***Reminder:*** *We need to develop a response to the following summary of the public comments received on landslides.*

Ex. 5 - Deliberative

Ex. 5 - Deliberative

***Comment:*** *Some commenters acknowledged that landslides caused by logging practices such as clear cutting are a real problem in Oregon and additional management measures are necessary to address these impacts. It was noted that Oregon does not have sufficient programs in place to control non-point pollution from forestry practices, particularly due to logging on private lands.*

*Others expressed their disagreement with the federal agencies' recent decision and argued that the evidence provided by the federal entities was misleading, only focusing on "landslide density relationships" rather than considering the "total number of landslides triggered during major storms". If consider the latter, one would see that the "potential increases in sediment delivery to public resources from landslides...is proportionally small". In addition, it was argued that EPA has not offered objective evidence that additional management measures are needed to maintain water quality. It was recommended that EPA consider a broader scale view over longer timeframes to evaluate whether water quality and designated uses are impaired. The commenter added that the federal agencies have not produced any evidence that landslides resulting from forest management activities have caused exceedances in water quality or negatively impacted aquatic life.*

## Landslide Prone Areas

Oregon proposes to address this element of the additional management measures for forestry condition through a mix of regulatory and voluntary approaches. While the state has adopted more protective forestry rules to reduce landslide risks to life and property and promotes some voluntary practices to reduce landslide risks through the Oregon Plan for Salmon and Watersheds (The Oregon Plan), Oregon still does not have additional management measures for forestry in place to protect high risk landslide areas to ensure that water quality standards and designated uses are achieved.

Since receiving conditional approval on January 13, 1998, Oregon amended the Oregon FPA rules to require the identification of landslide hazard areas in timber harvesting plans and road construction and place certain restrictions on harvest and road activities within these designated high-risk landslide areas for public safety(OAR 629-623-0000 through 629-623-0800). However, under these amendments, shallow, rapidly moving landslide hazards directly related to forest practices are addressed only as they relate to risks for losses of life and property, not for potential water quality impacts. Oregon still allows timber harvest and the construction of forest roads, where alternatives are not available, on high-risk landslide hazard areas as long as it is not deemed a public safety risk.

In addition to these regulatory programs, Oregon employs a voluntary measure under the Oregon Plan that gives landowners credit for leaving standing live trees along landslide prone areas as a source of large wood. The large wood, which may eventually be deposited into

stream channels, contributes to stream complexity, a key limiting factor for coastal coho salmon recovery. While this is a good management practice, the measure is not designed to protect high-risk erosion areas but rather to ensure large wood exists to provide additional stream complexity when a landslide occurs.

As noted in the January 13, 1998, findings, timber harvests on unstable, steep terrain can result in increases in landslide rates which contribute to water quality impairments. A number of studies continue to show significant increases in landslide rates after clear-cutting compared to unmanaged forests in the Pacific Northwest. For example, Robinson et.al (1999) found that three out of four areas studied in very steep terrain and landslide densities and erosion volumes greater in stands that were clearcut during the previous nine years. [1] Research by Montgomery et. al (2000), and Turner et. al. (2010) is also consistent with this finding that timber harvest increase landslide rates. Robinson et.al also found that timber harvests on unstable, steep terrain can result in increases in landslide rates of approximately 200 to 400 percent.[2] Montgomery et. al. (2000)[3] concluded that landslide rates in Mettman Ridge in the Oregon Coast Range increased after clear cutting at a rate of three to nine times the background rate for the region. The regional analysis from the Mettman Ridge study found that forest clearing dramatically accelerates shallow landsliding in steep terrain typical of the Pacific Northwest.

Turner et al. (2010)[4], also found that rain fall intensity, slope steepness, and stand age contributed to landslide rates. Very few landslides occurred when rainfall was less than or equal to a 100-year rainfall event) and at higher rainfall intensities, steep slopes had significantly higher landslide densities compared to lower gradient slopes. In addition, they found that at higher rainfall intensities, the density of landslides in recently harvested sites was roughly two to three times the landslide density in older stands.

Schmidt et. al (2001) examined the role of root cohesion on landslide susceptibility in forested landscapes. Root cohesion is a measure of the lateral reinforcing strength the root system provides.[5] A higher root cohesion, the better the root system can stabilize the soil, reducing the risk of landslides.. Schmidt et. al. found that median lateral root cohesion is less for industrial forests with significant understory and deciduous vegetation (6.8–23.2 kPa) compared to natural forests dominated by conifers (25.6–94.3 kPa). In clearcuts, Schmidt et. al found that lateral root cohesion is uniformly less than or equal to 10 kPa, making these areas much more susceptible to landslide.

In 2004, Sakals and Sidle modeled the effect of different harvest methodologies on root cohesion over time. [9] They found that, of the methodologies examined, clear-cutting produces

---

[1] Robinson, E.G., K. A. Mills, J. Paul, L. Dent, A. Sakugset, 1999. Oregon Department of Forestry Storm Impacts and Landslides of 1996

[2] Robinson, E.G., K. A. Mills, J. Paul, L. Dent, A. Sakugset, 1999. Oregon Department of Forestry Storm Impacts and Landslides of 996

[3] Montgomery, D. R., K. M. Schmidt, H. M. Greenberg & W. E. Dietrich, 2000. Forest clearing and regional landsliding. Geology 28: 311–314.

[4] Turner, T.R., Duke, S.D., Fransen, B.R., Reiter, M.L., Kroll, A.J., Ward, J.W., Bach, J.L., Justice, T. E., and R.E. Bilby. 2010. Landslide densities associated with rainfall, stand age, and topography on forested landscapes, southwestern Washington, USA. Forest Ecology and Management 259 (2010) 2233–2247

[5] Wu, T.H. 1995. Slope stabilization. *In* Slope stabilization and erosion control: A bioengineering approach. *Edited by* R.P.C. Morgan and R.J. Rickson. E & FN Spon, London, pp. 221–264.

[9] Sakals, M.E. and R.C. Sidle. 2004. A spatial and temporal model of root cohesion in forest soils. Canadian Journal of Forest Research 34(4): 950-958.

the greatest decline in root cohesion. Further, that root cohesion may continue to decline for 30 years post-harvest. That decline is attributed to the decay of the root systems of the harvested trees, and the fact that young root systems have smaller root volumes and less radial rooting extent. They concluded that clear-cutting on hazard slopes could increase the number of landslides as well as the probability of larger landslides. They also stated that a management approach requiring the retention of conifers on high-risk slopes would increase root cohesion and reduce the risk of landslide.

Not only has the science demonstrated that timber harvesting can contribute to landslides but that these landslides also degrade water quality and impair designated uses in streams the Pacific Northwest. Whittaker and McShane cited that:

> In the Pacific Northwest, landslide frequencies in areas with forest clearing are up to thirty-four times higher than natural background rates (Rood, 1984). Timber harvest is the primary factor responsible for this difference (Sidel et al., 1985). Landslides alter aquatic habitats by elevating sediment delivery, creating log jams, and causing debris flows that scour streams and stream valleys down to bedrock (Rood, 1984; Cederholm and Reid, 1987; Hogan et al., 1998). The short-term and long-term impacts of higher rates of landslides on fish include habitat loss, reduced access to spawning and rearing sites, loss of food resources, and direct mortality (Cederholm and Lestelle, 1974; Cederholm and Salo, 1979; Reeves et al., 1995). The restoration of geomorphic processes to natural disturbance regimes is crucial to the recovery of endangered salmonids (*Oncorhynchus* spp.) and other aquatic species in the Pacific Northwest as these species evolved under conditions with much lower sediment delivery and landslide frequency (Reeves et al., 1995; Montogomery, 2004).

In addition, in northern California, the North Coast Regional Water Quality Board and the U.S. Environmental Protection Agency listed the Elk River Watershed, under the Clean Water Act Section 303(d), as a sediment impaired water body.

> Sediment discharges and sedimentation exceed the water quality objectives for sediment, suspended material, settleable matter and turbidity resulting in adverse impact to several beneficial uses, including domestic water supplies (MUN), agricultural water supplies (AGR), cold water habitat (COLD); spawing , reproduction and early development(SPWN); rare, threatened, or endangered species (RARE), and recreation (REC-1 and REC-2). Sedimentation has also resulted in conditions of nuisance, including elevated rates of annual flooding, loss of property, loss of use of property, loss of access to property and risk to human health and welfare.

The North Coast Regional Water Quality Board is currently working on a TMDL to address the water quality impairments due to sedimentation in this watershed. Sediment budgets were established for both the North Fork and South Fork Elk Rivers. The report completed by Stillwater Sciences to support the development of the TMDL, indicates that:

> The majority of sediment delivered in the North Fork Elk River system originates from landslides. The main factors contributing to landslides and other management related sediment supply in the Elk River basin are (PWA 1998, PALCO 199, PALCO 2004a, PALCO 2004b):

- Poorly located, constructed , or maintained roads;
- Logging with ground-based systems on steep slopes;
- Harvesting on inherently unstable slopes;
- Temporary reduction in root strength from clear cutting; and
- Legacy problems associated with old skid trails and abandoned roads.

In Oregon, the State has identified several waters in the Mid-Coast Basin as being water quality limited due to sedimentation, turbidity and biocriteria impacts with sediment as the stressor. As part of the TMDL development process, the State is accessing the water quality impacts from landslides, and based on its findings, will assign load allocations, as appropriate to address the listings.

There is abundant evidence that shows clear-cutting increases the rate of landslides and that landslides can effect water quality and beneficial uses. Additional management measures are needed to provide greater protection of landslide prone areas for the protection of water quality in Oregon. To meet this additional management measure requirement, the state must adopt similar harvest and road construction restrictions for all high-risk landslide prone areas with the potential to impact water quality and designated uses, not just those areas where landslides pose risks to life and property. These restrictions could be site specific taking into account factors such as slope, geology and geography on existing or planned land management activities. The state may also want to consider using slope instability screening tools that help identify high-risk landslide areas to minimize landslide rates and potential impacts to water quality and beneficial uses.

If the Oregon plans to rely on voluntary efforts, the state must describe the full suite of voluntary practices it plans to use address this management measure, how the state will promote these voluntary practices, and meet the other requirements when using voluntary programs to meet 6217(g) management measure requirements (i.e., a legal opinion asserting the state has back-up authority to ensure implementation of the management measure, a commitment to use the back-up authority, and a description of the monitoring and tracking program the state will use to assess how it will monitor and track implementation of the voluntary approach.

***Reminder:*** *We need to develop a response to the following summary of the public comments received on landslides. We need to make sure we strengthen our rationale to address any apparent weaknesses the public pointed out in our proposed findings.*

***Comment:*** *Some commenters acknowledged that landslides caused by logging practices such as clear cutting are a real problem in Oregon and additional management measures are necessary to address these impacts. It was noted that Oregon does not have sufficient programs in place to control non-point pollution from forestry practices, particularly due to logging on private lands.*

*Others expressed their disagreement with the federal agencies' recent decision and argued that the evidence provided by the federal entities was misleading, only focusing on "landslide density relationships" rather than considering the "total number of landslides triggered during major storms". If consider the latter, one would see that the "potential increases in sediment delivery to public resources from landslides...is proportionally small". In addition, it was argued that EPA has not offered objective evidence that additional management measures are needed to maintain water quality. It was recommended that EPA consider a broader scale view over longer timeframes to evaluate whether water quality and designated uses are impaired. The commenter added that the federal agencies have not produced any evidence that landslides resulting from forest management activities have caused exceedances in water quality or negatively impacted aquatic life.*

**Formatted:** Left

## Landslide Prone Areas

-Oregon proposed~~d~~s to address this element of the additional management measures for forestry condition through a mix of regulatory and voluntary approaches. While the s~~S~~tate has adopted more protective forestry rules to reduce landslide risks to life and property and promoted~~d~~s some voluntary practices to reduce landslide risks through the Oregon Plan for Salmon and Watersheds (The Oregon Plan), Oregon still does not have additional management measures for forestry in place to protect high risk landslide areas to ensure that water quality standards and designated uses are achieved.

**Comment [AC1]:** Stick with this original language as it was written this way on purpose—to match the language we used in the 1998 conditional approval findings.

Since receiving conditional approval on January 13, 1998, Oregon amended the Oregon FPA rules to require the identification of landslide hazard areas in timber harvesting plans and road construction and place certain restrictions on harvest and road activities within these designated high-risk landslide areas for public safety-(OAR 629-623-0000 through 629-623-0800). However, under these amendments, shallow, rapidly moving landslide hazards directly related to forest practices are addressed only as they relate to risks for losses of life and property, not for potential water quality impacts. -Oregon still allows timber harvest and the construction of forest roads, where alternatives are not available, on high-risk landslide hazard areas as long as it is not deemed a public safety risk.

In addition to these regulatory programs, Oregon employs a voluntary measure under the Oregon Plan that gives landowners credit for leaving standing live trees along landslide prone

areas as a source of large wood. The large wood, which may eventually be deposited into stream channels, contributes to stream complexity, a key limiting factor for coastal coho salmon recovery. While this is a good management practice, the measure is not designed to protect high-risk erosion areas but rather to ensure large wood exists to provide additional stream complexity when a landslide occurs.

As noted in the January 13, 1998, findings, timber harvests on unstable, steep terrain can result in increases in landslide rates which contribute to water quality impairments. A number of studies continue to show significant increases in landslide rates after clear-cutting compared to unmanaged forests in the Pacific Northwest. ~~In a study completed in June 1999, "Oregon Department of Forestry, Storm Impacts and Landslides of 1996: Final Report"~~ For example, Robinson et.-al (1999) ~~indicated~~ found that ~~in~~ three out of four areas studied in very steep terrain and~~, both~~ landslide densities and erosion volumes ~~were~~ greater in stands that ~~which~~ were clearcut during~~in~~ the previous nine years.[1] –Research by ~~XX,~~ Montgomery et. al (2000), and Turner et. al. (2010) is also consistent with this finding that timber harvest increase landslide rates. ~~Other evidence X~~ Robinson et.al also~~X~~ found that ~~indicates that~~ timber harvests on unstable, steep terrain can result in increases in landslide rates of approximately 200 to 400 percent.[2]- ~~(I need to include a footnote for this document)~~

-

~~For example, in the 2000 study, "Forest Clearing and Regional Landsliding,"~~ Montgomery et. al. (2000)[3], concluded that landslide rates in Mettman Ridge in the Oregon Coast Range increased after clear cutting at a rate of three to nine times the background rate for the region. -The regional analysis from ~~this~~ the Mettman Ridge study found that forest clearing dramatically accelerates shallow landsliding in steep terrain typical of the Pacific Northwest.

~~Another study by~~ Turner et al. (2010)[4], ~~which Oregon also cited in its July 2013 submission, indicated~~ also found that rain fall intensity, slope steepness, and stand age contributed to landslide rates. Very few landslides occurred when rainfall was less than or equal to a 100-year rainfall event) and at ~~that at~~ higher rainfall intensities, steep slopes had significantly higher landslide densities ~~occurred on steep slopes~~ compared to lower gradient slopes. In addition, they ~~The study also~~ found that at higher rainfall intensities, the density of landslides in recently harvested sites was roughly two to three~~2-3~~ times the landslide density in older stands.

Schmidt et. al (2001) examined the role of root cohesion on landslide susceptibility in forested landscapes. Root cohesion is a measure of the lateral reinforcing strength the root system provides.[5] A higher root cohesion, the better the root system can stabilize the soil, reducing the risk of landslides.~~One reason landslides on hazard slopes are closely associated with forest~~

**Comment [CJ2]:** You described two studies: 2010 & 2000. Where can the others be found?

**Ex. 5 - Deliberative**

with certain amount of rainfall …).

**Comment [AC3]:** Need to provide citation for this study.

**Comment [AC4]:** Can we say found rather than "indicate?" **Ex. 5 - Deliberative**

Ex. 5 - Deliberative

**Formatted:** Highlight

---

[1] Robinson, E.G., K. A. Mills, J. Paul, L. Dent, A. Sakugset, 1999. Oregon Department of Forestry Storm Impacts and Landslides of 1996[1] ~~[citation for Robinson et. al 1999 study.~~

[2] ~~[citation or other study]~~Robinson, E.G., K. A. Mills, J. Paul, L. Dent, A. Sakugset, 1999. Oregon Department of Forestry Storm Impacts and Landslides of 996.

[3] Montgomery, D. R., K. M. Schmidt, H. M. Greenberg & W. E. Dietrich, 2000. Forest clearing and regional landsliding. Geology 28: 311–314.

[4] Turner, T.R., Duke, S.D., Fransen, B.R., Reiter, M.L., Kroll, A.J., Ward, J.W., Bach, J.L., Justice, T. E., and R.E. Bilby. 2010. Landslide densities associated with rainfall, stand age, and topography on forested landscapes, southwestern Washington, USA. Forest Ecology and Management 259 (2010) 2233–2247

[5] Wu, T.H. 1995. Slope stabilization. *In* Slope stabilization and erosion control: A bioengineering approach. *Edited by* R.P.C. Morgan and R.J. Rickson. E & FN Spon, London, pp. 221–264.

**Formatted:** Font: Calibri, 8 pt

**Formatted:** Font: Cambria

~~clearing is root cohesion. R~~[6]. [7]Schmidt et. al. found that median lateral root cohesion ~~(measured in kilopascals, a measurement of pressure)~~ is less for industrial forests with significant understory and deciduous vegetation (6.8–23.2 kPa) compared to natural forests dominated by conifers (25.6–94.3 kPa). In clearcuts, ~~the~~Schmidt et. al ~~paper~~found that lateral root cohesion is uniformly less than or equal to 10 kPa, making these areas much more susceptible to landslide.

~~In a 2004 paper,~~ In 2004, Sakals and Sidle[8] modeled the effect of different harvest methodologies on root cohesion over time.[9] -They found ~~ir findings suggest~~ that, of the methodologies examined, clear-cutting produces the greatest decline in root cohesion. Further, that root cohesion may continue to decline for 30 years post-harvest. That decline is attributed to the decay of the root systems of the harvested trees, and the fact that young root systems have smaller root volumes and less radial rooting extent. ~~Their findings~~ They concluded that ~~imply that~~ clear-cutting on hazard slopes could increase the number~~s~~ of landslides as well as the probability of larger landslides. They also stated that ~~A~~a management approach requiring the retention of conifer~~sous vegetation~~ on high-risk slopes would increase root cohesion and reduce the risk of landslide.

**Comment [AC5]:** Ex. 5 - Deliberative
Ex. 5 - Deliberative

**Comment [AC6]:** What other methodologies were examined? Would adopted one of the other methodologies be a bmp we'd want to promote?

**Comment [AC7]:** Ex. 5 - Deliberative
Ex. 5 - Deliberative

**Comment [AC8]:** Is this something they recommended or something we are concluding from their statement. Assuming it's the researches in which case we should be clear.

-Not only has the science demonstrated that timber harvesting can contribute to landslides but that these landslides also degrade water quality and impair designated uses in streams the Pacific Northwest. Whittaker and McShane cited that:

> In the Pacific Northwest, landslide frequencies in areas with forest clearing are up to thirty-four times higher than natural background rates (Rood, 1984). Timber harvest is the primary factor responsible for this difference (Sidel et al., 1985). Landslides alter aquatic habitats by elevating sediment delivery, creating log jams, and causing debris flows that scour streams and stream valleys down to bedrock (Rood, 1984; Cederholm and Reid, 1987; Hogan et al., 1998). The short-term and long-term impacts of higher rates of landslides on fish include habitat loss, reduced access to spawning and rearing sites, loss of food resources, and direct mortality (Cederholm and Lestelle, 1974; Cederholm and Salo, 1979; Reeves et al., 1995). The restoration of geomorphic processes to natural disturbance regimes is crucial to the recovery of endangered salmonids (*Oncorhynchus* spp.) and other aquatic species in the Pacific Northwest as these species evolved under conditions with much lower sediment delivery and landslide frequency (Reeves et al., 1995; Montogomery, 2004).

In addition, in northern California, the North Coast Regional Water Quality Board and the U.S. Environmental Protection Agency listed the Elk River Watershed, under the Clean Water Act Section 303(d), as a sediment impaired water body.

> Sediment discharges and sedimentation exceed the water quality objectives for sediment, suspended material, settleable matter and turbidity resulting in adverse

[6] ~~Wu, T.H. 1995. Slope stabilization. *In* Slope stabilization and erosion control: A bioengineering approach. *Edited by* R.P.C. Morgan and R.J. Rickson. E & FN Spon, London, pp. 221–264.~~
[7] ~~Schmidt, K.M., Roering, J.J., Stock, J.D., Dietrich, W.E.,Montgomery, D.R., and Schaub, T. 2001. Root cohesion variability and shallow landslide susceptibility in the Oregon Coast Range. Canadian Geotechnical Journal, **38**: 995–1024.~~
[8] ~~Sakals, M.E. and R.C. Sidle. 2004. A spatial and temporal model of root cohesion in forest soils. Canadian Journal of Forest Research 34(4): 950-958.~~
[9] Sakals, M.E. and R.C. Sidle. 2004. A spatial and temporal model of root cohesion in forest soils. Canadian Journal of Forest Research 34(4): 950-958.

impact to several beneficial uses, including domestic water supplies (MUN), agricultural water supplies (AGR), cold water habitat (COLD); spawing , reproduction and early development(SPWN); rare, threatened, or endangered species (RARE), and recreation (REC-1 and REC-2). Sedimentation has also resulted in conditions of nuisance, including elevated rates of annual flooding, loss of property, loss of use of property, loss of access to property and risk to human health and welfare.

The North Coast Regional Water Quality Board is currently working on a TMDL to address the water quality impairments due to sedimentation in this watershed. Sediment budgets were established for both the North Fork and South Fork Elk Rivers. The report completed by Stillwater Sciences to support the development of the TMDL, indicates that:

> The majority of sediment delivered in the North Fork Elk River system originates from landslides. The main factors contributing to landslides and other management related sediment supply in the Elk River basin are (PWA 1998, PALCO 199, PALCO 2004a, PALCO 2004b):
>
> - Poorly located, constructed , or maintained roads;
> - Logging with ground-based systems on steep slopes;
> - Harvesting on inherently unstable slopes;
> - Temporary reduction in root strength from clear cutting; and
> - Legacy problems associated with old skid trails and abandoned roads.

In Oregon, the State has identified several waters in the Mid-Coast Basin as being water quality limited due to sedimentation, turbidity and biocriteria impacts with sediment as the stressor. As part of the TMDL development process, the State is accessing the water quality impacts from landslides, and based on its findings, will assign load allocations, as appropriate to address the listings.

There is abundant evidence that shows clear-cutting increases the rate of landslides and that landslides can effect water quality and beneficial uses. Additional management measures are needed to provide greater protection of landslide prone areas for the protection of water quality in Oregon. To meet this ~~e~~ additional management measure ~~relating to high-risk landslide prone areas~~ requirement, ~~,~~ the s~~S~~tate must adopt similar harvest and road construction restrictions for all high-risk landslide prone areas with the potential to impact water quality and designated uses, not just those areas where landslides pose risks to life and property.- These restrictions could be site specific taking into account factors such as slope, geology and geography o~~r~~n existing or planned land management activities. ~~-~~The state may also want to consider using slope instability screening tools that help identify high-risk landslide areas to minimize landslide rates and potential impacts to water quality and beneficial uses. ~~The State employs a voluntary measure under the Oregon Plan that gives landowners credit for leaving standing live trees along landslide prone areas as a source of large wood. The large wood, which may eventually be deposited into stream channels, contributes to stream complexity, a key limiting factor for coastal coho salmon recovery.~~

**Comment [AC9]:** But what are the bmps that they should use once the high-risk areas are identified?

If the Oregon plans to rely on voluntary efforts, the state must describe the full suite of voluntary practices it plans to use address this management measure, how the state will promote these voluntary practices, and meet the other requirements when using voluntary programs to meet 6217(g) management measure requirements (i.e., a legal opinion asserting

the state has back-up authority to ensure implementation of the management measure, a commitment to use the back-up authority, and a description of the monitoring and tracking program the state will use to assess how it will monitor and track implementation of the voluntary approach. ~~While Oregon desires to better capture and evaluate the implementation and effectiveness of voluntary measures, the state has not shown how it intends to do to demonstrate how these voluntary programs ensure water quality and designated uses are protected from landslide impacts, nor has Oregon provided a commitment to exercise those back-up authorities where necessary to protect water quality and designated uses to ensure implementation of this measure. These are required elements if a state chooses to use voluntary programs to support its coastal nonpoint program (see the federal agencies' 1998 Final Administrative Changes guidance).~~