CONCRETE SCHOOL DISTRICT
HAZARD MITIGATION PLAN

Effective

December 19, 2016

Concrete School District

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Concrete, Washington 98237

P - 360-853-4000

The 2016 Concrete School District's Hazard Mitigation Plan is a living document which will be reviewed and updated periodically.

Comments, suggestions, corrections, and additions are enthusiastically encouraged from all interested parties.

Please send comments and suggestions to:

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EXECUTIVE SUMMARY

The Concrete School District Hazard Mitigation Plan covers each of the major natural hazards that pose significant threats to the District.

The mission statement of the Concrete School District Hazard Mitigation Plan is to:

> Proactively facilitate and support district-wide policies, practices, and programs that make the Concrete School District more disaster resistant and disaster resilient.

Making the Concrete School District more disaster resistant and disaster resilient means taking proactive steps and actions to protect life safety, reduce property damage, minimize economic losses and disruption, and shorten the recovery period from future disasters. This plan is an educational and planning document that is intended to raise awareness and understanding of the potential impacts of natural hazard disasters and to help the District deal with natural hazards in a pragmatic and cost-effective manner.

Completely eliminating the risk of future disasters in the Concrete School District is neither technologically possible nor economically feasible. However, substantially reducing the negative consequences of future disasters is achievable with the implementation of a pragmatic Hazard Mitigation Plan.

Mitigation simply means actions that reduce the potential for negative consequences from future disasters. That is, mitigation actions reduce future damages, losses, and casualties. Effective mitigation planning will help the Concrete School District deal with natural hazards realistically and rationally. That is, to identify where the level of risk from one or more hazards may be unacceptably high and then to find cost effective ways to reduce such risk. Mitigation planning strikes a pragmatic middle ground between unwisely ignoring the potential for major hazard events on one hand and unnecessarily overreacting to the potential for disasters on the other hand.

This mitigation plan focuses on the hazards that pose the greatest threats to the District's facilities and people: Earthquake, flood, volcano, wildlife and urban interface fire and landslide. Other natural hazards that pose lesser threats are addressed briefly.

Table of Contents

1.0 INTRODUCTION: 5-13-2016

1.1 What is a Hazard Mitigation Plan?

The Concrete School District Hazard Mitigation Plan covers each of the major natural hazards that pose significant threats to the District.

The effects of potential future disaster events on the Concrete School District may be minor - a few inches of water in a street - or may be major - with widespread damages, deaths and injuries, and economic losses reaching millions of dollars. The effects of major disasters on a district and on the communities served by a district can be devastating: the total damages, economic losses, casualties, disruption, hardships, and suffering are often far greater than the physical damages alone.

The mission statement of the Concrete School District Hazard Mitigation Plan is to:

> Proactively facilitate and support district-wide policies, practices, and programs that make the Concrete School District more disaster resistant and disaster resilient

Making the Concrete School District more disaster resistant and disaster resilient means taking proactive steps and actions to protect life safety, reduce property damage, minimize economic losses and disruption, and shorten the recovery period from future disasters.

This plan is an educational and planning document that is intended to raise awareness and understanding of the potential impacts of natural hazard disasters and to help the District deal with natural hazards in a pragmatic and cost-effective manner. It is important to recognize that the Hazard Mitigation Plan is not a regulatory document and does not change existing District policies or zoning, building codes, or other ordinances that apply to the District.

Completely eliminating the risk of future disasters in the Concrete School District is neither technologically possible nor economically feasible. However, substantially reducing the negative consequences of future disasters <u>is</u> achievable with the implementation of a pragmatic Hazard Mitigation Plan.

Mitigation simply means actions that reduce the potential for negative consequences from future disasters: mitigation reduces future damages, losses, and casualties.

The Concrete School District mitigation plan has several key elements:

1. Each hazard that may significantly affect the Concrete School District's facilities is reviewed to estimate the probability (frequency) and severity of likely hazard events.
2. The vulnerability of Concrete School District to each hazard is evaluated to determine the likely severity of physical damages, casualties, and economic consequences.
3. A range of mitigation actions are evaluated to identify those with the greatest potential to reduce future damages and losses to the Concrete School District and that are desirable from the community's political and economic perspectives.

1.2 Why is Mitigation Planning Important for the Concrete School District?

Effective mitigation planning will help the Concrete School District deal with natural hazards realistically and rationally. That is, to identify where the level of risk from one or more hazards may be unacceptably high and then to find cost effective ways to reduce such risk. Mitigation planning strikes a pragmatic middle ground between unwisely ignoring the potential for major hazard events on one hand and unnecessarily overreacting to the potential for disasters on the other hand.

Furthermore, the Federal Emergency Management Agency (FEMA) now requires each local government entity to adopt a multi-hazard mitigation plan to remain eligible for future pre- or post-disaster FEMA mitigation funding. Thus, an important objective in developing this plan is to maintain eligibility for FEMA funding and to enhance the Concrete School District's ability to attract future FEMA mitigation funding.

Further information about FEMA mitigation grant programs is given in Appendix 1: FEMA Mitigation Grant Programs.

1.3 The Concrete School District Hazard Mitigation Plan

This Concrete School District Hazard Mitigation Plan is built upon a quantitative assessment of each of the major hazards that may significantly affect the Concrete School District, including their frequency, severity, and the campuses most likely to be affected. This assessment draws heavily on statewide data collected for the development of the Washington State K–12 Facilities Hazard Mitigation Plan and on additional district-specific data.

These reviews of the hazards and the vulnerability of Concrete School District to these hazards are the foundation of the District's mitigation plan. From these assessments, the greatest threats to the District's facilities are identified. These high risk situations then become priorities for future mitigation actions to reduce the negative consequences of future disasters affecting the Concrete School District.

The Concrete School District Hazard Mitigation Plan deals with hazards realistically and rationally and also strikes a balance between suggested physical mitigation actions to eliminate or reduce the negative consequences of future disasters and planning measures which better prepare the community to respond to, and recover from, disasters for which physical mitigation actions are not possible or not economically feasible.

1.4 Key Concepts and Definitions

The central concept of mitigation planning is that mitigation reduces risk. **Risk** is defined as the threat to people and the built environment posed by the hazards being considered. That is, risk is the potential for damages, losses, and casualties arising from the impact of hazards on the built environment. The essence of mitigation planning is to identify facilities in the Concrete School District that are at high risk from one or more natural hazards and to evaluate ways to mitigate (reduce) the effects of future disasters on these high risk facilities.

The level of risk at a given location, building, or facility depends on the combination of **hazard** frequency and severity plus the **exposure,** as shown in Figure 1 below.

Figure 1.1

Hazard and Exposure Combine to Produce Risk

Risk is generally expressed in dollars (estimates of potential damages and other economic losses) and in terms of casualties (numbers of deaths and injuries).

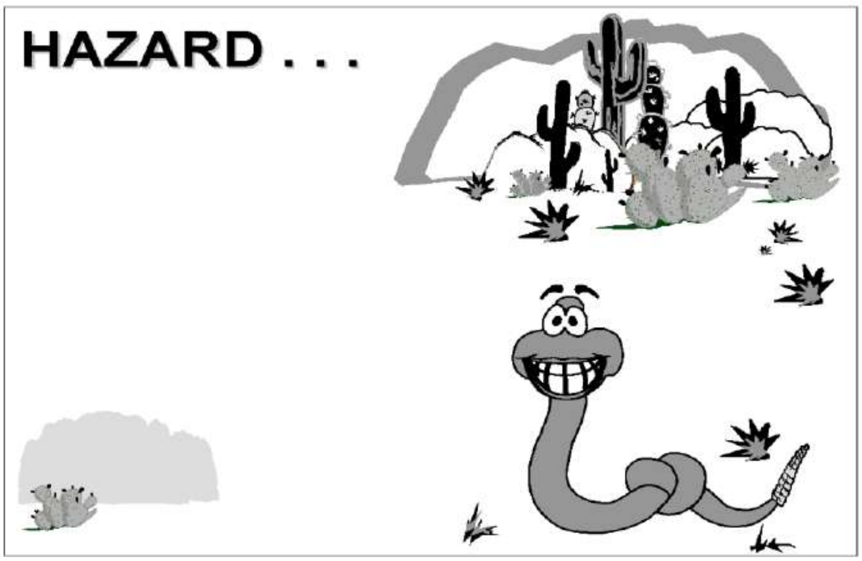
There are four key concepts that govern hazard mitigation planning: hazard, exposure, risk, and mitigation. Each of these key concepts is addressed in turn.

HAZARD refers to natural events that may cause damages, losses or casualties, such as earthquakes, tsunamis, and floods. Hazards are characterized by their frequency and severity and by the geographic area affected. Each hazard is characterized differently, with appropriate parameters for the specific hazard. For example, earthquakes are characterized by the probable severity and duration of ground motions while tsunamis are characterized by the areas inundated and by the depth and velocity of the tsunami inundations.

A hazard event, by itself, may not result in any negative effects on a community. For example, a flood-prone five-acre parcel may typically experience several shallow floods per year, with several feet of water expected in a 50-year flood event. However, if the parcel is wetlands, with no structures or infrastructure, then there is no risk. That is, there is no threat to people or the built environment and the frequent flooding of this parcel does not have any negative effects on the community. Indeed, in this case, the very frequent flooding (the high hazard) may be beneficial environmentally by providing wildlife habitat, recreational opportunities, and so on.

Figure 1.2

Hazard Alone Does Not Produce Risk



The important point is that hazards do not necessarily produce risk to people and property unless there is vulnerable inventory exposed to the hazard. Risk to people, buildings, or infrastructure results only when hazards are combined with an exposure to the hazard.

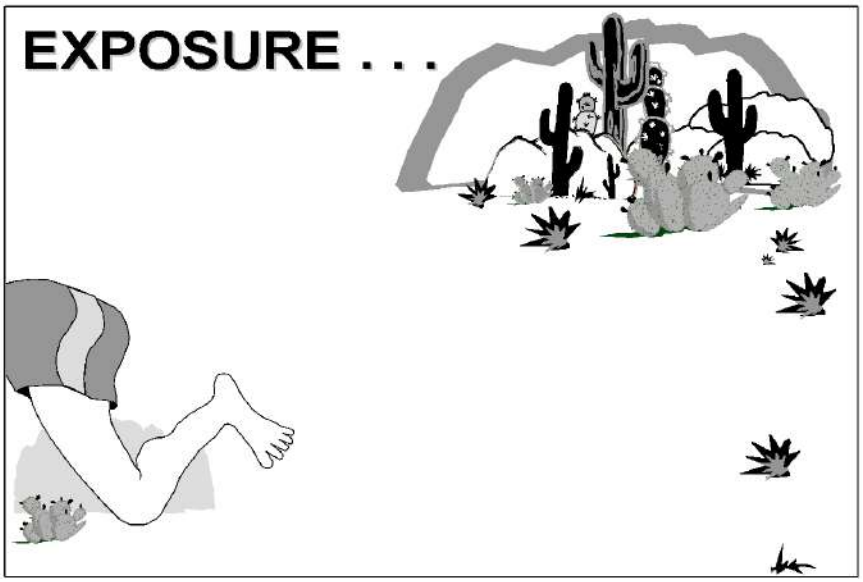
EXPOSURE is the quantity, value, and vulnerability of the built environment (inventory of people, buildings, and infrastructure) in a particular location subject to one or more hazards. Inventory is described by the number, size, type, use, and occupancy of buildings and by the infrastructure present. Infrastructure includes roads and other transportation systems, utilities (potable water, wastewater, natural gas, and electric power), telecommunications systems, and so on.

For the Concrete School District, the built-environment inventory of concern is largely limited to the District’s facilities. For planning purposes, schools are often considered critical facilities because they may be used as emergency shelters for the community after disasters and because communities often place a very high priority on providing life safety for children in schools.

For hazard mitigation planning, inventory must be characterized not only by the quantity and value of buildings or infrastructure present, but also by its vulnerability to each hazard under evaluation. For example, a given facility may or may not be particularly vulnerable to flood damages or earthquake damages, depending on the details of its design and construction. Depending on the hazard, different engineering measures of the vulnerability of buildings and infrastructure are used.

Figure 1.3

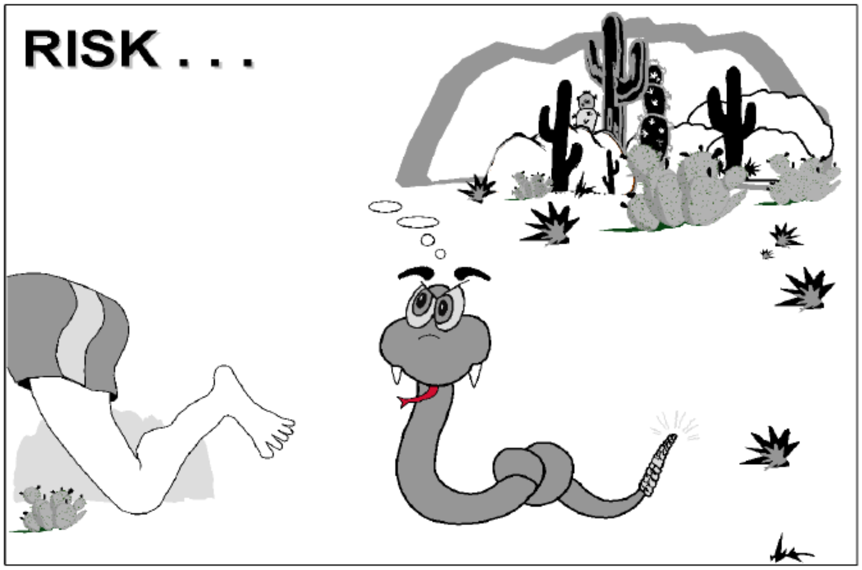
Exposure (Quantity, Value and Vulnerability of Inventory



RISK is the threat to people and the built environment - the potential for damages, losses, and casualties arising from hazards. Risk results <u>only</u> from the combination of Hazard and Exposure as discussed above and as illustrated schematically in Figure 1.4 below.

Figure 1.4

Risk Results from the Combination of Hazard and Exposure



Risk is the potential for future damages, losses, or casualties. A disaster event happens when a hazard event is combined with vulnerable inventory (that is when a hazard event strikes vulnerable inventory exposed to the hazard). The highest risk in a community occurs in high hazard areas (frequent and/or severe hazard events) with large inventories of vulnerable buildings or infrastructure.

However, high risk can also occur with only moderately high hazard if there is a large inventory of highly vulnerable inventory exposed to the hazard. Conversely, a high hazard area can have relatively low risk if the inventory is resistant to damages (such as strengthened to minimize earthquake damages).

MITIGATION means actions to reduce the risk due to hazards. Mitigation actions reduce the potential for damages, losses, and casualties in future disaster events. Repair of buildings or infrastructure damaged in a disaster is not mitigation. Hazard mitigation projects may be initiated proactively - before a disaster, or after a disaster has already occurred. In either case, the objective of mitigation is always to reduce future damages, losses, or casualties.

A few common types of mitigation projects are shown in Table 1.1 on the following page.

Table 1.1

Examples of Mitigation Projects

Hazard	Common Mitigation Projects
Earthquake	Structural retrofits for buildings
	Nonstructural retrofits for building elements and contents
	Replace existing building with new, current-code building
Tsunami	Enhance evacuation planning, including practice drills
	Build structure for vertical evacuation
Volcanic Hazards	Enhance evacuation planning, including practice drills
Floods	Flood barriers and other floodproofing measures
	Elevate at risk buildings
	Abandon campus at high risk (possible FEMA buyout) and build new campus outside of floodplain
Wildland/Urban Interface Fires	Enhance defensible space around buildings
	Fuel reduction measures near campus
	Improve fire resistance of existing buildings with non-flammable roofs and exterior finishes and other fire-safe measures
Landslides	Stabilize slopes with improved drainage and/or retaining walls.
Multi-Hazard	Replace vulnerable facility with new current-code facility, outside of high hazard zones when possible
	Obtain insurance to cover some damage/losses
	Enhance emergency planning, including drills
	Expand education/outreach to improve community understanding of natural hazards

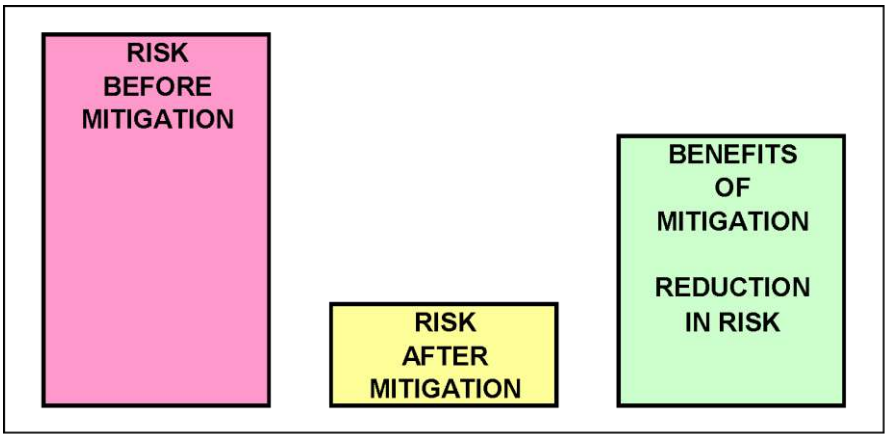
The mitigation project list above is not comprehensive; mitigation projects can encompass many other actions to reduce future damages, losses, and casualties.

1.5 The Mitigation Process

The key element for all hazard mitigation projects is that they reduce risk. The benefits of a mitigation project are the reductions in risk (i.e., the avoided damages, losses, and casualties attributable to the mitigation project). Benefits are the difference in expected damages, losses, and casualties before mitigation (as-is conditions) and after mitigation. These important concepts are illustrated on the following page.

Figure 1.5

Mitigation Projects Reduce Risk



Quantifying the benefits of a proposed mitigation project is an essential step in hazard mitigation planning and implementation. Only by quantifying benefits is it possible to compare the benefits and costs of mitigation to determine whether or not a particular project is worth doing (i.e., whether it is economically feasible). Real world mitigation planning almost always involves choosing between a range of possible alternatives, often with varying costs, and varying effectiveness in reducing risk.

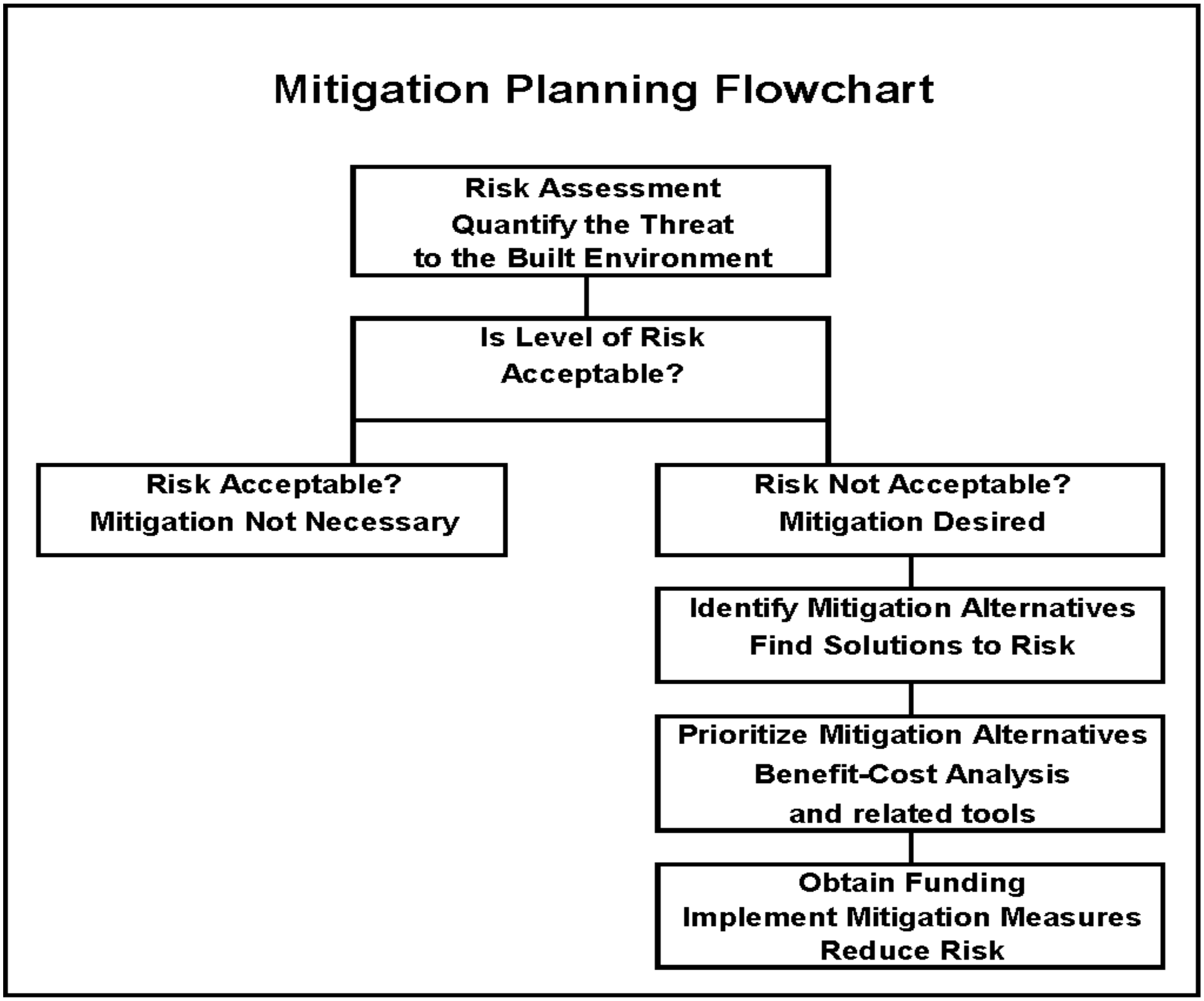
Quantitative risk assessment is centrally important to hazard mitigation planning. When the level of risk is high, the expected levels of damages and losses are likely to be unacceptable to the community and mitigation actions have a high priority: the greater the risk, the greater the urgency of undertaking mitigation.

Conversely, when risk is moderate both the urgency and the benefits of undertaking mitigation are reduced. It is neither technologically possible nor economically feasible to eliminate risk completely. Therefore, when levels of risk are low and/or the cost of mitigation is high relative to the level of risk, the risk may be deemed acceptable (or at least tolerable). Therefore, proposed mitigation projects that address low levels of risk or where the cost of the mitigation project is large relative to the level of risk are generally poor candidates for implementation.

The overall mitigation planning process is outlined in Figure 1.6 on the following page, which shows the major steps in hazard mitigation planning and implementation for the Concrete School District.

Figure 1.6

The Mitigation Planning Process



The first steps are quantitative evaluation of the hazards (frequency and severity) affecting the Concrete School District and of the inventory (people and facilities) exposed to these hazards. Together, these hazard and exposure data determine the level of risk for specific locations, buildings, or facilities in the Concrete School District.

The next key step is to determine whether or not the level of risk posed by each of the hazards affecting the Concrete School District is acceptable or tolerable. If the level of risk is deemed acceptable or at least tolerable, then mitigation actions are not necessary or at least not a high priority. There is no absolute universal definition of the level of risk that is tolerable or not tolerable. Each district has to make its own determination.

If the level of risk is deemed not acceptable or tolerable, then mitigation actions are desired. In this case, the mitigation planning process moves on to more detailed evaluation of specific mitigation alternatives, prioritization, funding, and implementation of mitigation actions. As with the determination of whether or not the level of risk posed by each hazard is acceptable or not, decisions about which mitigation projects should be undertaken can only be made by the Concrete School District.

1.6 The Role of Benefit-Cost Analysis in Mitigation Planning

Local government entities, such as the Concrete School District, that are considering whether or not to undertake mitigation projects must answer questions that don't always have obvious answers, such as:

> What is the nature of the hazard problem?
>
> How frequent and how severe are hazard events?
>
> Do we want to undertake mitigation actions?
>
> What mitigation actions are feasible, appropriate, and affordable?
>
> How do we prioritize between competing mitigation projects?
>
> Are our mitigation projects likely to be eligible for FEMA funding?

Benefit-cost analysis (BCA) is a powerful tool that can help communities provide solid, defensible answers to these difficult socio-political-economic-engineering questions. Benefit-cost analysis is <u>required</u> for all FEMA-funded mitigation projects, under both pre-disaster and post-disaster mitigation programs. However, regardless whether or not FEMA funding is involved, benefit-cost analysis provides a sound basis for evaluating and prioritizing possible mitigation projects for any natural hazard.

Further details about benefit-cost analysis are given in the Appendix 2: Principles of Benefit-Cost Analysis.

1.7 Hazard Synopsis

The following figure illustrates the relative level of risk from natural hazards for the six major hazards at the District's campus. These hazard levels are based on statewide GIS data and additional district-specific data entered into OSPI's ICOS PDM database.

Figure 1.7

Concrete School District: Major Hazards Matrix

STATE OF WASHINGTON

SUPERINTENDENT OF PUBLIC INSTRUCTION

DISTRICT PDM HAZARD SUMMARY

Concrete	**Earthquake**	**Tsunami**	**Volcanic**	**Flood**	**WUI**	**Landslide**
Administration Building	High	None**	Moderate	Low	High	Very Low
Concrete High School	High	None**	Moderate	Low	High	Moderate - High
Concrete K-6 School	High	None**	Moderate	Low	High	Moderate - High

All of the Concrete School District's facilities have substantial earthquake risk.

The probability of volcanic events from Mount Baker or Glacier Peak affecting the District is very low, but the consequences of such events are very severe and, therefore, the risk level is deemed to be moderate.

Flood risk is very low, although extreme events such as dam failures on the dams upstream from the campus could inundate the campus.

The risk from wildland/urban interface fires appears to be quite high based on ratings by the Washington Department of Natural Resources and because of the high vegetative fuel load in the heavily forested area just north of the campus. However, consultation with local fire agencies is necessary to more accurately determine the level of risk.

There is potentially significant landslide risk for the High School, the portables and part of the Elementary School because of the close proximity of these buildings to the very steep slope on the north side of the campus. Further evaluation is necessary to determine the level of landslide risk.

The tsunami risk is clearly nil, given the District's location.

Further details regarding these hazards and the level of risk to District facilities and people are presented in the following chapters:

Chapter 6: Earthquakes,

Chapter 7: Volcanic Hazards

Chapter 8: Floods

Chapter 9: Wildland/Urban Interface Fires

Chapter 10: Landslides

Chapter 11: Other Natural Hazards

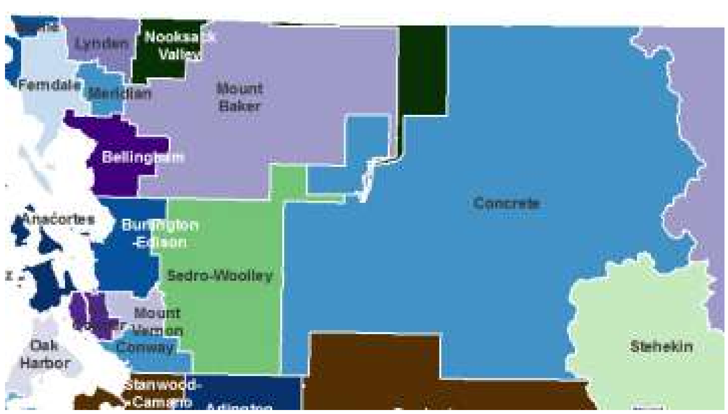
2.0 Concrete School District Profile

2.1 District Location

The Concrete School District is located in northwest Washington State. It is primarily in Skagit County with The district covers 1916 square miles of eastern Skagit and Whatcom (2504 sq.mi.pop. 201,140) counties.

Figure 2.1

Concrete School District Map



The district's only incorporated town is Concrete with a population of roughly 700 people. It also includes the smaller communities of Rockport, Newhalem, Diablo. Since much of this is public federal and state lands the district boundaries only includes approximately 4,800 people.

Figure 2.2

Concrete School District and Vicinity

Figure 2.3

Concrete School District Showing Schools

2.2 District Overview

Concrete began as a settlement, nestled where the Baker and Skagit rivers intersected. The actual town site was platted by Magnus Miller in 1890 and shortly after named Baker. Another town was formed on the opposite side of the Baker River called “Cement City.” When Superior Portland Cement Company built a plant in Baker in 1908, the two towns merged into the town of Concrete.

Since that time, Concrete has had trouble finding a stable industrial base with many residents commuting to other parts of Skagit County for employment.

The Mission: *Concrete School District is an educational cooperative of professionals, students, and community members committed to developing the full academic and civic potential of every student.*

The district has 36 certificated teachers. Concrete High School, which includes grades 7 through 12, has approximately 240 students. The grade school has approximately 260 students. In addition to the two schools, the district houses Head Start Preschool for approximately 20 students. It also offers a home school partnership program - Skagit River Schoolhouse - and an alternative high school - Twin Cedars High School. Other district staff includes 51 support staff.

Demographic data is often included in mitigation plans, especially in the context of evacuation planning and for communication, education, and outreach efforts. The data shown in Table 2.1 are for Skagit County, because census data are not compiled for the district's specific boundaries. These data are approximately representative of those for the Concrete School District.

Also included is Table 2.2 showing some recent data for Concrete High School's students.

Table 2.1

Selected Demographic Data

Skagit County

Population [1]	Number	Percent
Total	116,901	100%
Under 5 years	7,597	6.5%
Under 19 years	23,162	19.8%
19 to 64	67,266	57.5%
65 years and over	18,876	16.1%
Languages Other than English Spoken at Home [2]	**Number**	
Spanish	12,653	10.8%
Other Indo-European Languages	2,461	2.1%
Asian and Pacific Island Languages	1,109	0.9%
Other Languages	436	0.4%
[1] *Source: U.S. Census Bureau, 2010 Census*		
[2] *2013 American Community Survey 1-Year Estimates*		

Table 2.2

Selected Demographic Data

Concrete High School

Enrollment		
October 2013 Student Count		171
May 2014 Student Count		155
Gender (October 2013)		
Male	94	55.0%
Female	77	45.0%
Race/Ethnicity (October 2013)		
American Indian/Alaskan Native	2	1.2%
Hispanic / Latino of any race(s)	5	2.9%
White	160	93.6%
Two or More Races	4	2.3%
Special Programs		
Free or Reduced-Price Meals (May 2014)	81	52.3%
Special Education (May 2014)	19	12.3%
Transitional Bilingual (May 2014)	0	0.0%
Migrant (May 2014)	0	0.0%
Section 504 (May 2014)	0	0.0%
Foster Care (May 2014)	0	0.0%
Other Information (more info)		
Adjusted 4-Year Cohort Graduation Rate (Class of 2013)		73.8%
Adjusted 5-year Cohort Graduation Rate (Class of 2012)		83.7%

2.3 District Facilities

The Concrete School District has one campus that houses all of the district buildings.

Table 2.2

District Facilities

District Pre-Disaster Mitigation Summary						
Campus / Building	**Building Condition Rating**	**Number of Floors**	**Building Area**	**Year Built**	**Gross Square Feet**	**Structural System**
CONCRETE SCHOOL DISTRICT						
Administration Building						
Administration	89.38% Good	1	Admin	1981	19,372	RM1L
Bus Barn	81.68% Fair	1	Bus	1952	6,999	RM1L
Concrete High School						
Main Building	72.43% Fair	2	Main	1951	58,216	PC2M
Tech Building	90.71% Good	1	Tech	1952	7,875	RM1L
Concrete K-8 School						
Gym	90.72% Good	1	Gym	1981	12,264	RM1L
Main Building	83.66% Fair	1	Main	1981	32,182	RM1L
Portable B	Ratings Not Started	1	Portable B	1980	960	W1
Portable C	Ratings Not Started	1	C	1980	1,920	W1
Portable D and Headstart	Ratings Not Started	1	D	1980	2,772	W1

3.0 MITIGATION PLANNING PROCESS

3.1 Overview

The Concrete School District's mitigation planning process began in November 2014. The District's mitigation plan is consistent with, and draws extensively from, the Washington State K–12 Facilities Hazard Mitigation Plan. However, the Concrete School District's Hazard Mitigation Plan has an in-depth focus on the District, its facilities, and its people and includes more district-specific content, including district-specific hazard and risk assessments and mitigation priorities.

3.2 Mitigation Planning Team

The mitigation planning team was led by: Schuyler Brown, Facilities Supervisor, Concrete School District. The planning team included the following members:

- Dolores Elliott, Board Member, Concrete School District
- Shirley Moody, Fiscal Assistant, Concrete School District
- Janis Schweitzer, High School Teacher, Concrete School District
- Emily Roberts, Special Education Teacher Concrete School District
- Jeff Maher, Parent and Grounds Keeper, Concrete School District

The mitigation planning team's roles and responsibilities were defined as follows:

- Participate actively in planning team meetings,
- Provide local perspectives re: natural hazards and the threats that they pose to the District's facilities and people.
- Help to identify existing plans, studies, reports, and technical information for inclusion or reference in the mitigation plan.
- Forge consensus on mitigation action items and their priorities.
- Help to facilitate the public outreach actions during the mitigation planning process, and
- Provide review comments on draft materials during development of the Concrete School District Hazard Mitigation Plan.

3.3 Mitigation Planning Team Meetings

Mitigation planning team meetings are documented below with dates and brief summaries. Meeting agendas, attendees, and minutes for the planning team meetings are provided as an Appendix at the end of this chapter.

1st Meeting: *November 20, 2014 3 PM CHS Commons*

Mitigation Planning Kick-Off Meeting

Present: Concrete District Staff: Schuyler Brown, Dolores Elliott, Shirley Moody, Janis Schweitzer, Emily Roberts, and Jeff Maher.

Absent: None

Schuyler Brown presented an overview of the mitigation planning process, FEMA's requirements and a preliminary assessment of the hazards posing threats to the District's facilities, based on data compiled for the statewide OSPI K–12 Facilities Hazard Mitigation Plan. Discussed what our roles would be in creating the plan.

2nd Meeting…etc.

2nd Meeting: *December 4, 2014 3 PM CHS Commons*

Mitigation Meeting

Present: Concrete District Staff: Schuyler Brown, Dolores Elliott, Shirley Moody, Janis Schweitzer, Emily Roberts, and Jeff Maher.

Absent: None

The team discussed the relative dangers of the different natural hazards to our campus. Although we are located on a plateau that is safe from falling debris, it was noted that there is a definite danger of landslides due to liquefaction of the soil near the high school. We also talked about how natural disasters had affected the campus in recent history. Although no wild fire has come to the campus, the closeness of vegetation and timber stands was noted.

It was decided to put out a survey online and by hard copy. Schuyler and Shirley were put in charge.

3.4 Public Involvement in the Mitigation Planning Process

The District took robust efforts to involve the public and stakeholders throughout the mitigation planning process, including the following actions:

Notices

The District announced the initiation of the mitigation planning via:

- Posting a notice on the District's website,
- Distributing the notice via e-mail to a wide audience of stakeholders,
- Publishing in School bulletins.

Public Meetings

Public meetings were announced via the modes listed above and held on the following dates:

- Meeting 1 November 20, 2014
- Meeting 2 December 4, 2014

Public Surveys

A public survey was conducted to facilitate inputs about key aspects of the district's mitigation planning from district staff, parents, the public, and other stakeholders.

Titled" SURVEY REGARDING INCREASING LIFE SAFETY BEFORE DISASTER STRIKES", this survey was published online at Monkey.com on November 25, 2014 and was left up until February 2, 2015. The survey was announced on the school web site. There were only three responses. Paper copies of the survey were made available at district offices and public events. Seven hard copies were received back.

With such little feedback, it is hard to draw very specific conclusions. Most were more concerned about disasters that caused death or injury as compared to damage to facilities or disruption of services. There was higher concern for severe weather, floods, and landslides than earthquakes, volcanic events, and WUI fires. All thought it important to have strategies to be proactive in identifying natural hazards, more resources allocated to reducing risk, and better planning for future buildings.

Review and Comment on Mitigation Plan Drafts

Mitigation plan drafts were posted on the District's website for review on 3-30-2016. Notices of the District's requests for comments were solicited from all interested parties via district website and email.

3.5 Review and Incorporation of Existing Plans, Studies, Reports, and Technical Information.

The Concrete School District's Hazard Mitigation Plan drew heavily on the content of the Washington State K–12 Facilities Hazard Mitigation Plan and the Pre-Disaster Mitigation parts of the Office of Superintendent of Public Instruction's ICOS (Inventory and Condition of Schools) database. ICOS includes a comprehensive database of school facility information, including condition assessments, remodeling, and modernization and other data bearing on school facilities.

The Pre-Disaster Mitigation part of ICOS was invaluable in providing GIS data for campus locations and for automating the processing and interpretation of technical data relating to natural hazards and the risks that arise from these hazards to the district's facilities and people.

ICOS is an actively maintained database that will be periodically updated, including hazard and risk data. Thus, the strong linkage between ICOS and the district's mitigation planning will keep the mitigation plan "alive" and current and will be especially helpful during the 5-year updates.

4.0 GOALS, OBJECTIVES, AND ACTION ITEMS

4.1 Overview

The purpose of the Concrete School District Hazard Mitigation Plan is to reduce the impacts of future natural disasters on the district's facilities, students, staff and volunteers. That is, the purpose is to make the Concrete School District more disaster resistant and disaster resilient, by reducing the vulnerability to disasters and enhancing the capability to respond effectively to, and recover quickly from, future disasters.

Completely eliminating the risk of future disasters in the Concrete School District is neither technologically possible nor economically feasible. However, substantially reducing the negative impacts of future disasters is achievable with the adoption of this pragmatic Hazard Mitigation Plan and ongoing implementation of risk reducing action items. Incorporating risk reduction strategies and action items into the District's existing programs and decision making processes will facilitate moving the Concrete School District toward a safer and more disaster resistant future.

The Concrete School District Hazard Mitigation Plan is based on a four-step framework that is designed to help focus attention and action on successful mitigation strategies: Mission Statement, Goals, Objectives, and Action Items.

> **Mission Statement.** The Mission Statement states the purpose and defines the primary function of the Concrete School District Hazard Mitigation Plan. The Mission Statement is an action-oriented summary that answers the question "Why develop a hazard mitigation plan?"
>
> **Goals.** Goals identify priorities and specify how the Concrete School District intends to work toward reducing the risks from natural and human-caused hazards. The Goals represent the guiding principles toward which the District's efforts are directed. Goals provide focus for the more specific issues, recommendations, and actions addressed in Objectives and Action Items.
>
> **Objectives.** Each Goal has Objectives which specify the directions, methods, processes, or steps necessary to accomplish the Concrete School District Hazard Mitigation Plan's Goals. Objectives lead directly to specific Action Items.
>
> **Action Items**. Action Items are specific, well-defined activities or projects that work to reduce risk. That is, the Action Items represent the specific, implementable steps necessary to achieve the District's Mission Statement, Goals, and Objectives.

4.2 Mission Statement

The mission statement for the Concrete School District Hazard Mitigation Plan is to:

> **Proactively facilitate and support district-wide policies, practices, and programs that make the Concrete School District more disaster resistant and disaster resilient**

Making the Concrete School District more disaster resistant and disaster resilient means taking proactive steps and actions to:

- Protect life safety,
- Reduce damage to district facilities,
- Minimize economic losses and disruption, and
- Shorten the recovery period from future disasters.

4.3 Mitigation Plan Goals and Objectives

The following Goals and Objectives serve as guideposts and checklists to begin the process of implementing mitigation Action Items to reduce identified risks to the District's facilities, students, staff, and volunteers from natural disasters.

The Goals and Objectives are consistent with those in the Washington State K–12 Facilities Hazard Mitigation Plan. However, the specific priorities, emphasis, and language in this mitigation plan are the Concrete School District's. These goals were developed with extensive input and priority setting by the Concrete District's hazard mitigation planning team, with inputs from district staff, volunteers, parents, students, and other stakeholders in the communities served by the District.

Goal 1: Reduce Threats to Life Safety

Reducing threats to life safety is the highest priority for the Concrete School District.

Objectives:

A. Enhance life safety by retrofitting existing buildings or replacing them with new current-code buildings and by locating and designing new schools to minimize life safety risk from future disaster events.

B. Develop robust disaster evacuation plans and conduct frequent practice drills. When evacuation is impossible in the anticipated warning time consider other physical measures to shorten evacuation time.

C. Enhance life safety by improving public awareness of earthquakes, volcanic events, and other natural hazards that pose substantial life safety risk to the District's facilities, students, staff, and volunteers.

Goal 2: Reduce Damage to District Facilities, Economic Losses, and Disruption of the District's Services

Objectives:

A. Retrofit or replace existing buildings with a high vulnerability to one or more natural hazards to reduce damage, economic loss, and disruption in future disaster events.

B. Ensure that new facilities are adequately designed for hazard events and located outside of mapped high hazard zones to minimize damage and loss of function in future disaster events, to the extent practicable.

Goal 3: Enhance Emergency Planning, Disaster Response, and Post-Disaster Recovery

Objectives:

A. Enhance collaboration and coordination between the District, local governments, utilities, businesses, and citizens to prepare for, and recover from, future natural disaster events.

B. Enhance emergency planning to facilitate effective response and rapid recovery from future natural disaster events.

Goal 4: Increase Awareness and Understanding of Natural Hazards and Mitigation

Objectives:

A. Implement education and outreach efforts to increase awareness of natural hazards throughout the Concrete School District, including staff, parents, teachers, and the entire communities served by the District.

B. Maintain and publicize a natural hazards section in the high school library with FEMA and other publications and distribute FEMA and other brochures and other educational materials regarding natural hazards.

4.4 Concrete School District Hazard Mitigation Plan Action Items

Mitigation Action Items may include a wide range of measures such as: refinement of policies, studies, and data collection to better characterize hazards or risk, education, or outreach activities, enhanced emergency planning, partnership building activities, as well as retrofits to existing facilities or replacement of vulnerable facilities with new current-code buildings.

The 2015 Concrete School District's Hazard Mitigation Plan Action Items are summarized on the following pages:

Table 4.1

Concrete School District Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Multi-Hazard Mitigation Action Items								
Long-Term #1	Integrate the findings and action items in the mitigation plan into ongoing programs and practices for the district.	Ongoing	Local/Grant	CSD	X	X	X	X
Long-Term #2	Review emergency and evacuation planning to incorporate hazard and risk information from the mitigation plan.	Ongoing	Local/Grant	CSD	X	X	X	X
Long-Term #3	Consider natural hazards whenever siting new facilities and locate new facilities outside of high hazard areas.	Ongoing	Local/Grant	CSD	X	X	X	X
Long-Term #4	Ensure that new facilities are adequately designed to minimize risk from natural hazards.	Ongoing	Local/Grant	CSD	X	X	X	X
Long-Term #5	Maintain, update and enhance facility data and natural hazards data in the ICOS database.	Ongoing	Local/Grant	CSD	X	X	X	X
Long-Term #6	Develop and distribute educational materials regarding natural hazards, vulnerability and risk for K-12 facilities.	Ongoing	Local/Grant	CSD	X		X	X
Long-Term #7	Seek FEMA funding for repairs if district facilities suffer damage in a FEMA declared disaster.	Ongoing	Local/Grant	CSD	X	X		X
Long-Term #8	Pursue pre- and post-disaster mitigation grants from FEMA and other sources.	Ongoing	Local/Grant	CSD	X	X		X
Long-Term #9	Post the district's mitigation plan on the website and encourage comments stakeholders for the ongoing review and periodic update of the mitigation plan.	Ongoing	Local/Grant	CSD	X			X

Table 4.1

Concrete School District Mitigation Action Items - Continued

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Earthquake Mitigation Action Items								
Short-Term #1	Complete ASCE 41-13 Tier 1 evaluations for the District's 1950s and 1980s buildings, other than the portables.	1-2 Years	Local or Grant	CSD	X	X		X
Short-Term #2	Assess the ASCE 41-13 results and select buildings that have the greatest vulnerability for more detailed evaluations, including development of retrofit concepts.	1-5 Years	Local or Grant	CSD	X	X		X
Short-Term #3	Based on the above results, determine the District's priorities for seismic retrofits or replacements and implement as funding becomes available.	1-10 Years	Local, Bond or Grant	CSD	X	X		X
Short-Term #4	Have an engineer evaluate the foundations for the portables with significant occupancies, develop retrofit concepts and implement the retrofits as funding becomes available.	1-5 Years	Local or Grant	CSD	X	X		X
Long-Term #1	Maintain and update building data for seismic risk assessments in the OSPI ICOS PDM database.	Ongoing	Local	CSD	X		X	X
Long-Term #2	Enhance emergency planning for earthquakes including duck and cover and evacuation drills.	Ongoing	Local	CSD	X		X	X

Table 4.1

Concrete School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Volcanic Hazards Mitigation Action Items								
Short-Term #1	Develop and practice a volcano emergency evacuation plan, with designated evacuation methods and routes to the nearest safe haven location.	1-2 Years and Ongoing	Local	1 Year	X		X	X
Short-Term #2	Develop emergency evacuation protocols for pre-emptive evacuation when USGS volcano warning levels reach a pre-determined level.	1-2 Years	Local	1 Year	X		X	X
Short-Term #3	Update public education, emergency notification procedures and emergency planning for volcanic events, including ash fall events.	1-2 Years	Local	1 Year	X		X	X

Table 4.1

Concrete School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Flood Mitigation Action Items								
Short-Term #1	Enhance the District's emergency planning by including evacuation planning for dam failure events, in close coordination with Skagit County Emergency Management.	1-2 Years	Local	CSD, Skagit County	X		X	X
Short-Term #2	Ensure that District staff are aware of evacuation planning for dam failure events by conducting training and drills.	Ongoing	Local	CSD, Skagit County	X		X	X

Table 4.1

Concrete School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Wildland/Urban Interface Fire Mitigation Action Items								
Short-Term #1	Consult with local fire agency regarding level of fire risk for the District's campus.	1-2 Years	Local	CSD	X	X	X	X
Short-Term #2	Enhance emergency evacuation planning for all campuses for which wildland/urban fires are possible.	1 year	Local	CSD	X		X	X
Long-Term #1	Evaluate and consider implementing fire risk reduction measures including improving defensible space and upgrading building elements such as roofs with materials designed to be fire-resistant and covering vent openings with wire mesh to prevent embers from entering.	Ongoing	Local, Bond or Grant	CSD	X	X	X	X

Table 4.1

Concrete School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Landslide Mitigation Action Items								
Short-Term #1	Consult with a geologist or geotechnical engineer regarding landslide risk for the Elementary School, High School and portables.	1 Year	Local or Grant	CSD	X	X	X	X
Short-Term #2	Complete landslide risk assessment if recommended by the geologist or geotechnical engineer	1-2 Years	Local or Grant	CSD	X	X	X	X
Long-Term #1	Evaluate and implement landslide mitigation measures if warranted based on the results of the risk assessment evaluation, as funding becomes available.	2-5 Years	Local, Bond or Grant	CSD	X	X	X	X

Table 4.1

Concrete School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Other Natural Hazards Mitigation Action Items								
Short-Term #1	Evaluate portable buildings to make sure that they are adequately tied down to resist high winds and implement mitigation measures, if necessary.	1-2 Years	Local or Grant	CSD	X	X	X	X
Short-Term #2								

5.0 MITIGATION Plan Adoption, Implementation and Maintenance: REVISED – 12-19-16

5.1 Overview

For a hazard mitigation plan to be effective, it has to be implemented gradually over time, as resources become available. An effective plan must also be continually evaluated and periodically updated. The mitigation Action Items included in the Concrete School District's Hazard Mitigation Plan will be accomplished effectively only through a process which routinely incorporates logical thinking about hazards and cost-effective mitigation into ongoing decision making and capital improvement spending.

The following sections depict how the Concrete School District has adopted and will implement and maintain the vitality of the District's Hazard Mitigation Plan.

5.2 Plan Adoption

This is the Concrete School District's first Hazard Mitigation Plan, which became effective on December, 2016, the date of adoption by the Concrete School District's Board. The Board adopted the District's Hazard Mitigation Plan following FEMA's approval of the District's submitted plan. The Board's adoption resolution is shown on the following page.

Board of Directors Resolution Adopting the Concrete School District Hazard Mitigation Plan

Resolution Number #1202

A Resolution Adopting the 2016 Concrete School District Hazard Mitigation Plan

The Concrete School District resolves as follows:

Whereas, the Concrete School District has determined that it is in the best interest of the District to have an active hazard mitigation planning effort to reduce the long term risks from natural hazards to school facilities, and

Whereas, the Concrete School District recognizes that the Federal Emergency Management Agency (FEMA) requires the district to have an approved hazard mitigation plan as a condition of applying for and receiving FEMA mitigation project grant funding.

Now, therefore, be it resolved by the Concrete School District as follows:

The Concrete School District adopts the 2016 Concrete School District Hazard Mitigation Plan.

Passed by the School Board on the 19th day of December, 2016.

Board Chair

D Ellerls

Board Director

Board Director

W. Thompson

Board Director

J. Culver

Board Director

Attest:

Barbara Hawkings

Barbara Hawkings, Secretary to the Board of Directors

5.3 Implementation

The Maintenance Supervisor will have the lead responsibility for implementing the Concrete School District Hazard Mitigation Plan, with ongoing support from the Facilities Committee.

5.3.1 Existing Authorities, Policies, Programs, Resources and Capabilities

The Concrete School District and all school districts in Washington have much narrower domains of authorities than do cities and counties. The district's responsibilities are limited to constructing and maintaining its facilities and providing educational services for the district's students. The district's authorities are limited to these two areas.

The district's policies and programs related to hazard mitigation planning are limited to the criteria for siting new schools, design of new school buildings, maintenance of buildings and periodic modernization of buildings. The district's resources for these programs include district staff involved with siting, construction, maintenance and modernization of schools, supplemented by contractor and consultants when needed.

The completion of the Concrete District's Hazard Mitigation Plan has substantially raised the district's awareness and knowledge of natural hazards. Consideration of natural hazards will be included in siting of new schools, the design of new school buildings. Furthermore, mitigation measures to reduce risks from natural hazards will be incorporated into maintenance and modernization of buildings whenever possible.

The Concrete School District has the necessary human resources to ensure that the Concrete School District Hazard Mitigation Plan continues to be an actively used planning document. District staff has been active in the preparation of the Plan, and have gained an understating of the process and the desire to integrate the Plan into ongoing capital budget planning. Through this linkage, the District's Hazard Mitigation Plan will be kept active and be a working document.

District staff has broad experience with planning and facilitation of community inputs. This broad experience is directly applicable to hazard mitigation planning and to implementation of mitigation projects. If specialized expertise is necessary for a particular project, the District will contract with a consulting firm on an as-needed basis.

Furthermore, recent earthquake and tsunami disasters worldwide serve as a reminder of need to maintain a high level of interest in evaluating and mitigating risk from natural disasters of all types. These events have kept the interest in hazard mitigation planning and implementation alive among the Concrete School District Board, District staff and in the communities served by the District.
To ensure efficient, effective and timely implementation of the identified mitigation action items, the Concrete School District will use the full range of its capabilities and resources and those of the community. The district's goal is to implement as many of the elements of its mitigation strategy (Action Items) over the next five years as

possible, commensurate with the extent of funding that becomes available. This effort will be led by the Superintendent with the full support of the School Board, and with outreach and cooperation with the community, the region and the state, especially with the Office of Superintendent of Public Instruction.

Regulatory Tools (Ordinances and Codes)

- RCW 28A – Common School Provisions
- WAC Title 392 – Office of Superintendent of Public Instruction

Administrative Tools (Departments, Organizations, Programs)

Concrete School District Resources

- School Board
- Superintendent
- Parent Teacher Organization
- Upper Skagit Teacher Association
- Safety committee

Regional and State Resources

- Office of Superintendent of Public Instruction
- Washington State School Directors' Association - WSSDA
- Washington Association of School Administrators - WASA
- Washington Association of School Business Officials – WASBO
- Washington Association of Maintenance and Operation Administrators - WAMOA
- Rapid Responder System Education Service District 189.
- Skagit County, including Emergency Management, Public Works and GIS, Planning Department and Building Officials.
- Concrete Fire Department and Mutual Aid District 10, District
- Skagit County Sheriff's Department
- Aero Skagit
- Other

Other Technical Tools (Plans and Others)

Concrete School District Capabilities

- District Website
- School Closure Telephone Plan

- Evacuation Plan
- Lockdown Plan
- Fire Drills
- Earthquake Drills
- Bomb Threat Assessment Guide
- Emergency Response Plan
- Capital Facilities Plan
- Strategic Plan
- Policies and Procedures
- Student Rights and Responsibilities
- District Safety Plan

Regional Capabilities

- “Skagit County Hazard Mitigation Plan and Emergency Response Plan
- “Town of Concrete Hazard Mitigation Plan and Emergency Response Plan

Fiscal Tools (Taxes, Bonds, Funds and Fees)

Concrete School District Capabilities

- Authority to Levy Taxes
- Authority to Issue Bonds
- Funds
    - General Fund
    - Capital Project Funds
    - Debt Service Fund
    - Transportation Vehicle Fund
    - Booster Funds

- External Funds
    - OSPI School Construction Assistance Program Modernization / New in Lieu
    - FEMA Grants
    - HUD “CDBG” Grants
    - Foundation Grants

- Legislative Funding/Grants
- Other Grants

5.3.2 Integration into Ongoing Programs

As noted above, the Concrete School District's ongoing programs are more narrowly defined than those for cities and counties.

An important aspect of the Plan's integration into ongoing programs will be the inclusions of the mitigation plan's hazard, vulnerability and risk evaluations and mitigation Action Items, into ongoing capital improvement planning and other district activities, such as building maintenance, periodic remodeling or modernization of facilities and future siting and construction of new facilities.

For example, in evaluating a possible remodeling or modernization of buildings, the district will consider include retrofits to reduce the vulnerability to natural hazards as well as considering other alternatives such as replacement with a new building, when the retrofit is very expensive or a site has substantial risks from natural hazards that cannot be mitigated on the existing site.

5.3.3 Prioritization of Mitigation Projects

Prioritization of future mitigation projects within the Concrete School District requires flexibility because of varying types of projects, district needs and availability funding sources. Prioritized mitigation Action Items developed during the mitigation planning process is summarized in Chapter 4. Additional mitigation Action Items or revisions to the initial Action Items are likely in the future. The Concrete School District Board will make final decisions about implementation and priorities with inputs from district staff, the mitigation planning team, the public and other stakeholders.

The Concrete School District's prioritization of mitigation projects will include the following factors:

1. The mission statement and goals in the Concrete School District Hazard Mitigation Plan including:

   Goal 1: Reduce Threats to Life Safety,

   Goal 2: Reduce Damage to District Facilities, Economic Losses and Disruption of the District's Services,

   Goal 3: Enhance Emergency Planning, Disaster Response and Disaster Recovery, and

   Goal 4: Increase Awareness and Understanding of Natural Hazards and Mitigation

2. Benefit-cost analysis to ensure that mitigation projects are cost effective, with benefit exceeding the costs.

3. The STAPLEE process to ensure that mitigation Action Items under consideration for implementation meet the needs and objectives of the District, its communities, and citizens, by considering the social, technical, administrative, political, economic and environmental aspects of potential projects.

Cost Effectiveness of Mitigation Projects

As the Concrete School District considers whether or not to undertake specific mitigation projects or evaluate how to decide between competing mitigation projects, they must address questions that don't always have obvious answers, such as:

What is the nature of the hazard problem?

How frequent and how severe are the hazard events of concern?

Do we want to undertake mitigation measures?

What mitigation measures are feasible, appropriate, and affordable?

How do we prioritize between competing mitigation projects?

Are our mitigation projects likely to be eligible for FEMA funding?

The Concrete School District recognizes that benefit-cost analysis is a powerful tool that can help provide solid, defensible answers to these difficult socio-political-economic-engineering questions. Benefit-cost analysis is required for all FEMA-funded mitigation projects, under both pre-disaster and post-disaster mitigation programs.

However, regardless of whether or not FEMA funding is involved, benefit-cost analysis provides a sound basis for evaluating and prioritizing possible mitigation projects for any natural hazard. Thus, the district will use benefit-cost analysis and related economic tools, such as cost-effectiveness evaluation, to the extent practicable in prioritizing and implementing mitigation actions.

STAPLEE Process

The Concrete School District will also use the STAPLEE methodology to evaluate projects based on the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) considerations and opportunities for implementing particular mitigation action items in the district. The STAPLEE approach is helpful for doing a quick analysis of the feasibility of proposed mitigation projects.

The following paragraphs outline the district's STAPLEE Approach

Social:

- Is the proposed action socially acceptable to the community?
- Are there equity issues involved that would mean that one segment of the community is treated unfairly?
- Will the action cause social disruption?

Technical:

- Will the proposed action work?
- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?
- Is it the most useful action in light of other goals?

Administrative:

- Is the action implementable?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff, and technical support available?
- Are there ongoing administrative requirements that need to be met?

Political:

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

Legal: Include legal counsel, land use planners, and risk managers in this discussion.

- Who is authorized to implement the proposed action?
- Is there a clear legal basis or precedent for this activity?
- Will the district be liable for action or lack of action?
- Will the activity be challenged?

Economic:

- What are the costs and benefits of this action?
- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)?
- How will this action affect the fiscal capability of the district?
- What burden will this action place on the tax base or economy?
- What are the budget and revenue effects of this activity?

Environmental:

- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

5.4 Plan Maintenance and Periodic Updating

5.4.1 Periodic Monitoring, Evaluating and Updating

Monitoring the Concrete School District Hazard Mitigation Plan is an ongoing, long-term effort. An important aspect of monitoring is a continual process of ensuring that mitigation Action Items are compatible with the goals, objectives, and priorities established during the development of the District's Mitigation Plan. The District has developed a process for regularly reviewing and updating the Hazard Mitigation Plan. As noted previously, the Maintenance Supervisor, will have the lead responsibility for implementing the Concrete School District's Hazard Mitigation Plan and for periodic monitoring, evaluating and updating of the Plan. There will be ample opportunities to incorporate mitigation planning into ongoing activities and to seek grant support for specific mitigation projects.

The Concrete School District Hazard Mitigation Plan will be reviewed annually as well as after any significant disaster event affecting the District. These reviews will determine whether there have been any significant changes in the understanding of hazards, vulnerability and risk or any significant changes in goals, objectives and Action Items. These reviews will provide opportunities to incorporate new information into the Mitigation Plan, remove outdated items and document completed Action Items. This will also be the time to recognize the success of the District in implementing Action Items contained in the Plan. Annual reviews will also focus on identifying potential funding sources for the implementation of mitigation Action Items.

The periodic monitoring, evaluation and updating will assess whether or not, and to what extent, the following questions are applicable:

1. Do the plans goals, objectives and action items still address current and future expected conditions?
2. Do the mitigation Action Items accurately reflect the District's current conditions and mitigation priorities?
3. Have the technical hazard, vulnerability and risk data been updated or changed?
4. Are current resources adequate for implanting the District's Hazard Mitigation Plan? If not are there other resources that may be available?
5. Are there any problems or impediments to implementation? If so, what are the solutions?

6. Have other agencies, partners, and the public participated as anticipated? If no, what measures can be taken to facilitate participation?
7. Have there been changes in federal and/or state laws pertaining to hazard mitigation in the District?
8. Have the FEMA requirements for the maintenance and updating of hazard mitigation plans changed?
9. What can the District learn from declared federal and/or state hazard events in other Washington school districts that share similar characteristics to the Concrete School District, such as vulnerabilities to earthquakes and tsunamis?
10. How have previously implemented mitigation measures performed in recent hazard events? This may include assessment of mitigation Action Items similar to those contained in the District's Mitigation Plan, but where hazard events occurred outside of the District.

The Facilities Committee will review the results of these mitigation plan assessments, identify corrective actions and make recommendations, if necessary, to the Concrete School Board for actions that may be necessary to bring the Hazard Mitigation Plan back into conformance with the stated goals and objectives. Any major revisions of the Hazard Mitigation Plan will be taken to the Board for formal approval as part of the District's ongoing mitigation plan maintenance and implementation program.

The Facilities Committee will have lead responsibility for the formal updates of the Hazard Mitigation Plan every five years. The formal update process will be initiated at least one year before the five-year anniversary of FEMA approval of the Concrete School District Hazard Mitigation Plan, to allow ample time for robust participation by stakeholders and the public and for updating data, maps, goals, objectives and Action Items.

5.4.2 Continued Public Involvement and Participation

Implementation of the mitigation actions identified in the Plan must continue to engage the entire community. Continued public involvement will be an integral part of the ongoing process of incorporating mitigation planning into land use planning, zoning, and capital improvement plans and related activities within the communities served by the District . In addition, the District will expand communications and joint efforts between the District and emergency management activities in the Town of Concrete and Skagit County.

The 2014 Concrete School District Hazard Mitigation Plan will be available on the District's website and hard copies will be placed in the school and public libraries. The existence and locations of these hard copies will be posted on the District's website along with contact information so that people can direct comments, suggestions and concerns to the appropriate staff.

The Concrete School District is committed to involving the public directly in the ongoing review and updating of the Hazard Mitigation Plan. This public involvement process will include public participation in the monitoring, evaluation and updating processes outlined in the previous section. Public involvement will intensify as the next 5-year update process is begun and completed.

A press release requesting public comments will be issued after each major update and also whenever additional public inputs are deemed necessary. The press release will direct people to the website and other locations where the public can review proposed updated versions of the Concrete School District's Hazard Mitigation Plan. This process will provide the public with accessible and effective means to express their concerns, opinions, ideas about any updates/changes that are proposed to the Mitigation Plan. The District will ensure that the resources are available to publicize the press releases and maintain public participation through web pages, social media, newsletters and newspapers.

6.0 EARTHQUAKES

6.1 Introduction

Every location in Washington State has some level of earthquake hazard, but the level of earthquake hazard varies widely by location within the state. Historically, awareness of seismic risk in Washington has generally been high, among both the public and public officials. This awareness in based to a great extent on the significant earthquakes that occurred within the Puget Sound area in 1949 (Olympia earthquake), 1965 (Tacoma earthquake) and 2001(Nisqually earthquake), as well as on other smaller earthquakes in many locations throughout the state.

The awareness of seismic risk in Washington has also increased in recent years due to the devastating earthquakes and tsunamis in Indonesia in 2004 and Japan in 2011. The geologic settings for the Indonesia and Japan earthquakes are very similar to the Cascadia Subduction Zone along the Washington Coast.

The technical information in the following sections provides a basic understanding of earthquake hazards, which is an essential foundation for making well-informed decisions about earthquake risks and mitigation Action Items for K-12 facilities.

6.2 Washington Earthquakes

Earthquakes are described by their magnitude (M), which is a measure of the total energy released by an earthquake. The most common magnitude is called the "moment magnitude," which is calculated by seismologists from two factors – 1) the amount of slip (movement) on the fault causing the earthquake and 2) the area of the fault surface that ruptures during the earthquake. Moment magnitudes are similar to the Richter magnitude, which was used for many decades but has now been replaced.

The moment magnitudes for the largest earthquakes recorded worldwide and in Washington are shown below.

Table 6.1

Largest Recorded Earthquakes[1,2]

Worldwide	Magnitude	Washington	Magnitude
1960 Chile	9.5	1872 Chelan	6.8[a]
1964 Prince William Sound, Alaska	9.2	1949 Olympia	6.8
2004 Sumatra, Indonesia	9.1	2001 Nisqually	6.8
2011 Japan	9.0	1965 Tacoma	6.7
1952 Kamchatka, Russia	9.0	1939 Bremerton	6.2
2010 Chile	8.8	1936 Walla Walla	6.1
1906 Ecuador	8.8	1909 Friday Harbor	6.0

[a] Estimated magnitude.

Figure 6.1

Epicenters of Historic Earthquakes in Washington with Magnitudes of 3.0 or Higher[3]

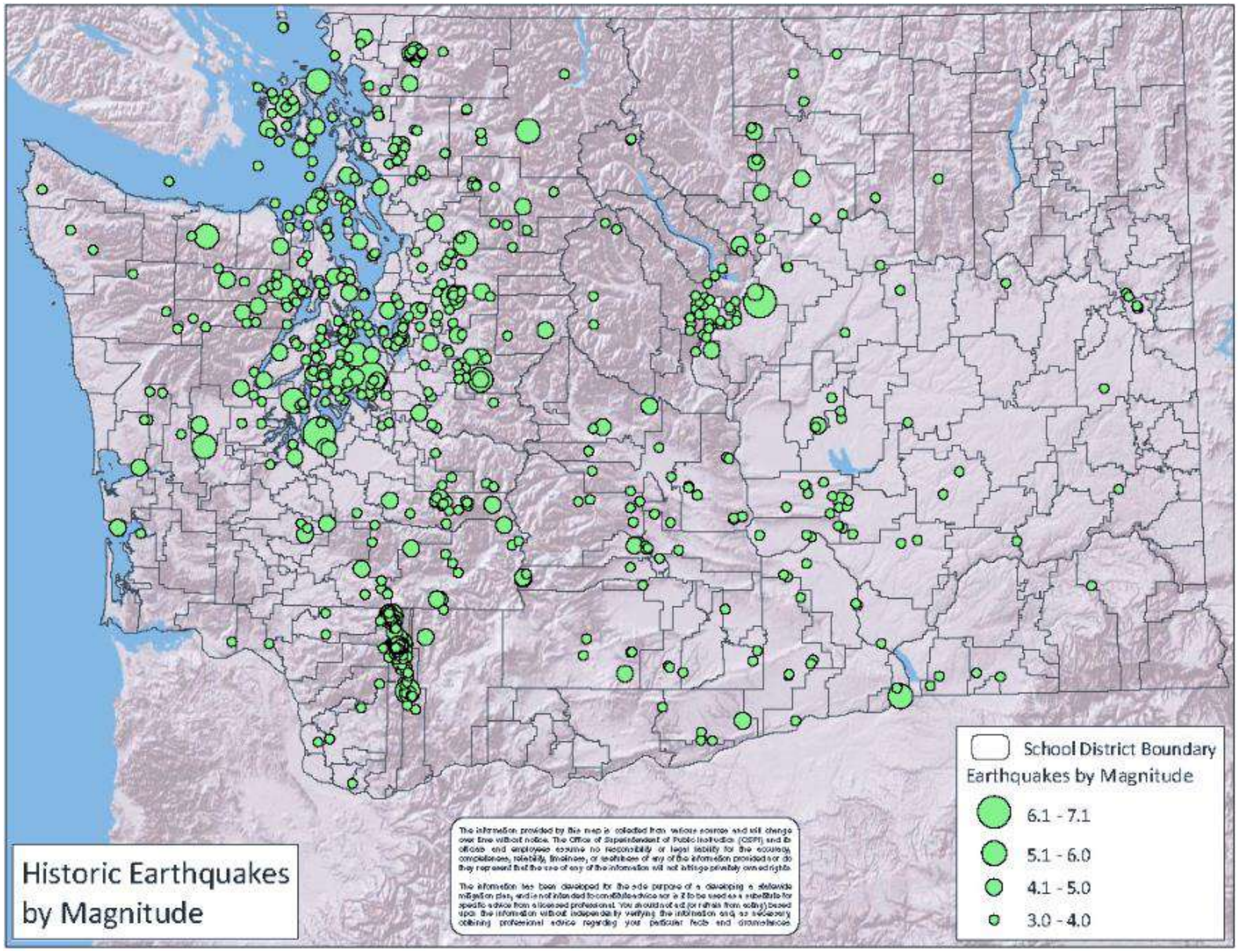


Table 6.1 and Figure 6.1 do not include the January 26, 1700 earthquake on the Cascadia Subduction Zone which has been identified by tsunami records in Japan and paleoseismic investigations along the Washington Coast. The estimated magnitude of the 1700 earthquake is approximately 9.0. This earthquake is not shown in Table 6.1 because it predates modern seismological records. However, this earthquake is among the largest known earthquakes worldwide and the largest earthquake affecting Washington over the past several hundred years. The closest analogy to this earthquake and its effects, including tsunamis, is the 2011 Japan earthquake.

Earthquakes in Washington, and throughout the world, occur predominantly because of plate tectonics – the relative movement of plates of oceanic and continental rocks that make up the rocky surface of the earth. Earthquakes can also occur because of volcanic activity and other geological processes.

The Cascadia Subduction Zone is a geologically complex area off the Pacific Northwest coast that ranges from Northern California to British Columbia. In simple terms, several pieces of oceanic crust (the Juan de Fuca Plate and other smaller pieces) are being subducted (pushed under) the crust of the North American Plate. This subduction process is responsible for most of the earthquakes in the Pacific Northwest and for creating the chain of volcanoes in the Cascade Mountains.

Figure 6.2 on the following page shows the geologic (plate-tectonic) setting of the Cascadia Subduction Zone.

There are three main types of earthquakes that affect Washington State:

1) "Interface" earthquakes on the boundary between the subducting Juan de Fuca Plate and the North American Plate,

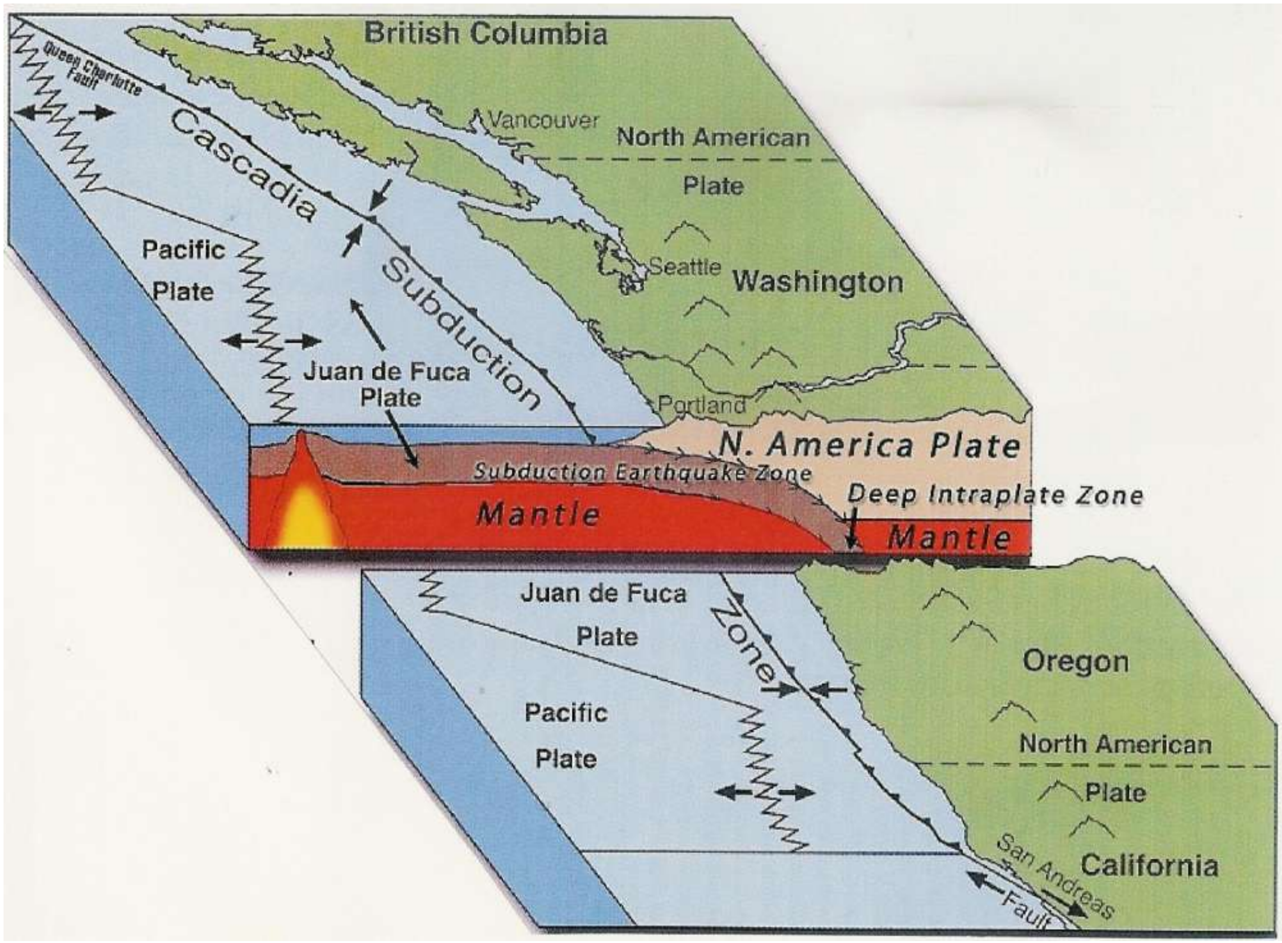
2) "Intraplate" earthquakes within the subducting oceanic plates, and

3) "Crustal" earthquakes within the North American Plate.

"Interface" earthquakes on the Cascadia Subduction Zone occur on the boundary between the subducting Juan de Fuca plate and the North American Plate. These earthquakes may have magnitudes up to 9.0 or perhaps 9.2, with average return periods (the time period between earthquakes) of about 250 to 500 years. These are the great Cascadia Subduction Zone earthquake events that have received attention in the popular press. The last major interface earthquake on the Cascadia Subduction Zone occurred on January 26, 1700. These earthquakes occur about 40 miles offshore from the Pacific Ocean coastline. Ground shaking from such earthquakes would be the strongest near the coast and strong ground shaking would be felt throughout much of western Washington, with the level of shaking decreasing further inland from the coast.

Figure 6.2

Cascadia Subduction Zone[4]

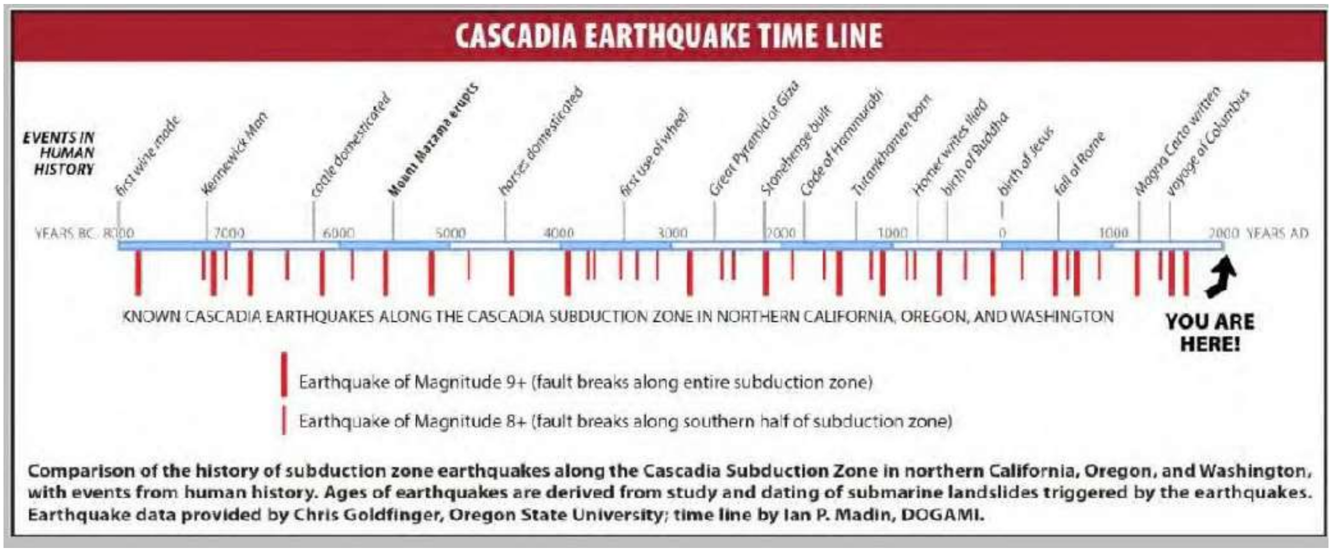


Paleoseismic investigations, which look at geologic sediments and rocks, for signs of ancient earthquakes, have identified 41 Cascadia Subduction Zone interface earthquakes over the past 10,000 years, which corresponds to one earthquake about every 250 years. Of these 41 earthquakes, about half are M9.0 or greater earthquakes that represent a full rupture of the fault zone from Northern California to British Columbia. The other half of the interface earthquakes represents M8+ earthquakes that rupture only the southern portion of the subduction zone.

The 300+ years since the last major Cascadia Subduction Zone earthquake is longer than the average timeframe of about 250 years for M8 or greater and is shorter than some of the intervals between M9.0 earthquakes. The time history of these major interface earthquakes is shown in Figure 6.3 on the following page.

Figure 6.3

Time History of Cascadia Subduction Zone Interface Earthquakes[5]



Comparison of the history of subduction zone earthquakes along the Cascadia Subduction Zone in northern California, Oregon, and Washington, with events from human history. Ages of earthquakes are derived from study and dating of submarine landslides triggered by the earthquakes. Earthquake data provided by Chris Goldfinger, Oregon State University; time line by Ian P. Madin, DOGAMI.

"Intraplate" earthquakes occur within the subducting Juan de Fuca Plate. These earthquakes may have magnitudes up to about 6.5, with probable return periods of about 500 to 1000 years at any given location. These earthquakes can occur anywhere along the Cascadia Subduction Zone. The 1949, 1965 and 2001 earthquakes listed in Table 1 are examples of intraplate earthquakes. These earthquakes occur deep in the earth's crust, about 20 to 30 miles below the surface. They generate strong ground motions near the epicenter, but have damaging effects over significantly smaller areas than the larger magnitude interface earthquakes discussed above.

"Crustal" earthquakes occur within the North American Plate. Crustal earthquakes are shallow earthquakes, typically within the upper 5 or 10 miles of the earth's surface, although some ruptures may reach the surface. In Western Washington crustal earthquakes are mostly related to the Cascadia Subduction Zone. Crustal earthquakes are known to occur not only on faults mapped as active or potentially active, but also on unknown faults. Many significant earthquakes in the United States have occurred on previously unknown faults.

Based on the historical seismicity in Washington State and on comparisons to other geologically similar areas, small to moderate crustal earthquakes up to about M5 or M5.5 are possible almost any place in Washington. There is also a possibility of larger crustal earthquakes in the M6+ range on unknown faults, although, the probability of such events is likely to be low.

6.3 Earthquake Concepts for Risk Assessments

6.3.1 Earthquake Magnitudes

In evaluating earthquakes, it is important to recognize that the earthquake magnitude scale is not linear, but rather logarithmic (based on intervals corresponding to orders of magnitude). For example, each one step increase in magnitude, such as from M7 to M8, corresponds to an increase in the amount of energy released by the earthquake of a factor of about 30, based on the mathematics of the magnitude scale.

Thus, a M7 earthquake releases about 30 times more energy than a M6, while a M8 releases about 30 times more energy than a M7 and so on. Thus, a great M9 earthquake releases nearly 1,000 times (30 [M7] x 30 [M8]) more energy than a large earthquake of M7 and nearly 30,000 times more energy than a M6 earthquake (30 [M6] x 30 [M7] x 30 [M8]).

The public often assumes that the larger the magnitude of an earthquake, the "worse" it is. That is, the "big one" is a M9 earthquake and smaller earthquakes such as M6 or M7 are not the "big one". However, this is true only in very general terms. Higher magnitude earthquakes do affect larger geographic areas, with much more widespread damage than smaller magnitude earthquakes. However, for a given site, the magnitude of an earthquake is <u>not</u> a good measure of the severity of the earthquake at that site.

For most locations, the best measure of the severity of an earthquake is the intensity of ground shaking. However for some sites, ground failures and other possible consequences of earthquakes, which are discussed later in this chapter (Section 6.6), may substantially increase the severity.

For any earthquake, the severity and intensity of ground shaking at a given site depends on four main factors:

- Earthquake magnitude,
- Earthquake epicenter, which is the location on the earth's surface directly above the point of origin of an earthquake,
- Earthquake depth, and
- Soil or rock conditions at the site, which may amplify or deamplify earthquake ground motions.

An earthquake will generally produce the strongest ground motions near the epicenter (the point on the ground above where the earthquake initiated) with the intensity of ground motions diminishing with increasing distance from the epicenter. The intensity of ground shaking at a given location depends on the four factors listed above. Thus, for any given earthquake there will be contours of varying intensity of ground shaking vs. distance from the epicenter. The intensity will generally decrease with distance from the epicenter, and often in an irregular pattern, not simply in perfectly shaped concentric circles. This irregularity is caused by soil conditions, the complexity of earthquake fault rupture patterns, and possible directionality in the dispersion of earthquake energy.

The amount of earthquake damage and the size of the geographic area affected generally increase with earthquake magnitude. Below are some qualitative examples:

- Earthquakes below about M5 are not likely to cause significant damage, even locally very near the epicenter.
- Earthquakes between about M5 and M6 are likely to cause moderate damage near the epicenter.
- Earthquakes of about M6.5 or greater (e.g., the 2001 Nisqually earthquake) can cause major damage, with damage usually concentrated fairly near the epicenter.
- Larger earthquakes of M7+ cause damage over increasingly wider geographic areas with the potential for very high levels of damage near the epicenter.
- Great earthquakes with M8+ can cause major damage over wide geographic areas.
- A mega-quake M9 earthquake on the Cascadia Subduction Zone could affect the entire Pacific Northwest from British Columbia, through Washington and Oregon, and as far south as Northern California, with the highest levels of damage near the coast.

6.3.2 Intensity of Ground Shaking

There are many measures of the severity or intensity of earthquake ground motions. The Modified Mercalli Intensity scale (MMI) was widely used beginning in the early 1900s. MMI is a descriptive, qualitative scale that relates severity of ground motions to the types of damage experienced. MMIs range from I to XII. More accurate, quantitative measures of the intensity of ground shaking have largely replaced the MMI. These modern intensity scales are used in the CONCRETE School District Hazard Mitigation Plan.

Modern intensity scales use terms that can be physically measured with seismometers (instruments that measure motions of the ground), such as acceleration, velocity, or displacement (movement). The intensity of earthquake ground motions may also be measured in spectral (frequency) terms, as a function of the frequency of earthquake waves propagating through the earth. In the same sense that sound waves contain a mix of low-, moderate- and high-frequency sound waves, earthquake waves contain ground motions of various frequencies. The behavior of buildings and other structures depends substantially on the vibration frequencies of the building or structure vs. the spectral content of earthquake waves. Earthquake ground motions also include both horizontal and vertical components.

A common physical measure of the intensity of earthquake ground shaking, and the one used in this mitigation plan, is Peak Ground Acceleration (PGA). PGA is a measure of the intensity of shaking, relative to the acceleration of gravity (g). For example, an acceleration of 1.0 g PGA is an extremely strong ground motion that may occurs near the epicenter of large earthquakes. With a vertical acceleration of 1.0 g, objects are thrown into the air. With a horizontal acceleration of 1.0 g, objects accelerate sideways at the same rate as if they had been dropped from the ceiling. 10% g PGA means that the ground acceleration is 10% that of gravity, and so on.

Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. The following generalized observations provide qualitative statements about the likely extent of damages from earthquakes with various levels of ground shaking (PGA) at a given site:

- Ground motions of only 1% g or 2% g are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
- Ground motions below about 10% g usually cause only slight damage.
- Ground motions between about 10% g and 30% g may cause minor to moderate damage in well-designed buildings, with higher levels of damage in more vulnerable buildings. At this level of ground shaking, some poorly designed buildings may be subject to collapse.
- Ground motions above about 30% g may cause significant damage in well-designed buildings and very high levels of damage (including collapse) in poorly designed buildings.
- Ground motions above about 50% g may cause significant damage in many buildings, including some buildings that have been designed to resist seismic forces.

6.4 Earthquake Hazard Maps

The current scientific understanding of earthquakes is incapable of predicting exactly where and when the next earthquake will occur. However, the long term probability of earthquakes is well enough understood to make useful estimates of the probability of various levels of earthquake ground motions at a given location.

The current consensus estimates for earthquake hazards in the United States are incorporated into the 2008 USGS National Seismic Hazard Maps. These maps are the basis of building code design requirements for new construction, per the International Building Code adopted in Washington State. The earthquake ground motions used for building design are set at 2/3rds of the 2% in 50 year ground motion.

The following maps show contours of Peak Ground Acceleration (PGA) with 10% and 2% chances of exceedance over the next 50 years to illustrate the levels of seismic hazard. The ground shaking values on the maps are expressed as a percentage of g, the acceleration of gravity. For example, the 10% in 50 year PGA value means that over the next 50 years there is a 10% probability of this level of ground shaking or higher.

In very qualitative terms, the 10% in 50 year ground motion represents a likely earthquake while the 2% in 50 year ground motion represents a level of ground shaking close to but not the absolute worst case scenario.

Figure 6.4 on the following page, the statewide 2% in 50 year ground motion map, is the best statewide representation of the variation in the level of seismic hazard in Washington State by location:

- The dark red, pink and orange areas have the highest levels of seismic hazard.
- The tan, yellow and blue areas have intermediate levels of seismic hazard.
- The bright green and pale green areas have the lowest levels of seismic hazard.

The detailed geographical patterns in the maps reflect the varying contributions to seismic hazard from earthquakes on the Cascadia Subduction Zone and crustal earthquakes within the North American Plate. The differences in geographic pattern between the 2% in 50 year maps and the 10% in 50 year maps reflect different contributions from Cascadia Subduction Zone earthquakes and crustal earthquakes.

These maps are generated by including earthquakes from all known faults, taking into account the expected magnitudes and frequencies of earthquakes for each fault. The maps also include contributions from unknown faults, which are statistically possible anywhere in Washington. The contributions from unknown faults are included via “area” seismicity which is distributed throughout the state.

An important caveat for interpreting these maps is that the 2008 USGS seismic hazard maps show the level of ground motions for rock sites. Ground motions on soil sites, especially soft soil sites will be significantly higher than for rock sites. Thus, for earthquake hazard analysis at a given site it is essential to include consideration of the site’s soil conditions.

The ground motions shown in the following figures represent ground motions with the specified probabilities of occurrence. At any given site, earthquakes may be experienced with ground motions over the entire range of levels of ground shaking from just detectible with sensitive seismometers to higher than the 2% in 50 year ground motion.

Figure 6.4

2014 USGS Seismic Hazard Map: Washington State[6]

PGA value (%g) with a 2% Chance of Exceedance in 50 years

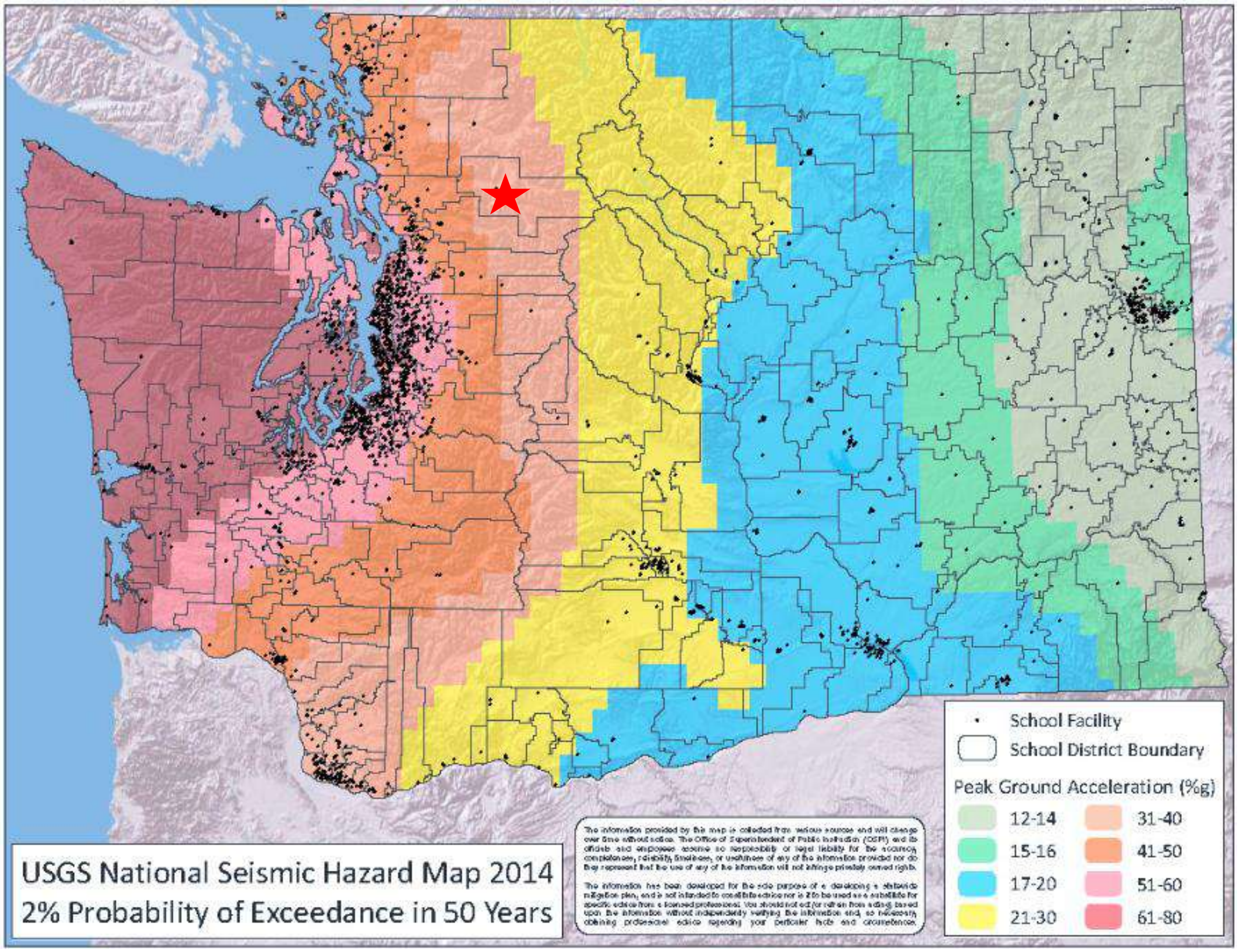


Figure 6.5

2014 USGS Seismic Hazard Map: Washington State[6]

PGA value (%g) with a 10% Chance of Exceedance in 50 years

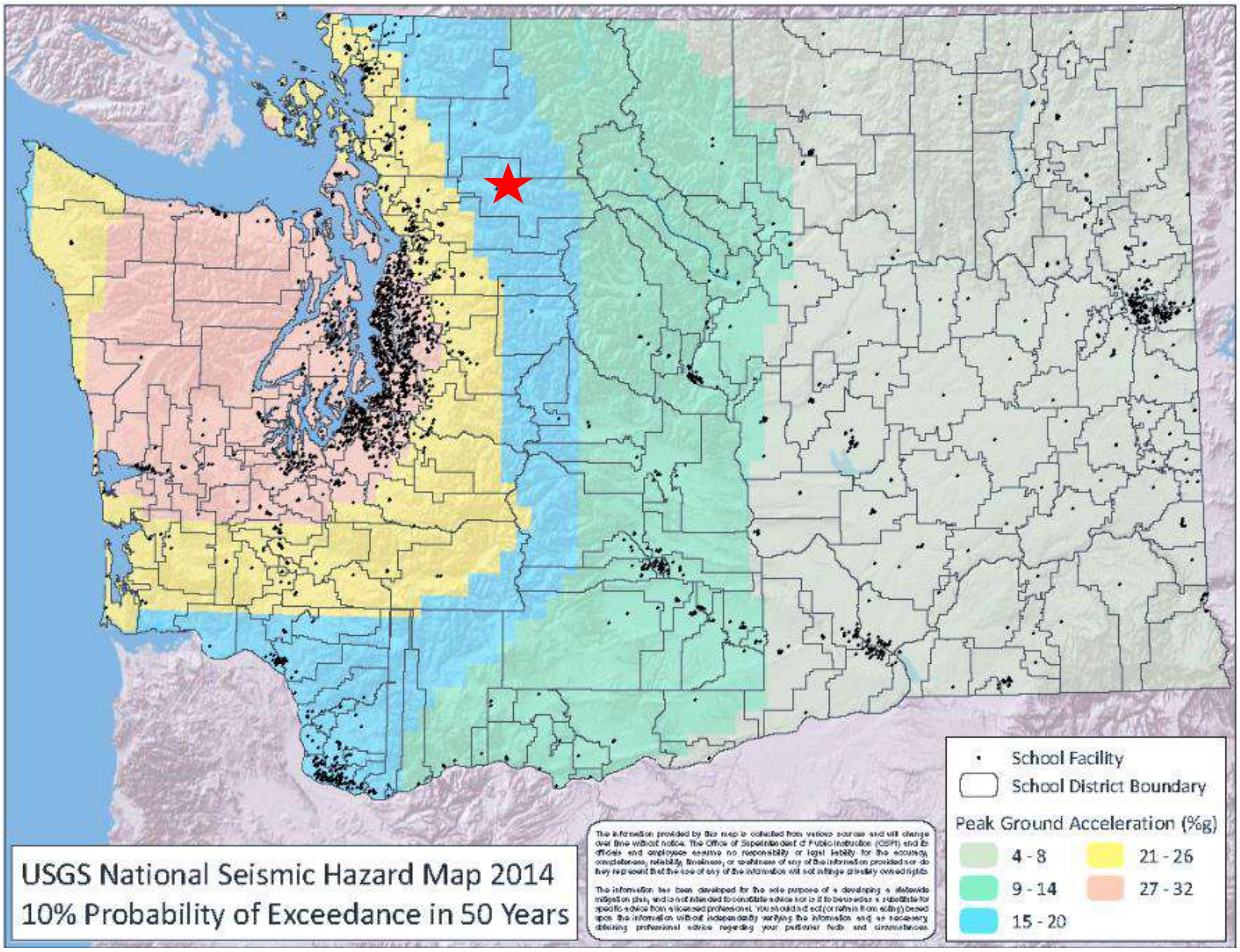


Figure 6.6

2014 USGS Seismic Hazard Map: Puget Sound Area
PGA value (percent g) with a 2% Chance of Exceedance in 50 years

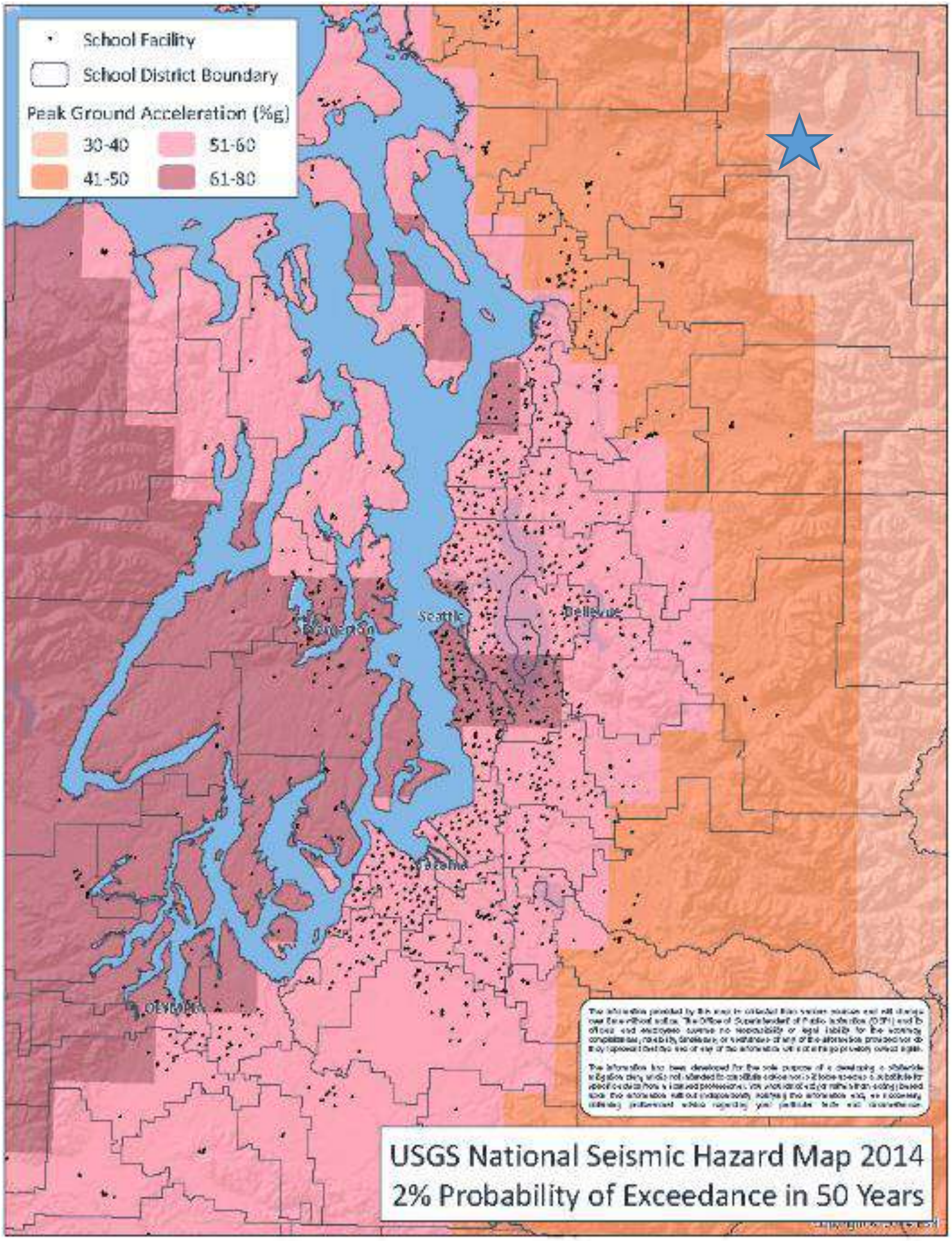
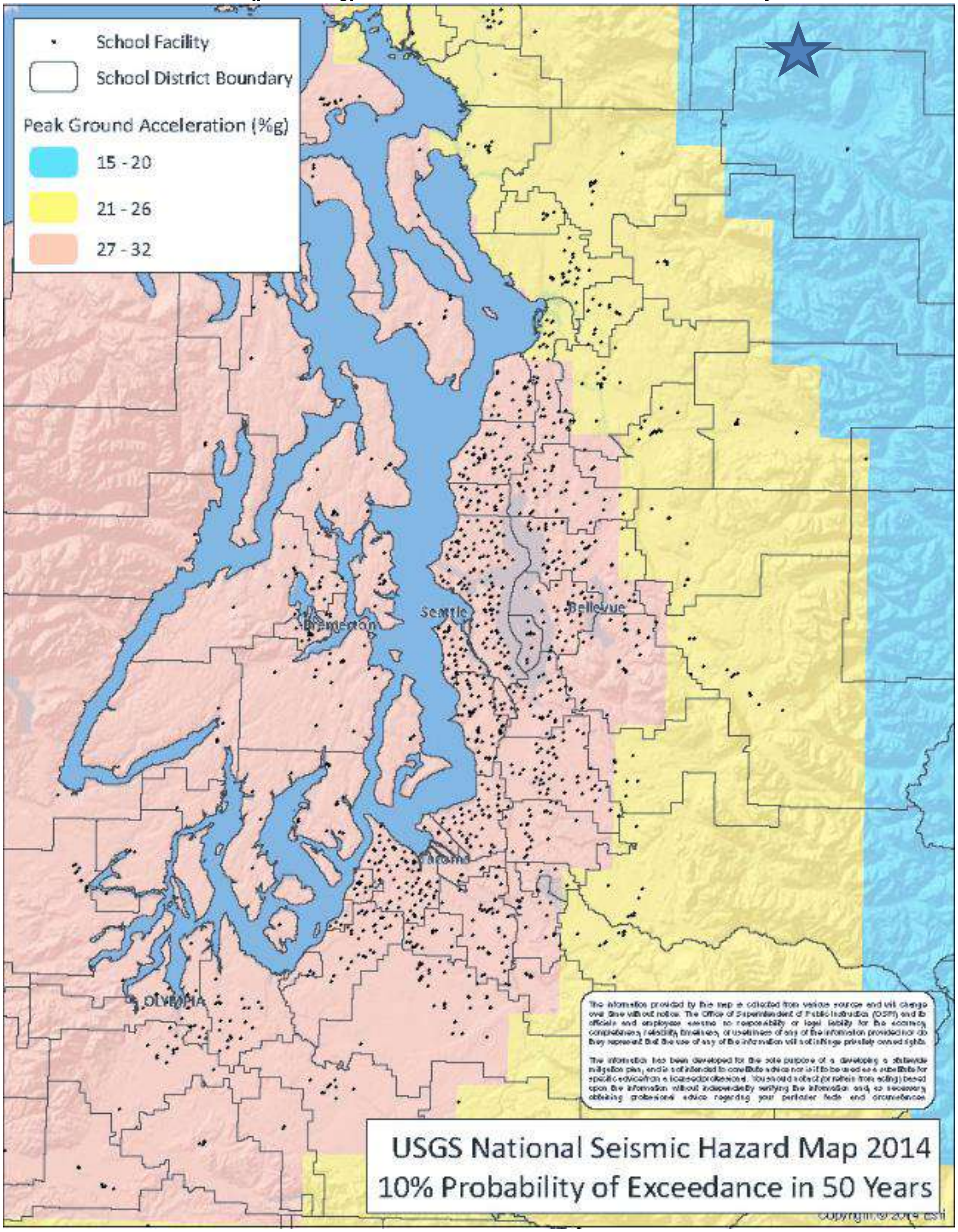


Figure 6.7
2014 USGS Seismic Hazard Map: Puget Sound Area
PGA value (percent g) with a 10% Chance of Exceedance in 50 years



6.5 Site Class: Soil and Rock Types

As discussed previously, the soil or rock type at a given location substantially affects the level of earthquake hazard because the soil or rock type may amplify or de-amplify ground motions. In general, soil sites, especially soft soil sites amplify ground motions. That is, for a given earthquake, a soil site immediately adjacent to a rock site will experience higher levels of earthquake ground motions than the rock site.

In simple terms, there are six soil or rock site classes:

- A – Hard Rock
- B – Rock
- C – Very Dense Soil and Soft Rock
- D – Firm Soil
- E – Soft Soil
- F – Very Soft Soil

Site classes for each campus in the CONCRETE School District are included in the campus-level report in Section 6.7. These estimates are from DNR or from site-specific determinations if such are entered into the OSPI ICOS PDM database.

6.6 Ground Failures and Other Aspects of Seismic Hazards

Much of the damage in earthquakes occurs from ground shaking that affects buildings and infrastructure. However, there are several other consequences of earthquakes that can result in substantially increased levels of damage in some locations. These consequences include: surface rupture; subsidence or elevation; liquefaction; settlement; lateral spreading; landslides; dam, reservoir or levee failures; tsunamis and seiches. Any of these consequences can result in very severe damage to buildings, up to and including complete destruction, and also a high likelihood of casualties.

6.6.1 Surface Rupture

Surface rupture occurs when the fault plane along which rupture occurs in an earthquake reaches the surface. Surface rupture may be horizontal and/or vertical displacement between the sides of the rupture plane. For a building subject to surface rupture the level of damage is typically very high and often results in the destruction of the building.

Surface rupture does not occur with interface or intraplate earthquakes on the Cascadia Subduction Zone and does not occur with all crustal earthquakes. Faults in Washington State where surface rupture is likely include the Seattle Fault System and the Tacoma Fault System.

6.6.2 Subsidence

Large interface earthquakes on the Cascadia Subduction Zone are expected to result in subsidence of up to several feet or more along Washington's Pacific Coast. For facilities located very near sea level, co-seismic subsidence may result in the facilities being below sea level or low enough so that flooding becomes very frequent. Subsidence may also impede egress by blocking some routes and thus increase the likelihood of casualties from tsunamis.

6.6.3 Liquefaction, Settlement and Lateral Spreading

Liquefaction is a process where loose, wet sediments lose bearing strength during an earthquake and behave similar to a liquid. Once a soil liquefies, it tends to settle vertically and/or spread laterally. With even very slight slopes, liquefied soils tend to move sideways downhill (lateral spreading). Settling or lateral spreading can cause major damage to buildings and to buried infrastructure such as pipes and cables.

Estimates of liquefaction potential for each campus in the Concrete School District are included in the campus-level report in Section 6.7. These estimates are from DNR or from site-specific determinations, if such determinations were entered into the OSPI ICOS PDM database by the District.

6.6.4 Dam, Levee and Reservoir Failures

Earthquakes can also cause failure of dams, levees and reservoirs. Campuses downslope from dams or water reservoirs or behind levees may be subject to flooding if the dams, reservoirs of levees fail as a result of an earthquake.

The Concrete School District campus has significant flood risk since it is downslope from several dams. Further information about the District's flood risk is included in the flood chapter in this mitigation plan

6.7 Seismic Risk Assessment for the Concrete School District's Facilities

The potential impacts of future earthquakes on the Concrete School District include damage to buildings and contents, disruption of educational services, displacement costs for temporary quarters if some buildings have enough damage to require moving out while repairs are made, and possible deaths and injuries for people in the buildings. The magnitude of potential impacts in future earthquakes can vary enormously from none in earthquakes that are felt but result in neither damages nor casualties to very substantial for larger magnitude earthquakes with epicenters near a given campus.

The vulnerability of the Concrete School District's facilities varies markedly from building to building, depending on each building's structural system and date of construction (which governs the seismic design provisions). The level of risk on a building by building level is summarized in the building-level earthquake risk tables later in this chapter.

The initial seismic risk assessment for the District's facilities at both the campus level and the building-level is largely automated from the data in the OSPI ICOS PDM database. The data used include GIS data for the location of each campus and district-specific data entered into the OSPI ICOS PDM database.

The three step hazard and risk assessment approach, outlined below, uses data in the OSPI ICOS PDM database for screening and prioritization of more detailed evaluations which usually require inputs from an engineer experienced with seismic assessments of buildings. The auto-generated reports help to minimize the level of effort required by districts and to reduce costs by prioritizing more detailed seismic evaluations, enabling the District to focus on the buildings most likely to have the most substantial seismic deficiencies. The three steps include:

1. An auto-generated campus-level earthquake report that summarizes earthquake hazard data including ground shaking, site class, and liquefaction potential and classifies the combined earthquake hazard level from these data. The campus-level report also includes priorities for building-level risk assessments and geotechnical evaluations of site conditions.

2. An auto-generated building-level earthquake report that is based on the ASCE 41-13 seismic evaluation methodology. The building-level report contains the data necessary to determine whether a building is pre- or post-benchmark year for life safety. If a building is post-benchmark it is generally deemed to provide adequate life safety and no further evaluation is necessary. If not, completing an ASCE 41-13 Tier 1 evaluation is recommended. The auto-generated report includes suggested priorities for Tier 1 evaluations.

3. The third step includes completion and interpretation of the ASCE 41-13 Tier 1 evaluations and:

    a. More detailed evaluation of one or more buildings that are determined to have the highest priority for retrofit or replacement from the previous step.

    b. Design of seismic retrofits for buildings for which a retrofit is the preferred alternative.

    c. Implementation of retrofits or replacement of buildings, as funding becomes available.

Table 6.2

Campus-Level Earthquake Report

Earthquake Campus-Level Hazard and Risk Report: Preliminary[1]									
Campus	Earthquake Ground Shaking 2% in 50 Years[2] (% g)	Site Class[°]	Earthquake Ground Shaking Hazard Level	Liquefaction Potential	Combined Earthquake Hazard Level	Recommendations			
						Building Level Risk Assessment		Geotechnical Evaluation	
						Yes/No[3]	Priority	Yes/No	Priority
CONCRETE SCHOOL DISTRICT									
Administration Building	38.34%	D-E	Moderate to High	Moderate to High	High	Yes	High	Yes	High
Concrete High School	38.34%	D-E	Moderate to High	Moderate to High	High	Yes	High	Yes	High
Concrete K-8 School	38.34%	D-E	Moderate to High	Moderate to High	High	Yes	High	Yes	High

[1] Campus level risk is generally proportional to the combined earthquake hazard, but depends very strongly on the seismic vulnerability of buildings which must be evaluated at the building level. Thus, earthquake risk cannot be defined meaningfully at the campus level, except by doing building-level evaluations and then aggregating building results to provide campus-level risk.

[2] Earthquake ground motion measured as peak ground acceleration (PGA) relative to the "g", the acceleration of gravity.

[3] "Limited" applies only to campuses with low ground shaking hazard level (2% in 50 year PGA less than 20% g) and means building-level risk assessments are recommended only for the most vulnerable building types.

[°] The six site classes are identified as follows: A-Hard Rock, B-Rock, C-Very Dense Soil and Soft Rock, D-Firm Soil, E-Soft Soil and F-Very Soft Soil. Estimates by DNR also include intermediate classes such as D-E, where the data is not sufficient to distinguish between D and E, as well as G-Unknown, when data is missing

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Table 6.3

Building-Level Earthquake Report

Building-Level Earthquake Report															
Building - Area	Seismic Design Criteria				Building Type	Seismic Design Basis	ASCE 41-13 Tier 1 Evaluation Recommended[1]		ASCE 41-13 Tier 1 Evaluation[a]			Mitigation Desired (Yes/No)	Mitigation Type	Mitigation Complete (Yes/No)
	Year Built	UBC or IBC	Code Year	Post-Benchmark (Yes/No)			Yes /No	Risk Level and Priority[2,3]	Completed (Yes/No)	ASCE 41-13 Compliant (Yes/No)	Further Eval Desired			
CONCRETE SCHOOL DISTRICT														
Administration Building Facility														
Administration - Admin	1981			No	RM1L	Moderate Code	Yes	Moderate to High	No					
Bus Barn - Bus	1952			No	RM1L	Low Code	Yes	Moderate to High	No					
Concrete High School Facility														
Main Building - Main	1951			No	PC2M	Low Code	Yes	Moderate to High	No					
Tech Building - Tech	1952			No	RM1L	Moderate Code	Yes	Moderate to High	No					

Concrete K-6 School Facility

Gym - Gym	1981			No	RM1L	Moderate Code	Yes	High	No					
Main Building - Main	1981			No	RM1L	Moderate Code	Yes	Moderate to High	No					
Portable B - Portable B	1980			No	MH	Pre Code	No	Low	No					
Portable C - C	1980			No	MH	Pre Code	No	Low	No					
Portable D and Headstart - D	1980			No	MH	Pre Code	No	Low	No					

[1] ASCE 41-13 seismic evaluations are recommended for buildings that were not designed to a "benchmark" seismic code deemed adequate to provide life safety. However, ASCE 41-13 recommends that post-benchmark code buildings be evaluated by an engineer to verify that the as-built seismic details conform to the design drawings. Most such buildings should be compilant, unless poor construction quality degrades the expected seismic performance of the building.

[2] The priority for 41-13 evaluations is based on the building type, the combined earthquake hazard level (ground shaking and liquefaction potential), the seismic design basis, and whether a building as been identified as having substantial vertical or horizontal irregularities. These priorities recoginize that many districts have limited funding for 41-13 evaluations. Districts with adequate funding may wish to complete 41-13 evaluations on all pre-benchmark year buildings.

[3] The earthquake risk level is low for all buildings for which an ASCE 41-13 evaluation is not recommended as necessary. For other buildings, the preliminary risk level and the priority for 41-13 evaluation are based on the earthquake hazard level, the building structural type, the seismic design level and whether a building has vertical and horizontal irregularities.

[a] The final determination of priorities for retrofit are based on whether a building is compliant with the 41-13 life safety criteria. If not, the priorities should be set in close consultation with the engineer who completed the 41-13 evaluation.

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The information has been developed and presented for the sole purpose of developing school district mitigation plans and to assist in determining where to focus resources for additional evaluations of natural hazard risks. The reports are not intended to constitute in-depth analysis or advice, nor are they to be used as a substitute for specific advice obtained from a licensed professional regarding the particular facts and circumstances of the natural hazard risks to a particular campus or building.

The campus-level earthquake hazard level is uniform for all of the buildings, with the same level of ground shaking and the same potential for liquefaction. The moderate to high potential for liquefaction, based on estimates by the Washington Department of Natural Resources raises the level of risk. For the same level of earthquake ground shaking, the occurrence of liquefaction will likely increase the level of damage, Given the moderate to high liquefaction potential, a geotechnical evaluation to determine the potential for liquefaction is rated a high priority.

All of the District's buildings were built in two time periods – the early 1950s and the early 1980s. Thus, all of these buildings were designed and built to much lower earthquake design standards than current or recent building codes, especially the 1950s buildings. The 1950s buildings likely had minimal consideration of earthquakes in their design, and perhaps none.

The priorities for seismic evaluations are:

- The early 1950s buildings,
- The early 1980s, buildings,
- Portables with significant occupancies, and
- Portables used only for storage with minimal occupancy.

A brief inspection of the portables indicated that none of them have foundations adequate for even low levels of earthquake ground motions. Thus, failure of the foundations is very likely at relatively low levels of earthquake ground shaking. Thus, these buildings appear to have significantly more earthquake risk than indicated in Table 6.3.

6.8 Previous Earthquake Events

The February 28, 2001 Nisqually Magnitude 6.8 earthquake caused minor foundation cracking to some of the District's buildings. The District's buildings likely experienced minor damage in the 1967 Tacoma Magnitude 6.7 earthquake, but records are no longer available. Damage to District facilities was minor in these relatively large earthquakes because the earthquakes occurred a considerable distance from Concrete and the level of ground shaking at the campus was much lower than it would be for earthquakes closer to Concrete.

6.9 Earthquake Hazard Mitigation Measures for K-12 Facilities

6.9.1 Typical Seismic Mitigation Measures

There are several possible earthquake mitigation Action Items for the District's facilities, including:

- Replacement of seismically vulnerable buildings with new buildings that meet or exceed the seismic provisions in the current building code,
- Structural retrofits for buildings,
- Nonstructural retrofits for buildings and contents,
- Installation of emergency generators for buildings with critical functions,

including designated emergency shelters, and

- Enhanced emergency planning, including earthquake exercises and drills.

Of these potential earthquake Actin Items, FEMA mitigation grants, which typically provide 75% of total project costs, may be available for structural or nonstructural retrofits and for emergency generators.

Earthquake Action Items for the Concrete School District are given in Table 6.4 on the following page.

Table 6.4

CONCRETE School District: Earthquake Action Items

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Earthquake Mitigation Action Items								
Short-Term #1	Complete ASCE 41-13 Tier 1 evaluations for the District's 1950s and 1980s buildings, other than the portables.	1-2 Years	Local or Grant	CSD	X	X		X
Short-Term #2	Assess the ASCE 41-13 results and select buildings that have the greatest vulnerability for more detailed evaluations, including development of retrofit concepts.	1-5 Years	Local or Grant	CSD	X	X		X
Short-Term #3	Based on the above results, determine the District's priorities for seismic retrofits or replacements and implement as funding becomes available.	1-10 Years	Local, Bond or Grant	CSD	X	X		X
Short-Term #4	Have an engineer evaluate the foundations for the portables with significant occupancies, develop retrofit concepts and implement the retrofits as funding becomes available.	1-5 Years	Local or Grant	CSD	X	X		X
Long-Term #1	Maintain and update building data for seismic risk assessments in the OSPI ICOS PDM database.	Ongoing	Local	CSD	X		X	X
Long-Term #2	Enhance emergency planning for earthquakes including duck and cover and evacuation drills.	Ongoing	Local	CSD	X		X	X

6.10 References

1. United States Geological Survey (2013). Largest Earthquakes in the World Since 1900.

http://earthquake.usgs.gov/earthquakes/world/10_largest_world.php

2. University of Washington (2002). Map and List of Significant Quakes in WA and OR, The Pacific Northwest Seismograph Network. University of Washington Department of Earth Sciences.

3. Washington State Department of Natural Resources (2013).

https://fortress.wa.gov/geology?Theme-wigm

4. Cascadia Region Earthquake Working Group (2005): Cascadia Subduction Zone Earthquakes: A Magnitude 9.0 Earthquake Scenario.

5. Oregon Seismic Safety Policy Advisory Commission (2013). The Oregon Resilience Plan.

6. Washington State Department of Natural Resources (2004). Liquefaction Susceptibility and Site Class Maps of Grays Harbor County, Washington. Open File Report 2004-20.

7.0 VOLCANIC HAZARDS: 6-28-2015

7.1 Overview

The Cascade Mountain Range, which runs from British Columbia into northern California, contains more than a dozen major volcanoes and hundreds of smaller volcanic features. In the past 200 years, seven of the volcanoes in the Cascade Range have erupted, including four in Washington State: Mount Baker, Glacier Peak, and Mount Rainier, and Mount St. Helens. Over the past 4,000 years (a geologically short time period), the most active volcano in the Cascades has been Mount St. Helens with about 14 eruptions.

Many other volcanoes in the Cascades are deemed active or potentially active. The Smithsonian Institution's Global Volcanism Project[1] lists seven active volcanoes in Washington. These volcanoes are listed below, along with Mount Hood in Oregon, which is close enough to Washington to potentially affect parts of Washington.

Table 7.1

Active Volcanoes in Washington[1]

Volcano	Type	Last Eruption
Mount Baker	Stratovolcano	1880
Glacier Peak	Stratovolcano	1700 $\pm$ 100
Mount Rainier	Stratovolcano	1894 (?)
Mount Adams	Stratovolcano	950 AD (?)
Mount St. Helens	Stratovolcano	1980 - 2008
West Crater	Volcanic Field	5750 BC (?)
Indian Heaven	Shield Volcanoes	6250 $\pm$ 100 BC
Mount Hood (Oregon)	Stratovolcano	1866

The numerous volcanoes of the Cascades differ markedly in their geological characteristics. The largest volcanoes are generally what geologists call composite or stratovolcanoes, which have steep slopes because they are built mostly by flows of viscous lava. Shield volcanoes have gentle slopes because they are built mostly by flows of more fluid, low viscosity lavas. Volcanic fields are areas where volcanic activity occurs or large areas from numerous vents, fissures and cinder cones.

The current USGS ranking of threat potential for the eight volcanoes shown above is shown in the following table: six of the eight volcanoes are ranked as having high to very high threat potential.

Table 7.2

USGS Volcano Threat Potential[2]

Volcano	USGS Threat Potential[a]
Mount Baker	High to Very High
Glacier Peak	High to Very High
Mount Rainier	High to Very High
Mount Adams	High to Very High
Mount St. Helens	High to Very High
West Crater	Low to Very Low
Indian Heaven	Low to Very Low
Mount Hood (Oregon)	High to Very High

[a] Qualitative ranking based on rate of volcanic activity, explosiveness, and consequences.

Detailed information about specific volcanoes may be found on the following websites.

Table 7.3

Volcano Websites

Institution	Website
United States Geological Survey (USGS)	www.usgs.gov
USGS Cascades Volcano Observatory	http://vulcan.wr.usgs.gov
Smithsonian Institution (Global Volcanism Project)	www.volcano.si.edu
Washington State Department of Natural Resources (see: Geology and Earth Resources Division)	www.dnr.wa.gov

Further information about volcanic hazards in Washington State, including references to USGS publications about each active volcano are included in Chapter 9 of the Washington State K-12 Facilities Hazard Mitigation Plan.

7.2 Volcanic Hazard Types

Volcanic eruptions often involve several distinct types of hazards to people and property, as well evidenced by the Mount St. Helens eruption. Major volcanic hazards include: lava flows, blast effects, pyroclastic flows, landslides or debris flows, ash falls, and lahars.

Proximal Volcanic Hazards (Effects Near a Volcano)

Lava flows are eruptions of molten rock. Lava flows for the major Cascades volcanoes tend to be thick and viscous, forming large steep cones and typically affecting only those areas near the eruption vent. However, lava flows from the smaller volcanoes in volcanic fields tend to be less viscous flows that spread out over wider areas. Lava flows obviously destroy everything in their path.

Blast effects may occur with violent eruptions, such as Mount St. Helens in 1980. Most volcanic blasts are largely upwards. However, the Mount St. Helens blast was lateral, with impacts up to 17 miles from the volcano. Similar or larger blast zones are possible in future eruptions of any of the major Cascades volcanoes.

Pyroclastic flows are high-speed avalanches of hot ash, rock fragments and gases. Pyroclastic flows can be as hot as 1500 ^{o}F and move downslope at 100 to 150 miles per hour. Pyroclastic flows are extremely deadly for anyone caught in their path.

Landslides or debris flows are the rapid downslope movement of rocky material, snow and/or ice. Volcano landslides can range from small movements of loose debris to massive collapses of the entire summit or sides of a volcano. Landslides on volcanic slopes may be triggered by eruptions or by earthquakes or simply by heavy rainfall.

Distal Volcanic Hazards

(Effects at Considerable Distances from a Volcano)

Lahars or mudflows are common during eruptions of volcanoes with heavy loading of ice and snow. These flows of mud, rock and water can rush down channels at 20 to 40 miles an hour and can extend for more than 50 miles. Large lahars may be hundreds of yards wide, tens of yards deep and capable of carrying large boulders more than 30 feet in diameter. In most cases, inundation by a lahar will result in complete destruction of buildings.

Ash falls result when explosive eruptions blast rock fragments into the air. Such blasts may include tephra (solid and molten rock fragments). The largest rock fragments (sometimes called “bombs”) generally fall within two miles of the eruption vent. Smaller ash fragments (less than about 0.1”) typically rise into the area forming a huge eruption column. In very large eruptions, ash falls may total many feet in depth near the vent and extend for hundreds or even thousands of miles downwind.

7.3 Volcanic Hazards for K-12 Facilities

There are only a few K-12 facilities located within the proximal volcanic hazard zones, as defined above. However, there many K-12 facilities at risk from lahars and all campuses have at least some risk from ash falls.

Lahars are often initiated when volcanic activity rapidly melts snow and ice at high elevations on a volcano. Volcanic ash and debris constitutes part of the load carried by lahars, but as lahars flow downslope they pick up additional debris loads from eroding sediments and vegetation. Large lahars may be up to hundreds of yards wide and tens of yards deep and capable of carrying large boulders more than 30 feet in diameter.

When a lahar occurs, evacuation to safe locations well outside of the anticipated lahar inundation zone must be completed before arrival of the lahar at a facility's location. Buildings inundated by lahar flows are generally totally destroyed and may be deeply buried under many feet of deposited debris.

> **Lahars pose an extreme life safety threat for K-12 campuses within lahar inundation zones**.

The United States Geological Survey's volcanic hazard map showing the Concrete School District's facilities within mapped volcanic hazard zones is shown as Figure 7.1 on the following page. The District's campus is within the possible lahar inundation zone for Mount Baker and Glacier Peak and also within the possible volcanic blast zone for Mount Baker.

The campus is within the USGS mapped lahar zone only for Case M – the most extreme lahar event believed possible – which has an estimate return period of about 14,000 years. This means that the probability of this occurring within the next 50 years is less than 1%. The probability of a lateral blast event – such as that that occurred at Mount St. Helens in 1980 – is even lower than the probability of the most extreme lahar event.

A higher-resolution map for the Town of Concrete is shown as Figure 7.2. This represents the extreme worst case lahar scenario – the largest lahar event considered possible by the UGSG.

However, extreme volcanic events with very large lahars and/or volcanic blasts can occur and could affect the district's campus. Given the low probability but very extremely catastrophic consequences of such events, the Concrete School District will include evacuations for volcanic events in its emergency planning.

Figure 7.1

USGS Volcanic Hazard Zones for the Concrete School

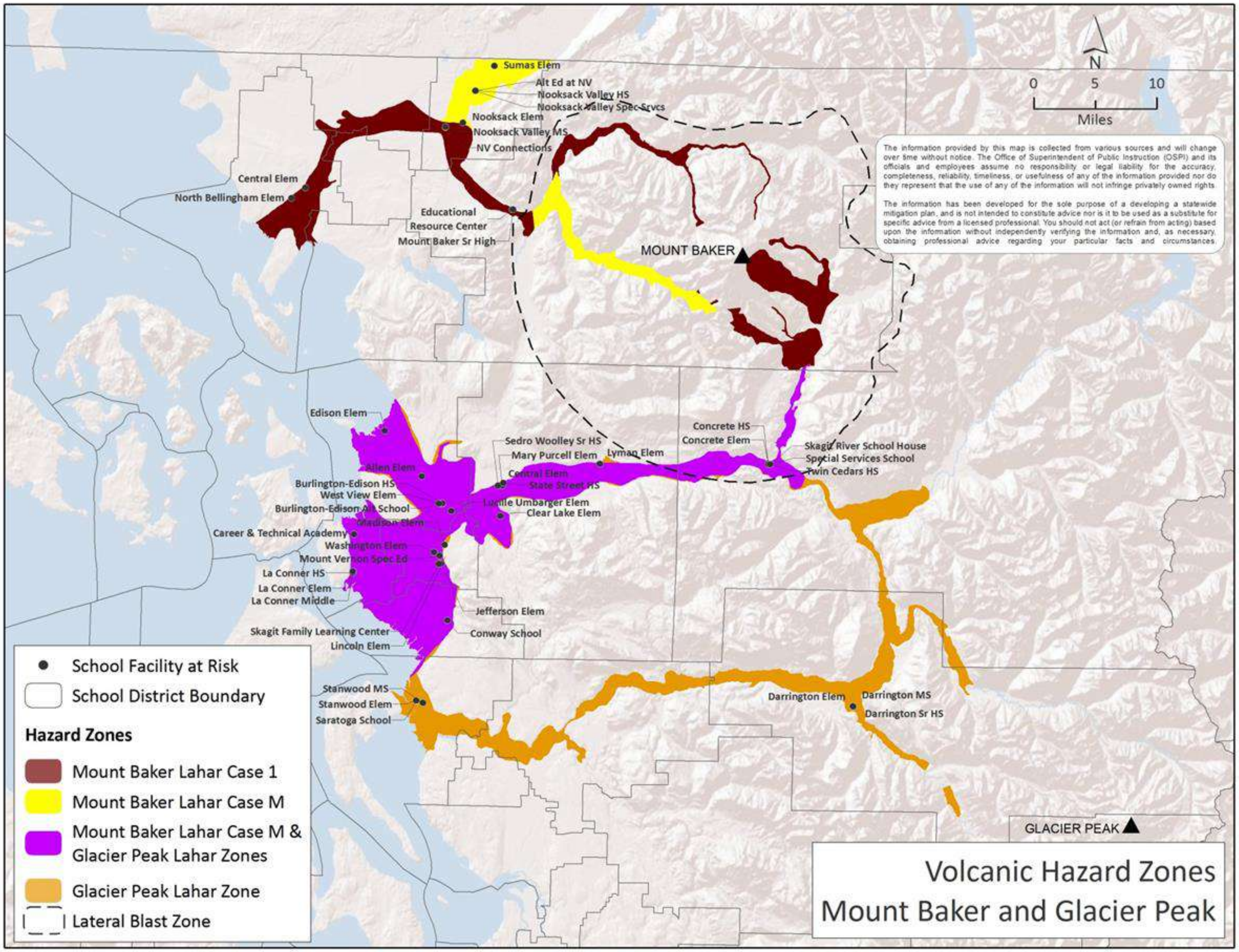
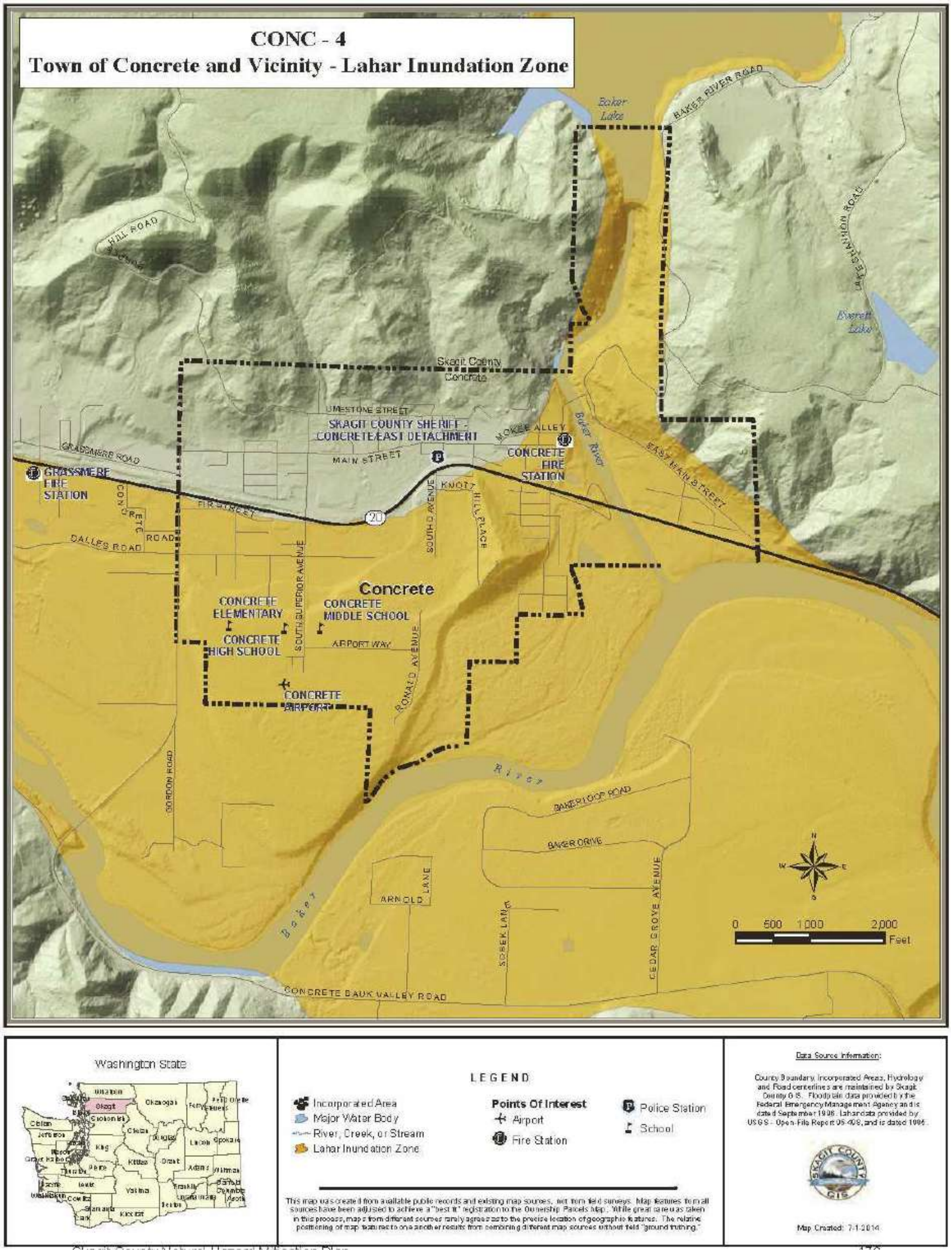


Figure 7.2

USGS Lahar Map for the Worst Case Scenario



The USGS probabilistic ash fall maps are shown in Figure 7.2 on the following page. The maps show the probabilities of 1 centimeter (0.4 inch) or more of ash and 10 centimeters (4 inches) or more of ash over a 30-year time period. The probabilistic ash fall contours are dominated by Mount St. Helens because this volcano is the most active volcano in the Cascades. The probabilistic ash fall contours are higher eastwards from Mount St. Helens and the other volcanoes because the prevailing winds are from the west.

For any volcanic eruption generating ash, the thickness of ash accumulations decreases with distance from the volcano. Thus, locations nearest to Mount St. Helen or to the other volcanoes will receive the highest ash accumulations.

Depending on which volcano erupts, the volume of volcanic ash ejected by an eruption and on prevailing wind directions at the time of eruption, the thicknesses of ash falls will vary markedly with location. However, ash falls may affect a significant number of K-12 facilities in Washington.

In extreme ash fall events, accumulation depths may reach several feet or more with the potential for building collapses from the ash load. None of the volcanoes in the Cascades are believed capable of generating such extreme volumes of ash. However, many roofs cannot support more than a few inches of wet ash. Extreme ash thicknesses are not necessary for building roofs to collapse.

Most ash fall events impacting K-12 facilities are likely to be relatively minor with an inch or less of ash likely. However, even minor amounts of ash fall can result in significant impacts. The impacts of ash falls on K-12 facilities include health effects and several other disruptive effects such as:

a) The inability of some schools to evacuate due to a combination of the disruption of vehicular traffic and health concerns that may preclude people being outside during heavy ash falls. In this case, shelter in place may be necessary, possibly for up to several days.

b) Respiratory problems for at-risk populations such as young children, people with respiratory problems and the elderly,

c) Clogging of filters and possible severe damage to vehicle engines, furnaces, heat pumps, air conditioners, commercial and public building combined HVAC systems (heating, ventilation and air conditioning) and other engines and mechanical equipment,

d) Clean-up and ash removal from roofs, gutters, sidewalks, roads vehicles, HVAC systems and ductwork, engines and mechanical equipment,

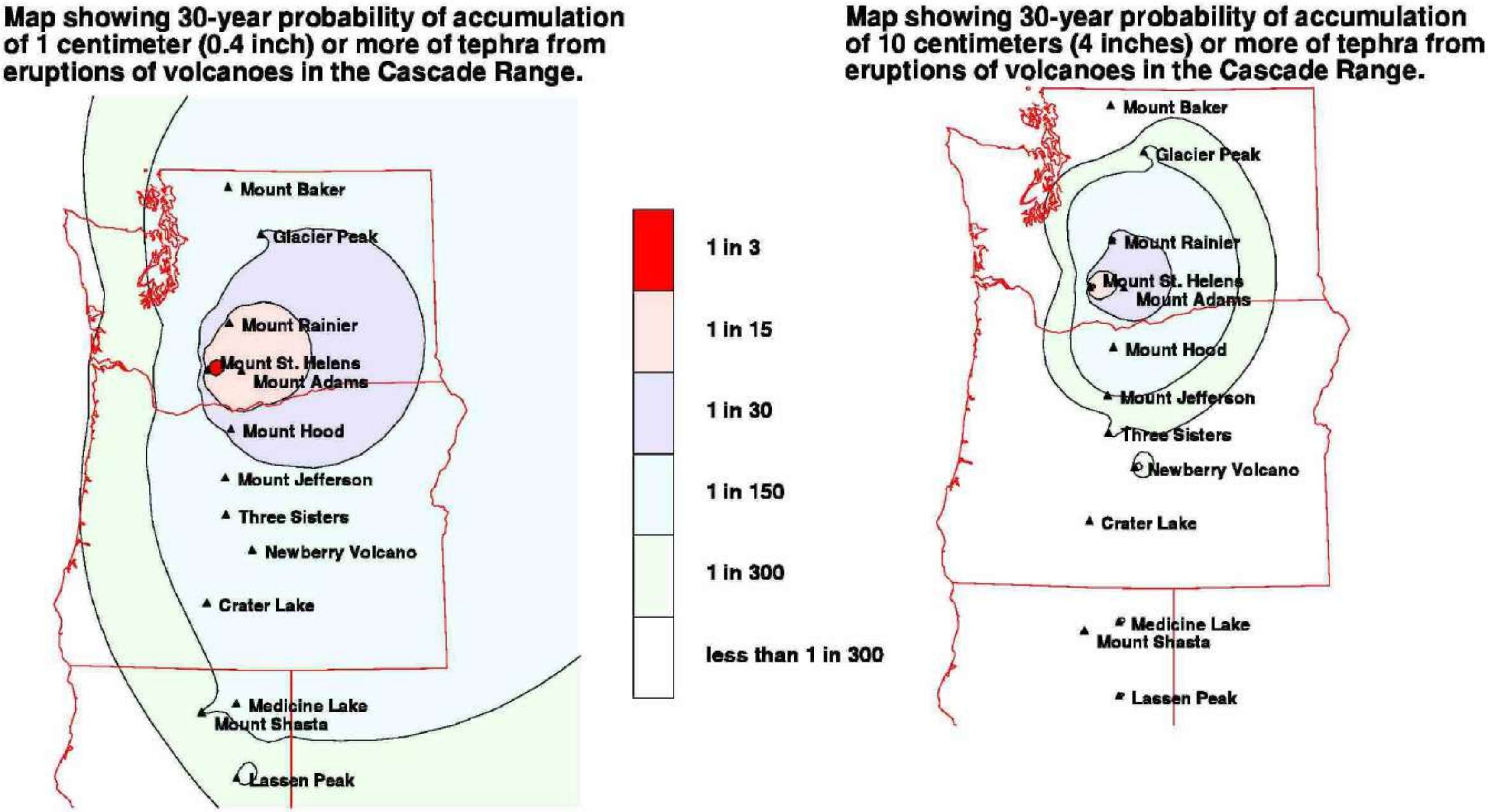
e) Impacts on public water supplies drawn from surface waters, including degradation of water quality (high turbidity) and increased maintenance requirements at water treatment plants,

f) Possible electric power outages from ash-induced short circuits in distribution lines, transmission lines and substations, and

g) Disruptions of vehicular and air traffic.

Figure 7.2

USGS Ash Fall Probabilistic Maps[3]



The term “tephra” used on the above USGS maps incudes volcanic ash, dust, cinders and other ejecta from an erupting volcano.

7.4 Volcanic Hazard and Risk Assessment

The potential impacts of future volcanic events on the Concrete School District are varies markedly from campus to campus. The following campuses are within or near mapped lahar zones or volcanic blast zones: insert list. The potential impacts for these campuses include deaths and injuries, damage to buildings and contents (including complete destruction in severe events), disruption of educational services, and displacement costs for temporary quarters if some buildings have enough damage to require moving out while repairs are made.

The potential impacts of future volcanic ash fall events are substantially less severe than those noted above, but all of the district's campus may be affected by ash falls. The potential impacts include health effects and disruptive effects as summarized on Page 7-6 (check page number).

None of the district's campuses have been affected by lahars, volcanic blasts, or ash falls.

For a given campus, the level of volcanic hazard and risk depends on several factors, including:

- Is the campus in or near a mapped volcanic hazard zone?
- If so, what are the estimated return periods for volcanic events that would affect the campus?
- How far from the campus is a safe area well outside of the hazard zone?
- How long would it take students and staff to reach the safe area?
- Can people reach the safe area in the anticipated time between awareness of an approaching lahar (or other volcanic event) and the arrival of the lahar at the campus?

The campus-level summary report for volcanic hazard and risk for the Concrete School District is shown in Table 7.4 on the following page.

There are important caveats regarding the interpretation of the results shown in Table 7.4:

1. Warning times for a lahar approaching a given campus will always be <u>much</u> shorter than the lahar travel time. With a lahar warning system, the estimated time between the initiation of a lahar and the issuance of a warning is about 30 minutes and it may take longer for the warning to reach a given campus.
2. Absent a warning system or other notification that a lahar has been initiated, the only warning of an approaching lahar would be a loud rumbling accompanied by a roaring sound similar to a locomotive or jet. The time interval between hearing an approaching lahar and lahar arrival may be only five to ten minutes, or even less.
3. The distance to the peak of a volcano is the straight line distance. The actual distance along valleys will be longer.

4. The lahar travel time estimates are rough estimates based on a typical flow velocity for lahars of 25 miles per hour. Actual travel times may be significantly shorter or longer than these estimates, depending on slopes and other channel characteristics.
5. The life safety risk levels are based on the volcanic hazard level with adjustments for travel times in three ranges: less than 15 minutes, 15 to 30 minutes and more than 30 minutes.

Table 7.4

Campus-Level Hazard and Risk Summary: Volcanic Hazards

Campus	Volcano	Distance to Peak (Miles)	Lahar Travel Time (Mins)	Volcanic Hazard Zones	Governing Volcanic Event	Return Period (Years)	Probability in 50 Years	Volcanic Hazard Level	Travel Time to Safe Area (Mins)	Life Safety Risk Level	Evaluate Mitigation (Yes/No)
CONCRETE SCHOOL DISTRICT											
Administration Building	Mount Baker	17.24	41	Blast Zone, Case M	Case M	14,000	0.360%	Very Low	60	Moderate	No
Concrete High School	Mount Baker	16.92	41	Blast Zone, Case M	Case M	14,000	0.360%	Very Low	60	Moderate	No
Concrete K-8 School	Mount Baker	16.88	41	Blast Zone, Case M	Case M	14,000	0.360%	Very Low	60	Moderate	No

The probability of severe volcanic events affecting the Concrete School District is very low with only extreme volcanic events from Mount Baker or Glacier Peak affecting the District. However, if such events were to occur the consequences of a volcanic blast and/or lahar could result in severe damage to the District's facility and potential loss of life.

If a volcanic blast were to occur in Mount Baker and was severe enough to reach the campus, evacuation would be essentially impossible, because the arrival time at the campus would be only a just few minutes.

Given the extreme consequences of a lahar or volcanic blast reaching the campus, the District will consider pro-active evacuation when (if) the USGS warning level reaches a high alert level.

7.5 Volcano Monitoring and Volcano Activity Alerts

The USGS monitors volcanic activity in the Cascade Range via networks of seismic sensors (which can detect earthquakes related to magma movements) as well as very accurate ground surface measurements. The USGS also has a volcanic warning and notification system with several levels of alert as a potential eruption becomes more likely and more imminent.

Figure 7.3

Volcanic Alert Levels for People on the Ground[4]

Alert Term	Description
NORMAL	Volcano is in typical background, noneruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to noneruptive background state.
ADVISORY	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
WATCH	Volcano is exhibited heightened or escalating unrest with increased potential of eruption, timeframe uncertain, or eruption is underway but poses limited hazards.
WARNING	Hazardous eruption is imminent, underway or suspected.

There is an important caveat on volcanic alerts: in most cases, volcanoes show signs of increasing activity before an eruption occurs. However, this is not always the case. For example, a volcanic eruption may occur without warning if a volcano suffers an extremely large landslide which releases pressure and results in an essentially immediate eruption.

The seismic monitoring systems summarized above cannot predict lahars or determine that a given event has produced a lahar. A USGS-designed lahar warning system in the Carbon River and Puyallup River valleys is operated by Pierce County. Mount Rainier poses the highest level of lahar risk because of the combination of the estimated frequency of lahars and the very large population within its mapped lahar zones. **None of the other Cascade volcanoes have lahar warning systems.**

Most volcanic eruptive events have precursor activity for days, weeks or months before an eruption. However, the exact time of an eruption cannot be predicted. It is also possible that some eruptions may have no precursor activity and thus no warning. For example, a major collapse of a volcanic peak could trigger a volcanic eruption without warning. This possibility appears higher for Mount Rainier than for other volcanoes in Washington because of the steep slopes and unstable rock on this peak.

Some hazard events closely analogous to volcanic hazard events, including landslides, debris avalanches or debris flows may occur in valleys below volcanoes without volcanic activity, with events triggered by earthquakes or heavy rain.

7.6 Volcanic Hazard Mitigation Measures

There are no physical measures that are practical from either an engineering perspective or an economic perspective to prevent lahars, lateral blasts, lava flows, pyroclastic flows or ash falls from affecting a campus.

The most effective mitigation measures to reduce life safety risks from volcanic events for campuses located within or near mapped volcanic hazard zones include the following:

1. Awareness. Ensure that staff and students are aware of lahar and other volcanic hazards.
2. Emergency Planning. Develop and practice an effective emergency evacuation plan, with designated evacuation methods, evacuation routes and pre-determined safe haven gathering locations. Given the high likelihood that the warning time will be very short, designated safe haven locations should be the location reachable in the shortest possible time.
3. For locations where there are impediments to the most rapid evacuation, such as a river without a nearby bridge, improving access by constructing a pedestrian bridge or other measures would reduce life safety risks from lahars.
4. Develop contingency plans and decision-making criteria for district actions when a volcano is showing signs of increased activities. For high risk campuses, it is essential to define criteria for which the risk is deemed high enough to warrant pro-active evacuation of a campus before volcanic activity.
5. Whenever possible, avoid building new facilities in or near mapped lahar zones or other volcanic hazard zones.

The Concrete School District's mitigation Action Items for volcanic hazards are shown in Table 7.4 on the following page. As noted previously, the probability of a volcanic event from Mount Baker or Glacier Peak affecting the district is very low. However, if such events were to occur, the consequences for the district could be very severe.

Given this information, the district's action items for volcanic events are focused on evacuation planning.

Table 7.5

Concrete School District: Volcanic Hazard Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed: Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Volcanic Hazards Mitigation Action Items								
Short-Term #1	Develop and practice a volcano emergency evacuation plan, with designated evacuation methods and routes to the nearest safe haven location.	1-2 Years and Ongoing	Local	CSD	X		X	X
Short-Term #2	Develop emergency evacuation protocols for pre-emptive evacuation when USGS volcano warning levels reach a pre-determined level.	1-2 Years	Local	CSD	X		X	X
Short-Term #3	Update public education, emergency notification procedures and emergency planning for volcanic events, including ash fall events.	1-2 Years	Local	CSD	X		X	X

7.7 References

1. Smithsonian Institution, Global Volcanism Project:

http://volcano.si.edu/world/region/.cfm?rnum=1201

2. United States Geological Survey, Volcanic Hazards Program:

http://volcanoes.usgs.gov/observatories/cvo/

3. United States Geological Survey, Volcano Hazards in the Mount Hood Region, Oregon -- Scott, et.al., 1997, USGS Open-File Report 97-88.

4. United States Geological Survey:

http://volcanoes/usgs.gov/activity/alertsystem/index.php

5. United States Geological Survey:

http://volcanoes/usgs.gov/volcanoes/mount_rainier_monitoring_98.html

8.0 FLOOD: 5-13-2016

8.1 Introduction

Parts of the area served by the Concrete School District may be subject to flooding from several different flood sources:

- Overbank flooding from rivers and streams,
- Local storm water drainage flooding, and
- Flooding from failures of dams, reservoirs or levees.

Overbank flooding from rivers and stream occurs throughout Washington, most commonly from winter storms with heavy rainfall from November to February. Flood events with significant contributions from snowmelt may also occur during the spring snowmelt season for watersheds with high enough elevations to have significant snowfalls. Although it is less common, overbank flooding can also occur at any time of the year. The severity of overbank flooding depends primarily on flood depth. However, other factors such as flood duration, flow velocity, debris loads, and contamination with hazardous materials also significantly impact the severity of any given flood event. Overbank flooding can be very severe and affect broad geographic areas.

Storm water drainage flooding, sometimes referred to as urban flooding, occurs when inflows of storm water exceed the conveyance capacity of a local storm water drainage system. With this type of flooding, the drainage system overflows, resulting in water ponding in low lying areas. Storm water drainage flooding is generally localized, with flood depths that may range from a few inches to several feet.

Failures of dams, reservoirs for potable water systems or levees results in flooding areas downstream of dams and reservoirs or behind levees. Failures of major dams operated and regulated by state or federal agencies are possible, but unlikely because these dams are generally well-designed, well-monitored and well-maintained. However, failures of smaller dams maintained by local governments, special districts or private owners are more common.

Failures of reservoirs for potable water systems occur, especially from earthquakes. These reservoirs typically have much smaller storage volumes than dams, so flooding from failures is generally localized, but may be severe where flows are confined in narrow channels which contain structures or infrastructure. Similar flooding may occur from failures of large diameter water pipes.

Levee failures before overtopping may occur at any time, not only during high water events but also under normal non-flood conditions. There are numerous causes for such failures, including scour, foundation failures, under-seepage, through-seepage, animal burrows, and others.

Historically, flooding has occurred in Washington State throughout recorded history. The most severe, widespread flood events were:

- May/June 1948: widespread flooding in Eastern Washington and along the Columbia River from spring snowmelt.
- November 1990: widespread flooding on Western Washington rivers as well as on several Eastern Washington rivers. This event was the flood of record, the greatest recorded flood, on many rivers in Northwest Washington.
- February 1996: major flooding on many rivers in Western and Southeastern Washington. This event was the flood of record on many rivers in Southwest Washington.
- January 2012: major flood in Western Washington. This event was the flood of record on some rivers.

Every county in Washington is subject to flood risk and has experienced major flood events. However, Western Washington has experienced more major flood events than Eastern Washington.

8.2 Flood Hazard and Risk Assessments: Concrete School District

The potential impacts of future floods on the Concrete School District are primarily damage to buildings and contents, disruption of educational services, and displacement costs for temporary quarters if some buildings have enough damage to require moving out while repairs are made. The likelihood of deaths or injuries is extremely low, because schools will be evacuated whenever flood warnings are issued and the district's facilities are very unlikely to be affected by flash flooding.

The approximate levels of flood hazards and vulnerability are identified in the following sections at the campus-level and the building-level.

8.3 Flood Hazard and Risk Assessments: FEMA-Mapped Floodplains

FEMA Flood Insurance Rate Maps (FIRMs) delineate the regulatory (100-year) floodplain areas in Washington. Per FEMA regulations, there are limitations on new development within the 100-year floodplain.

The 100-year flood is defined probabilistically. A 100-year flood does not occur exactly every 100 years. Rather, the 100-year flood is the flood with a 1% chance of being exceeded in any given year. A 1% annual chance of flooding corresponds to about a 26% chance of flooding in a 30-year time period. A given location may have two or more 100-year (or greater) flood events within a few years or have none in several decades or longer.

FEMA's floodplain mapping provides a good starting point for flood hazard risk assessments. Facilities within FEMA mapped floodplains have at least some level of flood risk. However, determining the level of risk quantitatively requires additional flood hazard data, including the elevation of facilities relative to the elevation of a range of flood events. It is also important to recognize that some facilities <u>not</u> within FEMA-mapped floodplains also have high levels of flood risk.

FEMA floodplain maps represent the best available data at the time the maps were prepared. FEMA has an ongoing map modernization/update process, but many existing FIRM maps are old – some more than 30 years old. In many cases, flood risk in a given location increases with time because increasing development within the watershed increases runoff, and because development and fill within floodplains or sedimentation in a river channel may increase flood elevations. In some cases, flood elevations for a 100-year flood using current data may be up to several feet higher than outdated floodplain maps indicate.

Flood risk at a given location may also decrease over time if flood control structures such as levees or upstream dams for flood control are constructed or improved. Old floodplain maps are not necessarily incorrect. However, older maps should be interpreted carefully because the older a map is, the more likely it is to be significantly incorrect.

Recent and future FEMA floodplain maps are available in digital GIS-format and are known as DFIRMs. Older maps, which were originally prepared in paper format only, have been digitized, but contain less detailed information than DFIRMs. These maps are known as Q3 maps. For any given location, the most recent FEMA maps should be used for flood risk assessments.

FEMA floodplain maps identify several types of flood zones, with varying levels of flood hazard. The FEMA flood zone designations have evolved over time, with older maps using different nomenclature than recent maps. FEMA's current and historical flood zone designations are summarized below.

Table 8.1

FEMA Flood Zones

HIGH RISK AREAS

ZONE	DESCRIPTION
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over 30 years. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones.
AE, A1 – A30	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over 30 years. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AO	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over 30 years. Average flood depths derived from detailed analyses are shown within these zones.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam).
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.

MODERATE TO LOW RISK AREAS

ZONE	DESCRIPTION
B and X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile.
C and X (unshaded)	Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level. Zone C may have ponding and local drainage problems that don't warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.

UNDETERMINED RISK AREAS

ZONE	DESCRIPTION
D	Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.

FEMA Flood Insurance Rate Maps are always accompanied by Flood Insurance Studies. Flood Insurance Studies contain summaries of historical floods, details of the flood mapping and quantitative flood hazard data which is essential for quantitative flood risk assessments.

FEMA Flood Insurance Studies and Flood Insurance Rate Maps include a large number of terms of art and acronyms. A good summary of the terms used in flood hazard mapping is available from FEMA.[1]

The level of flood hazard (frequency and severity of flooding) for a given campus or building is not determined simply by whether the campus or building is or is not within the mapped 100-year floodplain. Rather, the level of flood hazard depends to a great extent on the elevation of buildings relative to the elevation of various flood events, such as the 10-year, 50-year or 100-year flood event.

For example, consider two schools both within the 100-year floodplain of a given river. The first school has a first floor elevation three feet above the 100-year flood elevation and the level of flood hazard is low (but not zero). The second school has a first floor elevation three feet below the 100-year flood elevation and the level of flood hazard is very high. In this example, the six foot difference in elevations of the two schools makes an enormous difference in the level of flood hazard.

For buildings within most FEMA mapped flood zones, quantitative flood data in the Flood Insurance Study allow calculation of the probability of flooding for any building, if the building's first floor elevation is known. The flood data used to make this calculation include stream discharges (volume of water flowing in a river) and flood elevations for floods of several different return periods (typically, the 10-, 50-, 100- and 500-year floods). For further details about flooding, see Chapter 10 in the Washington State K-12 Hazard Mitigation Plan. The OSPI Mitigation Planning Toolkit also has more detailed guidance and templates to gather and use the types of flood hazard data discussed above.

The FEMA-mapped floodplain boundaries near the District's campus and the campus-level flood hazard and risk data for the Concrete School District are shown on the following pages.

As shown in Figure 8.1, the District's campus is well outside of the FEMA-mapped 500-year floodplain. Furthermore the elevation of the campus near the building is approximately 50 feet higher than the elevation of the 500-year flood boundary at the nearest location to the campus. Thus, the risk of overbank flooding of the campus from the river is essentially nil, even for events substantially larger than a 500-year flood event.

Figure 8.1

FEMA-Mapped 100-Year and 500-Year Floodplains

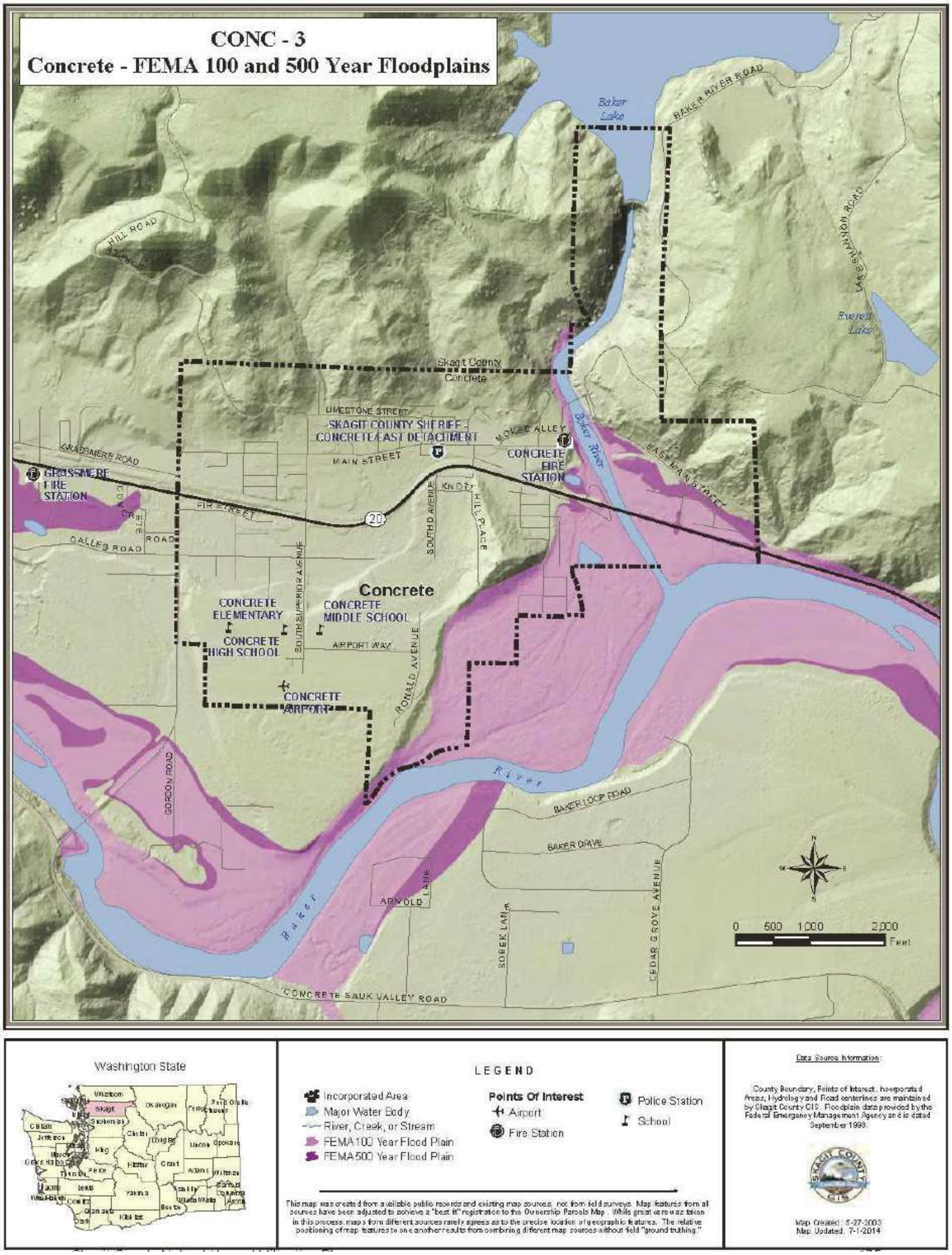


Table 8.2

Concrete School District Campus-Level Flood Hazard and Risk Report

Flood Campus-Level Hazard and Risk Report									Recommendation	
Campus	Within FEMA Floodplain	FEMA Flood Zone	Local Flood Study°	Within 0.5 Mile of FEMA Flood Zone[1]	Number of Flood Events in 20 Years[2]	Other Flood Concerns[3]	Campus at Grade Elevation (NAVD 1988)‡	Preliminary Flood Risk Level†	Complete Building Level Flood Assessment (Yes/No)	Priority
CONCRETE SCHOOL DISTRICT										
Administration Building	No		No	Yes	None	No	247	Low	No	Low
Concrete High School	No		No	Yes	None	No	243	Low	No	Low
Concrete K-6 School	No		No	Yes	None	No	212	Low	No	Low

° With quantitative flood hazard data, simuilar to FEMA Flood Insurance Study.

[1] Applicable only if campus is not within a mapped flood zone.

[2] Severe enough to result in school closure and/or damage to at least on building.

[3] Local storm water drainage flooding, campus near stream/river without FEMA flood mapping, campus behind levee or drownstream from a dam, campus on alluvial fan subject to sheet flows, campus near a migrating stream/river, or local flood study completed.

‡ Base on campus at grade elevation relative to flood elevations for 10, 50, 100 and 500 year flood elevations (if data entered on flood PDM screen) and/or on other district-entered data on the flood PDM screen.

† Preliminary estimate of flood risk, based on quantitative flood data (if enttered on the Flood PDM Screen) and/or on the number of flood events in 20 years and expressed concerns about floods. More accurate risk assessments require building-level assessments: flood risk may vary markedly from building to building on a given campus, depending on a building's elevation and other factors.

DISCLAIMER: The information provided in this report is collected from various sources and may change over time without notice. The Office of Superintendent of Public Instruction (OSPI) and its officials and employees take no responsibility or legal liability for the accuracy, completeness, reliability, timeliness, or usefulness of any of the information provided.
The information has been developed and presented for the sole purpose of developing school district mitigation plans and to assist in determining where to focus resources for additional evaluations of natural hazard risks. The reports are not intended to constitute in-depth analysis or advice, nor are they to be used as a substitute for specific advice obtained from a licensed professional regarding the particular facts and circumstances of the natural hazard risks to a particular campus or building.

8.4 Flood Hazard and Risk Assessments: Outside FEMA-Mapped Floodplains

Nationwide, more than 25% of flood damage occurs outside of FEMA-mapped floodplains. Campuses outside of FEMA-mapped floodplains may have significant flood risk if any of the following conditions apply:

- There is a history of floods from any source affecting or near a campus.
- Local storm water drainage flooding is common on or near a campus.
- Campus is near a river or stream not mapped by FEMA.
- Campus is on an alluvial fan subject to sheet flows.
- Campus is near a migrating river or stream.
- Campus is behind a levee or downstream of a dam or reservoir.
- A local flood hazard study is available for the campus and vicinity.

Guidance on evaluating flood hazards and risk for the above conditions is given in Chapter 10 in the Washington State K-12 Hazard Mitigation Plan and the OSPI Mitigation Planning Toolkit, and in the Hazard and Risk Assessments for School District Hazard Mitigation Plans: Technical Guidance Manual.

For flood-prone locations without quantitative flood hazard data, a different approach is required to evaluate flood hazards and flood risk than for locations where either a FEMA Flood Insurance Study or an equivalent local flood study provide the stream discharge and flood elevation data necessary for quantitative calculations. There are several possible options:

- For locations with a history of repetitive flooding, empirical estimates of the frequency (return period) of flooding can be made in two ways:
    - Using the FEMA Version 5.1 Benefit-Cost Analysis Damage-Frequency software, which is available for download on the FEMA website, along with guidance on using the software.
- For high value facilities where flood risk appears high, it may be worthwhile to have a local hydrologic and hydraulic study completed to obtain the types of quantitative flood hazard data contained in a FEMA Flood Insurance Study. Such local studies may also be worthwhile when the FEMA Flood Insurance Study is old and there are reasons, such as increased development in the watershed, to suspect that flood hazards may have significantly increased.
- For locations subject to stormwater drainage flooding, engineers knowledgeable about the stormwater system may be able to provide quantitative data on the conveyance capacity of the system to supplement historical flood data. Stormwater systems are often designed to handle only 2-year or 5-year flood events, and are infrequently designed to handle rainfall events greater than 10-year or 15-year events.

- Estimating flood hazards and risks for locations behind levees or downstream from dams or reservoirs requires consultation with subject matter experts.

Evaluation of flood hazards and flood risk outside of mapped-floodplains necessarily requires more engineering experience and judgment than required to interpret the flood data in mapped riverine floodplains.

One important caveat is that the absence of a history of past flood events may indicate that flood risk is low, but this is not necessarily the case. Flood risk is inherently probabilistic. A campus that hasn't had a flood in 10, or 20 or 30 years may have just been "lucky" and flood damage might occur with floods of similar return periods. Or, the flood risk might have increased over time because of increasing development upstream in the watershed (which increases runoff) or because of channel changes. Or, a campus might not have frequent flooding, but the level of damages for a 50-year or 100-year event might be very severe.

8.5 Flooding from Dam Failures

The Concrete School District's facilities are subject to possible flooding from failures of dams upstream from the district. Dam failures are unlikely, but possible. If dam failures do occur, the consequences can range from severe to catastrophic.

The inundation maps for the worst-case scenario failures of the dams upstream of Concrete on the Baker River and Skagit River are shown in Figures 8.2 and 8.3 on the following pages. Dam inundation maps typically consider the absolute worst case scenario of complete failure of a dam, when the reservoir is full, and river flows are at flood stage. Dam failure events that are less extreme than the worst-case scenario will result in substantial flooding downstream, but significantly less severe flooding than for the worst-case scenario.

For the worst-case scenario failure of the Upper and Lower Dams on the Baker River, parts of the Town of Concrete is inundated, but the District's campus is high enough to be outside of the mapped inundation area.

For the worst-case scenario failure of the three dams on the Skagit River (Ross Dam, Diablo Dam and Gorge dam), nearly the entire town of Concrete including the District's campus is inundated. This scenario considers failure of the largest dam (Ross) which also results in failures of the two much smaller dams between the Ross Dam and Concrete.

For very unlikely, but possible, extreme dam failure events, the only mitigation measure that is practical is to include evacuation for dam failure events in the District's emergency planning. For all of the possible dam failure events, the best action would be proactive evacuation when warnings of possible dam failures are issued. If the warning times are very short or nil, shelter in place is likely the best option for failure of the Baker River dams and perhaps also for failure of the Skagit River Dams. However, for failure of the Skagit River dams, evacuation on foot to the high elevation area northeast of the campus (as shown in Figure 8-3) may be possible. These possible alternatives should be carefully evaluated as part of the District's emergency planning, in close coordination with Skagit County's emergency planning for dam failure events.

Figure 8.2

Inundation Map: Failure of the Baker River Dams

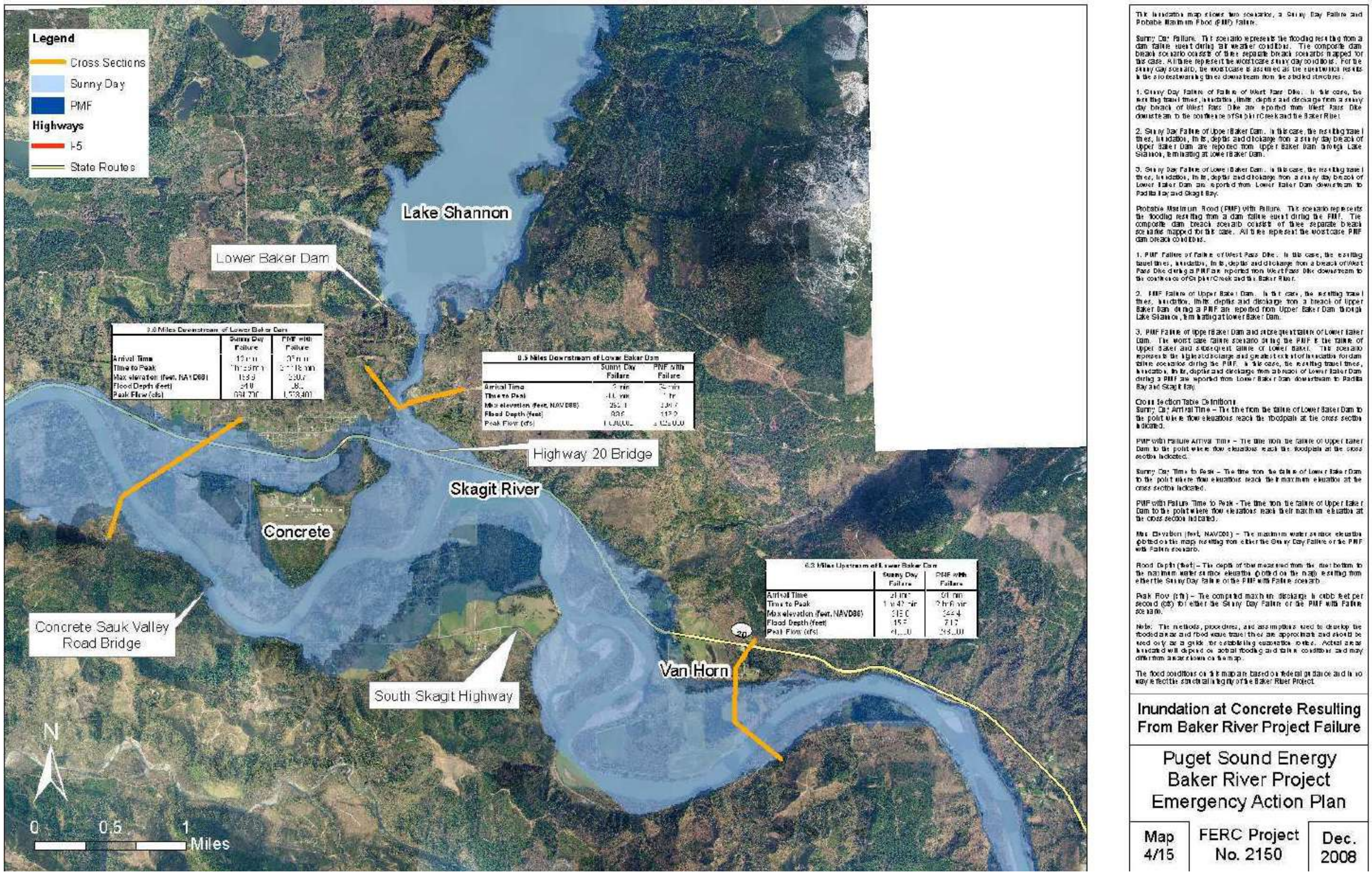
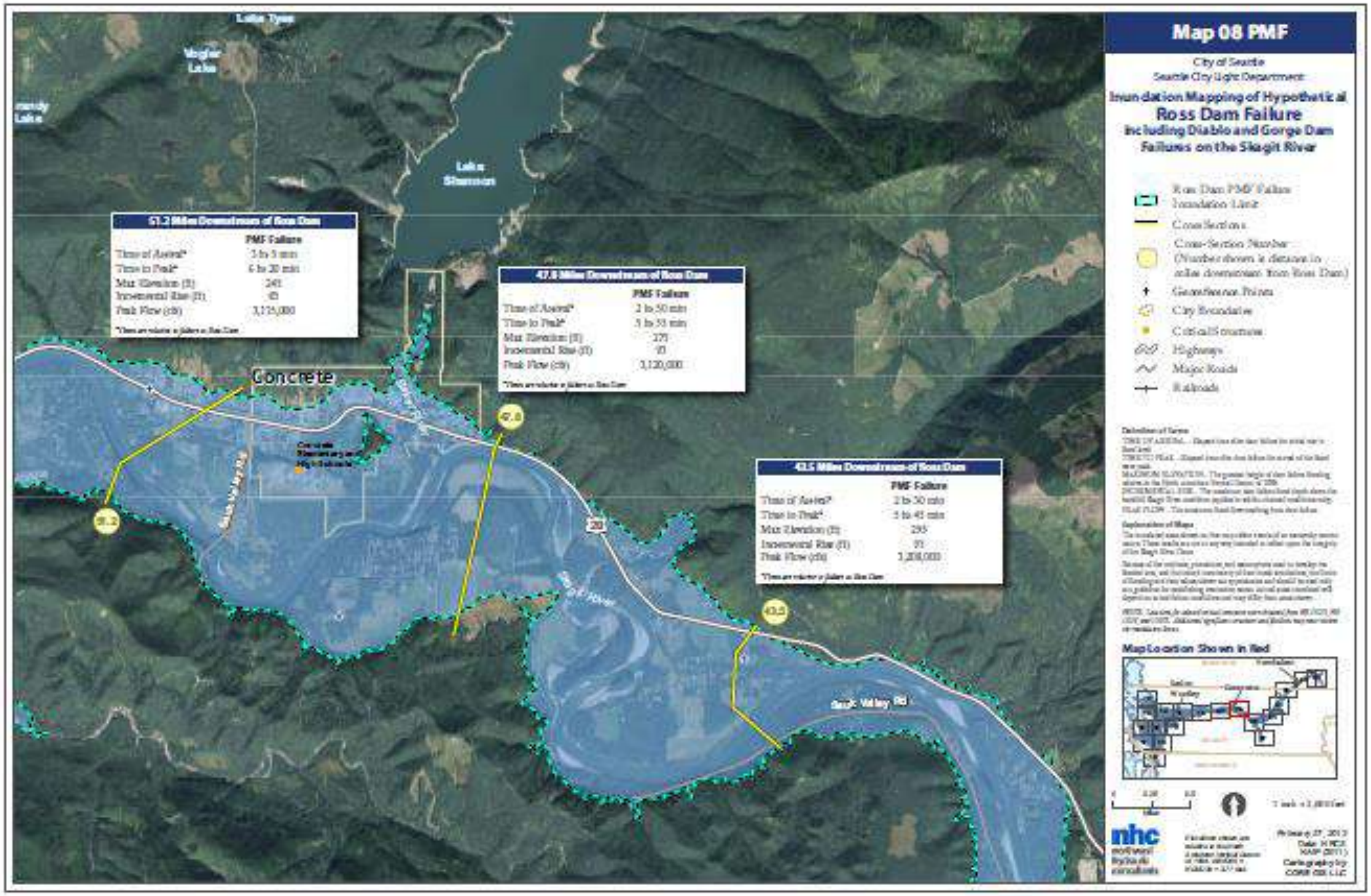


Figure 8.3

Inundation Map: Failure of the Skagit River Dams



8.6 National Flood Insurance Program Insured Structures

The Concrete School District has no NFIP insured structures.

8.7 Flood Mitigation Projects

For K-12 facilities with substantial levels of flood risk there are several types of potential flood mitigation measures available:

- Replacement of a facility at high risk from floods with a new facility located outside of flood hazard zones.
- Elevation of an existing building.
- Construction of levees, berms or flood walls to protect a facility.
- Installation of flood gates along with building water proofing measures.
- Minor floodproofing actions that address the most vulnerable elements in a facility; such projects include elevating at-grade utility infrastructure or relocating critical equipment or contents from basement levels of a building to higher levels.
- Local drainage improvements where stormwater drainage is a problem.

Replacing an at-risk facility with a new facility outside of flood hazards zones is essentially 100% effective in reducing future flood damages. A new replacement building also has other advantages such as energy efficiency and fully meeting current functionality requirements. Of course, the major impediment to widespread replacement is the cost.

The extent to which any of the above mitigation measures are warranted depends on the level of flood risk and on district priorities. For K-12 facilities at high flood risk, FEMA grant funding may be available for most of the flood mitigation measures noted above.

FEMA doesn't replace existing facilities, but does do acquisition/demolition projects in which the fair market value of a property is the total eligible project cost. FEMA-funded acquisition projects require demolition of the existing facility and deed restrictions to prevent future development of the area. Acceptable uses after demolition are limited to green space such as parks or sports fields with development limited to incidental structures such a restroom. With such projects, the FEMA funding, which is typically 75% of the total project costs, can be used towards building a replacement facility.

On a community or regional level, larger-scale flood control measures such as construction of upstream dams or detention basins and channel improvements may be effective in reducing flood risks. However, such larger-scale projects are outside the domain of responsibility for school districts.

The ABC School Districts flood mitigation Action Items are shown in Table 8.3 on the following page.

Table 8.3

Concrete School District: Flood Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed: Life Safety	Plan Goals Addressed: Protect Facilities	Plan Goals Addressed: Enhance Emergency Planning	Plan Goals Addressed: Enhance Awareness and Education
Flood Mitigation Action Items								
Short-Term #1	Enhance the District's emergency planning by including evacuation planning for dam failure events, in close coordination with Skagit County Emergency Management.	1-2 Years	Local	CSD, Skagit County	X		X	X
Short-Term #2	Ensure that District staff are aware of evacuation planning for dam failure events by conducting training and drills.	Ongoing	Local	CSD, Skagit County	X		X	X

The district's Flood Mitigation Action Items include only dam failure events because the risk from overbank flooding from the Baker River is nil.

8.8 References

1. FEMA 480: National Flood Insurance Program, Floodplain Management Requirements, A Study Guide and Desk Reference for Local Officials. Available in hard copy and on CD from FEMA at: (800) 480-2520.

9.0 Wildland/Urban Interface Fires: 6-27-2015

9.1 Overview

Fire has posed a threat to mankind since the dawn of civilization. Fires often cause substantial damage to property and may also result in deaths and injuries.

For the purposes of mitigation planning, we define three types of fires:

- Structure fires and other localized fires,
- Wildland fires, and
- Wildland/urban interface fires.

Structure fires are fires where structures and contents are the primary fuel. In dealing with structure fires, fire departments typically have three primary objectives: 1) minimize casualties, 2) prevent a structure fire from spreading to other structures, and 3) minimize damage to the structure and contents. Structure fires and the other common types of fires, such as vehicle or trash fires are most often limited to a single structure or location, although in some cases they may spread to adjacent structures.

Wildland fires are fires where vegetation (grass, brush, trees) is the primary fire fuel and with few or no structures involved. For wildland fires, the most common suppression strategy is to contain the fire at its boundaries and then to let the fire burn itself out. Fire containment typically relies heavily on natural or manmade fire breaks. Water and chemical fire suppressants are used primarily to help make or defend a fire break, rather than to put out an entire fire, as would be the case with a structure fire. For wildland fires, fire suppression responsibility is generally with state and federal fire agencies, although local agencies may also participate.

Wildland/urban interface fires are fires where the fire fuel includes both structures and vegetation. The defining characteristic of the wildland/urban interface area is that structures are built in or immediately adjacent to areas with essentially continuous vegetative fuel loads. When wildland fires occur in such areas, they often spread quickly and structures in these areas may, unfortunately, simply become additional fuel sources. Fire suppression efforts for wildland/urban interface fires focus first on savings lives and then on protecting structures to the extent possible. Local fire agencies have primary fire suppression responsibility for most wildland/urban interface fires, although state and federal agencies may also contribute.

9.2 Wildland/Urban Interface Fires

Many urban or suburban areas have a significant amount of landscaping and other vegetation. However, in most areas the fuel load of flammable vegetation is not continuous, but rather is broken by paved areas, open space and areas of mowed grassy areas with low fuel loads. In these areas, most fires are single structure fires. The combination of separations between buildings, fire breaks, and generally low total vegetative fuel loads make the risk of fire spreading much lower than in wildland areas.

Furthermore, most developed areas in urban and suburban areas have water systems with good capacities to provide water for fire suppression and fire departments that respond quickly to fires, with sufficient personnel and apparatus to control fires effectively. Thus, the likelihood of a single structure fire spreading to involve multiple structures is generally quite low.

Areas subject to wildland/urban interface fires have very different fire hazard characteristics which are more similar to those for wildland fires. The level of fire hazard for wildland/urban interface fires depends on:

- Vegetative fuel load,
- Topography,
- Climate and weather conditions,
- Ignition sources and frequency of fire ignitions, and
- Fire suppression resources (fire agency response time and resources of crews and apparatus, access and water supplies).

High vegetative fuel loads, especially brush and trees, increase the level of wildland/urban fire hazard. Steep topography increases the level of fire risk by exacerbating fire spread and impeding fire suppression efforts by making access more difficult.

The level of fire hazard in areas prone to wildland/urban interface fires is also substantially increased when weather conditions including high temperatures, low humidity, and high winds greatly accelerate the spread of wildland fires and make containment difficult or impossible.

Fire suppression resources are typically much lower in wildland/urban interface fire areas than in more highly developed areas. Fire stations are more widely spaced, with fewer resources of crews and apparatus and longer response times because of distance and/or limited access routes. Water resources for fire suppression are typically lower in these areas, which are often predominantly residential and may be served by pumped pressure zones with limited water storage or by individual wells which provide no significant water supply for fire suppression.

These reduced fire suppression resources make it more likely that a small wildland fire or a single structure fire in an urban/wildland interface area will spread before it can be extinguished.

The level of risk from wildland/urban interface fires for K-12 facilities depends on:

- Level of fire hazard as outlined above,
- Value and importance of buildings and infrastructure,
- Vulnerability of inventory at risk, including whether fire-safe construction practices and defensible space measures have been implemented, and
- Population at risk and the efficacy of evacuations.

Life safety risk in wildland/urban interface fires arises in large part from delays in evacuations, once a fire has started. For K-12 facilities with significant risk from wildland/urban interface fires, a well-defined, practical and practiced evacuation plan is essential to minimize potential life safety risk.

9.3 Wildland and Wildland/Urban Fire Hazard Mapping and Hazard Assessment

The three maps on the following pages present different measures of wildland and wildland/urban interface fire hazards in Washington. There are important caveats regarding these maps when making wildland/urban interface fire mitigation decisions for K-12 facilities within mapped fire hazard areas:

- The DNR rankings of Wildland/Urban Interface Communities of extreme, high, moderate or low risk should be interpreted as qualitative or semi-quantitative indicators of the relative level of risk. Facilities identified as being located in communities with "extreme" or "high" levels of risk may not have extreme or high risk as generally understood for mitigation planning purposes. Some of the extreme or high risk interface communities have long burn return periods (the average time interval between fire events) per the USGS Landfire map.
- The USGS Landfire Return Period values should also be interpreted as semi-quantitative indicators of the relative level of risk. The numerical estimates of the burn return period and the corresponding probabilities over a 50-year time period should not be interpreted literally.

The DNR rankings and the USGS Landfire Return Periods are based on analysis of fire regime characteristics – such as vegetative fuel loads, topography, climate and fire suppression resources. The USGS Landfire Return Periods may indicate higher levels of fire risk than suggested by historical fire data. Furthermore, most of the acreage burned has been wildland with relatively few structures and very few, if any, K-12 facilities.

Figure 9.1

Wildland/Urban Interface Communities Identified by Washington Department of Natural Resources

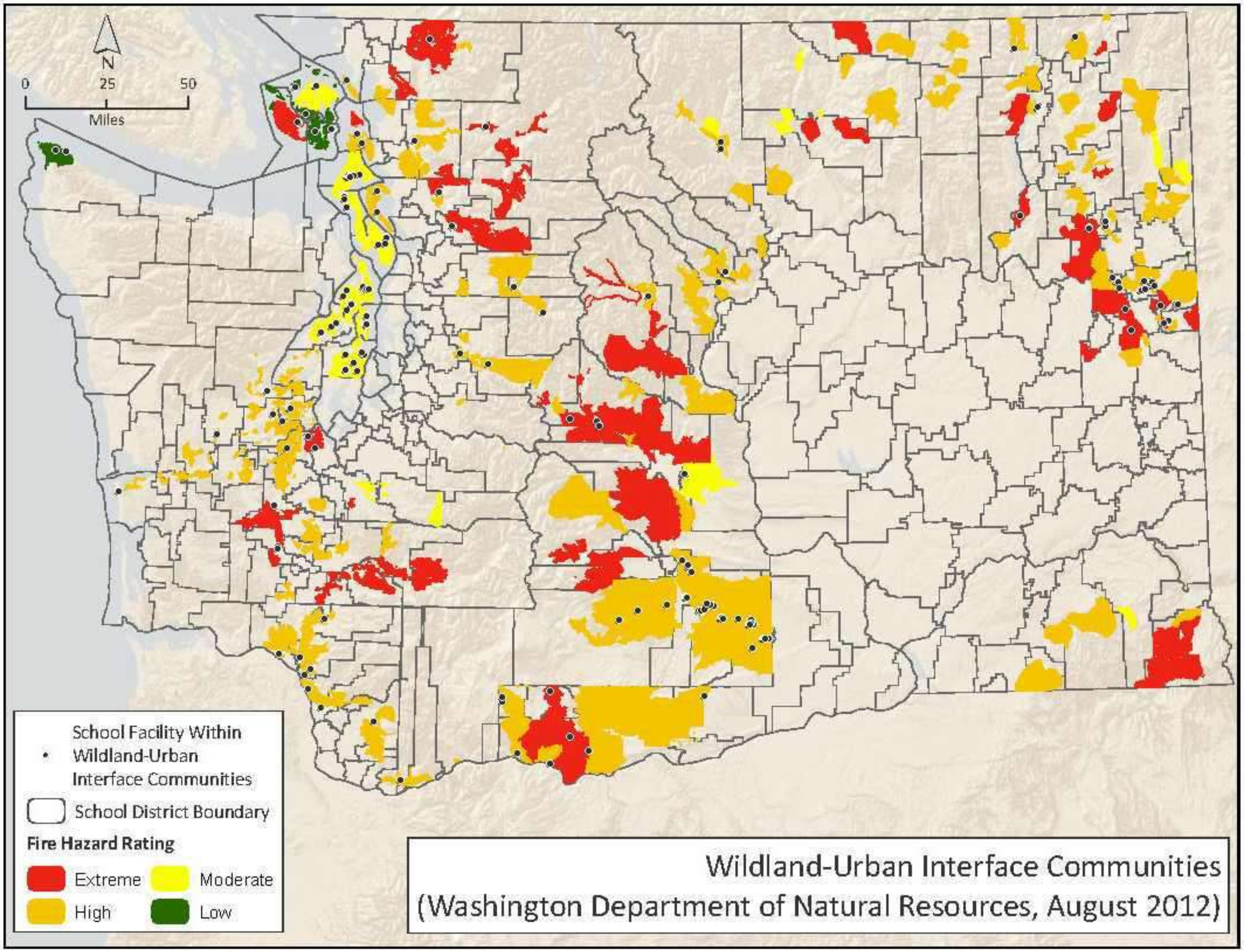
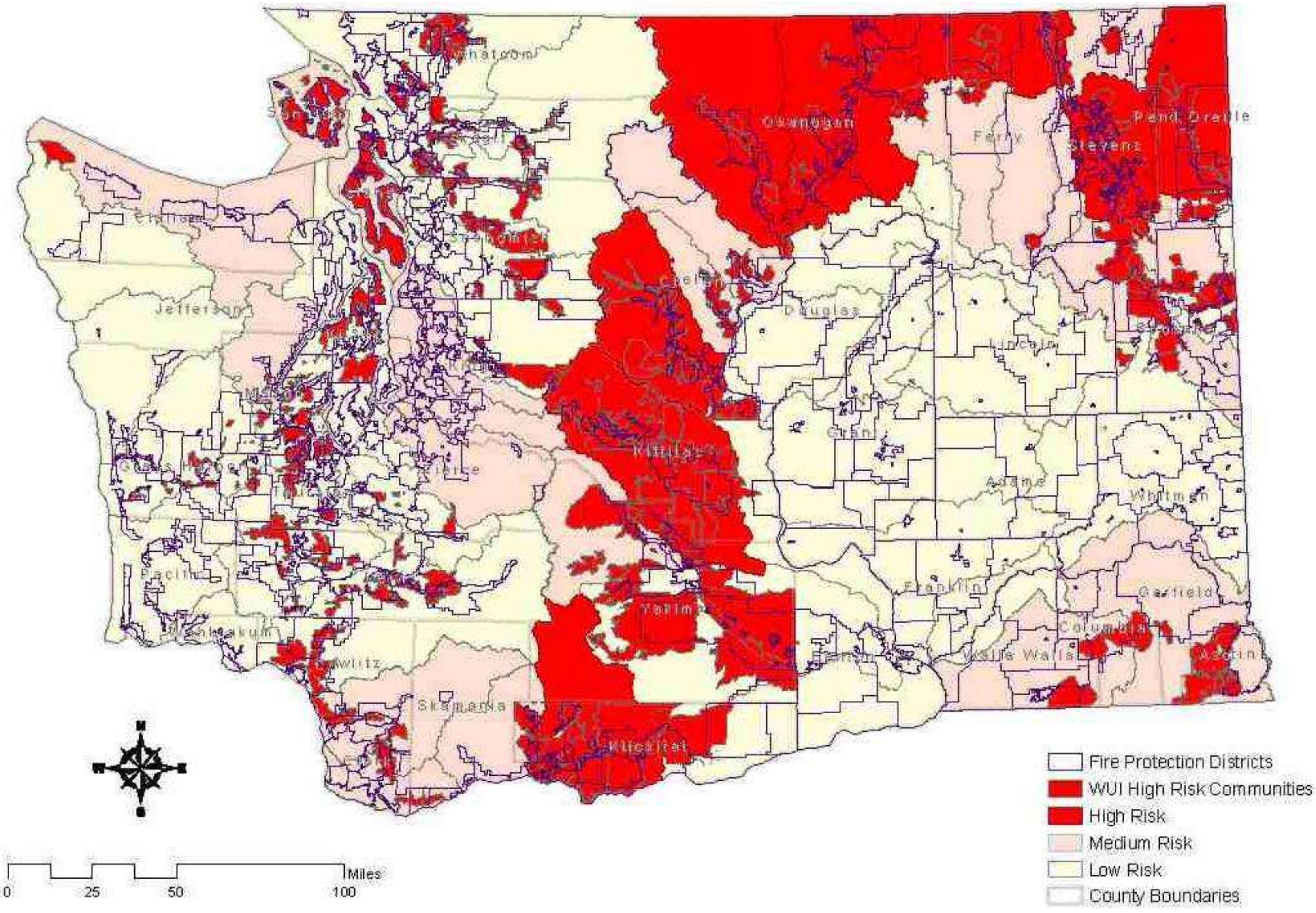


Figure 9.2

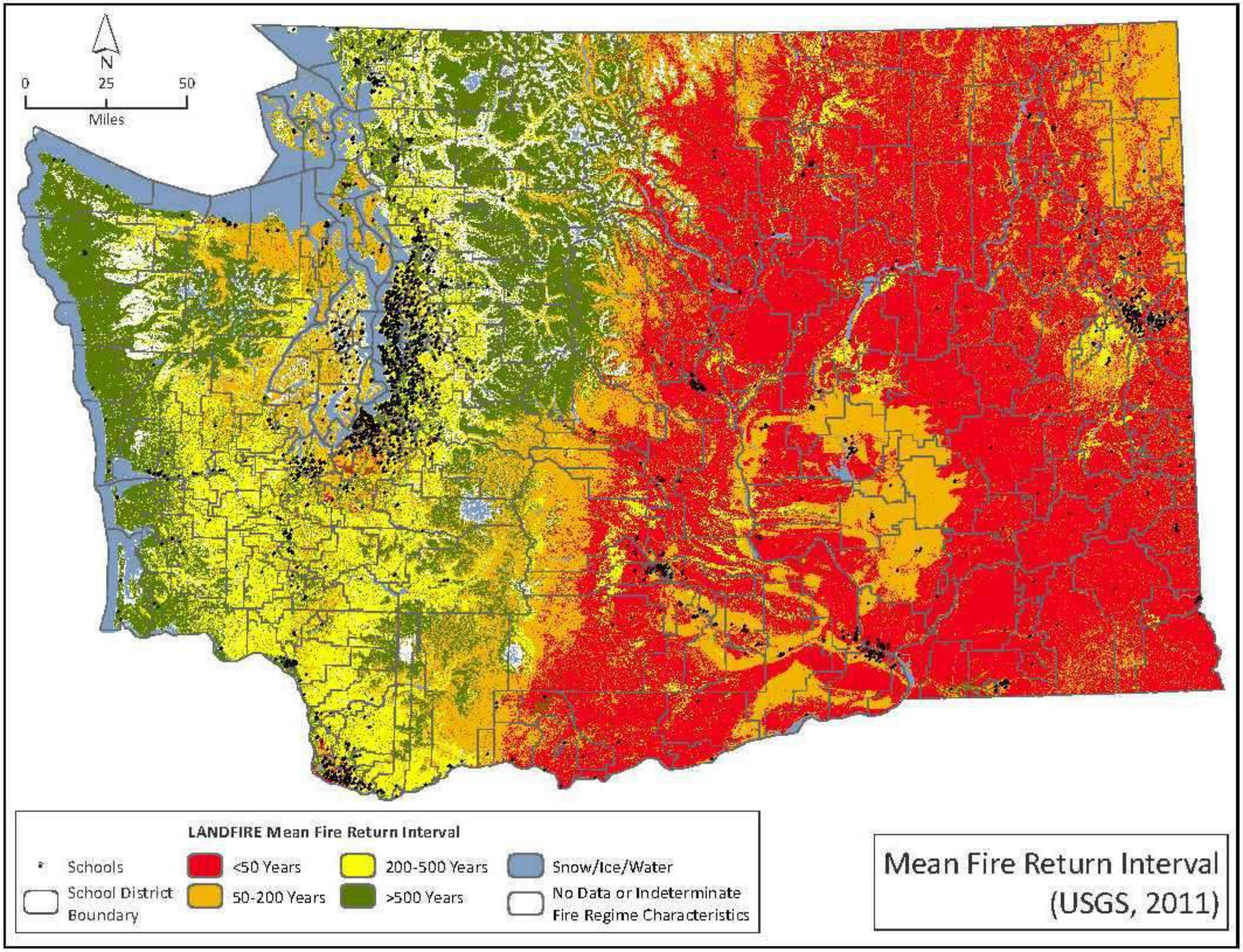
Washington Wildland/Urban Interface High Risk Communities and Statewide Assessment High and Moderate Risk Areas[1]



[1]Washington State Department of Natural Resources, Fire Risk Map, 209.

Figure9.3

United States Geological Survey Landfire Fire Return Period Map



9.4 Wildland/Urban Interface Fire Hazard and Risk Assessments

The potential impacts of future wildland/urban interface fires on the Concrete District are primarily damage to buildings and contents, disruption of educational services, and displacement costs for temporary quarters if some buildings have enough damage to require moving out while repairs are made. The likelihood of deaths or injuries is generally low, because schools will be evacuated whenever fire warnings are issued. However, in events where evacuation is not timely, there may a substantial risk of deaths and injuries.

The vulnerability of the Concrete District's facilities to wildland/urban interface fires varies from campus to campus. The approximate levels of wildland/urban interface fire hazards and vulnerability are identified at the campus level in the following sections.

There have been no historical wildland/urban interface fires that directly affected or came very close to the district's campus.

The campus-level wildland/urban interface fire hazard and risk report for the Concrete School District is shown on the following page. The fire hazard and risk levels are generated within the OSPI ICOS Pre-Disaster Mitigation database, by combining the DNR Wildland Interface Community rankings, the Landfire fire return periods and the campus-specific information entered into the database.

For campuses where the hazard and risk level is moderate or higher, the recommendation is to consult with the local fire agency regarding the level of risk at each campus and to determine whether fire mitigation measures may be appropriate. However, regardless of risk levels, all campuses in a wildland/urban interface should have evacuation plans for wildland/urban interface fire events.

More accurate evaluation of wildland/urban interface fire risk for a campus or a building starts with the fire hazard factors listed previously, but also requires higher-resolution, campus-level and building-level information, including:

- Vegetative fuel loads on, adjacent and near the campus, including fuel types, fuel density, and proximity of high fuel load areas to the campus,
- Extent to which campus buildings have fire-safe construction details and defensible space.
- The number of available evacuation routes and the effectiveness of evacuation plans.

Locations with only one or two evacuation routes, which might be blocked by a given fire event, have much higher life safety risk than locations with multiple possible evacuation routes. Evaluation of the above characteristics may require technical advice and support from fire professionals, including local fire agency staff or other fire experts. Such professional advice is beneficial for any campus in a wildland/urban interface.

Table 9.1

Concrete School District Campus Level Wildland/Urban Interface Hazard and Risk Assessment Report

Wildland and Urban Interface (Fire) Campus-Level Hazard and Risk Report							
							Recommendation
Campus	WUI Community DNR Rating	USGS Landfire Return Period Range[1] (Years)	High Fuel Load Areas Near Campus[2]	History of WUI Fires Affecting or Near Campus	Fire Agency Concern about WUI Fires	WUI Hazard Level and Preliminary Risk Level[3]	Consult with Local Fire Agency About Risk and Mitigation
CONCRETE SCHOOL DISTRICT							
Administration Building	Extreme	301-500	Yes	No	No	Very High	Yes
Concrete High School	Extreme	301-500	Yes	No	No	Very High	Yes
Concrete K-6 School	Extreme	301-500	Yes	No	No	Very High	Yes

The wildland-urban interface fire risk in Concrete is high because the community is largely surrounded by heavily forested area. As shown in the Google Earth image on the following page, the campus has somewhat lower wildland-urban interface fire risk because of the low vegetation area surrounding parts of the campus. However, given the communities overall risk and the limited evacuation routes available, pro-active evacuation when (if) wildland fires threaten Concrete is essential to ensure life safety for students and staff.


Concrete
Concrete
Burpee-Hill-Rd
Limestone-St
Hillside-Alley
Nellie-Ln
N-Superior-Ave
N-A-Ave
N-B-Ave
N-D-Ave
E-Ave
Baker-St
Thompson-St
Railroad-Ave
BN Railroad Grade
Grassmere-Rd
20
McDaniels-Dr
Sled-Run-Dr
N-Park-Ave
2nd-St
Fir-St
Pine-St
Dalles-Rd
Compton-Ln
S-Rietze-Ave
S-D-Ave
Division-Ave
S-Dillard-Ave
Donnyhill-Rd
3rd-St
Airport-Way
S-Superior-Ave
Matie-Ct
Gordon-Rd

9.5 Mitigation for Wildland/Urban Interface Fires

Common goals for reducing wildland/urban interface fire risk include:

1) reduce the probability of fire ignitions,

2) reduce the probability that small fires will spread,

3) minimize property damage, and

4) minimize life safety risk.

School districts are not responsible for fire suppression or community-wide mitigation measures for wildland/urban interface fires, which are the responsibility of cities, counties and fire agencies.

For districts with campuses determined to be at significant risk from wildland/urban interface fires, there are three types of practical mitigation measures:

- For life safety, develop and practice effective evacuation plans for wildland/urban interface fires,
- For existing facilities with significant risk:
  - Maintain the maximum possible defensible space around buildings and reduce vegetative fuel loads adjacent to a campus,
  - Implement fire-safe improvements such as non-flammable roofs, covering vent openings and overhangs with wire mesh to prevent entry and trapping of embers and others, and
- Whenever possible, site new facilities outside of areas with high risk of wildland/urban interface fires, include fire-safe features in the design and ensure the maximum possible defensible space around new buildings.

Some types of mitigation projects for wildland/urban interface fire may be eligible for FEMA and other grant funding, including:

- Defensible space activities,
- Hazardous fuel reduction activities, and
- Ignition resistant construction activities.

For existing buildings, implementing many ignition resistant building upgrades may be most cost-effective when done incrementally. For example, replacing an old roof covering with a non-flammable roof covering may be done at the time the existing roof has reached the end of its useful life and is scheduled for replacement.

The CONCRETE School Districts' mitigation Action Items for wildland/urban interface fires are shown in the table on the following page.

Table 9.2

Concrete School District: Wildland/Urban Interface Fire Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Wildland/Urban Interface Fire Mitigation Action Items								
Short-Term #1	Consult with local fire agency regarding level of fire risk for the District's campus.	1-2 Years	Local	CSD	X	X	X	X
Short-Term #2	Enhance emergency evacuation planning for all campuses for which wildland/urban fires are possible.	1 year	Local	CSD	X		X	X
Long-Term #1	Evaluate and consider implementing fire risk reduction measures including improving defensible space and upgrading building elements such as roofs with materials designed to be fire-resistant and covering vent openings with wire mesh to prevent embers from entering.	Ongoing	Local, Bond or Grant	CSD	X	X	X	X

10.0 LANDSLIDES 5-13-2016

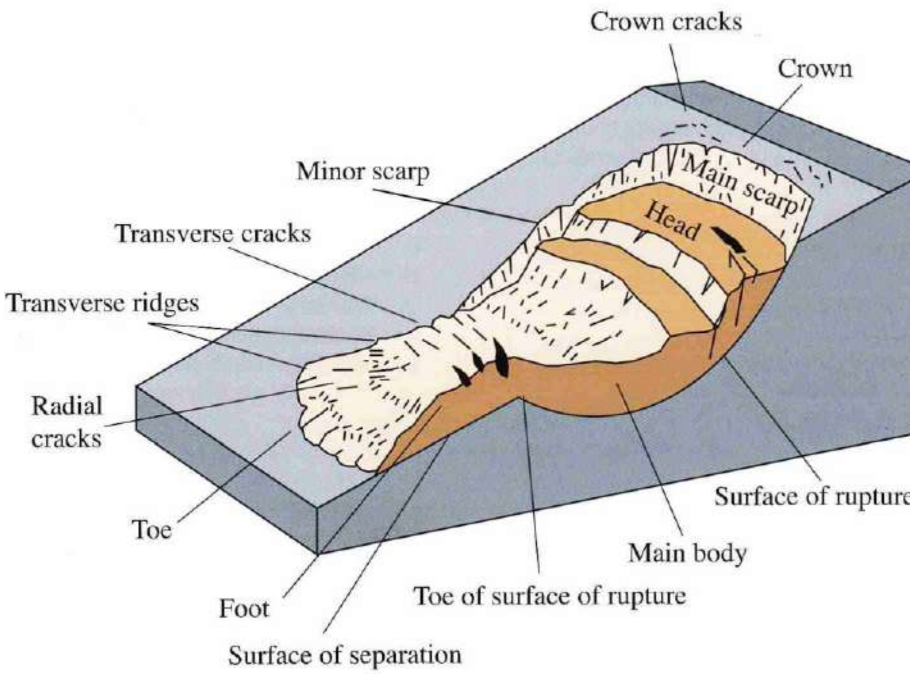
10.1 Landslide Overview and Definitions

The term “landslide” refers to a variety of slope instabilities that result in the downward and outward movement of slope-forming materials, including rocks, soils, and vegetation. Many types of landslides are differentiated based on the types of materials involved and the mode of movement.

The descriptive nomenclature for landslides is summarized in the following figure.

Figure 10.1

Landslide Nomenclature[1]



Debris flows and mudslides (mudflows) are often differentiated from the other types of landslides, for which the sliding material is predominantly soil and/or rock. Debris flows and mudslides typically have high water content and may behave similarly to floods. However, debris flows may be much more destructive than floods because of their higher densities, high debris loads, and high velocities.

There are three main factors that determine the susceptibility (potential) for landslides at a given location:

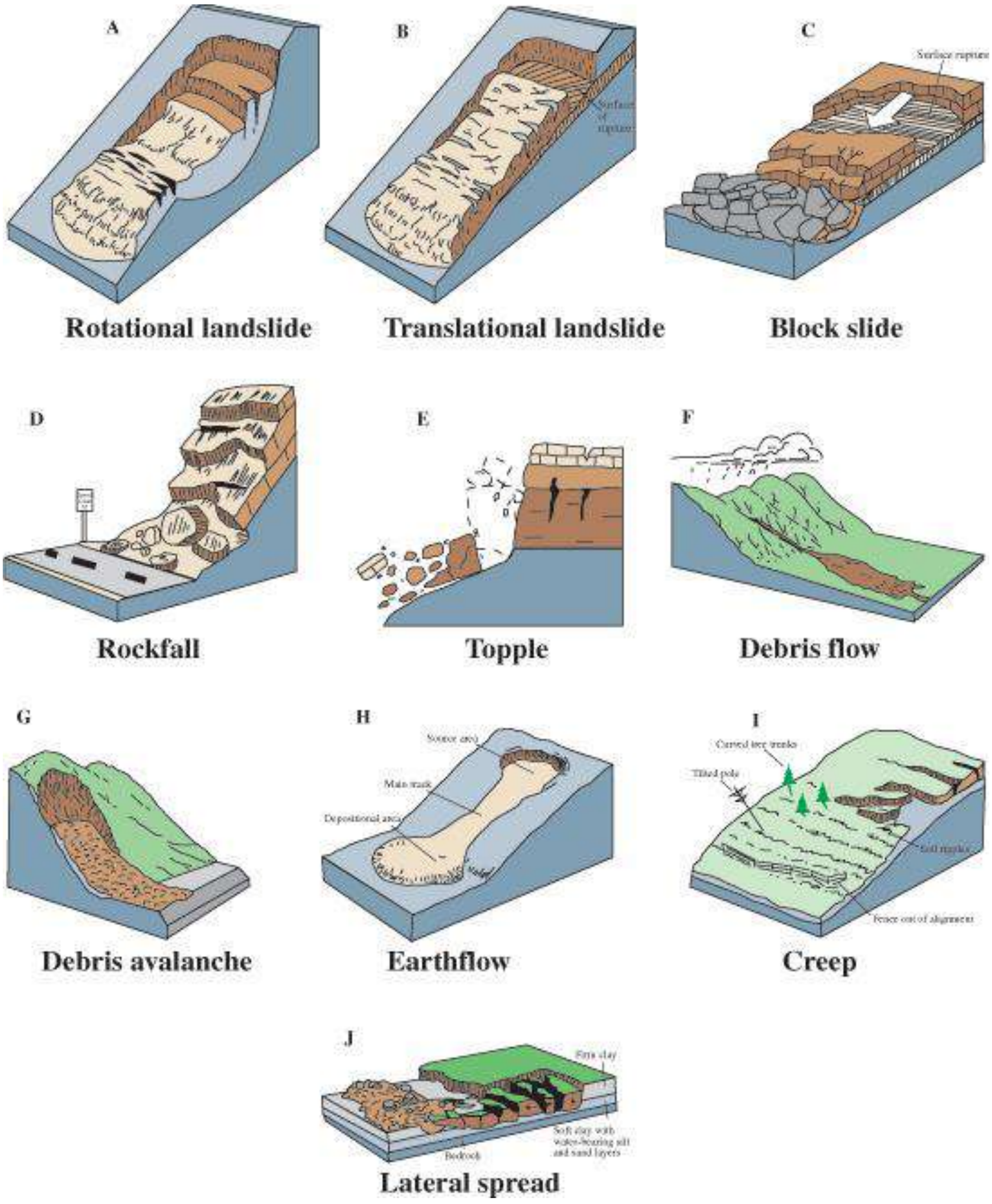
1) Slope,

2) Soil/rock characteristics, and

3) Water content.

Figure 10.2

Major Types of Landslides[1]



Steeper slopes are more prone to all types of landslides. Loose, weak rock or soil is more prone to landslides than are competent rocks or dense, firm soils. Water saturated soils or rocks with a high water table are much more prone to landslides because the water pore pressure decreases the shear strength of the soil or rock and thus increases the probability of sliding.

Most landslides occur during rainy months when soils are saturated with water. As noted previously, the water content of soils or rock is a major factor in determining the likelihood of sliding for any given landslide-prone location. However, landslides may occur at any time of year, in dry months as well as in rainy ones.

Landslides are also commonly initiated by earthquakes. Areas prone to seismically triggered landslides are exactly the same as those prone to ordinary (non-seismic) landslides. As with ordinary landslides, seismically triggered landslides are more likely from earthquakes that occur when soils are saturated with water.

Any type of landslide may result in damages or complete destruction of buildings in their path, as well as deaths and injuries for building occupants. Landslides frequently cause road blockages by depositing debris on road surfaces or road damage if the road surface itself slides downhill. Utility lines and pipes are also prone to breakage in slide areas.

The destructive power of major landslides was demonstrated by the devastating March 2014 landslide in Oso, Washington which resulted in several dozen deaths as well as extreme damage to buildings and infrastructure. This landslide is illustrated on the following page.

The following figures show examples of landslides in Washington State.

Figure 10.3

Oso Landslide 2014[3]

Before and After the Landslide

Landslide Type: Debris Flow (Mudslide)

Figure 10.4

Road 170 Near Basin City 2006[4]

Landslide Type: Debris Flow

Figure 10.5
Highway 410 Near Town of Nile 2009[5]
Landslide Type: Translational

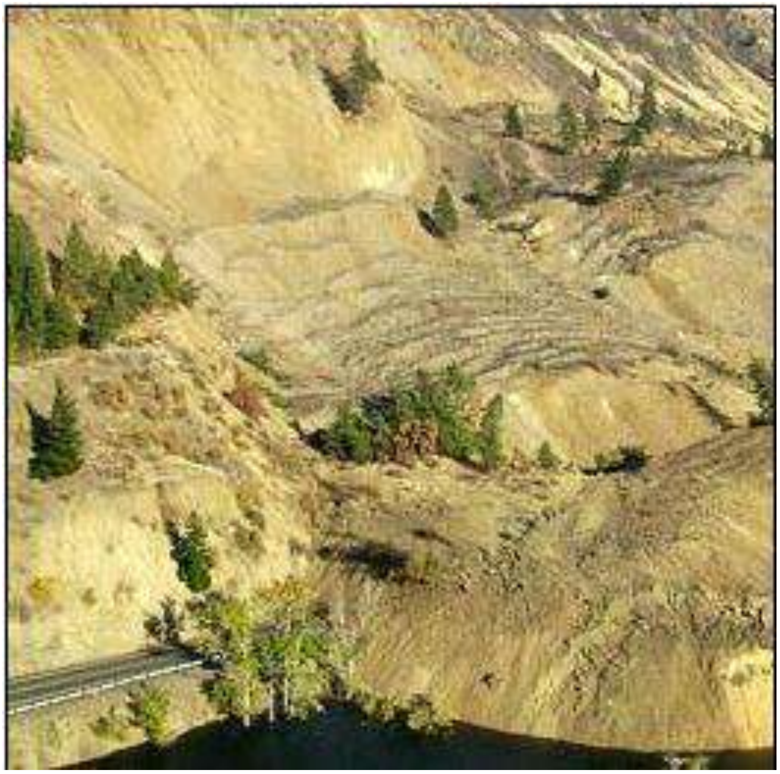


Figure 10.6
Rolling Bay, Bainbridge Island 1997[2]
Landslide Type: Debris Flow

10.2 Landslide Hazard Mapping and Hazard Assessment

There are two approaches to landslide hazard mapping and hazard assessment:

- Mapping historical landslides, which also provides an indication of the potential for future landslides, and
- Landslide studies by geotechnical engineers to estimate the potential for future landslides.

Maps of areas within Washington with moderate or high landslide incidence and landslide potential are shown in Figures 10.7 and 10.8.

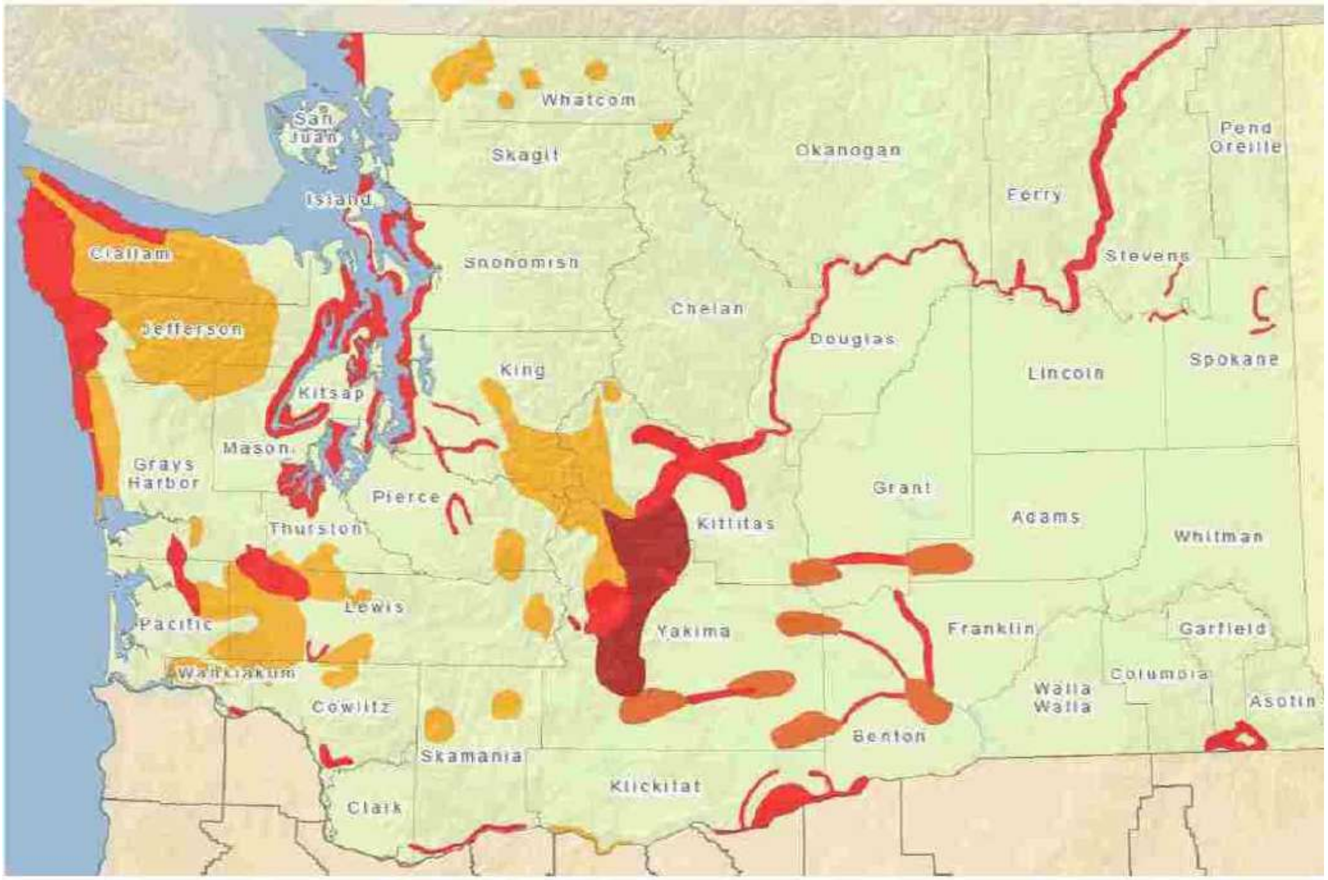
A more accurate understanding of the landslide hazard for a given campus requires a more detailed landslide hazard evaluation by a geotechnical engineer. Such site-specific studies evaluate the slope, soil/rock, and groundwater characteristics at specific sites. Such assessments often require drilling to determine subsurface soil/rock characteristics.

An important caveat for landslide hazard assessments is that, even with detailed site-specific evaluations by a geotechnical engineer, there is inevitably considerable uncertainty. That is, it is very difficult to make quantitative predictions of the likelihood or the size of future landslide events. In some cases, landslide hazard assessments by more than one geotechnical engineer may reach conflicting opinions.

These limitations and uncertainties notwithstanding, a detailed site-specific landslide hazard assessment does provide the best available information about the likelihood of future landslides. For example, such studies can provide enough information to determine that the landslide risk is higher at one location than another location and thus provide meaningful guidance for siting future development.

Given the above considerations, landslide hazard and risk assessments are generally qualitative or semi-quantitative in nature.

Figure 10.7
Landslide Incidence and Potential[2]



High Incidence: >15% of area involved

Moderate Incidence: 1.5% to 15% of area involved

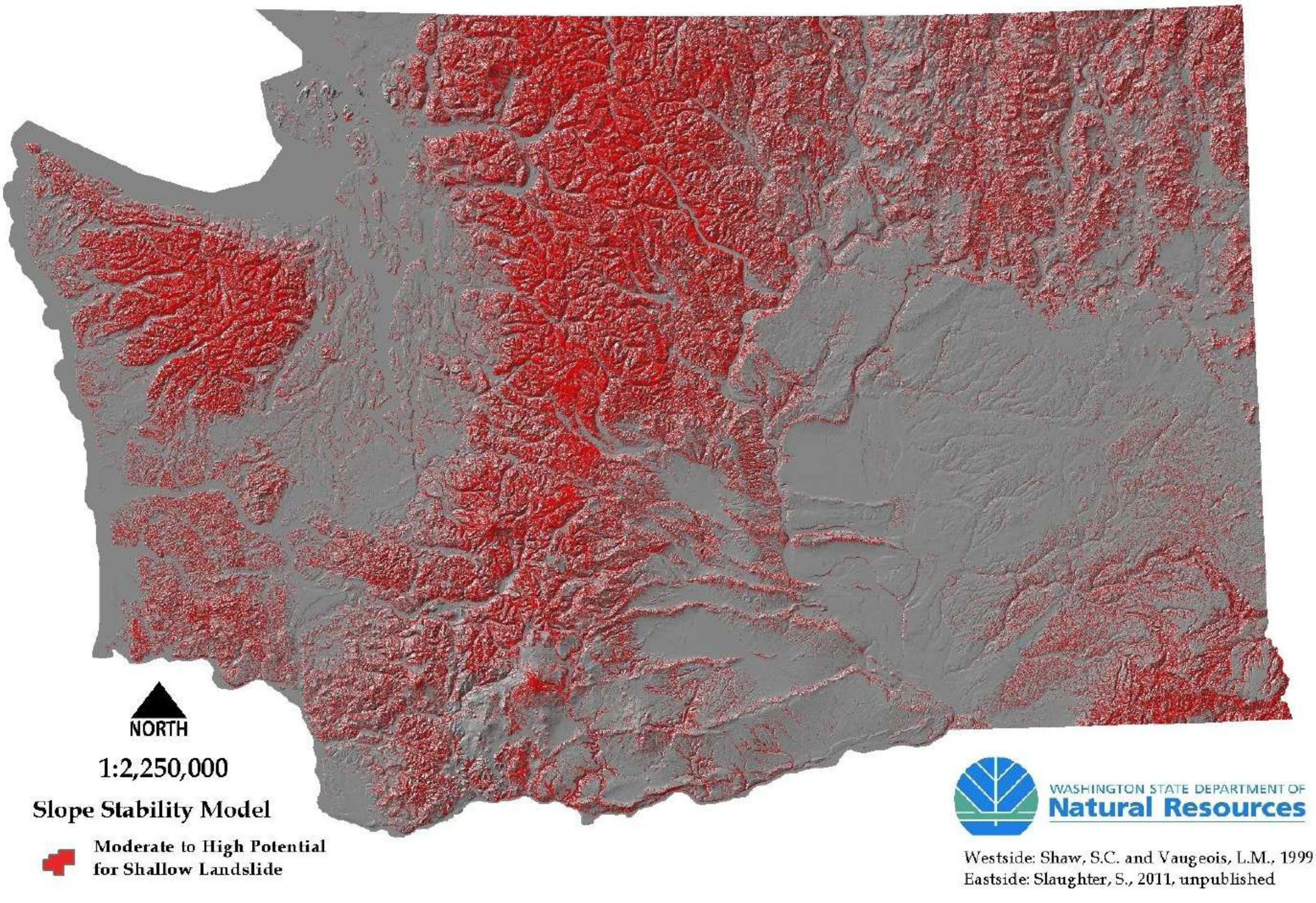
Low Incidence: <1.5% of area involved

High Susceptibility

Moderate Susceptibility

Figure 10.8

Department of Natural Resources – Landslide Potential Map[5]



10.3 Concrete School District: Landslide Hazard and Risk Assessment

The potential impacts of future landslides on the Concrete School District include deaths and injuries, primarily damage to buildings and contents (include possible complete destruction), disruption of educational services, and displacement costs for temporary quarters if some buildings have enough damage to require moving out while repairs are made.

The vulnerability of the Concrete School District's facilities to landslides varies from building to building. The approximate levels of landslide hazards and vulnerability are identified in the following sections.

There have been no historical landslides that directly affected or came very close to the district's campus.

Campus-level landslide hazard and risk assessments are made in the OSPI ICOS Pre-Disaster Mitigation database, using the following data:

- Slope data in the vicinity of each campus, from digital elevation data for the campus and a grid of data points in the north, south, east, and west directions from the campus.
- Whether or not the campus is within 500 feet of a DNR mapped landslide.
- Information provided by the Concrete School District.
  - Are there channels, gullies, or swales upslope from the campus?
  - Are there slumps or historical landslides upslope from the campus?
  - Are there buildings <50 feet from a deeply incised stream or other steep slopes?

The preliminary landslide hazard level is based on slope data only:

Slope	Preliminary Landslide Hazard Level
>40%	High
30% to 40%	Moderate
20% to 30%	Low
<20%	Very Low

The hazard and risk level is increased by one step (but not higher than “high”) if there are yes answers to any of the four data points listed above.

As stated previously, more accurate landslide hazard and risk assessment requires a site-specific investigation by a geologist, engineer, or geotechnical engineer. Consultation with one of these experts is recommended for all campuses where the preliminary determination of the level of landslide hazard and risk is “moderate” or higher.

Table 10.1 on the following page summarizes the preliminary landslide hazard and risk information for the Concrete School District’s campus. The maximum slope data, obtained from GIS elevation data do not adequately reflect the potential level of landslide hazard for the campus. There is a very steep slope on the north side of the campus, which is close to the High School, the northwest corner of the Elementary School and the portables near the Elementary School.

The preliminary landslide risk column in Table 10.1 has been edited to reflect presence of the nearby steep slope which has elevation drop of approximately 50 to 60 feet over a short horizontal distance. Field inspection of this slope found evidence of downslope movement on parts of this slope.

The Google Earth image on page 10-13 shows the steep slope area which is the densely forested area immediately north of the campus.

Without more detailed site-specific evaluation of landslide hazards and risk for each campus, it is not possible to make quantitative estimates of the level of landslide risk for each building.

A consultation with a geotechnical engineer regarding the stability and the degree of possible landslide risk to the District’s buildings noted above. A preliminary evaluation by the engineer will determine whether or not more detailed evaluation is warranted.

Table 10.1

Concrete School District: Campus-Level Landslide Hazard and Risk Assessment

Landslide Campus-Level Hazard and Risk Report								
Campus	**Maximum Slope Near Campus**	**Preliminary Landslide Hazard Level°**	**Within 500 feet of DNR Mapped Landslides[1]**	**Channels, Gullies or Swales Upslope**	**Slumps or Historical Landslides Upslope**	**Buildings <50 Feet From Incised Stream or Steep Slopes**	**Preliminary Landslide Risk Level[2]**	**Consult with Geologist or Geotechnical Engineer[3]**
Concrete								
Administration Building	16.25%	Very Low	No	No	No	No	Very Low	No
Concrete High School	8.80%	Very Low	No	No	No	Yes	Moderate - High	Yes
Concrete K-8 School	14.90%	Very Low	No	No	No	Yes	Moderate - High	Yes

° The preliminary hazard level reflects only the maximum slope near the campus, as calculated from GIS elevation data.

[1] Indicates that landslides occur near the campus; landslide hazard for the campus may or may not be significant.

[2] Preliminary landslide risk level based on the combination of the GIS data and campus-specific data (if such is entered). More accurate determination of landslide risk for a campus or for specific buildings requires consultation with a geologist or geotechnical engineer.

[3] Consultation means discuss with a geologist of geotechnical engineer knowledgeable about landslides to determine whether a more detailed study is warranted.

The landslide risk levels for the High School and the K-8 School were raised to reflect the very steep slopes just north of these buildings.

Figure 10.9

Google Earth Image Showing the Heavily Forested Area North of the Campus which is the Very Steep Slope Location

10.4 Mitigation of Landslide Risk

Mitigation of landslide risks is often difficult from both the engineering and cost perspectives. In many case, there may be no practical landslide mitigation measure. In some cases, mitigation may be possible. Typical landslide mitigation measures include the following:

- Slope stability can be improved by the addition of drainage to reduce pore water pressure and/or by slope stabilization measures, including retaining walls, rock tie-backs with steel rods, and other geotechnical methods.
- For smaller landslides or debris flows, protection for existing facilities at risk may be increased by building diversion structures to deflect landslides or debris flows around an at risk facility.
- For very high risk facilities, with a high degree of life safety risk, abandoning the facility and replacing it with a new facility may be the only possible landslide mitigation measure.
- For new construction, siting facilities outside of landslide hazard areas is the most effective mitigation measure.

The Concrete School District's mitigation Action Items for landslides are shown in the table on the following page.

Table 10.2

Concrete School District: Landslide Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Landslide Mitigation Action Items								
Short-Term #1	Consult with a geologist or geotechnical engineer regarding landslide risk for the Elementary School, High School and portables.	1 Year	Local or Grant	CSD	X	X	X	X
Short-Term #2	Complete landslide risk assessment if recommended by the geologist or geotechnical engineer	1-2 Years	Local or Grant	CSD	X	X	X	X
Long-Term #1	Evaluate and implement landslide mitigation measures if warranted based on the results of the risk assessment evaluation, as funding becomes available.	2-5 Years	Local, Bond or Grant	CSD	X	X	X	X

10.5 References

1. United States Geological Survey (2004), Landslide Types and Processes, Fact Sheet 2004-3072.

2. Washington State Military Department, Emergency Management Division (2009), Hazard Identification and Vulnerability Assessment (HIVA).

3. Google Earth photos (2013 and 2014).

4. Washington State Enhanced Hazard Mitigation Plan, Section 5.6, Hazard Profile – Landslide, October 2010.

5. Photo by Washington Department of Natural Resources:

    http://www.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=9224

6. Washington Department of Natural Resources (2011), unpublished map: Slope Stability Model for Shallow Landslide Potential, West and East Side.

11.0 OTHER NATURAL HAZARDS 6-27-2015

Previous chapters have addressed the natural hazards which pose the greatest risks for the Concrete School District's facilities and people. In addition to these hazards, there are other natural hazards which pose less risk to the District. This chapter addresses these other natural hazards.

11.1 Severe Weather

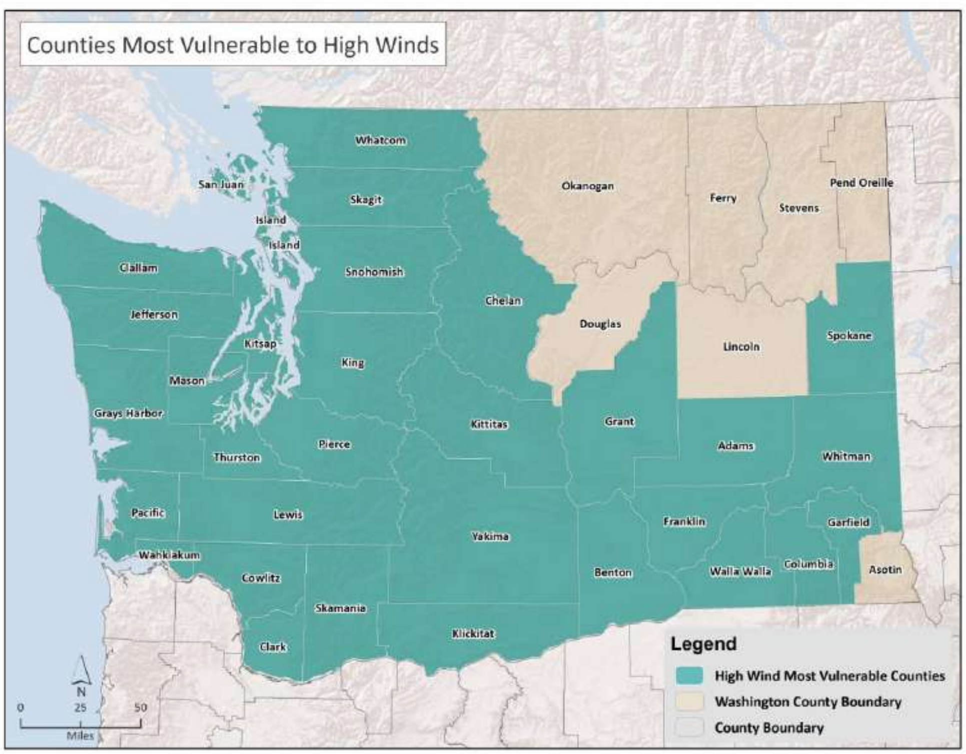
Severe weather events are possible throughout Washington State, including: high winds, snow storms, ice storms, thunderstorms, hail and tornadoes. Most such events have relatively minor impacts on K–12 facilities although more severe events may result in significant damages. Of these types of weather hazards, high winds pose the greatest risk to K–12 facilities, although the level of risk for most facilities is much lower than for facilities at high risk from the major hazards addressed in previous chapters.

High Winds

High wind events can occur anywhere in Washington, but the most severe events have occurred on the Pacific Coast and in the Cascades. The following map from the 2013 Washington State Enhanced Hazard Mitigation plan shows that nearly all counties in the state are deemed at significant risk from high wind events.

Figure 11.3

Counties Most Vulnerable to High Winds[1]



The most common impacts from high wind events are loss of electric power from downed overhead power lines due to tree falls or from direct wind forces on power lines. Damage to buildings can range from limited roof damage to major structural damage from wind or from tree falls onto buildings.

More severe events such as the 1962 Columbus Day windstorm result in more widespread damage to vulnerable buildings. Most K–12 facilities will suffer little or no damage in minor to moderate windstorms, with higher levels of damage mostly limited to very severe wind events, especially for the most vulnerable buildings, such as portables, that are not adequately tied down.

Snow and Ice Storms

Numerous snow and ice storms occur in Washington State every year. The principal impacts from severe storms are disruption of electric power from downed overhead lines and disruption of transportation. Severe snow or ice storms result in school closures but rarely result in significant damage to school facilities.

In severe storms, with unusually heavy loading of snow and/or ice, a few very vulnerable buildings may collapse. Most school buildings have been designed for snow loads and thus are unlikely to suffer significant damage except for extreme events with snow and/or ice loads well above the design loads. Districts with older buildings, especially large span buildings, in areas with high annual snowfalls may wish to evaluate some buildings for the capacity to withstand snow and ice loads on the roofs.

Thunderstorms and Hail Storms

Thunderstorms and hail storms occur fairly frequently in Washington State, although the frequency and severity of such events is much lower than in many parts of the United States. Severe thunderstorms may have high enough winds to result in downed overhead electric lines and tree falls with disruptions to utilities and transportation. However, the likelihood of thunderstorms severe enough to result in significant damage to K–12 facilities appears very low.

Hail storms may occur anywhere in Washington but are more common in eastern Washington. Hail storms with large diameter hail may cause significant damage to exposed vehicles and localized damage to some roofs. However, the likelihood of hail storms severe enough to result in significant damage to K–12 facilities appears extremely low.

Tornadoes

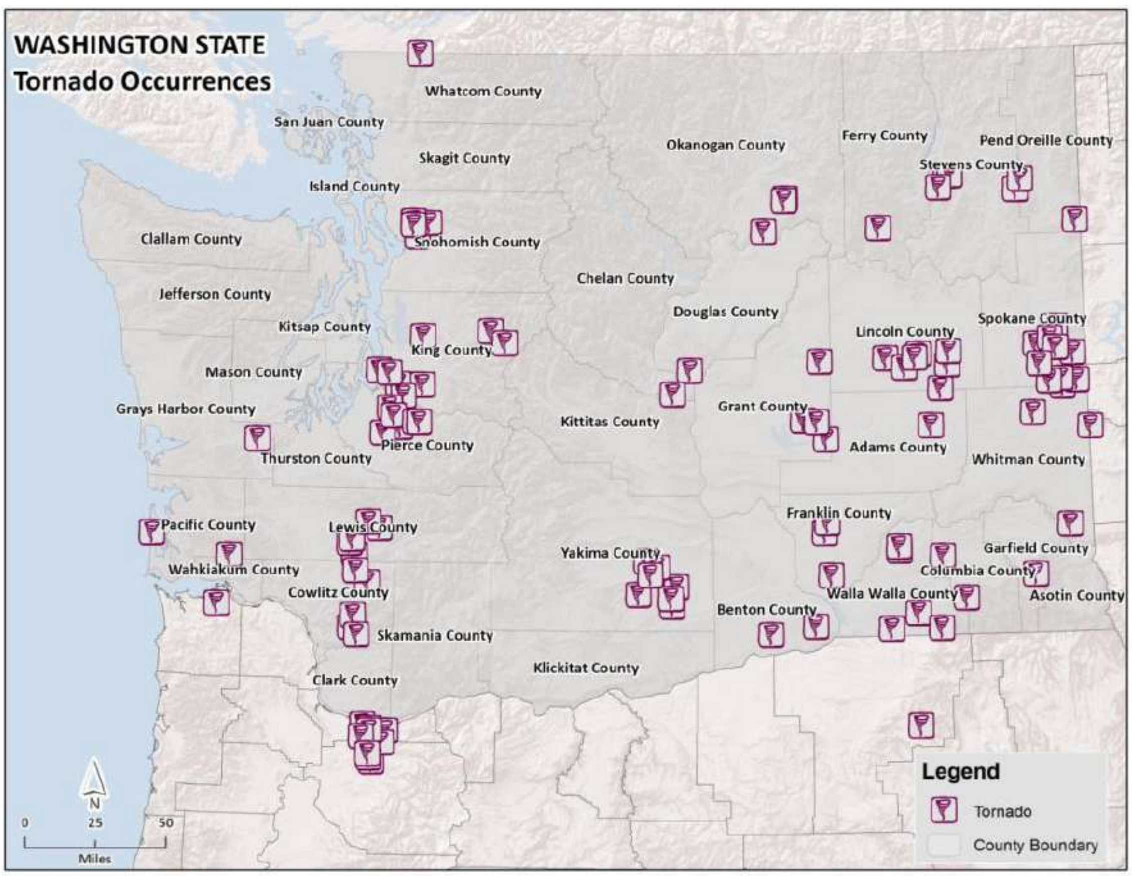
Between 1954 and 2012, nearly 100 tornadoes have been reported in Washington State, as shown in Figure 11.4 on the following page. The vast majority of these tornadoes were small, F0 or F1, on the Fujita Scale; or, EF-0 or EF-1, on the Enhanced Fujita Scale. Such small tornadoes often result in minor roof damage but do not generally cause significant damage to buildings, and rarely result in significant injuries or deaths.

The most severe tornado outbreak in Washington occurred in April 1972. An F3 tornado hit Vancouver with six deaths, about 300 injuries, and about $50 million in damages. On this same day, there was an F3 near Spokane and an F2 in rural Stevens County.

For K–12 facilities, the risk of significant damage and casualties from tornadoes is very low but not zero. Given the low level of risk, mitigation measures such as building safe rooms are not practical or cost-effective. However, the Concrete School District's emergency plan should include identifying the best available safe area in each school if a tornado were to occur. This area should be a small, interior room with the fewest windows, ideally with no windows.

Figure 11-4

Washington State Tornadoes Since 1950[1]



Extreme Temperatures

Extreme cold or extreme heat both pose some risks to students and staff, especially for those that walk or bicycle to/from school. Proactive decisions to close schools are sometimes made for either extreme cold or extreme heat periods. Closures during extreme heat are more likely for schools without air conditioning.

Extreme temperatures also pose some risk to school facilities in several ways:

- Heating and air conditioning systems in schools are more prone to equipment failures at times of extreme demand, such as during periods of extreme temperatures.
- Water pipes in poorly insulated school buildings may freeze during periods of extreme cold, resulting in burst pipes and water damage.
- Utility systems providing electric power and water to schools are more prone to failures during periods of extreme temperatures:
    - Electric power systems have more failures during periods of either extreme cold or extreme heat and such power outages may require school closures, depending on the duration of the outage.
    - Potable water systems may suffer damage during periods of extreme cold, especially small, rural systems with small diameter water pipes with low water flow rates. Loss of water supply typically necessitates school closures.

Severe Weather Events for the Concrete School District

The entire district campus is potentially at risk of severe weather events. Past damage from severe weather events has been limited to minor roof damage from windstorms and freezing of water pipes from under-insulated water pipes.

For the most part, addressing severe weather is more in the domain of emergency planning than mitigation planning. Emergency planning measures include developing and practicing responses for events that may require shelter in place (such as tornado warnings) or events that may require evacuations (such as power outages, loss of water service, or loss of air conditioning or heating during periods of extreme heat or cold).

Possible mitigation measures for severe weather events include the following:

- High Wind Events
    - Tie-downs for portable buildings.
    - Increased trimming for trees near above ground electric power lines feeding a school or large trees near school buildings.
    - Installing wind-resistant roofing materials for schools in high wind areas or with a history of wind damage to roofs.

- Snow and Ice Storms
  - Increased trimming for trees as for high winds as noted above.
  - Evaluate and possibly retrofit older buildings, especially large span buildings that may have been designed for inadequate snow loads.
- Extreme temperatures
  - Maintain heating and cooling systems in good working order and replace systems near the end of their useful life.
  - Insulate water pipes with a history of freezing or with poor insulation, in locations with frequent extended periods of below freezing temperatures.
- All Severe Weather Events
  - Install back-up power systems for selected district facilities, such as those designated as emergency shelters.

References

1. Washington State Enhanced Hazard Mitigation Plan (2013). Washington State Military Department, Emergency Management Division.

Table 11-1

Concrete School District: Other Natural Hazards Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Lead Agency	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Other Natural Hazards Mitigation Action Items								
Short-Term #1	Evaluate portable buildings to make sure that they are adequately tied down to resist high winds and implement mitigation measures, if necessary.	1-2 Years	Local, Grant	CSD	X	X	X	X