan is consistent with NMFS 4(d) protocols, implementation could reduce regulatory oversight

Disadvantages

- Requires staff time and equipment.
- Increased in cost due to the addition of new maintenance protocol requiring additional man-hours, equipment and costs for permitting and consultation.

- Limitations on maintenance activities due to environmental protection laws.

Time-Line

Short term/on going

Lead Agency

Public Works Department

Funding Source(s)

Stormwater utility: It is unknown at this time if current fees are sufficient to fund a program enhancement for maintenance. This would have to be determined by a feasibility analysis once enhanced policies and procedures are developed.

Require Freeboard of 1 Foot Minimum Above the BFE in Shaded X Zones (Other Flood Areas)

Description

This option requires by ordinance that new or substantially improved structures within the 500-year floodplain (Shaded “X” zone) have the top of the next higher floor, all electrical, heating, duct work, ventilation, plumbing, air conditioning and other service facilities be elevated to the flood protected elevation 1 foot above highest adjacent grade next to the building or be floodproofed to that elevation.

Advantages

- Reduces flood loss
- Provides for a factor of safety to account for the uncertainties in the hydrologic and hydraulic analyses and possible impacts from future development within the watershed
- Relatively inexpensive
- Contributes toward CRS points to help reduce flood insurance rates

Disadvantages

- Additional cost of development

Time Line

Short Term

Lead Agency

Public Works Department

Funding Source(s)

No additional cost to existing budgeted programs/Stormwater Utility.

Adopt Deep/Fast-Flowing Water Regulations.

Description

This regulatory option would expand the area to be regulated as a floodway. Would create a regulatory area based on a depth vs. velocity curve. Floodway regulations would then be applied to this area.

Advantages

- Reduces flood loss and potential threat to life and property
- Easily understood by the public
- Preserves conveyance
- Preserves the natural and beneficial functions of the floodplain
- Is consistent with State recommended policy (Residential floodway policy)
- Is a designation based on observed characteristics (depths vs. velocity)

Disadvantages

- Would require funding and staffing to determine this, which the City does not have on its own.
- Perceived as a potential reduction of use of the property; i.e. what happens to existing development in newly designated floodway areas?
- Establishing a regionally applicable (acceptable) depth/velocity curve
- Economic consequence for the property owner of additional analysis (ie, zero-rise)

Time Line

Short Term

Lead Agency

Public Works Department

Funding Source(s)

Cost for mapping of area of applicability, if needed. Stormwater Utility

Update Comprehensive Land Use Plan and Zoning Code

Description

Update the land use plan to reflect the physical realities of flooding in North Bend. Plan for development in “safer” areas. Utilize the Flood Plan as “best available data” in making land use recommendations in the Comp Plan and Zoning Code.

Advantages

- Provides for a realistic zoning and/or lower density zoning of property to reflect the hazards
- Promotes the development of property outside of hazard areas

Disadvantages

- Perceived as reduction in potential use of property

Time Line

Short Term/on-going

Lead Agency

Community and Economic Development Department

Funding Source(s)

No additional cost to existing budgeted programs. General Fund.

Update All Studies to Reflect ESA

Description

Update studies to reflect the impacts of ESA and the NMFS 2008 Biological Opinion regarding the implementation of the NFIP in Washington on the City of North Bend.

Advantages

- Provides for realistic recommendations and building standards and maintenance activities required by ESA
- Proactive with regard to what ESA may bring with future listings and actions
- Promotes the development of property outside of sensitive areas
- Provides a regionally specific study to guide North Bend Programs such that they are compliant with current and or future ESA mandates

Disadvantages

- Perceived as reduction in potential use of property
- Is it needed without evidence of species being impacted?
- Cost money for analysis

Time Line

Long term/on-going

Lead Agency

Community and Economic Development Department/Public Works

Funding Source(s)

General Fund, Stormwater Utility, WRIA (Watershed Resource Inventory Area) grant funding, Habitat Related Grants (HRG)

Transfer of Development Rights

Description

Transfer of Development Rights focus growth in urban areas where infrastructure and services such as sewer, water, and transportation exist or can be readily provided. This would allow residential densities to be transferred where appropriate. A permanent conservation easement would be placed on the sending site to maintain the property in uses consistent with the policy goals of the program. The City's current TDR program allows the transfer of development rights from lands that are in stream and wetland buffers, floodways, and channel migration zones, but the receiving area is currently only within the downtown core, which is located in the floodplain. The program could be expanded to allow additional areas outside of the floodplain to serve as receiving areas for development rights.

Advantages

Property owner's work together to develop land outside of the floodplain
Supports the City's planning policies to protect resource lands, fish and wildlife habitat, environmentally sensitive lands, provide open space, and preserve rural character
Preserves the natural and beneficial functions of the SFHA
Improves conveyance and storage
Consistent with King County's Transfer of Development Credit Program

Disadvantages

- Staff time to regulate
- Perceived as reduction in potential use of private property

Time Line

Short Term/on-going

Lead Agency

Community and Economic Development Department

Funding Source(s)

No additional cost to existing budgeted programs. General Fund.

Consistency with King County and City of Snoqualmie

Description

Update regulations for consistency with neighboring jurisdictions as required by GMA.

Advantages

- Consistency provides greater opportunity for preserving, restoring and regulating environmental issues throughout the watershed
- Recognizes community values
- Similar standards reduce conflict
- Compliant with state statute (RCW 86.12)

Disadvantages

- May increase the regulatory impact on property
- What is consistent?

- Who is the arbitrator?
- Are there penalties for not being consistent?

Time Line

Short Term/on-going

Lead Agency

Public Works Department/Community and Economic Development Department

Funding Source(s)

Stormwater utility

Continue Working with Neighboring Jurisdictions

Description

Solve problems by working together. This approach creates holistic, regional approach to managing floodplains and creates opportunity to cost-share by identifying other stakeholders within a watershed.

Advantages

- Reduces cost
- Consistency
- Opportunity to link with existing multi-jurisdictional programs such as the King County Regional Hazard Mitigation planning team WRIA programs, thus creating multiple tangible benefits
- CRS provides additional credit toward reduction in flood insurance for outreach projects.

Disadvantages

- May, at times be politically difficult
- May take more time due to increased coordination responsibility

Time Line

On-going

Lead Agency

All branches of North Bend City Government

Funding Source(s)

No additional cost to existing budgeted programs.

FEMA Map Updates/Additional Data

Description

Encourage FEMA to update as needed, the FIRM with additional study information which will result in more reliable data, mapping, flood elevations and predictions of velocity, whereby reducing risks to life and property. Require additional studies as needed for best available information when not available. Consider 2-dimensional modeling. Extend modeling, mapping and data collection to include newly annexed areas.

Advantages

- A better planning tool
- More realistic flood insurance rates
- Assists public information and awareness
- May reduce risk to life and property

Disadvantages

- May be expensive if not done cooperatively
- Not cost/beneficial
- No grant sources that will pay for this type of project

Time Line

Long Term

Lead Agency

Public Works Department

Funding Source(s)

Stormwater utility, benefit assessment, bond issue

Pursue All Avenues of Funding for Flood Hazard Reduction

Description

Reducing the flood hazards within the City of North Bend may be a very costly undertaking. The City should aggressively pursue outside sources of money to help defray the costs. These could include federal and state grant programs, low interest loans, cost sharing of projects with King County, the City of Snoqualmie, local developers and non-traditional sources of money that might be used for property acquisition.

Advantages

- Reduces the financial impact on the City
- Allows for the completion of more projects and the implementation of a more comprehensive program
- Can broaden the scope of the program to obtain outside sources of money

Disadvantages

- May cause the City to become involved in projects of uncertain value or that doesn't precisely fit for the community
- Costs associated with grant applications and the cost vs. benefits analysis of a project
- Identification of grant opportunities
- Most grants require a 'local match' - identifying or applying these matching funds can be difficult

Time Line

On-going

Lead Agency

All branches of North Bend City Government

Funding Source(s)

No additional cost to existing budgeted programs.

PROPERTY PROTECTION

Voluntary Flood-Proofing Program for Existing Structures

Description

This option would encourage property owners to voluntarily protect (flood-proof) existing structures to at least two feet above the BFE. The City would provide information on good techniques to use and where residents might go to obtain financial assistance.

Advantages

- Can reduce flood damage
- Voluntary program that might be funded by outside sources

Disadvantages

- Added program for City staff

Time Line

Long Term

Lead Agency

Public Works Department

Funding Source(s)

Majority of the cost for this initiative would be borne by the individual property owner. City could contribute by providing incentives discussed in Option 2 below.

Consider Incentive Program for Flood Hazard Mitigation

Description

This option would consider the creation of an incentive program to promote the voluntary mitigation of private property from the impacts of natural hazards that can impact North Bend. Incentives such as: building permit fee waivers, property tax incentives, low interest loans, insurance premium discounts, construction material discounts, have proven effective in encouraging private property owners to make mitigation a priority.

Advantages

- Promotes mitigation which eventually reduces vulnerability
- Requires communication with stakeholders as to the benefits of hazard mitigation
- Promotes awareness
- Helps to identify private sector planning partners

Disadvantages

- The potential loss of revenue depending on incentive used
- Choosing an incentive that will work and is fair and equitable and that is implementable by the City

Time Line

Short Term

Lead Agency

Public Works Department/Community and Economic Development Department

Funding Source(s)

Existing program budgets in those departments impacted could fund incentive program.

Willing Sellers Relocation of High Risk Structures

Description

This option permanently removes homes and businesses located in the SFHA. Structures at the highest risk of flooding should be highest on the priority list. These would be frequently flooded structures, those located in areas of deep and/or fast flowing water, or in identified channel migration zones.

Advantages

- Permanently reduces flood damages and the potential for loss of life
- Preserves storage and conveyance
- Open space
- May help restore the natural and beneficial functions of the floodplain
- CRS highly encourages and supports this effort providing large numbers of points toward lowering the CRS rating, which reduces flood insurance premiums

Disadvantages

- Costly, with or without grants
- May require land acquisition
- Spot acquisition can lead to land management problems (i.e. managing single lots in developed subdivisions)
- Dealing with prioritization perceptions

Time Line

Long Term

Lead Agency

Public Works Department

Funding Source(s)

Grant Funding: HMGP, PDM, FMA, FCAAP

Cost share: Storm Water Utility, Increase Cost of Compliance (ICC -Flood Insurance)

Willing Land Acquisition (Focus on High Risk Areas)

Description

This option acquires vacant land located in the floodplain or that could impact the floodplain (i.e. land within an area zoned for high density development that when developed could adversely impact flood conditions)

Advantages

- Maintains space for flood storage and conveyance
- Eliminates the possibility of future at risk construction and therefore, reduces the potential for future flood damages
- Could provide permanent riparian area
- Additional open space within the community
- May restore the natural and beneficial functions of the floodplain
- CRS highly encourages and supports this effort providing large numbers of points toward lowering the CRS rating, which reduces flood insurance premiums

Disadvantages

- Capital costs
- Managing the land once acquired
- Funding, most federal and state grants cannot be applied toward the purchase of vacant land

Time Line

Long Term

Lead Agency

Public Works Department

Funding Source(s)

Real Estate Excise Tax (REET), Conservation Futures, Trust for Public Lands, Habitat Related Grants (HRG)

Elevate Existing Structures at Risk

Description

This would promote the elevation of those structures at risk of flooding to a flood protection elevation.

Advantages

- Reduces the potential for future flood damages to the structure
- Reduces the risk to public health and safety
- Reduction in flood insurance premiums for insured properties
- Property owners with flood insurance policies can utilize a provision in their policy (ICC) that can be applied to the cost
- CRS highly encourages and supports this effort

Disadvantages

- Capital costs
- Monitoring post elevation compliance (i.e. conversion of areas below elevated floors to habitational uses)

Time Line

Long Term

Lead Agency

Public Works Department

Funding Source(s)

Grant Funding: HMGP, PDM, FMA, ICC (Flood Insurance), FCAAP
Cost share: Stormwater Utility.

Flood Insurance

Description

This option would continue the participation in the National Flood Insurance Program.

Advantages

- Provides for the availability of flood insurance
- Monetary benefits in case of flood damage to insured structures
- Maintains eligibility for other federally sponsored programs such as the Hazard Mitigation Grant program, Pre-Disaster Mitigation Grant program and the Flood Mitigation Assistance Grant program
- Maintains community compliance with NFIP regulations

Disadvantages

- Requires community to adopt and enforce floodplain regulations
- Cost associated with insurance premiums
- Maintaining community compliance with NFIP regulations

Time Line

On-going

Lead Agency

Public Works Department/Community and Economic Development Department

Funding Source(s)

No additional cost to existing budgeted programs.

Critical Facilities Protection

Description

Protect all critical facilities from suffering damages during a flood or the public from having reduced services. Facilities should be protected to at least 3 feet or more above the BFE. Access routes elevated to or above the level of the BFE shall be provided to all critical facilities to the extent possible. These facilities shall be allowed in SFHA's only if no feasible alternative site is available. Critical facilities include fire stations, police stations, hospitals, schools, emergency operation centers, water supply, and treatment facilities. (Existing city regulations)

Advantages

- Reduces the risk of damage to critical public facilities
- Reduces the loss of services to the citizens of North Bend

Disadvantages

- May require a significant capital outlay

Time Line

Long Term

Lead Agency

Public Works Department/Community and Economic Development Department

Funding Source(s)

Grant Funding: HMGP, PDM, FMA, FCAAP

Cost share: Water Fund, Sewer Fund, General Fund, and Stormwater Utility.

NATURAL RESOURCE PROTECTION

Maintain the Natural and Beneficial Functions of the SFHA

Description

This option would strive to preserve the natural and beneficial functions of open space parcels within the floodplain. Functions such as riparian habitat, wetlands, flood storage, flood conveyance, water quality, buffers, etc., are all considered beneficial functions of floodplains.

Advantages

- Maintains beneficial functions to prevent increased flood risk and a degraded environment
- Could provide permanent riparian area
- Preserves open space within the community
- Reduces 3rd party lawsuit exposure from ESA

Disadvantages

- May require stringent regulation, voluntary programs, staff training or capital cost

Time Line

Short Term

Lead Agency

Public Works Department

Funding Source(s)

No additional cost to existing budgeted programs. General Fund.

STRUCTURAL ALTERNATIVES

Provide Emergency Access and Evacuation Routes

Description

This option creates and maintains emergency access and evacuation routes during flood events. This could be accomplished by raising selected roadways within the City and/or the relocation of critical facilities out of the floodplain.

Advantages

- Improves road service
- Maintains access to homes, businesses, and critical facilities

Disadvantages

- May increase flood levels by reducing the amount of storage available (due to embankments) in the floodplain
- Major capital projects
- Potential wildlife and fisheries habitat impacts
- May require land acquisition

Time Line

Long Term

Lead Agency

Public Works Department

Funding Source(s)

Stormwater Utility, CIP funds, Infrastructure Assistance Coordinating Council (IACC) grant funding, DOT/TIB Funding, FCAAP, FEMA Post-Disaster Public Assistance mitigation measures.

Implement Prioritized Capital Improvement Projects Identified in the Stormwater Plan

Description

The City of North Bend's Stormwater Plan and its corresponding Capital Improvements Program for implementation has identified numerous projects that will have an impact on

flooding conditions in North Bend. This initiative supports the recommendations of this process and seeks alternative funding (i.e., grants) to augment the plan for implementation.

Advantages

- Coordinates the flood plan to other planning processes (CIP process)
- Identifies probable solutions for localized issues
- Heavy emphasis on benefits exceeding costs

Disadvantages

- Environmental impacts of structural solutions
- Maintenance
- Costs

Time Line

Short term

Lead Agency

Public Works Department

Funding Source(s)

Stormwater Utility, Grant Funding: FCAAP, WSDOT/TIB, PDM, HMGP

SOFTAP # 7/Eliminate Flood Overflows into Gardiner Creek

Description

Raise and improve Reif Road Levee or construct flood control berm along NW 8th Street and the Nintendo access road.

Advantages

- Reduces Gardiner Creek flows from 1080 cfs to 348 cfs
- Reduces base flood elevations up to 4 feet

Disadvantages

- Possible environmental impacts
- Maintenance

- Cost

Time Line

Long term

Lead Agency

Public Works Department

Funding Source(s)

Stormwater Utility, FCAAP

SOFTAP #2/Replace Ribary Creek Culverts and Dredge

Description

Replace Bendigo Boulevard South culverts with 20' x 5' box culvert (or equivalent).
Replace South Fork Avenue culvert with a 16' x 5' box culvert (or equivalent). Dredge 3,000 cubic yards of accumulated sediments from Ribary Creek from Mt Si Boulevard to 100 feet downstream of South Fork Avenue.

Advantages

- Provides sufficient capacity that 100-year flows will not flood Bendigo Blvd. South
- Reduces vulnerability to properties at risk
- Added protection to critical infrastructure

Disadvantages

- Possible environmental impacts
- Maintenance
- Cost

Time Line

Long Term

Lead Agency

Public Works Department

Funding Source(s):

Stormwater Utility, WSDOT, FCAAP

SOFTAP #8/Replace Gardiner Creek Culverts

Description

Widen channel at culvert entrance and replace existing 4-foot-diameter culvert at NW 8th with a 20' x 4' box culvert (or equivalent). Replace existing twin 3-foot-diameter culverts at Bendigo Boulevard North with a 16' x 4' box culvert (or equivalent).

Advantages

- Agency Coordination
- Prevent overtopping of Bendigo Boulevard by 100-year flows
- Reduces vulnerability to properties at risk
- Added protection to critical infrastructure

Disadvantages

- Possible environmental impacts
- Maintenance
- Cost

Time Line

Long Term

Lead Agency(s)

Joint project between Public Works and King County

Funding Sources

Stormwater Utility, WSDOT, FCAAP.

Levee Setback Together with South Fork Avenue SW Extension to North Bend Way

Description

Replace the existing levee on the left bank of the South Fork Snoqualmie River between Bendigo Boulevard South and West North Bend Way with a new setback levee that corresponds with a new road connection between those two roads.

Advantages

- Agency Coordination
- Significant additional flood storage capacity
- Reduces vulnerability to properties at risk
- Added protection to critical infrastructure
- Dual purpose with transportation improvements

Disadvantages

- Complexity of relocating or diverting flow of Ribary Creek
- Significant study and permitting requirements
- Maintenance
- Cost

Time Line

Long Term

Lead Agency(s)

Joint project between Public Works and King County

Funding Sources

Stormwater Utility, King County Flood Control Zone District, Transportation Benefit District

EMERGENCY SERVICES

Evacuation Plan

Description

This option creates an evacuation plan to be used when a flood event is imminent. This would be a portion of the City's Emergency Response Plan.

Advantages

- Reduces the risk of loss of life
- Prepares city and citizens to take advantage of the flood warning system
- Could be used during other emergencies.

Disadvantages

- Would require funds to create and administer

Time Line

Short Term

Lead Agency

Public Works Department, Police & Fire Department

Funding Source(s)

General Fund

Possible Department of Homeland Security grant funding for Emergency Management

Critical Facilities Planning

Description

This option focuses on warning and coordinating with the operators of identified critical facilities within North Bend. This warning and coordination will be in the form of a plan that will be an element of the flood plan mentioned under option #2.

Advantages

- Reduces the risk of damage to critical public facilities
- Reduces the loss of services to the citizens of North Bend

Disadvantages

- Cost to prepare plan

Time Line

Short Term

Lead Agency

Public Works Department, Community Services Department, the Fire and Police Departments

Funding Source(s)

General Fund

Possible DHS grant funding for Emergency Management

PUBLIC INFORMATION

Maintain the CRS Program

Description

This maintains the existing program that rewards floodplain management above and beyond the minimum requirements of the NFIP by lowering the cost of flood insurance premiums in participating communities.

Advantages

- Reduced flood damages through implementation of CRS activities
- Reduces the cost of flood insurance premiums
- Coordinates floodplain management at the local level
- Encourages public education

Disadvantages

- Cost to the City of maintaining the program

Time Line

Short Term/on going

Lead Agency

Public Works Department

Funding Source(s)

Stormwater Utility

Public Assistance/Information

Description

This option maintains the existing assistance program where citizens can come for information on hazards, funding programs, and activities they can undertake to reduce their risk.

Advantages

- Reduced flood damages through implementation of individual activities
- Assists interested property owners
- Informed public
- CRS credit toward reduced flood insurance premiums

Disadvantages

Small cost to the City for implementation

Time Line

Short Term/on going

Lead Agency

Public Works Department

Funding Source(s)

Stormwater Utility

Maintain/Enhance Public Outreach Program

Description

This option maintains an existing program to educate the public regarding flood hazards, the availability of flood insurance and/or flood protection methods.

Advantages

- Reduces life safety risks
- Reduces flood damages
- Public education
- CRS credit toward reduced flood insurance premiums

Disadvantages

- Costs to maintain the program

Time Line

Short Term/on going

Lead Agency

Public Works Department

Funding Source(s)

Stormwater Utility

The recommended policies summarized in this chapter are key to developing an effective floodplain management program in North Bend. Although conscientious floodplain policies address present citywide flooding issues and work toward preventing new flooding problems from occurring, they do not necessarily address the localized problems discussed in Chapter 8. The non-structural and structural alternatives described for each of the problem areas identified in Chapter 8 should be used as a starting point in developing effective solutions to each site-specific flooding problem. All of the potential capital improvement alternatives will need further study and analysis to assess their overall impacts on flooding and the environment, their cost and their benefits. In addition, the results of previous investigations and information from on-going studies, as they become available, should be synthesized to assist the City and the Advisory Committee in making informed decisions on these problem areas.

Several current studies will significantly add to the City's understanding of the flooding issues here in the city. These include:

- The revised Flood Insurance Study Issued April 2005
- The City of North Bend Stormwater Plan (currently being updated)
- The South Fork Tributaries Action Plan (SoFTAP)
- The Draft North Bend Benefit/Cost Analysis completed July 2002
- The Corp 205 study being considered, in cooperation with King County
- King County's Channel Migration Study
- King County's Flood Hazard Reduction Plan
- The King County Regional Hazard Mitigation Plan
- The King County Biological Effects Analysis Report
- The 2011 King County South Fork Snoqualmie River Gravel Removal Study

It is a recommendation of the flood plan that these studies are used as best available information until further information is available. The SoFTAP plan should be updated to include the required technical information for its inclusion in the FIS and FEMA flood maps. A study of the Ribary Creek/Kimball Creek connection should be considered as a potential relief of flooding related issues in the South Fork Interchange.

Implementation of the policies and programs should be undertaken by the City of North Bend immediately following the adoption of this plan. Many can be easily implemented by staff in a short period of time and should be completed within a reasonable time frame.

ACTION PLAN MATRIX

The following matrix illustrates all the key parameters to effective implementation of the action plan discussed. This matrix will illustrate the following:

- Action
- Lead Agency
- Estimated Cost
- Priority
- Potential Funding Sources
- Time Line
- Goals/Objectives the Action Addresses

At the end of the matrix is an explanation of how priorities were established. All actions identified that may be eligible for project grant funding under the Hazard Mitigation Grant Program (HMGP), Predisaster Mitigation Grant Program (PDM), Flood Mitigation Assistance Grant Program (FMA) and the Flood Control Account Assistance Program, will require a detailed cost/benefit analysis prior to the grant application to assure the benefits exceed the cost of the project. The priorities established have taken into account the *estimated* costs versus benefits in establishing the priority. The benefits versus costs are only one of five parameters utilized in establishing priorities.

**CITY OF NORTH BEND
FLOODPLAIN MANAGEMENT PLAN ACTION PLAN MATRIX**

Initiative #	Action	Lead Agency	Estimated Cost	Priority	Potential Funding Source	Time Line	Comments
Preventive Activities							
1	Increase Maintenance - Existing Facilities (swales, bridges etc)	Public Works	*Unknown	Medium	Stormwater Utility	Short Term OG	Goals: G-1, G-2 Objectives: O-2, O-3 *Can be funded by Stormwater utility, but may require a rate increase
2	Req. Freeboard of 1' Min. Above BFE, Areas Outside SFHA	Public Works	No additional cost to existing programs	High	General Fund	Short Term	Goals: G-1, G-2, G-4 Objectives: O-1, O-2, O-9 Can be addressed via CAO update
3	Deep/Fast Flowing Water Regulations	Public Works	Estimate \$10,000 for mapping area of applicability	Medium	General Fund/ Stormwater Utility	Short Term	Goals: G-1, G-2, G-4 Objectives: O-1, O-2, O-9 Public Works to delineate area of applicability including recently annexed areas and develop regulations
4	Update Comprehensive Land Use Plan	Community Services	No additional cost to existing programs	High	General Fund	Short Term OG	Goals: G-1, G-2, G-3, G-4, G-5 Objectives: O-1, O-2, O-3, O-4, O-5, O-6, O-7, O-8, O-9, O-10, O-11, O-12 GMA Process
5	Update all Studies to Include ESA Requirements and NMFS BiOp regarding NFIP implementation in Washington	Community Services/ Public Works	TBD Cost unknown due uncertainty of ESA impact in N. Bend	Medium	General Fund Stormwater Utility WRIA funding Habitat related grants	Long Term OG	Goals: G-3, G-4 Objectives: O-2, O-3, O-4, Best Available Science
6	Transfer of Development Rights	Community Services	No additional cost to existing programs	Complete	General Fund	Short Term OG	Goals: G-1, G-2, G-4, Objectives: O-1, O-2, O-3, O-9
7	Consistency with King County/City of Snoqualmie Plans	Community Services/ Public Works	TBD	High	General Fund Stormwater Utility	Short Term OG	Goals: G-1, G-2, G-3, G-4, G-5 Objectives: O-1, O-2, O-3, O-4

**CITY OF NORTH BEND
FLOODPLAIN MANAGEMENT PLAN ACTION PLAN MATRIX – (Continued)**

Initiative #	Action	Lead Agency	Estimated Cost	Priority	Potential Funding Source	Time Line	Comments
8	Continue Working With Local/State/Fed Agencies	All Branches of N. Bend Gov.	No additional cost to existing programs	High	All applicable City revenue sources	OG	Goals: G-1, G-2, G-3, G-4, G-5 Objectives: O-1, O-2, O-4, O-8, O-9,
9	Floodplain Delineation Update FEMA map	Public Works	Estimate \$500,000	Low	Stormwater Utility General Fund	Long Term	Goals: G-4 Objectives: O-5 2-D modeling? Alternative sources of funding (grants) not identified
10	Pursue All Avenues of Revenue for Flood Hazard Reduction	All Branches of N. Bend Gov.	No additional cost to existing programs	High	General Fund	OG	Goals: G-1, G-2, G-3, G-4, G-5 Objectives: O-8, O-12
Property Protection							
1	Voluntary Floodproofing Program for Existing Structures.	Public Works	Estimate \$3,000 per Household	Medium	Majority of Cost to be borne by property owners. City contribution could be in the form of incentives.	Long Term	Goals: G-1, G-2, G-5 Objectives: O-2, O-5, O-12 Grant funding dependant on cost vs. benefit and funding availability. Majority of the cost for this initiative to be borne by property owners.
2	Consider Incentive Program (Permit fee waiver, tax credit) for Voluntary Retrofit of Existing Structures in the Floodplain.	Community Services/ Public Works	TBD*	Medium	Permit fees General Fund	Short Term	Goals: G-1, G-2, Objectives: O-1, O-2, O-8, O-9, O-12 Cost associated with this initiative would be revenue lost from incentive(s) initiated.

**CITY OF NORTH BEND
FLOODPLAIN MANAGEMENT PLAN ACTION PLAN MATRIX – (Continued)**

Initiative #	Action	Lead Agency	Estimated Cost	Priority	Potential Funding Source	Time Line	Comments
3	Willing Sellers Relocation of High Risk Structures	Public Works	TBD based on willing sellers	Medium	Grant Funding ICC Stormwater Utility	Long Term	Goals: G-1, G-2, G-3, G-5 Objectives: O-2, O-3, O-9, O-12 Stormwater utility funds & ICC, grants could be used to apply toward cost share. However, program would be dependant on grant funding.
4	Willing Land Acquisition (Focus on High Risk Areas)	Public Works	TBD based on land availability	Medium	REET, IAC KC Cons. Futures Trust for Public lands	Long Term	Goals: G-1, G-2, G-3, G-4, G-5 Objectives: O-2, O-3, O-8, O-9, O-12
5	Retrofit (elevate) Existing Flood Prone Structures	Public Works	\$35,000 Per House	Medium	Grant funding: FMA, HMGP, PDM, ICC FCAAP	Long Term	Goals: G-2, G-5 Objectives: O-2, O-3, O-8, O-9, O-12
6	Continue to Participate in the National Flood Insurance Program.	Public Works/ Community Services	No additional cost to existing programs	High	General Fund Stormwater Utility	OG	Goals: G-1, G-2, G-3, G-4, G-5 Objectives: O-5, O-8
7	Protection of Critical Facilities	Public Works/ Community Services	TBD	Medium	Grant funding General Fund Stormwater Utility	Long Term	Goals: G-2, G-5 Objectives: O-2, O-3, O-8, O-9, O-12
Natural Resource Protection							
1	Maintain the Natural & Beneficial Functions of the SFHA	Public Works	No additional cost to existing programs	High	Stormwater Utility	Short Term	Goals: G-1, G-2, G-3, G-4, G-5 Objectives: O-1, O-2, O-3, O-4, O-9, Can be addressed via SAO update

**CITY OF NORTH BEND
FLOODPLAIN MANAGEMENT PLAN ACTION PLAN MATRIX – (Continued)**

Initiative #	Action	Lead Agency	Estimated Cost	Priority	Potential Funding Source	Time Line	Comments
Structural							
1	Provide Emergency Access to Critical Facilities	Public Works	Estimate \$250,000	Medium	Stormwater Utility CIP funds IACC grant Funding DOT Funding	Long Term	Goals: G-1, G-2, G-4, Objectives: O-2, O-3, O-4, O-11,
2	Implement Prioritized Capital Improvement Projects Identified in the City of North Bend Stormwater Plan	Public Works	\$1,839,000	High	Stormwater utility to be augmented by eligible grant funding upon availability	Short Term	Goals: G-1, G-2, G-5 Objectives: O-4, O-8, O-9
3	SOFTAP# 7 Eliminate Flood Overflows into Gardiner Creek.	Public Works	\$50,000 to \$1,300,000	High	Stormwater Utility Possible WSDOT*	Long Term	Goals: G-1, G-2, G-5 Objectives: O-4, O-8, O-9 *Depending on Budget and WSDOT priority.
4	SOFTAP#2 Replace Ribary Creek Culverts and Gravel Removal	Public Works	\$386,000 to \$550,000	Medium	Stormwater Utility Possible WSDOT* FCAAP	Long Term	Goals: G-1, G-2, G-5 Objectives: O-4, O-8, O-9 *Depending on Budget and WSDOT priority.
5	SOFTAP #8 Replace Gardiner Creek Culverts	Public Works KCFHRS	\$115,000 to \$160,000	Medium	Stormwater Utility Possible WSDOT* FCAAP	Long term	Goals: G-1, G-2, G-5 Objectives: O-4, O-8, O-9 *Depending on Budget and WSDOT priority Joint project w/KCFHRS
6	Levee Setback	Public Works and King County	Estimate 3 million (not including streets)	High	Stormwater Utility, TIB (roadway portion), King Co. Flood Control Zone Dist.	Long term	Goals: G-1, G-2 Objectives: O-1, O-2, O-4, O-5, O-9, O-11

**CITY OF NORTH BEND
FLOODPLAIN MANAGEMENT PLAN ACTION PLAN MATRIX – (Continued)**

Initiative #	Action	Lead Agency	Estimated Cost	Priority	Potential Funding Source	Time Line	Comments
Emergency Services							
6	Develop an Evacuation Plan	PW/Fire/Police/CS Department	Cost included in Flood Response Plan	Medium	General Fund DHS Grant Funding	Short Term	Goals: G-2, G-5 Objectives: O-2, O-4, O-5, O-6, O-11 Emergency Response plan would include a critical facilities and evacuation element
7	Critical Facilities Planning	PW/Fire/Police/CS Department	Cost included in Flood Response Plan	Medium	General Fund DHS Grant Funding	Short Term	Goals: G-2, G-5 Objectives: O-2, O-4, O-5, O-6, O-11 Flood response plan would include a critical facilities and evacuation element
8	Join “Storm Ready” Program	Public Works	No additional cost to existing programs	High	Stormwater Utility	Short Term	Goals: G-2, G-5 Objectives: O-2, O-4, O-5, O-6, O-7,
Public Information							
1	Maintain CRS Program, Pursue Classification Improvement.	Public Works	No additional cost to existing programs	High	Stormwater Utility	OG	Goals: G-2, G-5 Objectives: O-2, O-4, O-5, O-6, O-7,
2	Public Assistance/Information	Public Works	No additional cost to existing programs	High	Stormwater Utility	OG	Goals: G-2, G-5 Objectives: O-2, O-4, O-5, O-6, O-7
3	Maintain/Enhance Public Outreach Program	Public Works	No additional cost to existing programs	High	Stormwater Utility	OG	Goals: G-2, G-5 Objectives: O-2, O-4, O-5, O-6, O-7

Definitions of Time-Lines and Priorities	
Time-Line	Definition
Short-Term	Project to be pursued and or implemented in 1 to 5 years
Long-Term	Project to be pursued or implemented within 5 to 10 years.
Priorities	Definition
High	Initiative will meet multiple goals and objectives. Estimated benefits exceed estimated costs. Initiative is technically feasible. Is a short-term project. Initiative is a short-term or ongoing project or will involve an enhancement to an existing program at current funding levels, or additional funding has be identified and secured.
Medium	Initiative will meet multiple goals and objectives. Estimated benefits exceed estimated costs. Initiative is technically feasible. Initiative is “grant eligible”, or a source of funding has been identified and initiative would meet all criteria of a high priority project once funding was secured. Is a short–term project or has been designated as a long-term project due to funding availability.
Low	Initiative meets at least 1 goal and objective, Initiative is technically feasible. Estimated benefits equal or exceed estimated costs. Initiative is a long-term project. Additional funding eligibility or availability is unknown, and completion of initiative is totally dependent on securing an additional source of funding.

ADMINISTRATIVE ACTIONS

This section reviews the additional action items that are needed to administer and support the recommendations of the Action Plan. As such, some are not related to specific goals, objectives or mitigation recommendations in the previous chapters.

PROGRAM OVERSIGHT

Description

Monitor implementation of the Action Plan and report on progress and recommended changes to the Mayor and Council. An annual evaluation of the plan's implementation is required for credit under the Community Rating System. A public information committee could be created to monitor and evaluate the public information strategy. The plan will also be updated on a 5-year cycle. This cycle will be established such that it coincides with the update cycle of the King County Regional Hazard Mitigation Plan, for which North Bend is a multi-jurisdictional planning partner.

Timeline

Short-term/on-going

September 1st each year: Submit the annual evaluation report to the Mayor and Council. This timing coincides with the plan evaluation report that must be submitted by October 1st of each year for CRS credit. A five-year update is also required for continuing credit of this *Plan* under the Community Rating System and for DMA compliance.

Budget

Staff time.

COMMUNITY RATING SYSTEM

Description

Continue compliance with the Community Rating System for flood insurance premium rate discounts for the community. Identify additional activities that should be implemented in order to receive higher classifications.

Timeline

Short-term/on-going (as required)

Budget

Staff time.

APPENDIX A

ACRONYMS

LIST OF ACRONYMS

BCE	Before Common Era
BCEGS	Building Code Effectiveness Grading Schedule
BFE	Base Flood Elevation
BMP	Best Management Practice
BN	Burlington Northern Railroad
CAC	Community Advisory Committee
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
CPG	Civil Planning Guidance
CPP	Countywide Planning Policies (King County)
CRS	Community Rating System
CSMP	Comprehensive Stormwater Management Plan (City of North Bend)
DFIRM	Digital Flood Insurance Rate Map
DMA	Disaster Mitigation Act
DMA2K	Disaster Mitigation Act of 2000 (Federal Government)
DNR	Department of Natural Resources (King County or State of Washington)
DRI	Disaster Recovery Initiative
EIS	Environmental Impact Statement
EKCRWA	East King County Regional Water Association
ESA	Endangered Species Act (Federal Government)
FCAAP	Flood Control Account Assistance Program (Washington State Department of Ecology).
FEMA	Federal Emergency Management Agency
FIMA	Federal Insurance and Mitigation Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance (Washington State Department of Emergency Management)
FMP	Flood Management Plan
GIS	Geographic Information System
GMA	Growth Management Act (Washington State)
HEC-RAS	Hydraulic Engineering Center River Analysis System Model (USACE)
HEMP	Hydraulic Engineering Management Plan
HMGP	Hazard Mitigation Grant Program
HPA	Hydraulic Project Approval (Washington State Department of Fish & Wildlife)
I-90	Interstate Highway 90
IACC	Infrastructure Assistance Coordinating Council
IBC	International Building Code
ICC	Interagency Coordinating Council
JARPA	Joint Aquatic Resource Permit Application
KCFWC	King County Flood Warning Center
MO	Model Ordinance

MRCI	Municipal, Residential, Commercial, and Industrial Development and Redevelopment (under ESA)
NBMC	North Bend Municipal Code
NEPA	National Environmental Policy Act (Federal Government)
NFIP	Nation Flood Insurance Program
NMFS	National Marine Fisheries Service (Federal Government)
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service (Federal Government)
PDM	
PUD	Planned Unit Developments
RCW	Revised Code of Washington
RM	River Mile
RPA	Reasonable and Prudent Alternatives
SAO	Sensitive Areas Overlay (City of North Bend)
SEPA	State Environmental Policy Act (Washington State)
SFHA	Special Flood Hazard Area
SoFTAP	South Fork Tributaries Action Plan
SR 202	State Route (highway) 202
TDR	Transfer of Development Rights
TIB	Transportation Improvement Board
UGA	Urban Growth Area
USACE	United States Army Corps of Engineers (Federal Government)
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation

APPENDIX B

2005 FLOOD BENEFIT/COST ANALYSIS

Available at the City of North Bend

APPENDIX C

**NFIP COMMUNITY RATING SYSTEM
LOCAL OFFICIALS GUIDE**

Available at the City of North Bend

APPENDIX D
SOFTAP REPORT

Available at the City of North Bend