APPENDIX 3-B: ARCHIVE OF HAZARD MITIGATION SUCCESSES

In addition to the "Hazard Mitigation Successes" featured in each hazard chapter of this plan, the State IHMT also reports the following success stories in reducing Oregon's vulnerability to natural hazards.

Multi-Hazards

2010 – DCBS issues Emergency Preparedness Press Releases

In September 2010, the Department of Consumer & Business Services issued the first of several press releases entitled "Key Insurance Tips for Emergency Preparedness."1 The press release provided information on federal relief that is available post – disaster, and discussed the different types of disaster insurance available to Oregon citizens, including insurance programs covering earthquake, flood, wildfire, landslide, and erosion hazards. All news releases are available on DCBS's website: http://www.oregon.gov/DCBS/news.shtml.

2009 - Oregon Hazards Explorer

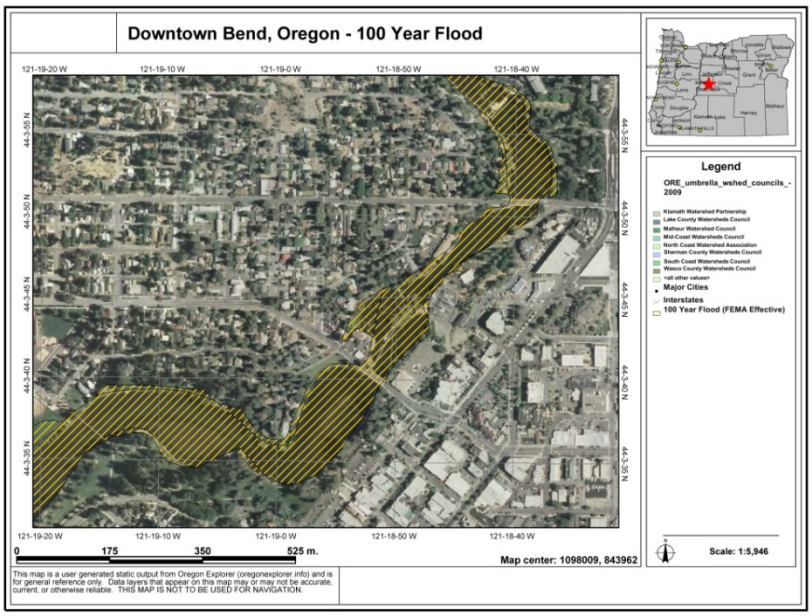

Figure 1: Oregon Hazard Explorer mapping tools allow access to all hazard information and the ability to map hazards for individual communities, and/or properties. Source: Oregon Hazard Explorer. http://www.oregonexplorer.info/hazards/

The Oregon Hazard Explorer is a web-based tool that functions as a one-stop-shop for local, state, and federal data. It offers local citizens, planners, public agency staff and community groups the opportunity to learn and make informed decisions about know hazards in Oregon. The Hazard Explorer also allows users to produce reports on known hazards in specific areas of interest, and offers a place to organize, archive, and access important hazards content in an existing digital repository.

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[1] Cheryl Martinis, *Key Insurance Tips for Emergency Preparedness*. September 2009. http://insurance.oregon.gov/news_releases/2010/090910-disasterpreparedness.pdf.

The Oregon Hazard Explorer is the result of a collaboration among various stakeholders including staff from the Oregon Department of Land Conservation and Development (DLCD); librarians and Oregon Explorer staff from the OSU Libraries; staff from the Institute for Natural Resources; financial support from DLCD; and input from members of the Hazard/Preparedness Framework Implementation Team. The project was initiated in response to a key recommendation by the Oregon Partnership for Disaster Resilience in their 2005 needs assessment. Phase 1 of the portal was made public in June of 2009, as is currently available online at: http://www.oregonexplorer.info/hazards.[2]

2006 - Take the steps required to receive FEMA approval of this state Natural Hazards Mitigation Plan as an "Enhanced State Mitigation Plan" under 44 CFR 201.5.

The State Interagency Hazard Mitigation Team – with considerable assistance from the University of Oregon's Oregon Natural Hazards Workgroup (ONHW) – achieved FEMA approval of the state Natural Hazards Mitigation Plan as an "enhanced plan" under 44 CFR 201.5, in 2006. By achieving this status, funding to the state under HMGP is 20% of the total estimated eligible Stafford Act disaster following presidentially declared major disasters. Funding eligibility was 7.5% before reaching enhanced status.

To maintain enhanced status, the state plan is reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities, and resubmitted for approval to the appropriate Regional Administrator every three years. Also, in order for the state to be eligible for the 20% HMGP funding, the Enhanced State Mitigation Plan must be approved by FEMA within the 3 years prior to the current major disaster declaration.[3] Achieving "enhanced" status marked the completion of an All-Hazards action within the Oregon NHMP.

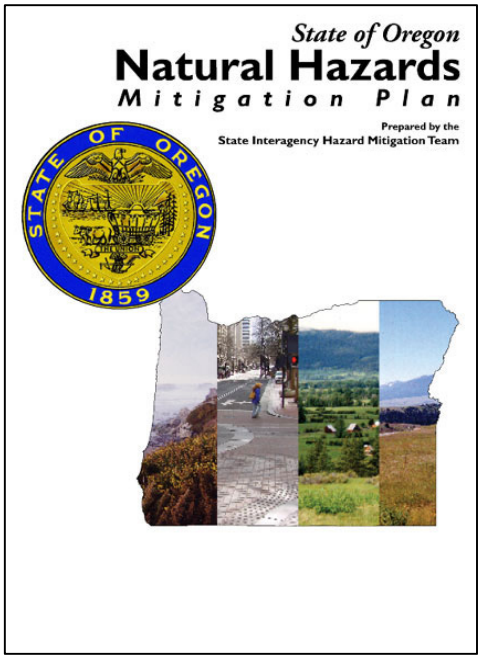

Figure 2: Oregon Natural Hazard Mitigation Plan. Available online at: http://csc.uoregon.edu/opdr/stateplan

[2] OSU Libraries. Oregon Hazards Explorer – *About the Oregon Hazards Explorer*. http://www.oregonexplorer.info/hazards/about

[3] 44 CFR 201.5 (2010)

2004 - Post Oregon's Natural Hazards Mitigation Plan on the World Wide Web

In 2004 the Oregon natural Hazards Workgroup coordinated the completion of Oregon's Natural Hazards Mitigation Plan and posted the plan on OPRD's website, now located at:

http://opdr.uoregon.edu/

The website utilizes a user-friendly design to facilitate easy access to the plan and its resources, while allowing for regular updating. This project marked the completion of a 2004 All-Hazards action within the Oregon NHMP.

2004 - Develop additional hazard mitigation chapters

This action was completed in 2004. The June 2000 *State of Oregon Natural Hazards Mitigation Plan* action items covered floods, landslides, and high wind hazards. Further development was needed for Oregon's other hazards - Coastal Erosion, Drought, Dust Storm, Earthquake, El Nino-La Nina, Fire, Tsunami, Volcanic Eruption and Winterstorm.

The completion of these chapters was one of the accomplishments of a collaborative effort between OPDR, the University of Oregon's Community Planning Workshop (CPW), and the Oregon Natural Hazard Workgroup (ONHW). The collaboration addressed All-Hazards within the Oregon NHMP, and now includes the additional chapters in the *State of Oregon Natural Hazards Mitigation Plan* updates.

2001 - Review of statewide land use planning Goal 7

In 1996 and 1997, Oregon was hit by devastating floods and landslides caused by heavy rain and melting snow. Due to these events, one of former Governor Kitzhaber's many actions was to call on the state's Department of Land Conservation and Development (DLCD) to review Statewide Planning Goal 7 - Areas Subject to Natural Disasters and Hazards.

Under contract to DLCD, the Community Planning Workshop (CPW) at the University of Oregon's Community Service Center facilitated a public process to evaluate Goal 7 and natural hazards planning in Oregon. The review showed that many communities experience difficulties in evaluating development proposals in the context of implementing risk reduction policies.

As a result of this review, DLCD revised Goal 7 language and concluded revisions by submitting a report to the Land Conservation and Development Commission (LCDC) in 2001. Goal 7 now includes a process for notification to local governments of new hazard information. It also requires that local governments review any new hazard information brought to their attention and determine if a local land use response is needed. LCDC adopted the revised Goal 7 in 2001. The revised Goal 7 became effective in June 2002.

2001 *Local Success* - Full Mitigation; Astoria Protects Against Flood, Windstorms and Earthquakes - Astoria

In 2000, Randy Stemper, life-long resident of Astoria and owner of Astoria Builders Supply Co., decided to design a new building for his business. The original owner built the first business structure in 1942, and since then the building had been damaged by flood and windstorms and had been repaired several times. During the 1996 severe flooding/high windstorm, the old building, which had been elevated, again suffered significant damage and loss of inventory. Randy began doing research to see what could be done to reduce or eliminate damages to his business.

Stemper hired engineers to design a building that would protect his investment from damages and his employees from injuries resulting from floods, windstorms, and earthquakes. The building is now anchored on pilings set 60 feet into the bedrock. The all-steel exterior is reinforced from the roof down to the floor and then secured to the pilings, and the roof sections were machined together so that there are no seams to catch the wind.

The new Astoria Builders Supply Co. began construction in 1997, finishing in 2001. Since that time, construction has been tested during the extreme high winds that hit Astoria in December 2007. The building withstood hurricane-force winds, with peak gusts of 85 miles per hour, with virtually no damage, saving thousands of dollars, and the business kept operating. Astoria, and other northwest coast communities that had suffered major damage, benefited by having the supplies ready when they needed them.

"I have used this type of continuous load-bearing construction on other buildings, including my new home," stated Stemper, "and these techniques will be used on the new Astoria hospital." The undamaged Astoria Builders Supply Co. is a testament to the rewards of building "stronger and smarter."[4]

Figure 3: The remodeled Astoria Builders Supply opened in 2002.

[4] FEMA Best Practices Portfolio. http://www.fema.gov/mitigationbp/brief.do?mitssId=5286.

Coastal Erosion

2009 - Construction Setbacks

With the assistance of Oregon State University researchers and others, geometric and numerical models of dune erosion have been developed and tested as of 2009. The models allow planners to numerically evaluate ocean processes and sediment transport that cause beach and dune erosion, and provide information that can be used to determine how oceanfront construction setbacks should be established in dune backed beach environments. Based on this research, an oceanfront construction setback methodology, which considers the full range of geologic and oceanographic factors affecting shoreline stability on the Oregon coast, was developed and field-tested. The setback methodology has been built into the model ordinance.

2009 - Oregon Creates GIS Database shoreline structure eligibility

The construction of riprap and other shoreline protective structures (SPS) continues to be a controversial issue facing the Oregon Coastal Management Program. A new tool developed by Coastal Program staff at the Department of Land Conservation and Development will help identify properties where SPS permit applications can be submitted. This will assist local planners and state agencies with decision-making as well as long range planning on Oregon's beaches.

Figure 4: The most common form of shoreline protective structures in Oregon is the riprap revetment. Photo courtesy of Oregon Coastal Atlas.

Statewide Planning Goal 18 describes limitations on where oceanfront shoreline protective structures (SPS) can potentially be permitted. These limitations are based on whether development existed on individual properties on January 1, 1977.[5] The term "development" can range from structures built on the property, to vacant, improved subdivision lots.

To build the project, a database table and form was developed that contain the necessary information to make a determination. This includes the parcel I.D, history of building, subdivision, and infrastructure improvements, comments regarding aerial photo interpretation, and information from city and county planners. Using this information, a final determination was made on whether the property owner is or is not eligible to apply for a permit. If eligible, the property owner may apply for a permit from the Oregon Parks and Recreation Department (OPRD), which eventually approves or denies the permit.

When converted to a GIS shapefile, the determinations can be graphically displayed, and the form information looked up in the attribute table. In addition to city and

[5] *Oregon Coastal Atlas.* http://www.coastalatlas.net/index.php?option=com_content&task=view&id=42&Itemid=9

county use, the GIS mapping also helps OPRD visualize potential build-out of SPS, and consider revision of policies to keep certain beaches from being affected by shoreline armoring in the future. The maps also display potential conflicts for future permitting, where eligible properties adjoin ineligible properties. Transfer of the data to the Oregon Atlas was done prior to the 2009 Oregon NHMP. The availability of data via the Oregon Atlas creates easier access to the information without the need for GIS software.[6]

2008 - Geotechnical Report Standards

The state developed a set of guidelines for the preparation of technical reports related to the impacts of coastal erosion. These guidelines were used by DLCD to prepare the hazards model ordinance for local government use and are being used in concert with other hazard mitigation projects and mapping projects. A report titled *Appraisal of Coastal Hazards Alleviation Techniques Applicable to the Oregon Coast* was prepared for use by local governments in assessing natural hazards mitigation options. Some coastal cities and counties require these standards through their local land use programs. The application of these standards, along with improved baseline hazards mapping, data, and updated background reports on climatological and geologic trends, result in recommendations that more accurately reflect the level of risk for a specific site. OPRD has also established standards for geotechnical information needed to support ocean shore permit projects.

DLCD published a report by Paul Komar, *Contents of Geotechnical Reports Related to the Impacts of Coastal Erosion and Related Hazards* (1993). In addition, DLCD published guidance related to permitting and siting decisions titled, *Beach Improvement Permit Information: Guidance for Establishing Project Need* (John Marra, 1998).

Geotechnical report standards were updated in 2008 with input from the Coastal Hazard Working Group. This ad hoc committee was established in 2004 to periodically review coastal hazard issues.

2005 - Geographical Information System Data Set of Beach Morphodynamics Derived from 1997, 1998, and 2002 Lidar Data for the Central to Northern Oregon Coast

The LIDAR beach morphology database was developed by DOGAMI staff and published in 2005 for public use. The database consists of beach profile cross-sections derived from LIDAR data that are spaced at 100 meter intervals for all beach and bluff-backed shorelines on the central and northern Oregon coast. The database may be viewed through GIS, as individual images stored on a CD, and via the *Coastal Atlas*.

The contribution of this work to hazard mitigation is in providing fundamental baseline information as to the response of beaches during the 1997-98 El Nino event as well as the gross response of beaches to extreme storms that occurred between

[6] *Oregon Coastal Atlas*. http://www.coastalatlas.net/index.php?option=com_wrapper&Itemid=28

1997 and 2002. This information is intended to be accessed by staff from regulatory state agencies, coastal managers, local government planning authorities, geotechnical firms, and the public in addressing coastal erosion related vulnerability and risk. [7]

2005 - Prepare and distribute coastal hazards video

Coastal storms and other natural processes pose particular challenges to those planning to build or buy property along the Oregon coast. In 2005 the DLCD, in conjunction with Oregon Sea Grant, produced a DVD video called *Living on the Edge, Buying and Building Property on the Oregon Coast*[8] to address such challenges. The 25-minute video portrays the chronic effects of waves, wind, and rain on coastal beaches and bluffs while knowledgeable engineers, planners, and realtors offer their insights and recommendations to address these issues successfully. *Living on the Edge* is intended for developers, realtors, lenders, and coastal officials as well as builders, buyers, and homeowners. Production and distribution of this video marked the successful completion of a 2004 *State of Oregon Natural Hazard Mitigation Plan*, short-term action item.

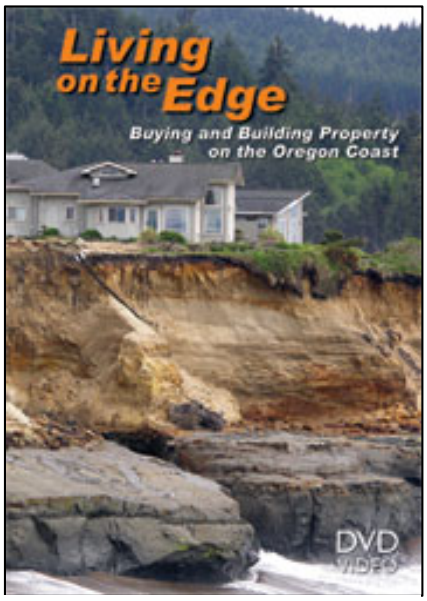

Figure 5: *Living on the Edge* - DLCD and Oregon Sea Grant produced DVD, offering recommendations for addressing coastal hazards

2004 - Oregon Beach and Shoreline Mapping and Analysis Program: Pacific Northwest Estuaries and Shores[9]

In 2004, staff from DOGAMI initiated a pilot beach and shoreline observing effort along the Rockaway littoral cell in Tillamook County to begin documenting both short and long-term changes in beach dynamics. The beach observing program utilizes Real-Time Kinematic Differential Global Positioning System (RTK-DGPS) technology to regularly measure changes in the elevation and position of the dune and beach face as they respond to storms, El Niño climate events, and in the long-term, changes that may occur as a result of climate change. While the initial emphasis was focused on the Rockaway littoral cell (25 monitoring sites), the Oregon Beach and Shorline Mapping and Analysis Program (OBSMAP) program has since been expanded to include several other littoral cells, which include: the Clatsop Plains - Seaside north to the Columbia River (six monitoring sites), Neskowin - Cascade Head to Cape Kiwanda

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[7] Allan J.C., Hart R. 2005. A geographical information system (GIS) data set of beach morphodynamics derived from 1997, 1998, and 2002 LIDAR data for the central to northern Oregon coast. Open file report O-05-09, Oregon Department of Geology and Mineral Industries, Portland, Oregon.

[8] Available online: http://seagrant.oregonstate.edu/video/flash/Living_On_the_Edge.html

[9] Available online: http://www.oregongeology.org/sub/nanoos1/index.htm

(15 monitoring sites), Beverly Beach - Yaquina Head to Otter Rock (15 monitoring sites), and the Newport littoral cell - Yachats to Yaquina Head (58 monitoring sites). Beach surveys are carried out either on a quarterly basis or bi-annually. Additional beach change information was derived from 1997, 1998 and 2002 Light Detection and Ranging (LIDAR) data, extending the record of coastal change back ten years. All data are posted on the DOGAMI web page for easy viewing and access. This project is ongoing and is part of DOGAMI's effort to begin to document climate change effects on the coast.

2004 *Local Success* - Gold Beach Ocean Shore Hazard Maps

New ocean shore hazard maps were produced by DOGAMI in 2003 and 2004, allowing Gold Beach to compare this current information with its ocean shore overlay zone, and evaluate whether new areas should be established to prohibit development and provide protection from ocean flooding and dune erosion.

2003 *Local Success* - Clatsop County

Clatsop County, working with DLCD and DOGAMI, amended and upgraded all of its local plan policies, zoning ordinances and hazard maps through the periodic review process. This project was completed in 2003.

2002 - Alternative Ocean Shore Protection Projects

The state of Oregon and Tillamook County implemented a pilot project at Cape Lookout State Park to evaluate the effectiveness of an alternative ocean shore protection structure (i.e., a dynamic revetment or cobble berm). The project was monitored by DOGAMI and OPRD to evaluate long-term effectiveness. DOGAMI published a report on their findings in

Figure 6: Erosion of Cape Lookout State Park, photographed during the 1997–98 El Niño. The remnants of the high dune ridge and a failed log seawall are seen in the background. Riprap temporarily protected the bathrooms, but they were removed after having been damaged the following winter when the March 1999 storm breached this area and washed through the campground (Allan and Komar, 2004)

[10] Allan, J.C., and P.D. Komar, 2002: A dynamic revetment and artificial dune for shore protection at Cape Lookout State Park, Oregon. *Proc. 28th International Conference on Coastal Engineering*, Cardiff, Wales.

Some individual landowners have installed alternative ocean shore protection structures (e.g., vegetative stabilization efforts along parts of Arch Cape and at Cannon Beach) via permits obtained from the OPRD. The state has provided technical assistance to support the development of these proposals.

2002 - Coastal Atlas

The *Coastal Atlas*, a web interface geographic information system, was created in 2002 by several partnering organizations, core contributors include; the Oregon Ocean - Coastal Management Program, Oregon State University Geosciences, and Ecotrust. Multiple public agencies have also contributed data to the atlas archives. [11]

The purpose of the Oregon Coastal Atlas is to store coastal-specific data available from diverse sources, and provide educational information on a variety of topics including coastal erosion, coastal hazards, shoreline protective structures, and rapidly moving landslides. The *Atlas* includes coastal hazards data, maps, etc., and makes this information available to a wide audience. In addition, the atlas contains tools that allow the user to visualize the extent of erosion and inundation to which specific locations would be subject using both hypothetical and real time data inputs. Another project on the *Atlas* shows where properties are eligible or not eligible for shoreline protective structure permit applications.

2001 *Local Success* - Tillamook County

Tillamook County worked with DOGAMI in 2000 and 2001 to develop new coastal erosion hazard maps for the entire county coastline. These data are available on CD as GIS files and may also be accessed via the *Coastal Atlas*.[12]

1999 - Regulation of Ocean Shore Projects[13]

Numerous improvements have been made to the state regulatory program administered by OPRD for ocean shore projects. In 1999, the Oregon Legislature acted to consolidate state review and permitting of proposed ocean shore projects into the OPRD. This was done at the request of OPRD and DSL to streamline the review process. Since then, OPRD has made substantial updates to its permit application form for ocean shore projects. OPRD has also established state rules for "emergency" ocean shore projects. The new rules define what constitutes an "emergency," define information requirements, set standards, and define the review process for emergency projects. The state rules for "non-emergency" projects have also been updated by OPRD to establish clear, consistent goals and policies.

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[11] Availble online: http://www.coastalatlas.net/

[12] Allan, Jonathan C & Priest, George R & Oregon. Dept. of Geology and Mineral Industries (2001). In Evaluation of coastal erosion hazard zones along dune and bluff backed shorelines in Tillamook County, Oregon Cascade Head to Cape Falcon : preliminary technical report to Tillamook County. State of Oregon, Dept. of Geology and Mineral Industries, Portland, Or

[13] Available online: http://www.oregon.gov/OPRD/RULES/oceanshores.shtml

The current state rules (e.g., OPRD ocean shore regulations) and many local land use programs discourage the use of "hard" shore protection structures that fix the ocean shoreline in place and may interfere with physical processes. Permit applicants must generally explore alternatives to "hard" solutions.

1998 - Coastal Hazards Model Overlay Ordinance

The DLCD's Coastal Management Program completed a Chronic Coastal Hazards Model Overlay Zone in 1998 that is a model ordinance for regulating development in hazardous coastal areas. The model ordinance contains provisions to identify potentially hazardous coastal areas, specifies a methodology to assess the potential risks to life and property those hazards may pose, and reduces potential risks by requiring proper mitigation.[14] The model ordinance is available to all coastal cities and counties. Over time, implementation of the model ordinance by local governments should result in reduced vulnerability to development from coastal erosion and other coastal hazards.

1995 - Littoral Cells and Planning

Headlands divide the Oregon coast into littoral cells, which form ideal planning and scientific boundaries. Eighteen littoral cells have been identified along the Oregon coast. The state has developed and refined a special area planning process designed to address coastal hazards at the scale of an individual littoral cell. A littoral cell management plan is a comprehensive, integrated, area-wide hazards management strategy unique to different physical and social settings found along the Oregon coast. It is focused on the reduction of risk to new and existing oceanfront development from chronic coastal natural hazards. A littoral cell management plan includes: littoral cell inventories, a chronic hazards management strategy, and implementing mechanisms. Littoral cell management planning is being implemented through state-local partnerships, with initial efforts focused in Lincoln County, Newport, Netarts, Bandon, and the Nesika Beach area of Curry County.[15]

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[14] Oregon Department of Land Conservation and Development. 1998. "Draft Chronic Coastal Natural Hazards Model Overlay Zone." *Model Ordinance, Planners Guide and Practitioners Guide*.

[15] Oregon Department of Land Conservation and Development, *Littoral Cell Management Planning,* 1995. http://www.oregon.gov/LCD/docs/publications/littora.pdf. May, 2011.

Drought

2011 – Umatilla Basin Aquifer Recharge Project[16]

The State of Oregon Water Resources Department, along with the Umatilla Basin Water Commission, have developed and provided funding for the multi-stage Umatilla Basin Recharge Project. This project began in October, 2011, and is intended to bring thousands of acre-feet of water from the Columbia River to the Umatilla Basin. The project is intended to recharge groundwater supplies in an area with four of the states seven critical groundwater areas, providing benefits for the agriculture industry of Umatilla and Morrow counties, and fish and wildlife resources of the Umatilla River.

The project diverts water from the Columbia River to a four acre man-made pond. Water seeps through the sandy soil into an aquifer 100 feet below the surface. As the aquifer fills, pressure will eventually push the water seven miles northeast to a dry spring, where it will accumulate before spilling into the Umatilla River and a portion will flow back into the Columbia.

Many area farmers believe that the added water will allow them to produce higher value crops that require a full season of irrigation, and in some cases, return dry acres to productivity. Farmers plan their annual cropping strategies around water use restrictions, and during dry winters lower-value crops are planted to ensure they can be brought to harvest using the limited water resources.

"For the (Westland) irrigation district and for the patrons of the district, the project could mean a little longer season," said Bob Levy, an area farmer and member of the State Board of Agriculture. "For those people in the critical ground water areas, it could mean a replacement of some water that they've lost over the last several years due to the declining ground water tables. And on the environmental side, the project could mean some new identifiable and quantifiable water for fish flows in the Umatilla River."

1989 - Emergency Water Shortage Powers

Oregon Revised Statutes 536.700 to .780 provides extraordinary measures that can only be enacted in an area where the Governor has declared a drought emergency. These measures provide the regulatory framework for mitigating adverse conditions caused by continual drought conditions by distributing available resources. Residents of these areas are then eligible for emergency water use permits to supplement existing uses. However, the emergency permits are subjected to a limited public interest review, and they can only be used on areas that have an existing water right that cannot be used because of drought conditions. Use from the new source cannot harm an existing use, and it must be determined that no harm to the public interest will occur. Additionally provisions allow jurisdictions to enter into options/agreements for moving water from one location to another, and placing

[16] Lies, Mitch. Aquifer Recharge Project Offers Water. Capital Press, September 22, 2011. Accessed January 11, 2011. Web. http://m.capitalpress.com/mobile/ml-umatilla-recharge-082611-art

numerous individual water rights under one jurisdiction for control and allocation. Use can be intended for various things including irrigation and instream water. These provisions were first authorized by the 1989 Oregon legislature, and last amended by the 1993 legislature. The provisions were used extensively during the summers of 1992 and 2001 with considerable success.

Dust Storms

2009 - ODOT intelligent transportation system highway advisory radio[17]

By 2009, three AM radio transmitters had been installed for Highway Advisory Radio along Interstate 84 in Morrow and Umatilla counties: one at the Boardman Safety Rest Area, another at the District 12 maintenance station, and the third near Mission. When an emergency occurs, the ODOT District 12 office selects the appropriate pre-recorded message on the system and transmits it via radio. At the same time, ODOT activates yellow flashing beacons. Motorists seeing the signs and flashing lights should tune to 1610 AM18 and comply with any messages. In the case of a dust storm, motorists are advised to slow down and exit the freeway as soon as possible. ODOT worked with OEM's CSEPP19 office in Pendleton and local emergency management personnel on this project.

Figure 7: Highway Advisory Radio System installed in northeast Oregon by a member of the ODOT District 12 sign crew: the signs advise motorists to tune to 1610 AM for traffic information when the lights on top of the sign are flashing. (Photo courtesy of ODOT)

Also installed in the system is the ability to re-broadcast National Weather Service (NWS) weather information. NOAA Weather Radio[20] is re-broadcast on a continuous basis unless there is an emergency. An emergency broadcast then overrides the NOAA Weather Radio service.

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[17] Oregon Department of Transportation. (2009). *Traffic Manual.* Retrieved from ODOT website: http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/Traffic_Manual_09.pdf

[18] The AM frequency is different for the station near Mission.

[19] CSEPP is the Chemical Stockpile Emergency Preparedness Program. The chemical stockpile in question is in the same vicinity as an area in Morrow and Umatilla counties occasionally subject to dust storms.

[20] NOAA Weather Radio (NWR) is a nationwide network of radio stations broadcasting continuous weather information direct from a nearby National Weather Service office. NWR broadcasts National Weather Service warnings, watches, forecasts, and other hazard information 24 hours per day: http://www.nws.noaa.gov/nwr/

2004 - Using the 'Wind Erosion Hazard Index' to predict dust storms

Prior to the creation of the 2004 State of Oregon Natural Hazard Mitigation Plan, representatives from the USDA Agricultural Research Service, located in Pullman, WA and near Pendleton, have collaborated with the staff from the NOAA National Weather Service in Pendleton to develop a wind erosion hazard index to improve the anticipation of soil and weather conditions that could lead to dust storms. This work takes into account the unique properties of the fine silt loam soils prevalent in the area.[21]

2004 - Using real-time video to issue dust storm warnings

In addition to improved warning capabilities made possible by the Wind Erosion Hazard Index (see #4 on page DS-8), prior to 2004, ODOT had installed a microwave system and roadside camera tower near the Lorenzen Road Interchange ten miles west of Pendleton. The microwave and camera structures flank the south side of the freeway, opposite the Rew Grain Elevator, a familiar sight for many traveling the dry flatlands between Pendleton and Boardman. Although the two structures have not replaced the grain elevator as a key navigational landmark, the camera images and weather information do serve motorists.

Figure 8: The microwave and camera towers along Interstate 84. The Rew Grain Elevator is to the right.

Two cameras are currently mounted on a metal tower next to the microwave tower. One provides a snapshot of the freeway and is posted on the TripCheck Web site:

http://www.tripcheck.com/Pages/RCMap.asp?mainNav=RoadConditions&curRegion=3

The other camera provides a real-time image, viewed by ODOT District 12 office personnel only. A weather station and visibility meter have also been added to the camera tower. These tools monitor blowing dust conditions during high winds. The real-time camera can be panned and tilted to check eastbound and westbound traffic as well as scan the nearby fields. With blowing dust a major concern, the camera provides an easy way to check the status of the freeway and quickly dispatch service providers to where they are needed. In addition to ODOT personnel, Oregon State Police are contacted if any dust storm activity is seen.

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[21] "The Stanfield… storms were probably derived from soils that are sandy loams or loamy sands… silt loam or coarser." Donald Horneck, Ph.D., Extension Agronomist - Hermiston

The cameras and weather monitoring equipment are part of an ongoing effort to provide immediate information about highway sections that are prone to blowing dust hazards. They are also items identified by the Community Solutions Team (CST) that was established in response to the multi-vehicle crashes that occurred in September 1999 near the towers.

2000 - Gates to close access to interstate 84 during hazardous conditions

ODOT has installed two gates for I-84 closures as recommended by the Community Solutions Team that met in early 2000. The gates were also funded by CSEPP. The gates are not across the freeway itself, but rather at on-ramps. There is one at the eastbound I-84 on-ramp at exit 165 (Port of Morrow, just east of Boardman). The other is on the westbound on-ramp at exit 202 (Barnhart Road, just west of Pendleton). State and local law enforcement officers and ODOT highway workers can close the gates, restricting access to I-84 due to hazardous dust conditions or other situations that make highway travel dangerous.

2000 - Additional emergency vehicle crossover access in dust prone areas

In response to recommendations made by the Community Solutions Team during the spring of 2000, ODOT developed additional emergency vehicle crossover access on the interstate (better access for emergency response by fire, ambulance, and police officials and equipment to accident scenes), especially in areas where blowing dust has historically been a problem.

Earthquake

Since the 1980s, there has been a heightened awareness of earthquake hazards in Oregon and this has resulted in many earthquake mitigation successes. Many resulted from partnerships between state and local governments and some involved the private sector and nonprofit organizations. A broad community effort characterizes many of the successes. Both structural and non-structural retrofits to buildings have been accomplished.

2010 - Oregon's Seismic Rehabilitation Grant Program (SRGP) Brief Fact Sheet

The SRGP is a competitive state funded grant program that provided $15 million total for 2010, and up to $1.5 million for individual projects of seismic rehabilitation of critical public buildings. Reducing property damage, injuries, and casualties caused by earthquakes is the goal of the SRGP. The SRGP does this by providing funds to strengthen public schools and emergency services buildings to mitigate damage during an earthquake. This is necessary because new research has shown that Oregon is at risk of a large, and potentially very damaging earthquake and tsunami, sooner than originally estimated. Grants were awarded in January, 2010. The SHGP fact sheet provides important information to all entities seeking grant funding for needed seismic rehabilitation of at-risk facilities.[22]

Figure 7: The Beaverton School District is among the first in the state to receive the Oregon Emergency Management Seismic Rehabilitation Grant Funding. (Photo courtesy of Oregon Emergency Management)

Eligible entities include:

- K-12 public schools, community colleges, education service districts, and institutions of higher education, buildings with a capacity of 250 or more persons that are routinely used for student activities.
- Hospital buildings with acute inpatient care facilities.
- Fire Stations
- Police stations, sheriff's offices, other facilities used by state, county, district or municipal law enforcement agencies.

[22] Oregon Emergency Management. (2009). Retrieved from OEM website: http://www.oregon.gov/OMD/OEM/plans_train/SRGP.shtml

2010 - April as Earthquake and Tsunami Awareness Month[23]

On March 17th 2010, Governor Theodore Kulongoski proclaimed the month of April as Earthquake and Tsunami Awareness Month. This provides opportunity for emergency management agencies to highlight preparedness and mitigation procedures and provide increased earthquake and tsunami information to Oregon residents and visitors.

2009 - Seismic Vulnerability Assessment of Oregon State Highway Bridges

With a majority of state owned bridges designed and built between 1950 and 1980, the state of Oregon would face a devastating post earthquake situation if a major event occurred in the state. The Oregon Department of Transportation (ODOT) began a study to define the magnitude of the problem by evaluating the vulnerability of state highway bridges in western Oregon. ODOT published the *Seismic Vulnerability Assessment of Oregon State Highway Bridges, Mitigation Strategies to Reduce Major Mobility Risks* in November 2009. The report was intended to be a first step in a comprehensive look at seismic risk to transportation systems that could include slides, fill slopes, local roads and bridges, and supply lines, such as fuel depots, electricity, water and sewer lines. Research and analysis published in this report was done to identify the most vulnerable highway segments of the state highway system and consider possible mitigation, including bridge retrofit and strengthening. Available highway funding is inadequate to achieve the desired standard for seismic safety. This analysis helps to establish the highest priority for retrofit, ensuring the best use of the limited Bridge Program funding.[24]

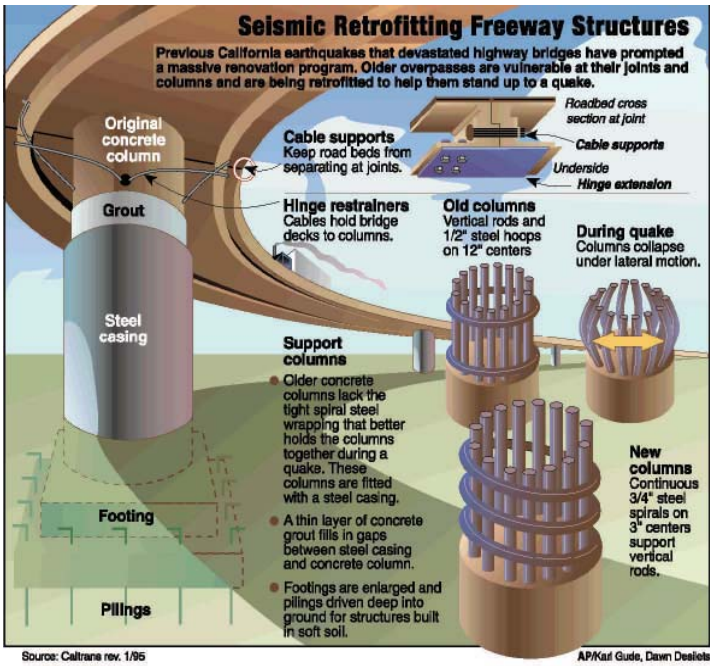

Figure 8: Diagram of freeway structure seismic retrofit

[23]Oregon Department of Geology and Mineral Industries. (2010) Retrieved from DOGAMI website: http://www.oregongeology.org/sub/earthquakes/april-eq-tsu-awareness.htm

[24] Oregon Department of Transportation. Bridge Engineering Section. Seismic Vulnerability of Oregon State Highway Bridges, Mitigation Strategeis to Reduce Major Mobility Risks. November, 2009.

2008 - Critical Energy Infrastructure: Public-Private Cooperative on Seismic Preparedness

The goals of this 1 day event were to bring together executives and senior engineers' decision makers from critical energy and telecommunication infrastructure organizations to: 1) Share evidence that earthquake preparedness is needed, 2) Encourage conduct of seismic vulnerability assessments of utility systems, and 3) Encourage development of mitigation plans and implementation of mitigation plans.

Oregon Public Utility Commission (PUC) Commissioner Ray Baum welcomed all the participants. He emphasized that the PUC is concerned about the state's earthquake preparedness, specifically utilities critical infrastructure due to their importance. The December 2007 wind and rain storm that landed on the NW Oregon Coast demonstrated that. Understanding how vulnerable our utilities critical infrastructures are in relation to a major seismic event is very important for our State's Emergency Preparedness and Response. Equally important is the proactive impact mitigation of such a catastrophic event.

Figure 9: Photograph taken at the Leadership Forum. John Eidinger, Governor's spokesperson Mark Ellsworth, Alex Tang, Stu Nishenko, PUC

Commissioner Ray Baum, Senate President Peter Courtney, Yumei Wang, Leon Kempner, Anshel Schiff, Pete McDonough, Ivan Wong,

J.R. Gonzalez (left to right). Photo by Irv Emmons.

Senate President Peter Courtney emphasized that the Legislature is concerned about the state's earthquake preparedness. He has championed 10 successful bills that have focused on preparing schools and emergency facilities for "Q9" –a magnitude 9 earthquake on the Cascadia subduction zone. The laws have led to work which have identified high risk buildings and promote mitigation. President Courtney outlined four points that are needed, 1). The Force, 2) Political Will, 3) Public Demand, and 4) Finish, the Close. He is concerned about communities (including coastal towns and transportation) and families.

Mark Ellsworth, the Governor's spokesperson, expressed the Governor's concern about the state's disaster readiness, including business continuity that relies on critical infrastructure. He recommended a higher level of preparedness ranging from individuals (3-7 days), to businesses, to communities, to utilities. He provided examples learned from the December 2007 severe storm with regard to response and recovery hampered by downed electricity and telecommunication systems.

Seven nationally recognized experts presented overviews of 1) Cascadia earthquake hazards and risk; 2) infrastructure vulnerability to earthquake damage; 3) state-of-practice lifeline seismic vulnerability studies and application; and 4) case studies of vulnerability studies by BPA and PG&E. Their talks were followed by a discussion session that included active audience participation. Participants expressed an interest to conduct seismic vulnerability assessments, and collaborate to reach the common goal of improved earthquake readiness in Oregon.

DOGAMI report O-08-10, titled OPUC-DOGAMI Leadership Forum and Seismic Critical Energy Infrastructures Workshop, is available to the public for purchase on CD-ROM from the Nature of the Northwest Information Center (NNW), 800 NE Oregon Street, Suite 177, Portland, Oregon, 97232. The report is also available online at http://www.naturenw.org.

2007 - Inventory and evaluate certain structures for seismic vulnerability

Figure 10: An example of 'soft story' conditions, where parking requirements result in large weak openings vulnerable to collapse. E-RVS methods would identify, inventory, and evaluate such conditions (Photo courtesy of FEMA)

In 2007, DOGAMI published the *Enhanced Rapid Visual Screening (E-RVS) Method for Prioritization of Seismic Retrofits in Structures*, which was conducted in 2006 and early 2007. E-RVS was developed to identify, inventory, and rank buildings that are potentially seismically hazardous by quantifying the probability of collapse, which is the predominant determinant of life safety risk for buildings. The E-RVS provides the necessary information for assigning Complete Damage (CODA) and Life Safety Risk Index (LSRI) scores to identified and inventoried buildings. Priority of risk reduction projects is then derived from these scores.

2007 - Update the *State Building Code* seismic design provisions

Revisions to the State Building Code were completed incrementally from 2004 through 2007. The revisions clarify that all new structural members must meet the current International Building Code, and removes a loophole that allowed structural design conforming to previous editions of code.

2007 - Adopt seismic risk maps for the State of Oregon based on the best scientific information currently available

The Oregon Building Codes Division (BCD) adopted USGS National Earthquake Hazard Maps from 2004 to 2007. [25] The BCD used this information to set statewide standards for design, construction and alteration of buildings that included resistance to seismic forces.

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[25] USGS. (2009) *Seismic Hazard Map.* Retrieved from USGS website: http://earthquake.usgs.gov/earthquakes/states/oregon/hazards.php

2007 - Oregon's Plan for Mitigating Earthquake Damage in Public School and Emergency Facilities

Nearly three-quarters of the primary and secondary schools in Oregon were built before the first statewide building codes were enacted in 1974 and nearly twenty years before the most modern codes were put into effect in 1993. In order to bring the almost 1,600 at-risk schools up to code, the state Senate passed bills in 2001 requiring public schools to meet life safety standards by 2022, and emergency facilities, such as hospitals and fire stations, meet these standards by 2032.[26]

Though Oregon's policy makers and citizens had set goals for mitigating seismic damage, and even developed ways to fund the project, there was no plan for making sure those set goals were met. In 2004, with the help of funds from the Federal Emergency Management Agency, the GO Bond task force was formed. Funding from FEMA (both NEHRP and Pre-Disaster Mitigation Grant Program) was used to create the Oregon GO Bond Task Force and facilitate a dialogue among a wide diversity of stakeholders in late 2004. Three concepts were developed:

- Performing a statewide needs assessment for all school and emergency facilities.
- Formation of a temporary committee to establish a new state program to distribute earthquake rehabilitation grants using state bond funds.
- Issue of state bond funds through the newly established grant program to state and local communities for the rehabilitation of fire stations, police stations and hospitals, and high occupancy school buildings.

With the help of Senator Peter Courtney, the recommendations of the GO Task Force were developed into Senate bills that were subsequently passed into law. These laws lay out a framework for a highly effective long term mitigation plan for Oregon's public schools and emergency facilities. They are a significant step forward from pre-disaster planning to actual evaluation and mitigation.

As its first plan of action, the task force set out to complete a statewide needs assessment by early 2007, which included schools (K-12), community colleges, fire stations, police stations, emergency operations centers, and acute-care hospitals. Upon completion of the assessments, a temporary committee was formed to establish a grant program to distribute the earthquake rehabilitation grant funds. The earthquake safety laws established a new grant program slated to be funded with approximately $1.2 billion in state bonds. Starting in 2007, funds could be allocated to communities to assist in the pre-disaster mitigation of high risk schools and emergency facilities, prioritized using the results from the statewide risk assessment.[27]

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[26] FEMA Best Practices Portfolio. http://www.fema.gov/mitigationbp/briefPdfReport.do?mitssId=3625

[27] Wang, Y., and Burns, W.J., 2006. Case History on the Oregon G.O. Bond Task Force: Promoting Earthquake Safety in Publics Schools and Emergency Facilities. 100 Anniversary Earthquake Conference: Commemorating the 1906 San Francisco Earthquake. Proceedings and Oral Presentation, Program, p.134.

While creating new public policies can be an incredibly difficult task, such policies can be very effective in moving towards a statewide goal such as seismic safety. The recent success that Oregon has had with the development of popular public policies can be used as a framework in other states to aid in disaster mitigation.

2006 - Oregon HAZUS User Group (ORHUG) - Geologic Hazards and Future Earthquake Damage and Loss Estimates[28]

In an effort to become more resilient to natural hazards, communities in Oregon have begun a large-scale endeavor aimed at pre-disaster mitigation. Part of the success of this endeavor is due to the Oregon Partnership for Disaster Resilience. The Partnership provides a collaborative, cost-effective approach to bring together resources – both human and financial – to enhance disaster mitigation and preparedness statewide.

Oregon Department of Geology and Mineral Studies (DOGAMI) partnered with Oregon Emergency Management (OEM) and the Oregon Natural Hazards Workgroup (ONHW) at the University of Oregon to assist local communities with their Pre-Disaster Mitigation plans. As of April 2011, all of Oregon's 36 counties have FEMA-approved natural hazard mitigation plans.

The goal of the DOGAMI-ONHW-OEM partnership was to assist all remaining counties in the state in developing plans utilizing this approach by 2010. In order to assist the remaining counties in the development of their natural hazards mitigation plans, DOGAMI identified the primary geologic hazards, developed countywide earthquake and landslide hazard maps for each county, performed future earthquake damage and loss estimates, and performed overall project management.

The 2004-2005 Mid/Southern Willamette Valley project focused on enabling local communities to develop mitigation plans by increasing local capacity through a series of workshops, communication and outreach, and plan development and research support. The project communities included Yamhill, Marion, Polk, Benton, Linn, and Lane Counties and the City of Albany (herein know as the "Mid/Southern Willamette Valley" communities).

DOGAMI took the lead on developing earthquake risk-assessment components for each of the participating ORHUG Geologic Hazards and Future Earthquake Damage Estimates communities. They utilized FEMA's HAZUS-MH loss estimation software to model two earthquake scenarios including local Crustal and Cascadia Subduction events.

With an improved HAZUS-MH study region, damage and loss estimates for two earthquake scenarios were modeled—resulting in expected total building damage on the order of $11.7 billion for a Cascadia Subduction Zone event. The outputs of the scenarios were used by the communities to develop action items aimed at reducing the risks posed by earthquakes.

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[28] FEMA Best Practices Portfolio. http://www.fema.gov/mitigationbp/brief.do?mitssId=4451

DOGAMI has also spearheaded the development and passing of four new seismic bills in the State Legislature. The laws allow schools and communities to become better prepared for future earthquakes by providing long term, stable state funding to help the highest-risk schools and emergency facilities to conduct seismic rehabilitation.

The hazard maps and damage and loss estimates developed in this study can serve as a starting point for identifying problem areas that should be further evaluated through general highlight of areas of higher and lower concern. DOGAMI produced several products as part of this project, including: GIS layers (maps) for each community depicting earthquake related hazard areas, and damage/loss estimates for each community for both a crustal fault earthquake, and a Cascadia subduction zone earthquake.

2005 - Seismic Needs Assessment and Rehabilitation of Oregon University System Buildings[29]

The Oregon University System and Oregon Department of Geology and Mineral Industries completed an assessment of all university buildings for seismic vulnerability using the FEMA 154 RVS method in 2005. The assessment activity was coordinated with a comprehensive deferred maintenance and energy survey that the Oregon University System was conducting. The assessment information will be incorporated into the deferred maintenance construction scheduling. The agencies also used awards from the FEMA Pre-Disaster Mitigation (PDM) Grant Program to sponsor a series of demonstration projects to incorporate seismic upgrades of selected buildings scheduled for deferred maintenance.

2001 *Local Success* - Benton County and the City of Corvallis

Benton County seismically surveyed schools in Corvallis and other school districts. The surveys were funded locally or federally through the National Earthquake Technical Assistance Program. The surveys will be used as the basis for prioritizing structural and non-structural retrofits, and potential construction of replacement buildings.

The City of Corvallis has adopted a local grading and excavation ordinance based on Chapter 33 of the *Uniform Building Code* (UBC). Section 3309.7 of the UBC states, "the building official may require a geotechnical investigation in accordance with Sections 1804.2 and 1804.5 (of the UBC) when, during the course of an investigation the report shall address the potential for liquefaction when all of the following conditions are discovered: 1. shallow ground water, 50 feet (15,240mm) or less. 2. unconsolidated sandy alluvium. 3. seismic zones 3 and 4." Corvallis has adopted this local standard to make it clear that they will require a geotechnical study of soil conditions where liquefaction soils may exist.

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[29] Wang, Yumei, 2010, "Oregon's Seismic Rehabilitation Grant Program: aka Courtney Grants," 9th US National and 10th Canadian conference on earthquake engineering: reaching beyond borders, Jul 2010, Toronto, CN.

On behalf of Benton County, DOGAMI produced *Earthquake Hazard and Risk Assessment and Water- Induced Landslide Hazard in Benton County, Oregon*, released as DOGAMI Open File Report O-01-05 in 2001.

2001 *Local Success* - City of Tillamook

Two structural and non-structural retrofit projects in Tillamook County received Western States Seismic Policy Council Awards in Excellence. Tillamook County taxpayers voted to approve the seismic upgrade of their only hospital. The hospital was retrofitted to seismic zone 4 standards exceeding the existing standards for that area and was the first hospital of its kind in the world to install fluid viscous dampers.

The Tillamook Early Childhood Education Center, which houses the Tillamook Bay Childcare Center and Head Start Program, was non-structurally retrofitted. The project was a joint effort by SAFECO Insurance, DOGAMI, Fred Meyer, Peake Sun Systems, and the Education Center.

DOGAMI produced *Preliminarily Seismic Hazard and Risk Assessments in Tillamook County, Oregon.* It has been released as DOGAMI Open File Report O-01-06 in December 2001.

2000 - Earthquake Hazard Maps[30]

The amount of damage sustained by a building during a strong earthquake depends on the size, type, and location of the earthquake, the characteristics of the soils at the site (ground response), and the characteristics of the building itself. Ground response can be further divided into three categories: liquefaction, amplification, and landsliding. The values from these specific hazards are combined to produce relative earthquake hazard maps, which do not depict the absolute earthquake hazard at any particular site.

From 1999 to 2000, DOGAMI produced relative earthquake hazard maps for most of the communities in Western Oregon which have a population over 5,000, and a bedrock shaking map for the entire state. In major population centers such as Portland, Salem, and Eugene/Springfield, subsurface sampling was conducted to measure soil and rock properties. In smaller communities such as coastal cities, existing data was used as well as surface observations.

In general, the maps show areas expected to be at higher risk, relative to other areas, during a damaging earthquake. Hence, these maps can be used by planners, lenders, insurers, and emergency responders for land-use decisions, hazard mitigation, and response planning. Planning the response to earthquake disasters and strengthening homes, buildings, and lifelines for power, water, communication and transportation can greatly reduce the impact of an earthquake.

For example, the Salem east and west quadrangle publication includes text and the following maps:

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[30]Oregon Department of Geology and Mineral Industries. (2011) Retrieved from DOGAMI website: http://www.oregongeology.org/sub/pub&data/EQPBLST5.HTM

- Liquefaction susceptibility map
- Amplification susceptibility map
- Landslide susceptibility map
- Relative earthquake hazard map

The maps show categories of relative susceptibility to earthquake-induced liquefaction, amplification of peak ground acceleration, landslides, and general earthquake hazard zones, respectively. Areas within the highest susceptibility zone have the greatest hazard and are likely to suffer the most intense damage related to ground response; those in the lowest hazard zone are likely to suffer the least.

Three earthquake hazards related to site geology (liquefaction, amplification, and landsliding) were evaluated individually. They were combined to develop the Relative Earthquake Hazard Map, which allows both technical and nontechnical users to gain an understanding of earthquake hazards and take steps to reduce the risk to life and property through planning policy, and other hazard mitigation measures. The map set was developed to serve as a regional planning tool and does not have site-specific accuracy. All areas shown on the map are susceptible to strong earthquake shaking due to the regional earthquake setting.

1997 *Local Success* - School Seismic Mitigation Following the Scotts Mills Earthquake

The Scotts Mills Earthquake of March 25, 1993, a shallow crustal event, caused the most damage within a radius of about 25 miles of the epicenter, primarily in the communities of Molalla, Woodburn, Newberg and McMinnville. More than 30 public buildings, including 16 schools, sustained damage.

It was apparent from these statistics that many school buildings are susceptible to earthquake damage, some of which can be life-threatening to students and teachers. Many school buildings in the Presidentially declared disaster area from this event were older buildings constructed prior to recognizing the significant earthquake hazard in Western Oregon. Structural seismic mitigation, providing sufficient strength so a building does not collapse and kill the occupants during (and immediately following) an earthquake, was not included in the original building design and construction, but can be implemented as a retrofit project. Non-structural seismic mitigation essentially reduces the falling hazards associated with building contents such as bookcases, lights and ceiling materials. Both structural and non-structural mitigation project opportunities became apparent during the damage assessment phase of the disaster recovery.

The Hazard Mitigation Grant Program (HMGP) funding for this disaster required a local cost-share of 50% as a match to the federal funding. With a great number of school buildings impacted by the disaster, it was agreed by FEMA and the state to identify projects that would provide mitigation benefits to school facilities. In October 1997, OEM and FEMA convened a special Hazard Mitigation Grant Workshop to develop seismic mitigation projects that would benefit school districts in the areas affected by the 1993 Scotts Mills event.

The outcome of the workshop was mixed. There was great interest in identifying, developing, and implementing mitigation measures, but the required 50% local cost-share was an impediment as many school districts did not have the required matching funds. One exception was the McMinnville School District that recently passed a bond measure to remodel and seismically upgrade a number of their school buildings. With the local bond-funding available and the remodeling soon to be underway, it was a fortuitous opportunity for McMinnville to apply for mitigation project funding under the HMGP. In fact, McMinnville qualified for the bulk of the HMGP project funding available. Other districts benefited from HMGP project funding also, but not to the extent of McMinnville.

The McMinnville School District had already identified specific school retrofit projects as part of the voter approved bond measure. The school district developed an overall plan to improve the seismic performance of various school buildings in the district. They addressed the most serious concerns on a priority basis in close collaboration with the district's consulting engineering firm, OEM, and FEMA. Specific projects that provided the most cost-effective mitigation were selected. For example, with many schools converting their heating systems from oil to natural gas, seismically-unsafe masonry chimneys were no longer required. Many of these tall chimneys have the potential to fall into classrooms below during an earthquake event. A very cost-effective mitigation measure to protect lives simply involved removal of the masonry chimney and replacement with a light-weight venting system. This type of mitigation measure was identified and selected by other school districts also. The following is a summary of school seismic mitigation following the Scotts Mills Earthquake:

- Replace and reinforce ceiling tiles and grid-work
- Upgrade roof diaphragm to wall connections
- Replace unreinforced masonry canopy with steel posts and canopy
- Demolish unreinforced masonry chimney and replace with light weight metal flue
- Reinforce cracked gymnasium concrete walls with epoxy injection
- Upgrade and reinforce roof diaphragm with plywood overlay during scheduled roof replacement
- Reinforce and tie-back brick parapets
- Strengthen roof structure (with beams and columns) of stadium
- Upgrade and reinforce concrete masonry walls to improve shear strength
- Laterally brace and tie overhead heating/cooling units
- Create interior shear walls by attaching plywood sheets

1997 - Statewide Bridge Retrofit Program

State and local agencies, led by ODOT, are taking proactive measures to increase the Oregon transportation system's resistance to earthquakes. The goal of this program is to determine the retrofit needs of Oregon's entire bridge inventory and to assist in the allocation of limited funds available for seismic retrofits. ODOT was the first to complete a year-long prioritization study for seismic retrofit of state owned bridges in 1993. The City of Portland completed a similar study of their city owned bridges in 1994. Other local agencies in Oregon followed suit with a comprehensive seismic

study covering all county and city owned bridges in Oregon in 1995. The results were combined into one statewide bridge seismic prioritization database in 1997. The database identifies vulnerabilities of each bridge, the bridge's importance in the overall transportation system, and estimated retrofit costs.

Figure 11: Seismic retrofit of Marquam Bridge in Portland using restrain cables. (Photo courtesy of ODOT)

A Cascadia Subduction Zone earthquake could affect approximately 70% of Oregon's 6,500 bridges. While ODOT's designs have always met the basic American Association of State Highway and Transportation Officials (AASHTO) criteria, bridge designs prior to 1958 did not account for seismic loading because the impact was not yet fully understood. Although some consideration was given to seismic loading between 1958 and 1989, it was not until the Loma Prieta earthquake in the San Francisco Bay area in 1989 that more sophisticated planning for seismic forces became a part of mainstream bridge design in Oregon. About 2,600 bridges are state owned. Many of the bridges are multi-span pre-cast/pre-stressed concrete beam bridges and cast-in-place tensioned bridges. Two types of seismic-related failures have been identified for these types of structures.

One type of failure occurs when the motion of the earthquake causes the bridge's superstructure (bridge deck, beams, and girders) to separate from the substructure (columns and foundation). When this happens, this portion of the travel route immediately becomes unusable and inhibits emergency access. This type of damage can take several months to rebuild. If on a critical freight route, the loss to Oregon businesses would be many times the cost of the repair. Typical seismic retrofit details to prevent this type of failure include longitudinal cable restraints and the addition of concrete or steel shear lugs for transverse force restraint. This type of seismic retrofit is called a "Phase 1" seismic retrofit.

The second type of failure occurs when the motion from the earthquake causes the bridge's substructure (especially the columns but also the foundation) to collapse from the seismic force. Substructure seismic retrofit is called "Phase 2" seismic retrofit and, for certain bridges, can exceed the replacement cost of the structure.

This type of work involves footing strengthening and column jacketing to increase ductility.

Seismic retrofit can greatly increase the resistance of bridges to earthquake damage, but no amount of retrofit investment can assure absolutely no damage from a subduction zone earthquake. The degree of seismic resistance is a trade-off of risk reduction versus cost. ODOT's strategy is to do Phase 1 retrofit before Phase 2 in order to quickly reduce risk to as many bridges as possible. An example of a successful seismic retrofit project is the Marquam Bridge in Portland over the Willamette River.

ODOT has 1,155 state owned bridges (46 percent of ODOT's inventory) that require seismic retrofit, at a total cost of $517.2 million. If the Phase 1 and Phase 2 seismic retrofit were to be spread over a 20 year period, the approximate cost would be $26 million per year.

1997 - Identification of Seismic Lifeline Routes

To help prioritize which bridges to retrofit first, ODOT worked with local governments to designate seismic lifeline routes beginning in 1997. Local emergency program managers were asked to designate routes for their jurisdictions. ODOT established preliminary lifeline routes for areas of the state that did not respond to this request. The information initially was used as a tool to help assess the seismic retrofit needs of the state and local agency bridge inventories.

- Priority I are routes essential for emergency response during the first 72 hours after an event.
- Priority II are routes desirable for emergency response during the first 72 hours after an event or routes essential for economic recovery.
- Priority III are other emergency response routes or routes which serve relatively few people but are still important because they are the only access.

The routes were selected only considering a seismic event. The routes were selected because they are considered the most likely to be available after a seismic event. Generally, freeways were not selected as Priority I routes because they have more potential obstacles and are therefore more likely not to be available after a seismic event.

The lifeline data gathering is one of the first of its kind on a statewide basis in Oregon. Although the data may require refinement, it is a sound starting point for continued dialogue and coordination of mitigation efforts among various agencies across the state, be it for emergency, economic, or other reasons. Maps showing seismic lifeline routes by county are available from ODOT.

1996 - Seismic rehabilitation demonstration project

Built in 1966, Ondine Hall provides student housing as well as other student services, such as classrooms, a theatre, and a laboratory. In 1996, this building was evaluated by structural engineers using the FEMA "178" methodology. The assessment in 1996 detected many serious structural seismic deficiencies which posed a serious life-

safety threat to hundreds of students. A FEMA PDM Grant of $2.3 million was allocated to conduct a partial seismic upgrade to Ondine Hall. The FEMA grant provided 75% of the mitigation cost; the remaining 25% was funded by the Oregon University System and PSU. The rehabilitation design mitigated the inadequate shear wall thickness, the inadequate bracing on the first and second floors (which are considered to be soft stories), and the lack of vertical continuity in the rebar located in the concrete columns. These upgrades are intended to improve the building to a life-safety performance level.

Figure 12: New structural cross-bracing and a wall of steel plates, burnished for aesthetic reasons, are permanently visible in Ondine Hall cafeteria.

1993 *Local Success* - Seismic Mitigation in Klamath Falls following 1993 Earthquakes

Klamath Falls is situated in an earthquake prone area between the High Cascades volcanic regime and the Basin and Range system of faulting. Klamath Falls has experienced minor earthquakes since the 1950s. On September 20, 1993, earthquakes hit 16 to 20 miles west-northwest of Klamath Falls. At 8:15 pm, a foreshock earthquake (a smaller earthquake preceding larger events) of magnitude 3.9 struck. Two main shocks registered at magnitudes of 5.9 and 6.0. The earthquakes were felt over a 200-mile radius and caused extensive damage in Klamath Falls resulting in the deaths of two people. Public facilities sustained damages of over $1.6 million, while 940 residences suffered at least minor damages involving cracked walls, broken windows, collapsed chimneys, and damaged plumbing. Businesses reported damages exceeding $2 million, while other non-residential structures estimated damages around $260,000.

Klamath Falls has had a dangerous building ordinance since 1976. The city, since the 1993 earthquakes, is working to amend the ordinance to better reflect seismic hazards. Two miles north of Klamath Falls, the Oregon Institute of Technology (OIT) experienced non-structural damage, including toppled bookcases and filing cabinets, and collapsed storage shelves. Most of the structural damage was limited to buildings with brick walls. Oregon Institute of Technology sought funding to help pay for retrofitting. Mitigation measures were put into place including: anchoring

bookshelves, changing building practices to reflect the seismic hazard, and no longer building with brick. Mitigation projects in Klamath Falls have included a new Government Center and Courthouse, and the Baldwin Hotel seismic retrofit.

1993 *Local Success* - City of Portland

In 1993, revisions to the State Building Code and the seismic rezoning in Oregon resulted in Portland identifying many of its buildings as potentially dangerous under its local dangerous building code ordinance. To minimize the impact on the community, the city did not require these buildings to be immediately retrofitted. The city instead focused on owners who were requesting permits to structurally alter or change the occupancy of existing buildings. The city concentrated on improving unreinforced masonry buildings (URMs), whose original design for resistance to seismic load makes them more susceptible to seismic damage than other buildings. The city allowed a phase-in period for retrofit requirements providing building owners with time to fund projects. Incentives including tax credits were also provided to help offset retrofit costs. This is an ongoing program.

The city also formed a seismic task force comprised of building owners, financial institutions, engineers, and architects to analyze the city's seismic risks. Portland first obtained an inventory of buildings within the Portland Metro area. They formed a partnership with Portland State University (at a cost of $12 per building) to conduct inspections of buildings to identify those at risk from seismic hazards. Portland also funded a study concerning the level of risk the city faces and the potential cost of rehabilitating the buildings in their community.

The report from this study outlines the following topics:

- A review of Portland's earthquake hazards from known faults or fault zones;
- An assessment of the life safety risks associated with some classes of buildings when subjected to the range of future earthquakes that can affect Portland;
- An analysis of the benefits associated with life safety seismic retrofits of vulnerable existing buildings compared to the typical costs of such retrofits; and
- Conclusions regarding the types, locations and uses of buildings that would be good candidates for seismic retrofit.

From this, Chapter 24.85 from Title 24 of Portland's *City Code* was formulated. Chapter 24.85 addresses seismic-specific upgrades to existing buildings, design standards, building additions and alterations, and the phasing of improvements. It applies to building permits seeking to change the occupancy, add square footage, or otherwise alter buildings. There must be a seismic evaluation performed if structural work is planned for any building built prior to 1974.

In 2000, the Portland Water Bureau completed a vulnerability analysis of its facilities and found many of them need to be strengthened to address seismic issues. The Bureau has developed a retrofitting schedule that will be implemented over the next decade.

Fire – WUI

2011 - Develop a matrix of current SB 360, National Fire Plan, and other wildfire interface mitigation projects to improve collaboration and reduce duplicative efforts.

The need for this action item has been significantly diminished by the growth and evolution of the *Community Wildfire Protection Plan* (CWPP) process. A major component of each CWPP development includes the identification and prioritization of mitigation projects, accounting for the objectives, capacity, and current projects of Federal, State, and local wildfire protection entities. Oregon has CWPP's for 34 of the 36 counties. Plans for the two remaining counties are underway. Several counties have additional CWPP's for individual communities.[31]

2010 - Development of the Oregon Department of Forestry Wildfire Prevention Plan [32]

The objective of the 2010 Statewide Fire Prevention Plan is the prevention of fires by modifying undesirable behavior patterns of people. To meet this objective, ODF has analyzed statewide fire problems; determined where prevention efforts will be effective; and prioritized the efforts with respect to suppression costs, number of fires and acres burned.

The Wildfire Prevention Plan's main purpose is to protect 15.8 million acres (24,900 square miles) of private and public forestland from fire. The targeted area includes 3.5 million acres of 'wildland-urban interface', which are forest lands with residences and other structures within the reach of wildfire in that area. By creating and using environmentally sound and economically efficient strategies, the total cost to protect Oregon's timber and other forest resources will be minimized while also minimizing wildfire damage to protected resources.

2009 - Leverage grant funds to build initial attack capacity in high-risk interface areas.

Through federal grant funding programs, increased fire district tax rates, and other mechanisms, significant strides have been made in the improvement of small rural volunteer fire departments to successfully conduct initial attack activities on wildland fires. The increased capacity of rural volunteer fire departments allows them to effectively suppress fires before they burn out of control, threaten structures, and require many times more resources. To build initial attack capacity, fire departments needed interface firefighting apparatus, equipment, and training.[33] Grant funding for

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[31] Oregon Department of Forestry. (2011) *Oregon Community Wildfire Protection Plans Updated Status by County.* Retrieved from ODF website: http://www.oregon.gov/ODF/FIRE/CWPPOregonMap.pdf

[32] Available on the Oregon Department of Forestry Website: *www.oregon.gov/ODF/centraloregon/docs/2010_COD_Prevention_Plan.pdf*

[33] U.S. Fish and Wildlife Service. (2011) *Rural Fire Assistance*. Retrieve from USFWS website: http://www.fws.gov/fire/living_with_fire/rural_fire_assistance.shtml

such improvements came from Assistance to Firefighters grants, Rural Fire Assistance grants, State Fire Assistance grants, and Volunteer Fire Assistance grants. As of 2009, initial attack is successfully executed on over 97% of all wildland fires occurring within the state, indicating successful implementation of this action item, an achievement toward NHMP goals #1 and #2.

2009 - Update and improve wildland interface maps.

This 2004 Oregon NHMP short – term action item was successfully completed upon the deployment of a web-based *Wildfire Risk Explorer*[34] in 2009, by the Natural Resources Digital Library at Oregon State University. This was an achievement toward NHMP goals #5 and #6. This internet site allows agencies and the general public to learn and make informed decisions about known wildfire risk by providing a vast array of maps and information about the wildfire situation in Oregon. The *Wildfire Risk Explorer* provides the following:

- Provides access to all the GIS data used to develop Oregon's 2005 Statewide Communities-At Risk Assessment.
- Enables users to produce reports on known wildfire risk for specific areas of interest.
- Offers a place to organize, archive and access community wildfire protection plans in an existing digital repository (ScholarsArchive).

Figure 13: Oregon Department of Forestry calls in an air tanker retardant drop for quick and effective "initial attack" on an interface fire

2009 - Develop a plan to ensure and maintain initial attack capacity in high-risk wildland interface areas.

As of 2009, this 2004 Oregon NHMP long-term action item has been completed, an achievement toward NHMP goals #1 and #2. The Oregon Department of Forestry (ODF) has an ongoing process through which initial attack capacity is annually evaluated and adjusted as a part of its fiscal budgeting process. In recent legislative sessions, the Oregon Legislature has made special appropriations available to ODF for the purpose of obtaining aircraft and other specialized initial attack resources. In addition, collectively, local structural fire agencies have substantially increased their initial attack capacity. Currently, initial attack is successfully executed on over 97% of all wildland fires occurring within the

[34] Oregon State University Natural Resources Digital Library. (2011) *Wildfire Risk Explorer.* Available on OSU Libraries website: http://oregonexplorer.info/wildfire

state, indicating that resources are adequate to achieve rapid and effective initial attack.

2008 - Expansion of the Rangeland Fire Protection Association Movement

Rangeland fire protection associations (RFPA) are nonprofit, locally governed associations of landowners which have organized to provide fire protection to their rangeland in portions of eastern Oregon. These organizations are formed under the authority of the Board of Forestry and receive training and other assistance from the Department of Forestry. They typically are organized in portions of the state which have no form of private-land fire protection whatsoever. The first RFPA was formed in northern Malheur County in the 1960s. In 1988, three new RFPAs formed in Harney County. Since that time, and especially since 2000, the number of RFPAs has continued steadily. As of early 2008, eleven RFPAs were operational in seven counties and four more locales were moving toward formation of a RFPA.

2006 - Wildfire Awareness Week

Although still small compared to other wildfire awareness campaigns, Wildfire Awareness Week has successfully brought together the states of Oregon and Washington, plus a variety of agencies, to heighten public awareness of the wildfire threat and the mitigation actions they can take to reduce their personal risk. In 2006 Governor Ted Kulongoski declared the first full week of May as "Wildfire Awareness Week" in Oregon by issuing a proclamation.35 The National Weather Service was also a major participant and featured wildfire related messages in their products. In 2007, the Office of State Fire Marshal assembled and distributed a package of materials to local fire agencies. In 2008, the Keep Oregon Green Association organized the campaign and focused the message on the need to use fire-resistant plants in wildland-urban interface settings. The Governors of both states have annually issued Wildfire Awareness Week proclamations and, in 2008, a joint proclamation was promulgated.

Figure 14: A Douglas County firefighters takes the opportunity to educate youth in fire management and fire prevention during fire awareness week 2010 as part of the Douglas County Fire Prevention Cooperative. (Photo courtesy of Douglas Forest Protective Association)

2006 - Fire resistant plants for home landscape

Developed by OSU Extension Service in 2006, this full-color, 44-page booklet describes basic landscape measures that homeowners can take to better protect their property from wildfire. It illustrates a wide range of fire resistant plants that are suitable for use near structures and notes each plant's preference for sun, water needs, attractiveness to butterflies and birds, and whether or not it's deer-resistant.

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[35] Oregon.gov. (2009). Oregon State Police-Oregon Office of State Fire Marshal. *Wildfire Awareness Week 2009*. Retrieved from Oregon.gov website: http://www.oregon.gov/OSP/SFM/CommEd_WAW_2009.shtml

Although designed as a regional publication, it has received national attention, with requests for copies being received from California to Pennsylvania and from throughout the Great Basin. Additionally, the publication is being increasingly mentioned and cited as a reference source in nationally distributed articles and books.

At the national level, recognition for an early version of the publication came in the form of a national education Silver Award from the Association of Natural Resource Extension Professionals (ANREP).

Copies have been used to help conduct workshops and many have been handed out to homeowners in targeted high risk wildfire areas. Fire educators have indicted the publication is very useful because it is highly visual, complete, and because it describes a wide array of plants from which homeowners can choose.

The publication is being distributed throughout Oregon, Washington, and Idaho as a "Pacific Northwest Extension Publication." The initial printing of 80,000 copies was rapidly depleted. Of the 40,000 copies received by the Oregon Department of Forestry, all had been requested and distributed within six months. In addition to print copies, the publication has also been made available for internet downloading and web interest has been unusually high. By mid-2007, of the 40 OSU publications published in 2006, this booklet received the highest number of internet "hits:"[36]

2006- Firewise Communities

For a variety of reasons, the amount of natural vegetation fuels available to be burned by wildfires has increased at a dramatic rate over the past few decades, especially on federal lands. Fuels are now commonly found in quantities significantly in excess of the amounts which occurred naturally. These fuel accumulations have served to increase the intensity and severity of wildfires and increasingly threaten structures and whole communities. One example of doing the work necessary to reduce these fuels is the isolated Fall River Estates subdivision in Deschutes County. In combination with other mitigation practices, their fuel reduction efforts led the way to being designated as Oregon's first "Firewise Community."[37] Since then,

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[36] Oregon State University Publications and Media Catalog. Retrieved from OSU website: http://extension.oregonstate.edu/catalog/html/pnw/pnw590/pnw590.pdf

[37] Oregon Department of Forestry. (2010) Stu Otto, Redmond, receives national field forester award. Retrieved online at ODF website: http://www.oregon.gov/ODF/newsroom/newsreleases/2010/NR1009.shtml

developments in LaPine, Sunriver, Bend, Ashland, Sisters, Birkenfeld, and Philomath have joined.[38] Oregon's FireFree served as one catalyst for the national Firewise program.

2005 - Continue high priority on initial attack on fires as they start in high risk WUI zones.

This action was first completed in 2005, an achievement toward NHMP goals #1 and #2. This has become standard operating procedure for fire agencies in Oregon and at the time of this actions completion, the Oregon Department of Forestry (ODF) had incorporated the policy of an aggressive initial attack into its fiscal budgeting process and into its standard operating plans. In recent legislative sessions, the Oregon Legislature has made special appropriations available to ODF for the purpose of obtaining aircraft and other specialized initial attack resources to suppress new ignitions, so that fires are not given an opportunity to grow or to threaten structures. In addition, collectively, local structural fire agencies have substantially increased their initial attack capacity. In 2005, initial attack was successfully executed on over 97% of all wildland fires occurring within the state, indicating successful implementation of this action item.

2005 - Notification plan for air quality and health impacts from wildfire

This action item was successfully completed and incorporated into the *Oregon Smoke Management Plan,* an achievement toward NHMP goals #1 and #4. The State Forester and the Department of Environmental Quality approved the plan for the purpose of managing smoke in designated areas, and safeguarding public health while maintaining forest landowners' ability to burn in order to meet land management objectives. The plan includes reporting and notification recommendations for tracking emissions and alerting the public to potential health impacts due to smoke. The plan was developed by the State Forestry Department in cooperation with federal and state agencies, landowners and organizations that were affected by the plan. The most recent review of the Smoke Management Plan was conducted by a committee appointed by the State Forester. The final Smoke Management Review Committee Report with recommendations was submitted to the State Forester and the Board of Forestry on September 07, 2005.[39]

2004 – Development of Wildfire Risk Assessment Methodology

As of December, 2004, this Oregon NHMP action item has been successfully completed and incorporated into the *Community Wildfire Protection Plan* (CWPP) process, an achievement toward NHMP goal #5. A standard, statewide risk assessment was developed by an interagency Fire and Fuels Hazard Mitigation

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38 Firewise Communities. (2011) Firewise Communities/USA Recognized Sites. Retrieved online from Firewise website: http://www.firewise.org/

39 Oregon Department of Forestry, (2005) Oregon Smoke Management Plan, Retrieved from ODF website: http://www.oregon.gov/ODF/FIRE/SMP/SM_Review.shtml.

Subcommittee[40]. This common starting point made it easier for communities to initiate the CWPP process, and allows for statewide consistency. To evaluate the wildland-urban interface fire risks within various jurisdictions, the process and data sets enable a tiered approach that is appropriate at several scales including county, city or neighborhood level risk assessments. Figure 1 below illustrates Lane County's use of this risk assessment methodology.

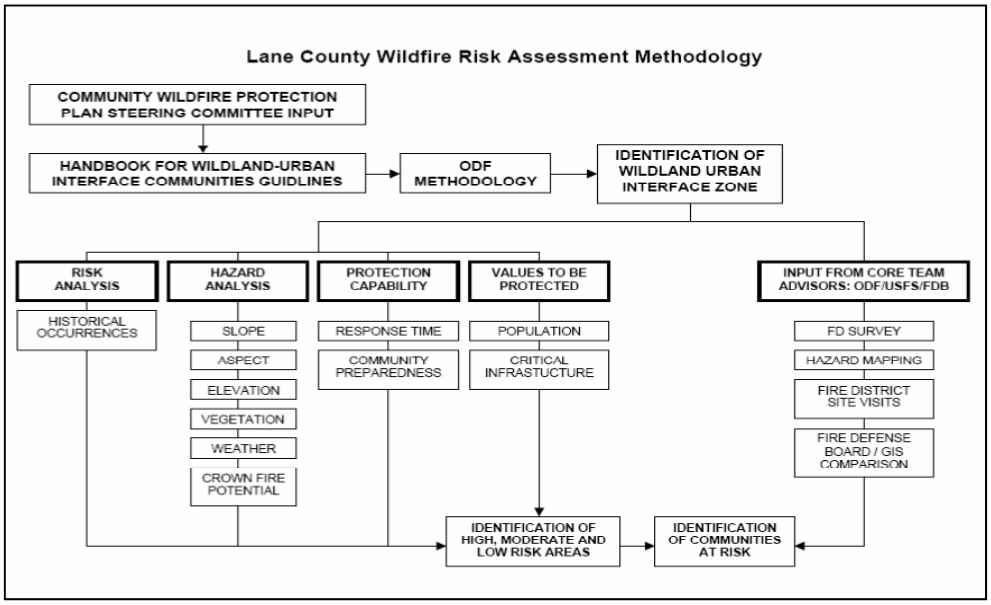

Figure 15 Wildfire Risk Assessment Methodology Source: Lane County Land Management Division, 2005

2003 - Development of Wildfire Severity Plans

ODF has developed severity plans for forest fires to ensure that adequate funding and resources are available during high fire danger periods. For example, during 2003, the Legislative Emergency Board authorized the department to implement a "severity plan" using State General Fund money reserved specifically for fire emergencies. A total of $1.2 million was spent during fire season as the ODF Fire Program leased an air tanker and a lead plane from Alaska, and contracted with Oregon aviation firms to place several helicopters on standby. The extra dollars also enabled the department's protection districts to secure additional hand crews and fire engines prior to predicted peak fire periods. Most of 2002 and into 2003 saw El Niño conditions as the result of a warm episode as measured by Equatorial sea-surface temperatures.

By assessing weather conditions, burning indices, fuel loads and other factors, ODF drew inferences for dozens of 2003 wildfires at which severity resources were deployed. In southwestern Oregon and elsewhere in the state, regular district personnel did most of the firefighting. The severity resources were brought into play

40 Oregon Department of Forestry. Report of the Forest Fuels and Hazard Mitigation Committee. Forest Fuels and Hazard Mitigation Committee. December 10, 2004. Insititute for Natural Resources. 210 Strad Ag Hall. Oregon State University.

Figure 16: The September 2003 Herman Creek Fire in the Columbia River Gorge, as viewed from across the Columbia River (image by O. T. Helgerson, WSU)

only when conditions had reached a threshold at which spending a little extra early-on could preclude significant timber loss and large suppression costs later.

2003 - Community Wildfire Protection Plans

The process of developing a CWPP assists a community in determining its priorities for protection of life, community values, and critical infrastructure. As an added benefit, the process has proven to be a catalyst for improved coordination and communication between residents and emergency response agencies.

Since the enactment of the Healthy Forest Restoration Act of 2003[41], all at – risk communities in Oregon were encouraged to complete a CWPP. The first step is to complete a risk assessment. A standard, statewide risk assessment methodology was developed by an interagency Fire & Fuels Hazard Mitigation Subcommittee, organized by the Department of Forestry and the Office of State Fire Marshall. This common starting point made it easier for communities to initiate the CWPP process and it allows for statewide consistency.

Some CWPPs in Oregon have been in place for more than five years. Such CWPPs have predominantly been developed for specific communities, such as the Applegate Valley and the upper Deschutes River Watershed. These two communities were among the first community-level plans developed in Oregon.

Josephine County worked hard to complete the first countywide plan. As their effort progressed, it became clear to planners, fire service agency representatives, and to others involved in the effort that multiple objectives could be successfully accomplished in a more cost and time efficient manner, by working on such a countywide basis, rather than by tying a number of community plans together.

2001 - FEMA's Assistance to Firefighter / Prevention and Safety Grants

Since 2001 Assistance to Firefighter grants, used to fund apparatus, equipment and training programs, have helped many Oregon fire departments increase their capacity to initial attack wildland interface fires and have enabled them to improve training and equipment standards needed for firefighting response under the *Conflagration Act*. The Office of State Fire Marshal has conducted grant-writing workshops (some in partnership with FEMA Region X) for local fire departments and has provided information and consultation on applying for grants. [42]

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[41] Healthy Forest Restoration Act of 2003(P.L. 108-148)

[42] National Defense Authorization Act for Fiscal Year 2001(P.L. 106-398)

2000 - National Fire Plan and Other Federally Funded Projects

Since funding of local fire planning, prevention and mitigation projects first became available in 2000 under the *National Fire Plan* (NFP). Oregon has aggressively sought funding for a wide variety of projects. NFP monies can be used to fund fuels reduction, education and prevention, community planning and alternative uses of fuels. These monies have been used primarily to fund fuels reduction on individual properties, and to establish community fuel breaks in the most wildfire prone portions of the state. NFP funds have also been used to help spread the FireFree program outside of central Oregon, to educate local officials about the wildland interface situation and how they can help, to implement Senate Bill 360, to improve public awareness about the wildfire problem and to better identify areas at risk. The NFP has also funded a wide variety of projects through a number of nonprofit organizations and local governments.

1993 - Wildfire Hazard Zones

The process to identify and declare the presence of wildfire hazard zones (WHZ) resulted from legislative action in 1993, spurred on by the 1990 Awbrey Hall Fire in central Oregon. The primary focus of the WHZ process is to address the problem of widespread use of flammable roofing materials in fire prone areas through instruments of conveyance. For some communities, complying with local covenants means that flammable roofing materials must be used. WHZ can supersede such requirements.

Figure 17: The skyline of Bend's west side, as seen on Augst 4th, 1990 as the Awbrey Hall Fire threatened the city. (Photo courtesy of KTVZ.com)

The WHZ process allows any local jurisdiction with building code or life safety ordinance authority to identify the presence of a WHZ, using a required set of criteria. Once declared, provisions of Oregon's building code become applicable. These provisions prohibit the use of flammable roofing materials on new construction and require the use of fire-safe materials when roofing is replaced. Other provisions are also activated, for example the requirement to clearly identify the address of a structure.

1975 - Fire Prevention Cooperatives

Since the mid-1970s, fire prevention cooperatives have been highly successful at the creation and delivery of cost effective fire prevention programs that address specific local needs. Cooperatives increase the effectiveness of local fire prevention efforts by identifying common fire problems and then developing a joint approach. The cooperative concept recognizes that no one agency has the personnel, expertise or financial resources needed to develop, implement and deliver all of the fire awareness, education and public safety needs of a region of the state.

1972 - Rural Fire Assistance and Volunteer Fire Assistance Grants

Using federal Rural Fire Assistance and Volunteer Fire Assistance grant programs first established in the Rural Development Act of 1972, and administered by the Oregon Department of Forestry, approximately $1 million is annually distributed to local fire departments. These funds have been used primarily to improve firefighter skills and to purchase badly needed equipment. Because the funds are distributed on a priority basis, determined by need, most of the grants are received by small fire departments, many of which are located in or adjacent to interface areas. [43]

[43] Rural Development Act of 1972 (P.L. 92-419).

Flood

The people of Oregon have a long history of respecting natural hazards and using community-based planning to minimize flooding impacts. Oregon has one of oldest and most comprehensive statewide land use planning programs in the nation. Oregon's state and local floodplain management programs are rooted in the statewide land use planning program and have been quite successful over the years at minimizing loss of life and damage to property from flooding. Part of the key to success is that all counties and cities with flood hazard areas regulate their floodplains and participate in the National Flood Insurance Program. Both the state and the federal government have benefited greatly[44] from the work done by Oregon's local governments to prepare comprehensive land use plans, implement floodplain development codes, and comply with the NFIP.

Oregon's floodplain management program has enjoyed much success over the years. The results of the state program have included greater public awareness of flood risks, enhanced understanding among local officials and the public of the benefits of the NFIP, continued implementation of local floodplain development ordinances that meet – and in many cases exceed – NFIP requirements, and ongoing technical assistance for local governments and others regarding flood hazards. Oregon residents have also benefited from increased coordination between emergency managers and floodplain program managers, and better communication among state-level hazard mitigation agencies. Oregon's floodplain management program continues to be steadfast, but also looks to be innovative and proactive wherever possible in its efforts.

2009 *Local Success* - City of Rufus Catchment Basins

The City of Rufus is located along the Columbia River at the bottom of Gerking Canyon, which drains a watershed largely comprised of dryland wheat fields. Heavy rainfall associated with summer thunderstorms or rapid snow melt coincident with an extended rain event causes significant runoff that carries water and rocky debris through town impacting roads, bridges, housing, and the community well system. The HMGP funded multi-objective catchment basin project was designed to control runoff before it reaches town by detaining the precipitation in small catchment basins in the dryland wheat fields above town. As of 2009, not only were peak runoff flows reduced, but also soil erosion in the fields is controlled and the detained water is given a chance to percolate into the ground to improve soil moisture. This project included partnerships with the NRCS and the Sherman County SWCD, leveraging FEMA's HMGP project funding.

2007 *Local Success* - Northport Plaza: Above the Flood

[44] In 1996 FEMA indicated that, as a result of Oregon's excellent statewide land use planning program, an average of

$10 million in flood losses are avoided annually. Also, as a result of the statewide land use planning program, Oregon's cities and counties had the highest participation rate in the NFIP in the nation.

Tillamook, OR – The completion of a building elevation project came none too soon for the tenants of Northport Plaza along U.S. Highway101 north of the city center of Tillamook, Oregon. The most recent flooding of the area occurred just six weeks after the Plaza's two buildings had been raised by about 3 feet, which was enough to put the floors about 1 foot above the highest level reached by the floodwaters in early December 2007.

Figure 18: Businesses, such as the one shown above, were encouraged to locate in areas that suffered damage due to flooding in 1996. Elevation projects has allowed them to avoid further flood damage.

The city encouraged businesses to move to the 2-mile stretch of U.S.101 when they annexed it 25 years ago. Many of the business owners who accepted the invitation have done well along this busy stretch of coastal highway. But the almost annual flooding of the area by the Wilson River and its associated sloughs, particularly the major, damaging flood of 1996, has caused city officials to re-think that initial predevelopment stance. Businesses are now being encouraged to leave the flood zones and move to higher ground.

After the 1996 flood, Tillamook County became proactive in mitigating flood damages, according to Bill Campbell, director of the county's Department of Community Development. The county began to work with property owners in the flood-prone areas to secure funding available through FEMA's Hazard Mitigation Grant Program (HMGP).

Funding to assist communities plan and implement measures to reduce flood losses is also available through FEMA's Flood Mitigation Assistance (FMA) Program. Part of the funds used to elevate the Northport Plaza and to acquire two commercial properties along U.S.101 were provided by the FMA Program.[45]

2006 *Local Success* - Rogue River Restoration

A consortium of landowners, sport and conservation groups, and local, state, and federal agencies joined together in June 2000, to form the Rogue River Stakeholders Group with the objective of restoring a section of the Rogue River that had been impacted by pre-Mined Land Restoration Act gravel quarrying. A three-phase restoration plan was formulated by 2001, and completed by 2006.[46] The restoration plan's purpose is to avoid future impacts and mitigate current impacts to fisheries and water quality that have resulted from the channel capture of an ODOT gravel pond (12 feet deep) during the 1997 New Year's Day Storm and ensuing flooding on the Rogue River.

The idea is to restore conditions to guide future channel adjustments within the historic channel migration zone. The most significant aspect of this project is protection of the Rogue River and side channels from being de-watered by river avulsion into 60-foot deep gravel ponds threatening the stability of the river upstream and local near-river landowners and agriculture.

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[45] FEMA Best Practices Portfolio. http://www.fema.gov/mitigationbp/brief.do?mitssId=5186.

[46] Rogue River Stakeholder Group. *Phase 3 Project Completion Report*. OWEB Project No. 204-098. February 2007

The restoration plan allows the system to adjust away from high-risk features. Streambank erosion is a natural process and all floodplain activities should allow adequate space for future channel adjustments. However, channel avulsion into man-made features, such as gravel pits, is an unnatural erosion process. These legacy mine sites will not safely accommodate future channel migration. The restoration plan is not a plan to return the channel to its pre-1997 course, nor is it a plan to channelize or fix the location of the current channel. This is a plan concordant with the geomorphic trends and natural tendencies of the Rogue River. This plan will counteract the threat of imminent and artificial channel avulsion. Funding for the project was acquired from a variety of federal and state sources.

2005 - Review and update state building codes to accurately reflect requirements of the NFIP

This action item from the 2004 Oregon NHMP was completed in 2005, an accomplishment towards NHMP goal #1, 2, 3, and 4. The 2005 Oregon Residential Specialty Code was reviewed and updated to provide up-to-date structural code addressing building design and construction. The purpose was to safeguard the public health and safety in all communities by meeting NFIP requirements.[47]

2005 - Building codes/NFIP Crosswalk

This action was completed during 2005, an accomplishment towards NHMP goal # 2. DLCD completed this project to identify and compare requirements for local government regulation of floodplain development found in the NFIP regulations and Oregon state building codes. The project analyzed how the NFIP regulations and state building codes compare for floodplain development and developed a "crosswalk" document illustrating in detail the relationship between these federal and state standards. The project resulted in changes to the 2008 Oregon Residential Specialty Code.

2004 *Local Success* - Motel Open for Business after Elevation[48]

Tillamook is an outdoor lover's paradise. The native American Indian word Tillamook means "land of many waters", a perfect description for a community surrounded by Tillamook Bay on the Pacific Ocean and five rivers, the Wilson, Tillamook, Kilchis, Miami and Trask. Throughout the year, the area's natural beauty attracts locals and tourists to hike, fish, camp, and explore the beach.

This spectacular "land of many waters" is prone to frequent flooding. Local residents like Debi Smith, general manager of the Western Royal Inn, take flood warnings in stride. She's lived in this small Oregon coastal community most of her life and winter

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[47] Oregon Department of Land Conservation and Development. (2007). Recommnedations for Improvements to the Adminstration of the NFIP and Flood Related State Building Codes. Retrieved from Oregon.gov. website: http://www.oregon.gov/LCD/HAZ/docs/general/building_codes-floodplain_task_force_report.pdf?ga=t

[48] Oregon Emergency Management. (2007) *Best Practices FEMA 1672-DR-OR. Motel Open for Business after Elevation.* Retrieved from OEM website: www.oregon.gov/OMD/OEM/.../best_practices_brochure_tillamook.pdf

storms commonly fill the rivers and flood warnings are routine. However, on November 6, 2006, the weather outside was anything but routine. A record setting rainfall of more than 20 inches had fallen in 48 hours. Access to the motel along Highway 101 was closed due to dangerously high water.

From the window in the motel office, Smith watched the flood waters rise four feet in two hours. Some travelers who failed to heed the warnings of highway flooding found themselves stranded in their vehicles. She rushed from her office to offer help as they swam toward the safe haven of the motel. She says her staff fed the flood victims, laundered their clothes and provided safe, dry and warm rooms until the waters receded more than three days later.

Figure 19: The Western Royal Inn in Tillamook was elevated in 2004, avoiding flood damage during the 2006 flood.

The Western Royal Inn has not always been a safe haven from raging flood waters. In 1996, another violent rain storm slammed into Tillamook and other nearby coastal communities. Three feet of flood waters swamped the first floor of the motel and destroyed 20 of the 40 rooms. The motel owner struggled to keep the business open.

In 2003, MKT Investments bought the motel and began the task of repairing it with the goal of making sure that when the next big flood arrived, Western Royal Inn would stay open for business. The first task was to raise the building almost four feet. The four foot elevation requirement was determined by FEMA flood maps and the local ordinance requiring the first floor be two feet above the 100-year base flood elevation. Contractors brought in many hydraulic jacks to raise the structure and pour cement support pilings. The building was then anchored to the concrete pilings.

After the motel was anchored, work began on renovating the damaged rooms and building a ramp to provide access for disabled guests. Contractors also installed a flood damage resistant skirting to conceal the concrete pilings. The elevation project took about six months, and was completed in 2004. Smith said the motel suffered

minor flood damage during the 2006 flood event – loss of some insulation and nine inches of mud in the parking lot. Elevating the motel meant they were back in business in just a few days. Flood mitigation worked.

2004 - Support federal legislation limiting payments for repetitive losses

This action was completed during 2004 when Congress passed the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act (FIRA), an accomplishment towards NHMP goal #2 and #3. The Act provides additional tools for addressing the impact of repetitive loss properties (RLP's) on the national flood insurance fund. Legislation limiting payment on RLP's was necessary because according to FEMA, RLP's account for 1% of the total policies nationwide. However, this 1% accounts for an annual average of 30% of amounts paid in claims. A five-year pilot program (through FY 2009) was established to (1) define 'severe repetitive loss,' (2) authorize additional funds for mitigation of these properties, and (3) mandate a 50% increase in premiums for these property owners should they decline a mitigation offer. Mitigation efforts included government assisted structure elevation, flood proofing, demolition, or relocation of structures having been substantially or repetitively damaged by flooding. By reducing the number of RLP's, actual flood insurance could be reduced, relieving the upward pressure to raise flood insurance rates, and helping to stabilize the long term financial condition of the NFIP. [49]

2000 *Local Success* - Residential Elevations along the Siletz River

For a very long time, floods along the Siletz River in Oregon have destroyed homes, and caused major disruption to peoples' lives. In response to the floods of 1996 and 1998, Oregon Emergency Management (OEM), the Federal Emergency Management Agency (FEMA), and Lincoln County started a program in 2000 to elevate homes in harm's way. The combination of two FEMA funding sources and money from the participating homeowners has significantly reduced the possibility of future flood damages to these homes.

Figure 20: An elevated residence along the Siletz River

Lincoln County experienced damaging floods in February 1996, December 1998, and November (Thanksgiving Day) 1999. Many of the homes located on the Siletz River were built before flood maps were developed and were built well below the base flood elevation.

Also, prior to the 1996 flood event, many homeowners did not have flood insurance. This was a major oversight by home-owners because flood insurance is the only sure

[49] Senate Report. 108-262, p. 2.

way to obtain enough money to repair your home and put your life back together. After the '96 and '98 events, many more homeowners purchased flood insurance and became eligible for additional funds to elevate homes if they were substantially damaged in the future.

On behalf of effected homeowners, Lincoln County applied for two separate FEMA Flood Mitigation Assistance Program grants for $143,370 and one post-disaster grant via FEMA's Hazard Mitigation Grant Program totaling $1,315,452 in order to elevate 51 homes. Depending on the situation, participating homeowners provided personal funds to match 25% of the grant funding value.

Via Increased Cost of Compliance, those homeowners who had a National Flood Insurance Program policy and were substantially damaged also received an additional $15,000 with their flood insurance payment, which could be used to offset their 25% share of the cost for elevating their homes.

2000 - Unified Sewerage Agency[50]

On May 12, 2000, the Unified Sewerage Agency (USA) of Washington County, Oregon, signed a Partnership Agreement with FEMA under the Cooperating Technical Communities (CTC) initiative (now the Cooperating Technical Partners [CTP] initiative). Under that Agreement, USA and FEMA agreed to work together to ensure flood-hazard information for the incorporated and unincorporated areas of Washington County served by USA is kept up to date and accurate.

The first mapping activity being undertaken by USA and FEMA is a revised study of the 166-square-mile Tualatin River. Under its agreement with FEMA, USA will perform detailed hydrologic and hydraulic analyses and prepare floodplain and floodway mapping for the Tualatin River and its tributaries.

According to USA, the project will result in the development of numerous products that will be of value to the community officials and residents of Washington County.

FEMA will use the digital topographic, hydrologic, and hydraulic data and mapping to produce a new Digital Flood Insurance Rate Map (DFIRM) for all of Washington County. This will mean up-to-date flood hazard information for residents in the Cities of Beaverton, Cornelius, Forest Grove, Hillsboro, King City, Lake Oswego, North Plains, Portland, Rivergrove, Tigard, Tualatin, and Wilson; the Towns of Gaston and Sherwood; and the unincorporated areas of Washington County will be shown on one FEMA flood map.

1999 *Local Success* - Tillamook County Cow Pads[51]

The February 1996 floods resulted in the death of 700 dairy animals on the farms in the Tillamook floodplain. Almost every farm lost cows. The flooding on the Nehalem River also had a very significant impact on the Sunset drainage district and all its members, resulting in widespread devastation, as well as damage to the levee

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[50] FEMA Best Practice Portfolio. http://www.fema.gov/mitigationbp/brief.do?mitssId=1365.

[51] FEMA Best Management Portfolio. http://www.fema.gov/mitigationbp/brief.do?mitssId=78.

system. The district encompasses nearly 1,000 acres, most of which is agricultural land supporting six dairy farms. In Nehalem, the Marti Dairy farm lost their whole herd and their house too.

The total economic loss in this area was estimated to be $5 million in both livestock and milk production. There are approximately 18 dairies in Tillamook County that need elevated refuge areas for livestock because their locations are in areas susceptible to severe flooding.

The creation of cow pads is an innovative solution to saving livestock during flooding. In the February 1996 flood, farmers couldn't get their cows to higher ground. This FEMA Hazard Mitigation Grant project provided funds to bring higher ground to the cattle. Tillamook County determined that the amount of fill for the cow pads was permissible on the 100-year floodplain, and completed construction in 1999.

With appropriate permits in place, FEMA mitigation funds were used to construct four cow pads on three farms. These large mounds of dirt will serve as a safe holding area during flooding. The pads are built to an elevation of approximately 4 feet above the 100-year base flood elevation and will be large enough to accommodate the entire herd. The Chelone Dairy Farm will have a massive cow pad that covers almost an acre to hold 600 cows. The pads will be built in close proximity to existing barn structures, which are subjected to flooding, and will be the location and foundation for new milking barns.

At the same time, this project solves another problem for the Oregon Department of Transportation (ODOT): what to do with the excess soil and rock debris from landslides on roads and highways in the area. The project got a jump start, when Oregon Department of Transportation volunteered to supply rock and soil from nearby landslides free of charge. Over 200,000 cubic yards of dirt from the massive Fishery Point slide on Highway 101 south of Nehalem has been used to construct the cow pads. According to the Tillamook County Community Department, ODOT was pleased to have a useful disposal site for excess dirt.

Community meetings were held with residents to identify properties that would benefit from being elevated by determining flood zone and repetitive flooding history and projection. In addition, the County worked on a continual basis with Oregon Emergency Management.

This project is expected to save over $5 million in losses. Farmers will no longer fear flooding, and will no longer lose cows and have to replace their stock. The cow pads will provide a safe haven for the herds.

Standard Homeowner's insurance policies do not cover flood damage. The National Flood Insurance Program makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities.

1999 - Advanced Measures to Reduce Flood Damage

The U.S. Army Corps of Engineers used data from real-time monitoring and forecasts, as well as the records of impacts caused by historical events to prepare and implement advance measures to reduce flood losses prior to 1999 La Niña flooding in

Tillamook County. Projects included several new tide gates and floodway improvements. Bolstered by a long-range seasonal forecast from the National Weather Service that anticipated an "elevated risk" of heavy precipitation in Tillamook due to wintertime La Niña conditions (Keeton 1999), county emergency management staff, local elected officials, the Governor, and the Oregon congressional delegation persuaded the Corps of Engineers to fund and construct several emergency measures to mitigate the effects of possible flooding. Officials credit these measures, which were completed two days before a major flood hit the Tillamook area in November 1999, with reducing flood damages substantially.

1999 *Local Success* - Vernonia Acquisition and Elevations: Moving Properties out of the Floodway[52]

Following an extended period of unseasonably cold weather and heavy snowfall in the Pacific Northwest, warming temperatures and rain began thawing the snowpack and frozen rivers throughout Oregon. Streams rose quickly and reached flood stage in many locations. At least 25 Oregon rivers reached flood stage. Mudslides, avalanches in the mountain passes, and road washouts also occurred in many parts of the State. Extensive earth movement was experienced in many areas, including landslides, stream bank erosion, and significant amounts of sediment transport.

Initial assessments reported an estimated $280 million of damage, of which one-third was to private property, and the remainder was to public property. On February 8, 1996, Governor Kitzhaber declared a State of Emergency for 18 counties within Oregon. By February 9, 1996, a Federal disaster was declared for a total of 27 counties.

In Vernonia, the City was aware that a significant number of the structures proposed to be elevated as part of the hazard mitigation project were within the floodway. The City's flood hazard ordinance identifies specific requirements for structures within the floodway. The objective of the acquisition and elevation project was to bring all substantially damaged residences into compliance with the FEMA flood insurance requirements. The best alternative taken was to rapidly implement the program to prevent property damage from recurring within Vernonia's floodways and floodplains at the lowest possible cost and within the quickest timeframe.

The City first worked from a prioritized list of properties to acquire located within the floodway and to elevate houses two feet above floodplain level. In order to inform citizens of the hazard mitigation process, a project manager was hired to gather input and hold a number of public meetings. In addition to these meetings, an Unmet Needs committee formed to address and focus specifically on mitigation. Presentations were given identifying the planning process, floodway/floodplain definitions, and criteria for home elevations. Citizens were given the opportunity to ask questions and provide input on flood prevention measures. The City sent letters to property owners with a return form to confirm interest in the mitigation project.

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[52] FEMA Best Management Portfolio. http://www.fema.gov/mitigationbp/brief.do?mitssId=167.

The majority of residents whose homes were substantially damaged could not afford to elevate their homes. In early 1996, Vernonia was less than two percentage points away from a citywide low-to-moderate income rating. To address the financial needs of this community, the City met with the Oregon Emergency Services, FEMA and Oregon Economic Development.

All of the structures proposed for acquisition are located within the floodway along the Nehalem River. Floodways serve as a natural drainage area as rivers fill to their maximum capacity. Moving the structures out of the floodway would allow water to move freely along its natural course. This in turn will decrease water velocity which would lessen erosion damage. Property acquisition and movement projects concluded in 1999.

1998 *Local Success* - City of Prineville Mobile Home Park Acquisition

Crook County experienced a wetter than normal May 1998 followed by a 24-hour period of intense rain late in the month that caused many small streams and rivers to run at capacity or spill over their banks. Ochoco Creek flooded causing significant damage in the City of Prineville and adjacent unincorporated areas. Residential housing was particularly hard-hit by this event; in one mobile home park essentially all but two residences were deemed uninhabitable as a result of the flooding. The community determined that the acquisition of the mobile home park was a top priority, removing all structures from this low-lying area in the floodplain.

Multi-objective benefits were also gained including the continuation of a linear park fronting the creek, the creation of a pervious-surfaced parking lot for a nearby baseball field, and the opportunity for future mobile home tenants to be located outside the flood hazard area. Funding from HMGP and FEMA's Public Assistance Program, the OECDD, and local match dollars worked together to accomplish this project.

1997 *Local Success* - Mapleton Home Elevation Project

Three damaging flood events occurred in Mapleton, Oregon during 1996-1997. Beginning in late 1997, Oregon Emergency Management (OEM) coordinated the elevation of 23 homes above the 100-year base flood elevation in a project that brought together homeowners, county government, a local consulting engineer, several contractors, and a regional bank.

Topography of the community places essentially all develop-able land in the floodplain or floodway. Outside the flood-plain, the hillsides are too steep for development and are even of greater hazard as a result of recurring debris flows. The consulting engineer provided evaluations of cost-effective, specific construction techniques for each home, taking into account the past flooding in the community. With the help of the Lane County emergency services and planning departments, many homeowners are very grateful that they were able to participate in the Hazard Mitigation Grant Program to elevate their homes.

Subsequent floods in 1998 and 1999 were a test for the recently elevated homes, and none of the homes elevated through the HMGP sustained water damage. In 1998, the Siuslaw River at Mapleton was more than nine feet above flood stage.

People along Riverview Avenue, where the Siuslaw spilled over its banks, used shovels and squeegees to scrape mud from driveways, garages and doorsteps. Despite the dirty job, most residents expressed relief that the homes that had been raised escaped with essentially no damage.

1997 *Local Success* - Johnson Creek floodway acquisition

Seven major floods have occurred on Johnson Creek during the past 35 years. While only 6% of Portland's 100-year floodplain is associated with Johnson Creek, 78% of the City of Portland's repetitive loss claims come from there.

Figure 21: Flooded residence located in the Johnson Creek floodway

Floods during Feb. '96 on Johnson Creek totaled $4.7 million in damages, including loss of revenue to businesses. In 1997, as part of a changing national trend to avoid risk in floodplains, the Portland Bureau of Environmental Services (BES) developed the Johnson Creek Willing Seller Land Acquisition Program. The program's goal is to help move people and property out of harm's way to minimize repetitive losses.

Willing sellers are offered the real market value for their property and are under no obligation to sell. Once the City purchases the properties and structures are removed, many are converted to constructed wetlands, floodplain terraces, and open space for flood management, habitat, and passive recreation purposes.

1997 *Local Success* - Nehalem businesses raise their town

February 1996 floods devastated areas of Oregon's Tillamook County bordering the Pacific Ocean. The Nehalem River reached 1.6 feet above base flood elevation. This area of the county is a watershed to the sea for three major rivers. In all the flood zones of these rivers, people have repetitive losses in the hundreds of thousands of dollars. In the two blocks, which comprise downtown Nehalem, every business flooded, many had 3 feet of water. There was 4 feet of water over the only highway through town, and the town was isolated for 2 days. In search of a solution to damages caused by floods such as this, local and state government formed a partnership with the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) to bring financial assistance to help the town of Nehalem protect itself against the periodic flooding of the Nehalem River. The Nehalem community raised most of their town.

FEMA's hazard mitigation funds were used on two separate projects: one managed by the county to elevate 28 residences in the floodplain; and the other, managed by the City of Nehalem to elevate 11 commercial and 4 residential structures.[53]

Figure 22: An elevated business - Downtown Nehalem

In December 1998, floods again impacted Tillamook County; yet, there was no damage to the elevated homes. Expected annual savings in avoided damages and emergency response costs are estimated at $40,000 per year per residence. A county ordinance now requires that houses be elevated 3 feet above base flood elevation.

At Pete's Antiques, contractors used hydraulic jacks to elevate the building four feet. The four foot elevation requirement was determined by FEMA flood maps and the local ordinance requiring the first floor be two feet above the 100-year base flood elevation. Large, wooden beams were installed to anchor the structure to a six inch thick slab of concrete.

Ten years later, a raging winter storm deluged the area with over 20 inches of rain in 48 hours. The Nehalem River spilled over its banks into the town, flooding the streets again. But this time, businesses suffered little or no damage. The flood waters never reached the first floor of most buildings. Within a few days, the artists and merchants were back in business. No one knows better than the Oregon town of Nehalem that flood mitigation is worth the investment.[54]

[53] FEMA Best Practices Portfolio. http://www.fema.gov/mitigationbp/brief.do?mitssId=168

[54] Oregon Emergency Management. FEMA Best Practices. FEMA – 1672 – DR – OR. Retrieved from OEM website:
http://www.oregon.gov/OMD/OEM/docs/plan_train/best_practices_brochure_nehalem.pdf?ga=t

Landslides – Debris Flows[55]

2008 - Organize Oregon and Southern Washington LIDAR Consortium

This action was completed in 2008, an accomplishment towards Oregon NHMP goals # 1, 2, 3, and 5. The Oregon 74th Legislative Assembly directed DOGAMI to extend LIDAR collection efforts throughout the state. Legislators approved the consortium model for data collection and data sharing and provided modest seed money. The ultimate goal: To provide high-quality LIDAR coverage for the entire state. To achieve this goal, DOGAMI formed the Oregon LIDAR Consortium (OLC), which works to develop cooperative agreements for the collection of high-quality LIDAR that benefits the public at large, the business community, and agencies at all levels of government.

In winter 2007 and spring 2008 DOGAMI developed data specifications and selected a vendor (Watershed Sciences Inc., Corvallis, Oregon) through a national competitive bidding process. During this time DOGAMI also developed several funding partnerships for data collection blocks. Initially, the area of primary interest was the inhabited portions of western Oregon, but partners with funding for interests outside of that area are also welcomed. Several partnerships have been developed that includes areas outside the original target, where partners are willing to pay the full cost of data acquisition. As of October of 2009, the OLC has 11 data acquisition blocks under contract and is finalizing the details of funding partnerships for other areas. The cost for data acquisition depends on the size of the area and includes contract management and quality control by DOGAMI.

The basic OLC strategy for developing data acquisition areas is to start with a local funding partner and work to enlarge that area by finding additional partners and adding OLC funds to link areas together into large contiguous blocks.

2003 - Forest practices public safety regulations

This action was completed in 2003, an accomplishment towards Oregon NHMP goals # 1, 2, and 3. The Shallow, Rapidly Moving Landslide and Public Safety Rules became effective January 1, 2003. The Oregon Department of Forestry prepared *Forest Practices Technical Note 2, version 2.0*, to provide a summary of administration and application of the Landslides and Public Safety Rules. This technical note is designed to help forest practices foresters, landowners, and operators screen forestlands prior to harvesting or road construction to identify locations subject to the Shallow, Rapidly Moving Landslide and Public Safety Rules. Operations identified through this screening process are subject to further assessment using *Forest Practices Technical Note 6: Determination of Rapidly Moving Landslide Impact Rating*.

2002- Identification of Geographic Areas More Susceptible to Debris Flows

The Oregon Department of Geology and Mineral Industries and the Oregon Department of Forestry co-produced a model for determining areas in Western

[55] Oregon Department of Geology and Mineral Industries. (2011). *Oregon LIDAR Consortium.* http://www.oregongeology.org/sub/projects/olc/default.htm

Oregon that are susceptible to rapidly moving landslides (debris flows), as conveyed by DOGAMI publication IMS-22 (2002). The Department of Forestry has also written administrative rules that limit some activities on landslide susceptible slopes. In addition, state agencies are working together to forecast and advise the public of potential debris flow dangers during periods of heavy rain. [56]

1999 *Local Success* - Local Landslide Ordinance

In November 1999, the Oregon Department of Land Conservation and Development (DLCD) awarded a grant to Douglas County to develop a model landslide ordinance for local governments. This grant produced not only the Douglas County model, but also led to several other ordinances. DLCD identified the following ordinances as exemplifying the principles of Goal 7 and holds these up as models for local governments in the development of landslide hazard ordinances:

- City of Salem Landslide Hazard Ordinance
- Marion Co. Geologically Hazardous Areas Overlay Zones
- Douglas County Geologic Hazards Overlay Ordinance

Model ordinances are available on the DLCD website:

http://www.oregon.gov/LCD/HAZ/landslideslocalgov.shtml

These ordinances provide an example of how communities can address risk reduction for geologic hazards. Parts of the South Salem Hills and Eola Hills in West Salem were mapped to characterize landslide types and processes. The size of the South and West Salem slide areas and manifestations of recent movement made these areas of significant concern.

Segmented characterization of the landslide areas provided the opportunity to consider developing different sets of requirements from place to place. The landslide risk related to other geologic hazards such as streambank erosion and earthquake ground response and lends itself to a multi-hazard risk reduction strategy. Hazard characterization was contracted-out to the private sector and focused on knowledge of geology, proper segmentation of slide types, and developing various strategy options to reduce risk in each segment of the slides.

Benefits of this work include a factual basis for regulating development in areas at higher risk to geologic hazards, resulting in the citing and/or construction of structures in ways that respect the hazard.

In Salem, concurrent with the mapping effort, a technical advisory committee was formed to advice the city on the preparation of a hazard mitigation plan, In addition, a landslide hazard advisory committee was formed to advise the city, as well as Marion County, on hillside development ordinances.

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[56] Oregon Department of Geology and Mineral Industries. (2002) *Interpretive Map Series. IMS – 22*. 2002. Retrieved from DOGAMI website: http://www.coastalatlas.net/documents/IMS-22.pdf

1999 - Storm Impacts Study[57]

In response to the landslides of 1996, the Oregon Department of Forestry completed a Storms Impacts Study, a ground-based study designed to evaluate the performance of forest practice rules under extreme conditions. A total of eight study areas (52 mi^2) were investigated by on-the-ground surveys of all stream channels in the study areas. Five of the eight study areas were chosen specifically because they experienced high rates of landslide activity and channel impacts. Three sites were randomly selected. Aerial reconnaissance and ground-based survey methods were utilized to identify and investigate all landslides on forestland that delivered sediment and debris to channels. All forest access roads in six of the study areas (170 mi. in length) were surveyed for landslides and washouts.

Figure 23: At-risk home acquisition and restoration project in Warrendale Oregon

The results of the Storm Impacts Study were published in June 1999, and directly used to provide scientific basis for Oregon Department of Forestry's Landslide and Public Safety Rules. These rules provide policy direction for the department's forestry practices.

1997 *Local Success* - Property Acquisitions

Since 1997, voluntary acquisition projects funded by the Hazard Mitigation Grant Program for landslide mitigation have been implemented in:

Dodson-Warrendale (Multnomah County) –This project took place in the unincorporated community of Dodson-Warrendale, in East Multnomah County. The subject properties were six homes located in landslide damaged or landslide threatened areas, their demolition and restoration of the sites to open space. Municipal water lines and/or wells leading to the homes required decommissioning in addition to septic systems.[58]

City of Portland – acquisition of residential properties damaged by landslides, or in jeopardy of being damaged in northwest and southwest areas of town. Acquisition is ongoing as funding becomes available and as the need arises, and;

City of Dallas – Clay Street acquisitions on a sliding bluff above Rickreal Creek.

1997 - Debris Flow Warning System

Oregon Department of Forestry meteorologists are responsible for forecasting storms that may trigger debris flows. These forecasts are developed using real time data from telemetered rain gauges and other hydro-meteorological data. Advisories

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[57] Oregon Department of Forestry.(2011). *Storm Impacts and Landslides of 1996: Final Report.* Available online at ODF website: http://www.oregon.gov/ODF/privateforests/docs/StormImpactsFinal.pdf?ga=t

[58] Sigirsit, Dennis. Landslide Forum, February 6th, 2006. Flood & Landslide Hazard Mitigation Projects. 10 Years of Progress and Succes.

and warnings are issued as appropriate. Information is broadcast over NOAA Weather Radio, the Law Enforcement Data System, and ODOT reader boards.

ODF has identified three segments of state highways that are of highest concern for debris flow vulnerability. ODOT places warning signs on each end of these three highest hazard areas when conditions may lead to debris flows. In order of concern, the three areas are Oregon Highway 38, milepost 6.5 to milepost 17; Interstate 84, from about milepost 20 to milepost 40; and Oregon Highway 6, milepost 5 to milepost 35.

DOGAMI provides additional information on debris flows to the media and through them to the public. Information is also posted to National Weather Service, ODF, and DOGAMI websites. These warning systems were established in 1997 and are ongoing actions.

The warning system provides information so that the traveling public can make informed decisions about routes and timing of travel. It also can assist persons living or working in higher hazard areas to make decisions about evacuating those areas until the danger is reduced.

Tsunamis

2009 - Tsunami Ready, Tsunami Prepared[59]

In 2009, DOGAMI initiated the TsunamiReady™, TsunamiPrepared program to help coastal communities build on existing plans or start new work toward tsunami preparedness by offering financial support, material resources, mentoring and guidance. DOGAMI's TsunamiPrepared Outreach Coordinator will help recruit Community Organizers and volunteers, and facilitate community-based preparedness activities, including:

- Tsunami awareness surveys
- Door-to-door outreach campaigns
- Community-wide tsunami evacuation drills
- Workshops targeting businesses, the lodging industry, residents, and visitors
- Tsunami education in K-12 schools

2008 - Tsunami Inundation Maps

Using the latest in geologic mapping, DOGAMI is producing new and improved inundation maps to help in mitigation and public education efforts. The project benefits Oregon by providing valuable resources to both the general public and local government officials to prevent loss of life and to minimize the destruction of property.[60] Tsunami inundation maps also assist coastal communities in the development of other natural hazard mitigation activities, such as the formulation of tsunami evacuation routes of coastal communities. The project began in 2008, with planned completion by 2015.

Figure 24:

2005 - Tsunami Public Education

Public education efforts help to create a culture of awareness in areas at risk from geologic hazards. An objective of Oregon's Tsunami Hazard Mitigation Program is to empower people in communities to prepare for tsunamis and build resilient communities. Education efforts focus on revising tsunami evacuation maps, and launching a variety of web-based products to facilitate the dissemination of tsunami information to the public.[61] Project benefits include the prevention of loss of life through education of the public and policy makers on

[59] Oregon Department of Geology and Mineral Indstries. (2011). Oregon Geology Fact Sheet. Series FS-007. *Tsunami Ready, Tsunami Prepared.*

[60] Maps available at Oregon Department of Geology and Mineral Industries website: http://www.oregongeology.org/sub/earthquakes/Coastal/Tsumapsbycity.HTM

[61] Oregon Department of Geology and Mineral Industries. (2011). Oregon Tsunami Clearinghouse. *Oregons Tsunami Hazard Mitigation Program.* Retrtieved from DOGAMI website: http://www.oregongeology.org/tsuclearinghouse/thmp.htm

planning and mitigation. This project began in 2005, and has an end date of 2015.

2005 *Local Success* - Rockaway Beach[62]

Through the efforts of the mayor and others in the community, Rockaway Beach has sirens in place, tsunami evacuation routes identified and signed, and evacuation sites established. One evacuation site has a sea cargo container that houses emergency supplies. These supplies are renewed and replenished by Rockaway Beach. NOAA granted Rockaway Beach Tsunami Ready status in June, 2005.

2002 *Local Success* - Cannon Beach[63]

Through the efforts of the Cannon Beach Fire Protection District, Cannon Beach is well prepared for tsunami hazards. They have an advanced tsunami warning siren system. The system includes a voice component that explains to the public what action they need to take. Cannon Beach has had an evacuation map for several years and it was recently upgraded. They have tsunami educational and evacuation signs in place. They were also the first Oregon community chosen for NOAA's Tsunami Ready Program in August, 2002.

2001 - Technical Resource Guide

DLCD contracted with the University of Oregon Community Planning Workshop to develop *Planning for Natural Hazards - Oregon Technical Resource Guide* in June, 2001. The manual includes a section on tsunamis.

1995 - State of Oregon Tsunami Program

The National Oceanic and Atmospheric Administration (NOAA) funds the National Tsunami Hazard Mitigation Program (NTHMP), an active tsunami program that has been facilitating cooperation between local, state, and federal agencies since 1995.[64] Oregon's Tsunami Program is the result of such efforts, and aims to advance the mission of the NTHMP in Oregon by reducing loss of life and property damage from tsunamis. Some completed projects include:

- A state/federal tsunami mitigation plan has been completed. This plan addresses warning, mapping, and mitigation.
- Tsunami inundation zone legislation was passed in 1995. The state places certain restrictions on the siting of critical facilities in tsunami inundation zones.

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[62] National Oceanic and Atmospheric Administration. (2005). NOAA News Releases 2005. *NOAA Declares Rockaway Beach ORE. TsunamiReady and StormReady.* Retrieved from NOAA website: http://www.publicaffairs.noaa.gov/releases2005/jun05/noaa05-r270.html

[63] National Oceanic and Atmospheric Administration. (2002). NOAA News Releases 2002. *Cannon Beach Named Oregon's First TsunamiReady Community.* Retrieved from NOAA website: http://www.publicaffairs.noaa.gov/releases2002/aug02/noaa02r215.html

[64] National Tsunami Hazard Mitigation Program: 2009 – 2013 Strategic Plan, (2010).

- Tsunami inundation zone maps have been completed for the entire Oregon coast. These maps will continue to be updated with more recent data as feasible.
- Tsunami information signs have been installed in coastal communities. Roadside markers and information signs have also been installed along major coastal routes.
- A pilot tsunami modeling effort was initiated at Cannon Beach in 2007. This recent mapping effort includes the development and implementation of new earthquake source models, hydrodynamic model benchmark testing, and hydrodynamic model calibration against paleo-tsunami deposits obtained in Ecola Creek. A similar effort was implemented in 2008 near Bandon to develop a new south-coast tsunami model. Once completed, the revised and calibrated tsunami model will be used to develop new tsunami inundation and evacuation maps for the entire Oregon coast.

Volcanic Hazards

2009 - Central Cascades Volcanoes Coordination Plan

Prior to the 2009 State of Oregon NHMP, federal, state, tribal, and local governments cooperated to develop a plan for coordinating any response to volcanic activity in the central Cascade Range.

There are several volcanoes that are considered active and high hazard in the area including Newberry Volcano, Crater Lake, and the Sisters Volcanoes. The plan reviews the geologic history and hazards, and sets the foundation for coordinated incident response to volcanic activity.

2005 - Mt. Hood Volcano Coordination Plan[65]

In September, 2005, OEM facilitated a collaborative effort between federal, state, and local governments, working together to revise a coordination plan for Mount Hood eruptions. The plan reviews geologic history, lists the agencies that developed and approved the contents of the plan, delineates education and coordination activities appropriate between and during eruptions, and requires a yearly meeting of participants to update the plan. At a minimum, preparation of the plan has made all potentially affected jurisdictions aware of the nature of the hazard, has outlined response strategies, and has produced a directory of agency phone numbers that will be needed in an emergency.

2004 - Mt. St. Helens Volcanic Eruption Forecast of 2004

The monitoring of Mount St. Helens since the 1980's by the Cascade Volcano Observatory was put to the test in September, 2004. Volcanologists observed a change in the seismicity as well as the heat output on the dome area and were able to give notice of an impending eruption. Although the volcanic activity remained limited to occasional steam and ash plumes with almost continual lava extrusion on the dome the media and public interest remained intense for several month. The activity lasted almost four years before geologists pronounced the eruption had ceased. From October 2004 until the cessation of active eruption in 2008, about 125 million cubic yards of lava formed a new dome on the crater floor. Some hazards persist in the form of heat in the new lava dome and the risk of minor explosions that could send a dusting of ash up to 50 miles away. Benefits of this project include increased safety for surrounding residents, and reduced potential for disruption of essential services due to volcanic activity. Monitoring efforts can also provide opportunities for educating the public about vulnerabilities and risks associated with a volcanic eruption.

2002 - Cascade Fury

During April 2002, Oregon Department of Transportation and Oregon State Police took part in a multi-state emergency response exercise "Cascade Fury." This exercise, sponsored by the U.S. Department of Transportation and the Federal

[65] Oregon Emergency Management: Mt. Hood Coordination Plan. (2005).

Emergency Management Agency, focused on the impacts a volcanic eruption would have on transportation systems in the Pacific Northwest. State transportation departments and state emergency management agencies from Washington, Idaho, and Alaska also took part.

Wind Storms

2008 - Danger Trees on the Right of Way Committee Final Report[66]

The Right of Way Committee was formed at the recommendation of the State Interagency Hazard Mitigation Team in 2007. The purpose of the committee was to investigate the feasibility of establishing proactive, collaborative vegetation managements measures for roadways in the state of Oregon, and to find ways to prevent the type of storm damage that occurred during the winter storm of 2007, when tens of thousands of trees fell across Oregon roads and electrical transmission lines causing significant risk to public safety, millions of dollars of damage and disruption of state commerce. The Right of Way (R/W) Committee was formed and held its first meeting May 29, 2008 at the OPUC.

Figure 25: Windstorm causing downed limbs and trees to block the road. (Photo courtesy of OPUC)

The R/W Committee project focused on Senate District 16 in the northwestern corner of the state, where the 2007 winter storm caused considerable damage. The goal of the project was to refine the storm damage prevention processes and tools for a specific area of the State. This was done by reviewing codes and regulations at the local, state, and federal levels, developing an informational video to educate interested persons, and developing a collaborative mapping tool system to help identify problem areas for trees in proximity to highways and powerlines (website), and develop recommendations to address the Danger Trees on the R/W.

[66] Danger Trees on the Right of Way Committee: Final Report, 2010. Available online at: http://www.puc.state.or.us/PUC/safety/Final_Report.pdf

The R/W Committee recommendation has two parts. First, through the committee process it was agreed that existing authorities could provide better results with a more deliberate approach to communication. ODOT and ODF agreed to, and have already begun, to implement a communication strategy that will better predict and respond to potential danger trees and corridors prior to catastrophic failure.

After significant debate around the existing scenic highway provision in the Forest Practices Act, the R/W Committee recommends leaving the statute as-is. Provisions for public safety are prominent in the statute and the better use of that provision is the part of the communication plan mentioned above. The commitment to better communication, not only with ODOT and ODF but landowners, utilities, counties, and others, will be enhanced significantly by the mapping tool generated from the Committee's work.

The second part of the recommendation is a statutory change to the reforestation provision in the Forest Practices Act. The proposed change will simply remove the mandate for reforestation in an area where it is reasonable to predict dangerous situations will arise as new trees reach maturity. ODOT would be required to make the determination and provide it to ODF and the landowner. Over time, that unproductive forestland could be purchased by ODOT and placed within the rights of way for regular maintenance.

2004 - Hazard Tree Mitigation through education

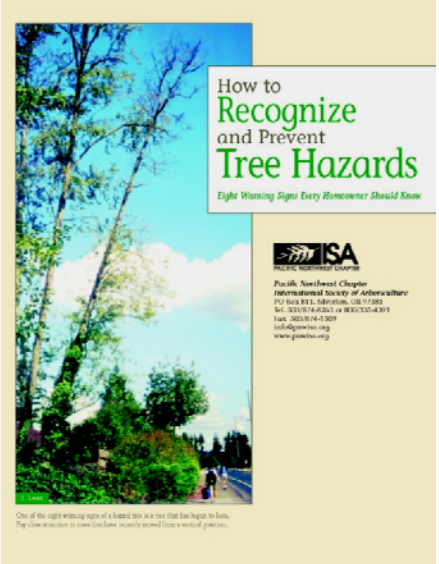

Figure 26: A homeowner's guide produced by the Northwest Chapter of the International Society of Arboriculture.

As part of mitigation activities, Oregon Emergency Management and the Oregon Department of Forestry cooperated to provide a grant program to help address hazard tree mitigation. Actions completed include: use of posters and news articles, demonstrations at an annual tree fair, printing and distribution of 40,000 copies of a new homeowner's guide to tree hazards, and mailing tree care brochures to utility customers along with their bills.

A severe winter storm and ensuing strong winds produced significant property damage and power outages across Benton, Lane, Linn, Marion, and Polk counties in February of 2002. Many downed trees created safety hazards and power outages. Some damage could have been prevented had people learned more about what it takes to prevent hazard trees.

By providing grant dollars to Oregon communities from 2003 to 2004, the agencies have been able to increase public education and awareness about the dangers of hazard trees, and helped the public understand both hazard tree prevention and how to properly care for trees. Although not all tree failures can be prevented, every effort must be made to learn from tree failures and help the public understand how their actions can help lower the risk.

2004 *Local Success* - Reducing damage, maintaining electrical service

During the late December 2003, early January 2004 wind, snow, and ice storms in the Willamette Valley, what was once a sure bet for power outages is now a mitigation success. The Emerald Circuit is a main distribution line among three substations serving approximately 800 homes; assorted businesses, a fire station and two SUB water reservoirs. As a backup, this line provides power to another 400 homes, schools, a shopping center, and numerous traffic signals.

By undergrounding the Emerald Circuit overhead electric line, the Springfield Utility Board (SUB) has strengthened their capability for future delivery of services and increased their capacity to respond to other emergency problems. The previous 12kV overhead line power line had also provided power to an important communication facility at the summit of Harness Mountain. This facility was used as a relay station for the Federal Aviation Administration and the Oregon State Police, but had been plagued with repetitive outages and required difficult emergency measures to restore power. By 2004, the underground electric line virtually eliminated outages caused by wind, ice, or snow.

2002 - Reducing Falling Vegetation Damage to Electric Utilities

A December 12, 1995 windstorm battered more than ten counties in Western Oregon, causing extensive damage to the electric utility and telecommunications infrastructure in the area. Much of the damage to power lines was a result of falling vegetation. FEMA approved a hazard mitigation grant to mitigate future losses to utility infrastructure. The grant assisted utilities in refining and better publicizing tree pruning practices, right-of-way clearing policies, and in sharing techniques that reduce powerline breakage by improved and alternate attachments to poles.

A consumer-oriented program was also initiated to assist property owners in selecting trees that are “powerline friendly.” This project is expected to make a big difference over time in reducing windstorm damage to power and telecommunications lines and poles. Emerald PUD (Lane County) estimates savings of at least $30,000 per year for their utility alone. This hazard mitigation project leveraged funding resources from the HMGP, people’s and rural electric cooperatives, private utilities, and the Bonneville Power Administration.

On February 7, 2002, another significant windstorm struck many of the same counties. In the Hazard Mitigation Survey Team Report developed following that storm, “the consensus of the participants was that the implementation of mitigation measures since (the December 1995 storm) had lessened the impact of the most recent event”.

Hence, the powerline friendly program noted above reduced losses from the February 2002 event as well as other wind events that didn’t meet federal disaster thresholds. Homeowners learned the importance of managing vegetation near the feed line from the utility pole to their house (oftentimes trees impact this last 100 feet of above-ground line) and cities replaced hazard trees near powerlines with lower-growing, power-friendly trees. These proactive outreach efforts on vegetation management have helped both the investor and consumer-owned utilities around the state.

Likewise, hazard mitigation accomplished after the February 2002 wind event later provided reduced losses from a December 2003 to January 2004 winter storm (ice and snow loading) event. In this case, reduced losses to utilities were largely due to the success of the undergrounding projects. For example, the Cline Hill Underground Project (eastern Lincoln County) implemented by Consumers Power, Inc., was successful in totally eliminating electric service disruption and infrastructure losses from the wind and heavy rain events of late December 2005 – January 2006.

Winter Storms

2009 - Interagency "Fire and Ice" Agreement

As of 2009, the Oregon Department of Forestry (ODF) and the Oregon Department of Transportation (ODOT) have a cooperative "Fire and Ice" agreement for sharing some permanent, full time employees to perform seasonal work. These employees fight fires in the summer and plow snow in the winter. Depending on weather conditions, an employee in one of these positions typically works May through October performing ODF fire protection duties and then works November through April operating equipment for ODOT winter needs. The worker remains an ODF employee even while receiving direction and work from ODOT. Both agencies and the public benefit from the ability to retain skilled, experienced employees to perform seasonal work from year to year.

2009 - Grant Funds Put More Troopers on Mountain Passes

Oregon's weather can change quickly and without warning. During the winter, conditions hit early and often cause problems for many travelers who are either ill-prepared or do not follow driving safety tips and Oregon chain up laws. To help emphasize the importance of being prepared and complying with traffic laws, ODOT has again provided overtime funding for enforcement to put more Oregon State Police (OSP) troopers on selected mountain passes for the 2008-2009 winter season.

OSP chain enforcement efforts received a grant from ODOT's Transportation Safety Division to provide more than 500 hours of overtime enforcement in 12 selected mountain passes. Every winter, interstate and state highway mountain passes see numerous motor vehicle crashes resulting in many injuries and deaths. Traffic often backs up, creating even more dangerous driving conditions. In many cases, these crashes are associated with excessive speed and lack of required chain equipment, or in the case of passenger vehicles, the appropriate tires and traction devices.

"We can't emphasize enough the importance of being prepared for upcoming driving challenges by having the appropriate chain equipment and tires, as well as driving safely at all times as dictated by the road and weather conditions," said Sergeant Alan Hageman of the OSP Patrol Services Division. "The overtime grant funds will be put to good use putting more troopers in these areas when needed throughout the winter."

Mountain pass areas targeted for the extra enforcement using provided grant funds are:

- Interstate 5 - Siskiyou Summit
- Interstate 5 - Sexton Mountain (between Roseburg and Grants Pass)
- Interstate 84 - Cabbage Hill
- Interstate 84 - Ladd Canyon
- Interstate 84 - Three Mile Hill (between Huntington and Ontario)
- Interstate 84 – Weatherby (between Baker City and Huntington)
- Oregon 58 - Willamette Pass
- U.S. 20 - Santiam Pass

- U.S. 26 - Mt. Hood Pass
- U.S. 97 - Spring Creek
- Oregon 140W - Doak Mountain
- Oregon 140W - Seldom Hill

These problematic mountain passes were selected during the last couple years and are targeted again this year because they have been plagued by crashes during the winter months," said Sergeant Hageman. "Having the right size and number of chains required, and the appropriate tires on your vehicle when traveling where they may be required, is good for you and other drivers."

2008 - Avalanche Control Experts Help Clear Highway

The stretch of U.S.20 between milepost 79 and milepost 80 just west of the Santiam Pass Summit is among the most snow slide prone highways in Oregon. Hogg Rock, with its south-facing slopes that range in pitch from 30 to 40 degrees, has very few natural "anchors" such as trees, which tend to prevent snow slides. Most slides occur on slopes that range from 30 to 45 degrees in pitch, according to the Northwest Weather and Avalanche Center.

Figure 27: The lead skier prepares to throw a concussion charge to bring down unstable snow on Hogg Rock above U.S. 20. (Photo courtesy of ODOT)

ODOT has tried a variety of slide control techniques to manage the snow. Most often tried is an air-blast, where an explosive charge is placed below a snow fracture area on a Hogg Rock slope. The blasts send a percussive wave at the unstable snow pack in an attempt to generate a slide.

The blasting – which requires closing the highway for several hours for safety reasons – has been only minimally effective. Extreme care is required because these steep slopes above U.S. 20 contain shale outfall that become unstable when heavy loads such as moisture-laden snow accumulates. On top of this loose rock are boulders ranging in size from 2,000 pounds to more than 25,000 pounds. ODOT highway crews do not want to try to bring down snow and end up bringing down loose rock or destabilizing the slopes to an extent that additional rock comes down throughout the rest of the year.

Three professional ski patrollers from Mt. Bachelor skied to the rescue on Friday, February 1, 2008 by providing expert avalanche control work for the unstable snow pack in the Hogg Rock area, just west of Santiam Summit.

A series of snow slides closed the highway at about 6:30 a.m. Thursday, January 31, from milepost 75 to milepost 80. The slides ranged from five feet to 15 feet in depth and covered about three fourths of a mile of the highway. Given the unstable snow pace above the highway, blizzard conditions, gusting wind and the risk for additional slides, ODOT managers decided to keep the highway closed overnight. The next morning, they decided to try a suggestion made by an ODOT employee who is also a member of the National Ski Patrol to shake loose the unstable snowpack and reopen the vital highway.

The ODOT employee, ODOT Region 2 Public Information Officer Joe Harwood, contacted Mt. Bachelor President Matt Janey and Pro Patrol Director Curtis Norsen, who immediately agreed to provide assistance. After lining up three Mt. Bachelor ski patrollers, Harwood then arranged for a certified demolitions transporter from Knife River to hook up with the group and deliver avalanche charges.

Harwood and Norsen, along with patrollers John Millslagle and Betsy Nelson, arrived at Santiam Summit before dawn Friday morning and armed the charges with cut-timed detonation cord. The four then skied up about 1.5 miles into the Hogg Rock area. They set off ten separate explosions in an effort to trigger slides and bring down the unstable snow so that ODOT could reopen the highway. The charges, a combination of TNT and PETN, were thrown over a large, exposed area below the sheer face of Hogg Rock.

“We at ODOT are grateful for the expertise and assistance of Mt. Bachelor and the Mt. Bachelor Ski Patrol," said ODOT Director Matt Garrett. "Without their timely and unselfish help, we would not have been able to reopen the highway so quickly."

Following completion of the slide control work, ODOT crews from Santiam Junction spent about three hours clearing excess snow from the highway. The highway was reopened about 1 p.m. Friday, February 1.

2004 - Winter Practices Minimize Impact on Fish

ODOT has revised its winter highway maintenance practices to both cut costs and avoid affecting fish habitat while maintaining the same high standards for public safety. ODOT’s winter maintenance practices minimize the effects of sanding and the related cleanup in sensitive areas.

ODOT’s fish-friendly maintenance changes include:

- Using environmentally safe road deicers that replace or complement sanding. ODOT uses either calcium magnesium acetate (CMA) or magnesium chloride (with a rust inhibitor added) to treat roads. These products are mixed with water to form liquids and are sprayed on highways and bridges to keep ice from forming.
- Placing barriers where appropriate and practical to keep sanding materials out of waterways. Road sand can cover spawning areas and can damage fish eggs.
- Identifying and mapping areas where maintenance work could affect fish habitat. Staff educates highway crews on environmentally sensitive maintenance practices for those areas.

- ODOT minimizes use of sidecast sweeping that pushes sand to the side of the road, especially on or around bridges. Reclaimed and cleaned sand is reused for berms, shoulder rebuilding, etc., as appropriate.
- Adjusting truck speeds when sweeping and plowing to keep sand, soil, and road chemicals out of waterways.

ODOT highway maintenance workers also are reducing the amount of sand they spread by using winter maintenance chemicals more often during winter storms. The problem with sand is that once spread on the highway, it is easily moved off the roadway by the traffic and is effective for only a short period of time. Although ODOT has added these other tools to the winter maintenance toolbox, CMA and magnesium chloride are not a total replacement for traditional sanding practices. Winter maintenance chemicals are also not a replacement for responsible winter driving.

2003 - ODOT enters into Deicing Agreement with Warm Springs Tribes

In January 2003, ODOT and the Warm Springs Confederated Tribes worked out an agreement for the use of chemical deicers on highways crossing the reservation. In the past, ODOT was allowed to only use sand on U.S. 26 and Oregon 216 through the reservation.

The tribe was concerned the use of magnesium chloride or other deicers would harm the aquatic life in Beaver Creek, and prohibited ODOT from using chemical deicers. Tribal representatives also were concerned that sand might act as a cement-type material on the bottom of Beaver Creek, and prevent fish from using the stream as a spawning habitat.

Technicians from ODOT's Clean Water Program took soil and water samples from Beaver Creek before any deicer was applied. Monitoring of Beaver Creek will take place for two years. The amount of sand applied on almost 35 miles of state highways through the reservation was drastically reduced, which will help improve the fish habitat. Another goal was to decrease the overall accident rate for U.S. 26 through the winter months.

2002 - Award-Winning Traveler Information Web Site

Figure 28: Camera image from the TripCheck website

Since 2002, ODOT has facilitated delivering information to the traveling public, helping people to make good decisions about traveling during winter weather. TripCheck provides traffic incident, weather, and highway condition reports, as well as useful links to bus, rail, airport, and truck information.

It contains images from approximately 140 road cameras, including over 40 in rural areas such as mountain passes where knowing road conditions can be crucial to safety:

http://www.TripCheck.com/

The website was recognized by the Federal Highway Administration as one of the best for traffic information in 2002. It also received national recognition from the American Association of State Highway and Transportation Officials. During the winter months of January through March 2003 TripCheck.com averaged about 800,000 visits per month. During the nine-day period starting Christmas Eve 2003 through New Year's Day 2004, it received more than 1.2 million visits.