6.0 WINTER STORMS

6.1 Overview

Winter storms affecting Lane County are generally characterized by a combination of heavy rains, and high winds throughout the County, sometimes with heavy snowfall (especially in the Cascades). Heavy rains can result in flooding, as well as debris slides and landslides. High winds commonly result in tree falls which primarily affect the electric power system, but which may also affect buildings and vehicles. This chapter deals primarily with the rain and wind effects of winter storms. Larger scale flooding is addressed in Chapter 6. Debris flows and landslides are addressed in Chapter 8.

Winter storms can also involve ice and snow, most commonly at the higher elevations in Lane County, especially in the Cascades, but sometimes in the Willamette Valley as well. The most likely impact of snow and ice events on Lane County are road closures limiting access/egress to/from some areas, especially roads to higher elevations such as Highway 58 into the Cascades or Highway 126 over the Coast Range. Winter storms with heavy wet snow or high winds and ice storms may also result in power outages from downed transmission lines and/or poles.

Average annual snowfalls at lower elevations in Lane County are generally low. For example, average snowfall at the Fern Ridge Dam weather station near Veneta is only 3.0”. Average monthly snowfalls at this weather station for the months for February, March, November, and December are 0.3”, 0.1”, 0.1” and 0.6”, respectively.

Major snow storm events do occur occasionally at lower elevations in Lane County. Major snow storms affecting the Willamette Valley occurred in 1884, 1892, 1909, 1916, 1919, 1937, 1950, 1969, and 1989. January 1950 snowfalls were especially high, with 54” in Albany and 36” in Eugene. In January 1969, Eugene had 47” of snow. Thus for the Willamette Valley portion of Lane County, most winters result in little snowfall, with major storms of 10” or more snow occurring typically about every 10 or 20 years. There are few practical mitigation actions for such infrequent major snow storms, other than common sense measures applicable to many hazards, such as encouraging residents to maintain emergency supplies of food and water for a few days and emergency generators for critical facilities.

However, average annual snowfalls are much higher in eastern Lane County. Average snowfalls for Oakridge are 12.6” and for McKenzie Bridge the average snowfall is 28.7”. Thus, in the Cascades, snowfalls occur every year, with corresponding impacts on road travel. Highway 58, which runs through Pleasant Hill, Lowell, Westfir and Oakridge, provides a low elevation pass through the Cascades to the east Lane County border, and closes 3-4 times per year for several hours at a time. The same is true for the McKenzie River portion of Highway 126 East which runs through Walterville, Deerhorn and Blue River. For eastern Lane County communities, maintaining emergency supplies, including a second source of heat, and emergency generators for critical facilities are particularly important.

For completeness, we also briefly address other severe weather events, including hail and lightning strikes and tornadoes. Hail events are possible in Lane County, generally during summer thunderstorms, with the most recent significant event being August 4, 1999 (what made this event significant?). However, hail damage is generally minor and few practical mitigation alternatives are applicable to hail.

Nationwide, lightning is the number two weather related killer, second only to floods. NOAA data show that lightning causes about 90 deaths per year, with at least 230 injuries (NOAA Technical Memorandum NWS SR-193, 1997). Lightning injuries appear to be systematically underreported and thus the actual injury total is most likely significantly higher.

Deleted: nationwide

For Oregon, casualties from lightning are very low, with totals of only 7 deaths and 19 injuries reported over a 35 year period (NOAA). Thus, the level of risk posed by lightning strikes in Lane County, while not zero, is very low. Public education about safe practices during electrical storms is the only available mitigation measure to reduce casualties from lightning. Lightning strike damage to buildings or infrastructure is generally relatively minor and few practical mitigation alternatives are applicable to lightning, other than installing lightning arrestors on critical facilities subject to lightening damage.

Tornadoes also do occur occasionally in Oregon. However, Oregon is not among the 39 states with any reported tornado deaths since 1950. Historically, tornadoes in Grant County were reported to have killed a total of four people in 1894 and 1887. NOAA records (Portland office) show four historical tornadoes in Lane County. On November 24, 1989, a tornado touched down in the south hills of Eugene, uprooting several tall fir trees, and damaging utility lines and a camper, but causing no injuries. Another poorly documented tornado may have occurred in 1975 near Eugene, with very minor damage. In 1984, a small tornado was reported near Junction City with damage to a barn and shelter. In 1937, a possible tornado uprooted hundreds of trees and demolished summer homes and camps near McKenzie Bridge.

Climate and weather conditions in Oregon make the occurrence of major tornadoes appear unlikely. The most practical mitigation actions for tornadoes are public warnings and taking shelter.

6.2 Winter Storms Hazard Assessment

6.2.1 Rain Hazard Data

Severe winter storms usually include heavy rainfall. The potential impact of heavy rainfall depends on both the total inches of rain and the intensity of rainfall (inches per hour or inches per day). In the context of potential flooding, “rainfall” also includes the rainfall equivalent from snow melt. Flash floods, which are produced by episodes of intense heavy rains (usually 6 hours or less) or dam breaks are rare in Lane County (and western Oregon) but do represent a potential meteorological hazard.

Large drainage basins, such as that for the Willamette River typically have response times of a day or two: the total rainfall (plus snow melt) over periods of several days or more are what determines the peak level of flooding along the Willamette, McKenzie or Suislaw Rivers. Smaller rivers have response times of several hours.

Smaller, local drainage basins, have shorter response times. Levels of peak flooding may be governed by rainfall totals over a period of an hour to a few hours.

However, the major rivers affecting Lane County all have multi-purpose dams, and thus the usual natural correlation between rainfall events and flood levels does not apply. Rather, flooding along such rivers is predominantly affected by water release patterns from the dams. For the major rivers, dam operating characteristics and capacities are included in the flood modeling for FEMA-mapped floodplains.

Statistical rain fall data for Lane County are shown on the following map from NOAA data. This map shows the 24-hour 100-year rainfall totals. Such rainfall maps are prepared using what is known as orographic modeling. Rainfall gauge stations are relatively widely spaced. However, for modeling the localized impacts of heavy rainfall, higher resolution rainfall maps are needed. Orographic modeling considers topography, wind effects, and soil conditions and calibrates rainfall contours to conform to measured runoffs from stream gauge readings. Using these modeling techniques, rainfall maps are produced with higher spatial resolution than would be possible relying solely on rain gauge data.

Lane County rainfall data are summarized in Table 6.1 below.

Table 6.1
Lane County Rainfall Data

Period	Rainfall Amount (inches)				
	Coast	Coast Range	Willamette Valley	Cascade Foothills	Cascades
Average Annual	60-70	120+	40-50	50-70	70-90
2-year 24 hour	3-4	5+	2-3	3-4	4-5
25-year 24 hour	4-6	8+	4-5	5-6	6-7
100-year 24 hour	5-6	9-10	5-6	6-8	8-9

The rainfall data shown in Table 6.1 give general overview of the potential for winter storm flooding in Lane County, but whether or not flooding occurs at specific sites depends heavily on specific local drainage conditions.

The frequency of rainfall events is interpreted in the same manner as the frequency of flood events. Thus, a 2-year rainfall event simply means that such rainfalls have a 50% chance of happening in any given year. A 25-year or 100-year rainfall event mean simply that such rainfalls have a 4% or 1% chance, respectively, of happening in any given year.

For modeling the flood impacts of winter storms we suggest using the 24-hour precipitation maps. The 24-hour precipitation totals are a reasonable measure of flood risk for small drainage basins. Longer duration precipitation totals govern flooding on larger rivers, but such flooding is already included in the modeling behind FEMA's floodplain mapping and covered by the discussion of flood hazards in Chapter 6.

Lane County 24-Hour 100-Year Rainfall Data

INSERT MAP

For Lane County as a whole, we note that 2-year and 25-year 24-hour precipitation totals are 4" to 5+" and 5" to 8+", respectively in the Coast Range, with values almost as high in the Cascades. Such totals are high enough to generate significant potential localized flooding problems. However, whether or not localized flooding does occur depends on specific local drainage conditions. For example, 5" of rain in one area may cause no damage at all, while 5" of rain in a nearby area may cause road washouts and flooding of buildings.

For Lane County, identification of specific sites subject to localized flooding during winter storms is based on historical occurrences of repetitive flooding events. About 60 such sites in the County, where localized storm water drainage flood has been repetitive and problematic, were shown in Chapter 6 Floods (see Storm Water Problem Locations Map in Section 6.4).

An action-list of the ten most problematic sites for roadway flooding is given below in Table 6.2

Please alpha-sort the table below by Community and then Region.

Table 6.2
Top Ten Candidates for Drainage Problem Mitigation

Address	Community	Region	Milepost[1]
3110 Love Lake Road	Junction City	Willamette Valley	1.450
4335 Vaughn Road	Noti	Coast Range	8.350
1628 Coleman Road	Coburg	Willamette Valley	0.090
6068 Edenvale Road	Pleasant Hill	Cascade Foothills	0.700
5070 North Fork Suislaw Road	Florence	Coast	5.700
6122 Parvin Road	Dexter	Cascade Foothills	0.400
5036 Sweet Creek Road	Mapleton	Coast Range	4.570
1625 Hermann Road	Coburg	Willamette Valley	0.520
4093 Powell Road	Lorane	Willamette Valley	0.139
4096 Simonsen Road	Lorane	Willamette Valley	0.159

[1] Beginning milepost for road section requiring elevation and culvert upsizings.

6.2.2 Wind Hazard Data

Wind speeds associated with winter storms vary depending on meteorological conditions, but also vary spatially depending on local topography. For Lane County, the wind hazard levels are highest directly at the coast and then fairly uniform across most of the rest of the county. In the hilly areas, however, the level of wind hazard is strongly determined by local specific conditions of topography and vegetation cover.

A regional overview of wind hazards is shown by the data in Figures 6.3 and 6.4 which show contours of wind speed (in kilometers per hour) for western Oregon (Wantz and Sinclair, Distribution of Extreme Wind Speeds in the Bonneville Power Administration Service Area, Journal of Applied Meteorology, Volume 20, 1400-1411, 1981). These data are for the standard meteorological data height of 10 meters (about 39 feet) above ground level. Figures 6.3 and 6.4 show wind speed contours for recurrence intervals of 2-years and 50-years, respectively. These data are for sustained wind speeds. Peak gusts are commonly 30% or so higher than the sustained wind speeds. These wind-speed data are fairly old, but still representative of overall wind storm conditions in Oregon and in Lane County.

As shown in Figures 6.3 and 6.4, statistical wind speed data vary with location in Lane County. The highest wind speeds are on the immediate coast. Furthermore, wind speeds in the Willamette Valley and in the Cascades are typically somewhat higher than in the Coast Range or in the Cascade Foothills. Data from Figures 6.3 and 6.4 are summarized in Table 6.5 below. Table 6.5 shows 2-year and 50-year wind speeds for the major regions of Lane County in both kilometers/hour (from the maps) and miles per hour (converted from kilometers per hour).

Table 6.5
Wind Speed Data for Lane County

Period	Sustained Wind Speeds (km/hr)				
	Coast	Coast Range	Willamette Valley	Cascade Foothills	Cascades
2-year	75	65	70	60	65
50-year	120	100	110	100	110

Period	Sustained Wind Speeds (miles/hr)[1]				
	Coast	Coast Range	Willamette Valley	Cascade Foothills	Cascades
2-year	47	40	43	37	40
50-year	75	62	68	62	68

[1] Conversion from map contours in kilometers per hour is 0.6214 miles per kilometer

For Lane County, the 2-year recurrence interval sustained wind speeds range from about 60 to 75 km/hour or about 37 to 47 miles per hour. These 2-year wind speeds are too low to cause widespread substantial wind damage. However, there may be significant local wind damage at sites where local wind speeds are higher or where there are especially exposed locations, such as at the boundary between clear cut and forested lands.

For Lane County, the 50-year recurrence interval wind speeds range from about 100 to 120 km/hour or about 62 to 75 miles per hour. These wind speeds are high enough to cause widespread wind damage. Damage may be severe at particularly exposed sites. Thus, for most regions of Lane County winter storms with significant direct wind damage are not likely every year or every few years, but perhaps once every decade or so, on average, with major wind storm events happening at intervals averaging a few decades.

However, as shown above in Figures 6.3 and 6.4, wind speeds are typically higher along the immediate coastal region. Thus, the frequency and severity of wind storms events is somewhat higher for Florence and other coastal communities than for the Willamette Valley and the other regions of Lane County.

Figure 6.3
Wind Speed Contours for 2-Year Recurrence Interval
(km/hour)

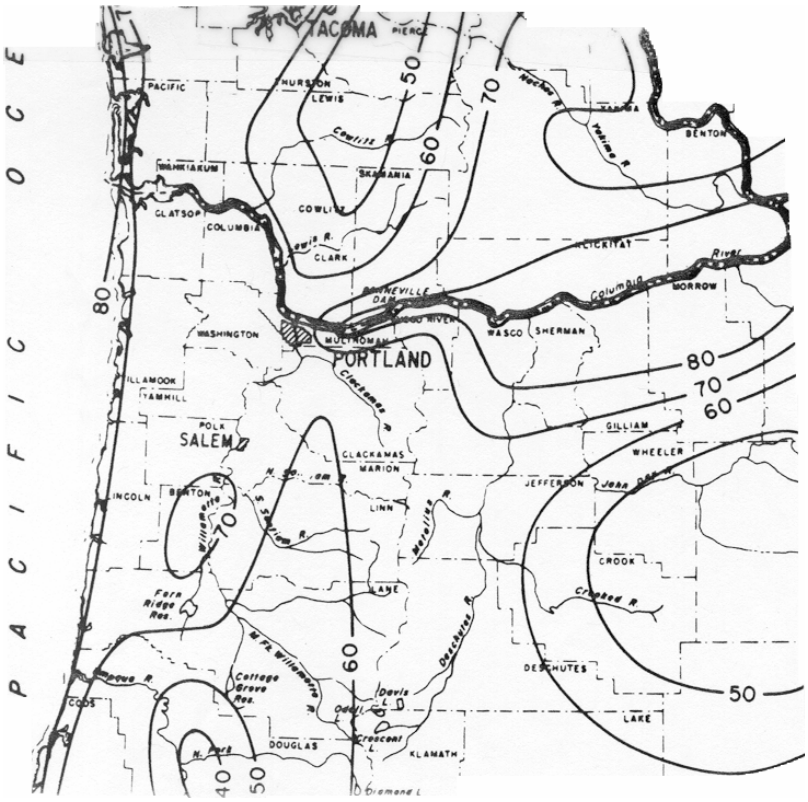
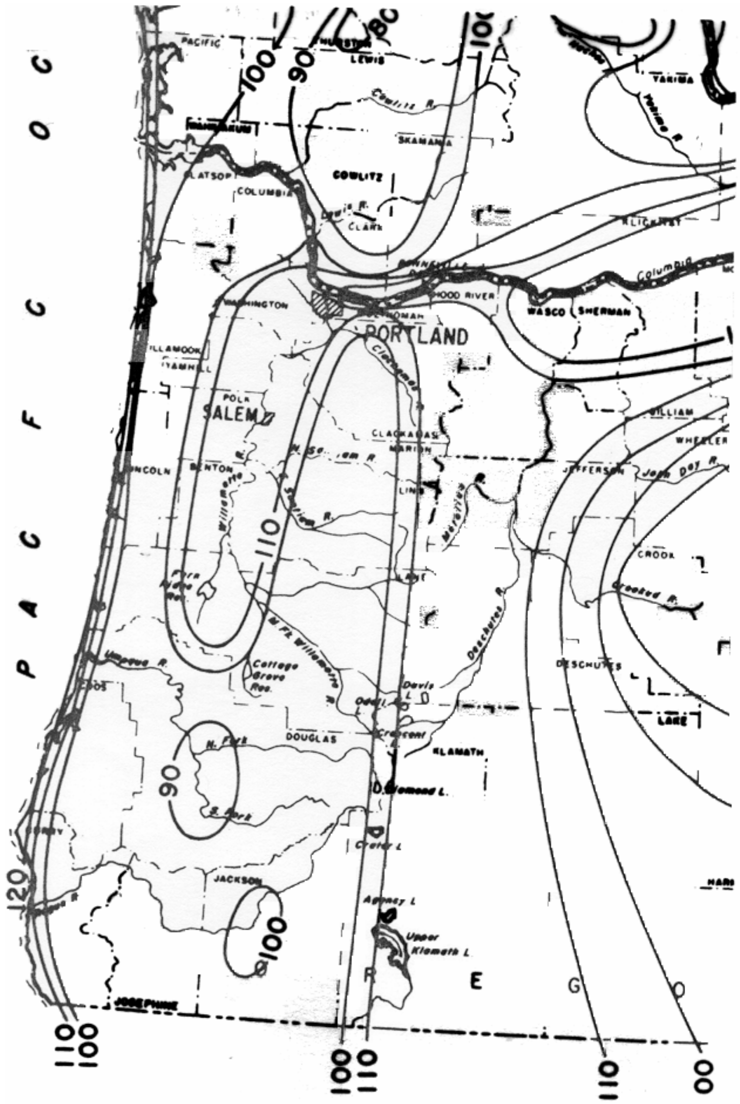


Figure 6.4
Wind Speed Contours for 50-Year Recurrence Interval
(km/hr)



6.2.3 Historical Winter Storm Data for Lane County

Winter storms can affect the Lane County area directly, or indirectly, with damage outside the area but affecting transportation to/from the area and/or utility services (especially electric power). Historically, the area has often been subject to both direct and indirect impacts of winter storms.

Deleted: with damage within Lane County Area,

The winter storms that affect Lane County are typically not local events affecting only small geographic areas. Rather, the winter storms are typically large cyclonic low pressure systems moving from the Pacific Ocean that usually affect large areas of Oregon and/or the entire Pacific Northwest.

Deleted: and

Deleted: thus

Deleted: whole

Historical winter storm data complied by the Portland Office of the National Weather Service (www.wrh.noaa.gov/Portland/windstorm.html) list the following major winter storm events with substantial wind damage in Oregon:

1. February 7, 2002
2. December 12, 1995
3. November 13-15, 1981
4. March 25-26, 1971
5. October 2, 1967
6. March 27, 1963
7. October 12, 1962
8. November 3, 1958
9. December 21-23, 1955
10. December 4, 1951
11. November 10-11, 1951
12. April 21-22, 1931
13. January 20, 1921
14. January 9, 1880.

The website referenced above has informative narrative summaries of each winter storm event, including wind speed data and damage reports. Similar compilations of historical wind storm data have been compiled by Wolf Read (The Storm King) at Oregon State University (http://oregonstate.edu/~readw/). The OSU website has a vast archive of historical winter storm data for Oregon.

The impacts of the major historical winter storm events listed above varied significantly with geographic location. Similar variations in impacts occur as well with the numerous smaller winter storm events. However, in terms of sustained wind speeds in the Willamette Valley and damage levels, the 1880 and 1962 storms stand out as the most severe such events.

The most recent major winter storm event to impact Lane County is the February 7, 2002 storm. National Weather Service data show peak sustained winds and peak gusts at the Eugene Airport of 49 mph and 70 mph, respectively. This windstorm was a Federally-declared disaster (FEMA-1405-DR-OR) for five counties, including Lane County. In the five county FEMA-declared disaster area, damages and costs to public facilities eligible for FEMA reimbursement (75%) totaled more than $6 million. Damages to private property are not included in this $6 million figure and so total damages were likely much higher than the FEMA reimbursement figure.

The 2002 windstorm event had significant impacts on Lane County Area, primarily from tree falls. Widespread tree falls resulted in significant damages to utility lines and poles as well as damages to vehicles and buildings. The most widespread impact on Lane County was numerous areas with localized loss of electric power from downed electric lines and poles.

6.3 Winter Storm Risk Assessment

Winter storm flooding and wind impacts may affect both infrastructure and buildings. Localized flooding from winter storms very commonly affects the transportation system, especially roads. Severe winter storms will result in numerous road closures due either to washouts or due to depth of water on road surfaces. Such localized flooding also affects buildings located in the flooded areas. Additional road closures are likely in some events from landslides/mudslides as well as from snow/ice storms.

Wind impacts from winter storms arise primarily from tree falls, which may affect vehicles and buildings, to some extent, but whose primary impact is often on utility lines, especially overhead power lines. Widespread wind damages may result in widespread downing of trees or tree limbs with resulting widespread downage of utility lines. Such tree-fall induced power outages affect primarily the local electric distribution system, because transmission system cables are generally less prone to tree fall damage because of design and better tree-trimming maintenance. In severe wind storms, direct wind damage or wind driven debris impacts on buildings cause building damages, especially for more vulnerable types of construction such as mobile homes.

Deleted: electric

As discussed above in Section 6.1, both winter storm flood hazards and winter storm wind hazards have highly localized impacts. The location and severity of such impacts depend very strongly on specific local conditions. Therefore, it is difficult to make regional risk assessment or loss estimates from mapping the hazards and overlaying the inventory: such a risk assessment simply requires too much detailed data which are not available.

An alternative approach is to document the severity and locations of winter storm flood and wind damage from historical events. A good example of this approach is the excellent summary of damages and losses experienced in a report that documented the damages in the February 1996 floods: **The Cascades West Region of Oregon and the February Flood of 1996: A Regional Flood Recovery Plan for Benton, Lane, Lincoln, and Linn Counties**, Oregon Cascades West Council of Governments, November 1996.

Deleted: the

For more quantitative risk assessment of localized flooding and wind damages arising from winter storms, the best approach is to systematically gather data on sites of repetitive damages due to localized flooding or wind damages. By documenting (and mapping using Geographic Information System software) the sites of repetitive damage events, along with documentation of the type and cost of damages and losses, the most seriously impacted sites can be clearly identified. Clearly, such repetitive loss sites with significant damages are likely candidates for mitigation actions.

The probable impacts of winter storms on Lane County are summarized below in Table 6.6.

Table 6.6
Probable Impacts of Winter Storms on Lane County

Inventory	Probable Impacts
Portion of Lane County affected	Entire County may be affected by road closures or loss of electric power; otherwise direct damages to buildings and infrastructure are likely to be localized and relatively minor
Buildings	Isolated minor damage from tree falls, some buildings affected by flood damage in major storms, especially in the storm water drainage problem areas identified in Section 6.3
Streets within communities	Minor road closures due to tree falls and flooding; limited impact because of short detour routes within communities
Roads within and to/from Lane County	Potential closures of some roads and major highways due to snow, debris flows or landslides, localized flooding and tree falls
Electric power	Loss of electric power may be localized due to tree falls on local distribution lines or affect larger areas if tree falls affect transmission lines
Other Utilities	Generally minor or no impacts on other utilities from winter storms
Casualties	Small potential for casualties (deaths and injuries) from tree falls or contact with downed power lines

6.4 Mitigation of Winter Storm Impacts

Potential mitigation projects for winter storms address any of the aspects of such storms, including floods, winds, and landslides (see Chapter 8)This reads awkward. See also Chapter 13 for additional discussion of the disruptions to utility and transportation systems.

Deleted: .

For winter storm flooding, the mitigation measures discussed in Chapter 6 (Floods) for local storm water drainage flooding are the same measures for the flood aspects of winter storms. Common mitigation projects include: upgrading storm water drainage systems, construction of detention basins, and structure-specific mitigation measures (acquisition, elevation, flood proofing) for flood-prone buildings. For roads subject to frequent winter storm flooding, possible mitigation actions include elevation of the road surface and improved local drainage. For utilities subject to frequent winter storm flooding, possible mitigation actions include improved local drainage, elevation or relocation of the vulnerable utility elements to non-flood prone areas nearby.

Deleted: exactly the mitigation

For wind effects of winter storms, the most common and most effective mitigation action is to increase tree trimming effects, because a high percentage of wind damage to utilities, buildings, vehicles, and people arises from tree falls. Trimming of trees subject to falling on utilities, buildings, vehicles, and people is an effective mitigation measure. However, economic, political and esthetic realities place limits on tree trimming as a mitigation action. Future wind storm damage in Lane County could be almost eliminated by cutting down all large trees in the area. Obviously, such an extreme mitigation measure is neither practical nor desirable for many reasons.

Effective tree trimming mitigation programs focus on limited areas where tree falls have a high potential to result in major damages and economic losses. High priority areas include examples such as the following:

1) Transmission lines providing electric power to the area,
2) Major trunk lines providing the backbone of the electric power distribution system within the area
3) Distribution lines for electric power to critical facilities in the area,
4) Specific circumstances where falling of large trees poses an obvious threat to damage buildings and/or people or close major transportation arteries.

Other effective mitigation projects as identified by Blachley-Lane Electric Cooperative, Emerald Public Utility District and Lane Electric Cooperative, Inc., include:

- Overhead to underground utility conversions, (undergrounding overhead lines) especially in heavily forested areas will greatly minimize outages. Unfortunately, cost is prohibitive to underground all rural systems but very effective in areas which have chronic problems.

- Rerouting overhead utilities out of heavily forested areas and nearer to roads with improved access would both minimize tree-caused outages and speed up restoration times in the event there is damage.

- Reframing and reconductoring sections of overhead lines to a more safe and reliable formation. This would include replacing old brittle wire, changing the configuration of existing wire, upgrading to stronger crossarms, changing from tie wire-type to clamp-type insulators. These are changes in configuration that help to minimize outages.

All utilities do these types of projects, but have limited resources and have to balance and weigh the impacts of improved reliability with affordable electric rates.

The report on the February 1996 floods, *The Cascades West Region of Oregon and the February Flood of 1996: A Regional Flood Recovery Plan for Benton, Lane, Lincoln, and Linn Counties*, November 1996, contains many dozens of examples sites which experienced winter storm flood (mostly) and other winter storm impacts. This report also included strategies for recovery and mitigation. There were ten county-wide strategies and fifteen community-specific strategies for the communities of Coburg, Cottage Grove, Florence, Mapleton, Marcola, Mohawk, the Port of Suislaw, and Springfield. Most of the county-wide strategies addressed planning issues, such as updating hazard mitigation plans, but also included flood mitigation measures such as stream bank stabilization efforts and an inventory and assessment of existing flood control dikes and levees in Lane County. ???? Selected examples of mitigation projects addressing flood aspects of winter storms are summarized below in Table 6.6. Because the 1996 even was predominantly a flood event, these strategies all address flood issues, and do not include measures for winds or other aspects of winter storms.

Deleted: The community-specific measures flood mitigation projects similar to those discussed in the Chapter 6 (Floods).

Table 6.7
Selected Mitigation Measures from 1996 Flood Report

Community	Mitigation Project/Strategy
Coburg	Storm water mitigation for downtown area
Cottage Grove	Erosion protection for banks of Row River and Coast Fork of the Willamette River
Florence	Storm water drainage upgrade for Idelwood subdivision
Marcola	Update and expand the Storm Water Master plan and include flood mitigation measures to prevent future damages
Mohawk	Stabilize the river bank, restore drainage systems and improve riparian vegetation along the Mohawk River.

Detailed analysis, benefit-cost analysis, and prioritization of winter storm mitigation projects for localized flooding or wind effects follows a methodology essentially identical to that described in Section 3.2 of the Regional All Hazard Mitigation Master Plan for Benton, Lane, Lincoln, and Linn Counties (Phase One, 1998). The analysis in Section 3.2 of the Phase One Plan 1998 for flooding outside of mapped floodplains uses a frequency-damage relationship to annualize risk and then to estimate the benefits of alternative mitigation projects. This same approach is applicable to evaluation of mitigation projects for wind effects of winter storms as well as for flood effects. This approach is also illustrated by examples in the Appendix to this Lane County Multi-Hazard Mitigation Plan.

The following table contains winter storm mitigation action items from the master Action Item table in Chapter 4.

Table 6.8
Winter Storm Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Ideas	Plan G		
					Public Awareness	Life Safety	Protect Property
Winter Storms Mitigation Action Items							
Short-Term #1	Enhance tree trimming efforts especialy for transmission llines and trunk distribution lines.	Elecric utility, City	Ongoing	pg. 4-3 pg. 7-9		X	
Short-Term #2	Encourage property owners to trim trees near service drops to individual customers	All Hazard Mitigation Planning Committee	Ongoing	pg. 4-3 pg. 7-9	X	X	
Short-Term #3	Ensure that all critical facilities in Lane County have backup power and emergency operations plans to deal with power outages	All Hazard Mitigation Planning Committee	1-2 Years	pg. 4-3 pg. 7-9		X	
Long-Term #1	Consider upgrading lines and poles to improve wind/ice loading, undergrounding critical lines, and adding interconnect switches to allow alternative feed paths and disconnect switches to minimize outage areas	Elecric utility, City	5 Years	pg. 4-3 pg. 7-9		X	
Long-Term #2	Encourage new developments to include underground power lines	Elecric utility, City	ongoing	pg. 4-3 pg. 7-9		X	