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EFFECTS OF POST-FIRE SALVAGE LOGGING ON COMPACTION, INFILTRATION, WATER REPELLENCY, AND SEDIMENT YIELD AND THE EFFECTIVENESS OF SUBSOILING ON SKID TRAILS

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EFFECTS OF POST-FIRE SALVAGE LOGGING ON COMPACTION,
INFILTRATION, WATER REPELLENCY, AND SEDIMENT YIELD AND THE
EFFECTIVENESS OF SUBSOILING ON SKID TRAILS

By

Iskender Demirtas

A THESIS

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

In Forestry

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This thesis has been approved in partial fulfillment of the requirements for the Degree of
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Preface

Effects of Post-Fire Salvage Logging on Compaction, Infiltration, Water Repellency, and Sediment Yield and The Effectiveness of Subsoiling on Skid Trails.

Research and field data obtained in collaboration with Joe Wagenbrenner of Michigan Tech and the USDA Forest Service and Will Olsen of Michigan Tech. Research questions and analysis of data were completed by Iskender Demirtas with assistance by Joe Wagenbrenner.

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Also, I am happy and very grateful to my spouse Bahar Demirtas who helped me in the field and cooked incredibly delicious food every day. She saved my time for my thesis and she was my collaborator in the field, and she motivated me to spend better time while working also lighten my burden and saved me time for my thesis.

Also, I owe many thanks to my committee for their valuable time, energy, and helping my research come to a conclusion.

Lastly, I owe the greatest thanks to Joe Wagenbrenner for the unique and wonderful chance to work in a new field. Also, he spent a lot of time to teach me how to become a scientist in the field, classroom and through improving my writing. Also, most importantly, my largest win is a good life discipline from him for professional work life.

Abstract of Thesis

Post-fire salvage logging operations can induce environmental problems. This study assessed the effects of different disturbances from post-fire salvage logging on soil bulk density, water repellency, field saturated hydraulic conductivity (Kfs), ground cover, and sediment yields after the 2013 Rim Fire in California. Hillslope plots were installed in three locations (Sawmill, lower Femmons, and upper Femmons). The plot-scale disturbances were burned and untrafficked (low and high slope controls and logged only with no traffic), or burned and trafficked (few and many pass skid trails). Additional measurements were made in nearby areas that included the plot-scale disturbances as well as feller buncher tracks and mixed disturbed areas. We measured soil bulk density at two depths. Kfs was measured using a dual head ring infiltrometer. Water repellency was measured at the mineral soil surface and at 1 cm and 3 cm soil depths. Ground cover was measured in each hillslope plot. Sediment yields from the hillslope plots were measured using sediment fences. Measurements in burned areas were made in water years 2015 and 2016. Bulk density, water repellency, and Kfs measurements were also made in one unburned logged site. We assessed the effectiveness of subsoiling of skid trails in nearby burned areas, sometimes across the contour, as a mitigation practice by recording the presence or absence of rills or gullies.

The mean bulk densities in the trafficked plots were significantly higher than in untrafficked plots. Kfs was 10 times higher in untrafficked areas than in the many pass skid trails in the burned sites and significantly higher in the unburned site. There was no significant difference in KFS for any of the disturbance classes between the burned and unburned sites. In the burned areas, WDPT was highest at the 3 cm depth and was lower

in trafficked areas than untrafficked areas. WDPT was also significantly lower in burned areas than in unburned areas, where strong water repellency occurred across all depths and disturbance conditions. Untrafficked areas had relatively low bare soil in 2015 and the amount of bare soil decreased significantly in 2016. The trafficked plots had more bare soil than the untrafficked plots, and sometimes the differences were significant.

The annual sediment yield in the untrafficked plots in the Sawmill site was 1.9 Mg ha⁻¹ in the 2015 water year and this value significantly decreased to 0.14 Mg ha⁻¹ in the 2016. The sediment yields in the trafficked skid trail plots were 6.2 and 1.2 Mg ha⁻¹ in 2015 and 2016, respectively, and the 2016 yield was significantly greater than the untrafficked value. The annual sediment yields were also very low in untrafficked plots in the Femmons sites in 2016, and the trafficked plots produced significantly higher sediment yields. Some of the many pass skid trails were subsoiled (ripped) by logging contractors as part of the logging operation using a winged subsoiler with the wings set 45-60 cm below the soil surface. 53% of the 53 subsoiled skid trails had no rills or gullies present, and the rate of rilling or gullying increased with increasing skid trail slope. Subsoiling of skid trails with slopes more than 6% was not effective at reducing erosion because of the high incidence of rills or gullies.

These results indicate that salvage logging equipment compacted the soil in the burned forest. Soil compaction reduced water repellency and Kfs and increased bulk density, bare soil, and sediment yields. The sediment yields were most closely related to the change in bare soil. To reduce sediment yields from salvage logging, forest managers should consider increasing the ground cover on skid trails and other trafficked areas.

EFFECTS OF THE POST-FIRE SALVAGE LOGGING ON COMPACTION, INFILTRATION, WATER REPELLENCY, SEDIMENT YIELD AND EFFECTIVENESS OF SUBSOILING ON SKID TRAILS

1. Introduction¹

Wildfires are common large-scale natural disturbances around the world (Lindenmayer et al., 2008). Climate change is a significant factor that will make fires more frequent (Lindenmayer et al., 2008). For the management of forest ecosystems after a natural disturbance generally salvage logging is applied to recoup the economic value (Lindenmayer et al., 2008).

Wildfires have influences on infiltration, runoff, and erosion processes by burning surface cover, destroying soil structure, and increasing levels of soil-water repellency (DeBano, 1981; Ingalsbee, 2002; Martin and Moody, 2001). Specifically, after a fire infiltration capacity can decrease because of burned vegetative cover and destroyed soil structure (Benavides-Solorio and MacDonald, 2001; Larsen et al., 2009; Moody et al., 2013), and soil erosion can increase because burning can expose the soil to the erosive effects of rainfall and surface runoff (Benavides-Solorio and MacDonald, 2001; Larsen et al., 2009; Moody et al., 2013; Moody and Martin, 2001; Morris, 2013; Wagenbrenner et al., 2015).

Unburned forests generally produce low erosion rates, and these range from 0.02 to 1.2 Mg ha⁻¹ in small forested catchments in the western United States (Patric et al., 1984). In contrast, in a study of Colorado Front Range wildfires of varying ages,

¹ This thesis is in preparation for submission to a journal. It may be published in the future.

sediment delivery of 6.7 Mg ha^{-1} and 10.7 Mg ha^{-1} was measured in high burn severity sites in the first and second years after burning, respectively (Pietraszek, 2006). High burn severity fires have been indicated to increase runoff and the amount of sediment yields (Robichaud et al., 2013; Wagenbrenner et al., 2015), and these increases are caused by a series of changes in the underlying hydrologic processes (Wagenbrenner et al., 2015).

During a wildfire, most of the living vegetation and litter cover burn and this induces bare soil. Depending on the severity of the wildfire the loss of organic material can cause a series of changes in the underlying hydrologic processes including enhanced water repellency and lower infiltration rates (Moody and Martin, 2001; Pierson et al., 2008). High burn severity areas have more exposed bare soil than lower severity areas (Benavides-Solorio and MacDonald, 2001; Benavides-Solorio and MacDonald, 2005).

Precipitation is usually considered the most significant control on post-fire hydrologic and erosion responses (Moody et al., 2013). Post-fire sediment delivery is usually strongly affected by rainfall intensity (Larsen et al. 2009). A correlation analysis of factors controlling erosion in a study in Montana showed that sediment production was positively correlated with rainfall intensity and amount of bare soil (Wagenbrenner et al., 2015).

Many types of vegetation in fire-prone areas develop hydrophobic components in their leaves, and these can leach from the litter into the soil (Huffman et al., 2001). During burning, the heat can force hydrophobic substances downward through the soil profile, and this can induce the formation of or enhance an existing water-repellent soil

layer (DeBano, 1981; Neary et al., 2005). Extensive water repellent layers may prevent infiltration and contribute to runoff and erosion (DeBano, 1981), although this mechanism has not always been supported by empirical results (DeBano, 1981; Neary et al., 2005). After the fire, the soil is usually more water repellent in drier summer months, and soil water repellency declines in soil exposed to moisture (DeBano, 1981).

Burning most or all of the ground cover and vegetation can decrease interception and transpiration rates (Barkley, 2011). Reduction of the canopy and ground cover increases the evaporation rate from the surface of the soil (Barkley, 2011). The lack of plants, litter cover and other components expose the soil surface directly to raindrops, and this can lead to increased soil sealing and decreased infiltration (Pierson et al., 2008). Also, there is a strong nonlinear relationship between reduced vegetative cover and increased surface soil erosion (Larsen et al., 2009; Morris, 2013). Reduction in surface cover increases the erosion from rain splash and also increases overland flow velocities, which increase peak flows, sheet wash, rilling and gullyng (Moody et al., 2013; Robichaud et al., 2010).

Due to fire, the structure of organic soil changes because of the loss of the organic soil materials (DeBano, 1981; Neary et al., 2005), and this tends to make the soil more erodible (DeBano, 1981). These changes in soil properties and hydrologic processes increase runoff and can cause an increase in erosion of up to several orders of magnitude (Benavides-Solorio and MacDonald, 2001; Morris, 2013; Robichaud, 2000).

Salvage logging is described by the Society of American Foresters (Helms, 1998) as “dead, damaged and dying tree removal because of injurious factors to recover losing

economic value and preparation for plantation.” Salvage logging is widely performed around the world (Lindenmayer et al., 2008). Salvage logging is a common response to wildfire by forest managers on public and private land (Lindenmayer et al., 2008). Salvage logging can be done after a wide variety of disturbances, including wildfires (McIver and Starr, 2001), insect attacks (Radeloff et al, 2000), hurricanes, cyclones, and other severe windstorms (Foster and Orwig, 2006; Nilsson, 1975).

Burned trees rapidly lose economic value which requires rapid salvage logging in the first two to three years after a fire (Mciver and Starr, 2001). Salvage logging has also been practiced for safety concerns to reduce the risk of standing dead trees from falling on forest roads, other infrastructure, or on forest workers or visitors (Ne'eman et al., 1997; Shore et al., 2003). Sometimes fire-killed trees are removed to reduce the potential for pathogens and pests which can subsequently invade adjacent unburned forests (Hughes and Drever 2001).

Although salvage logging activities have benefits, the logging operations can induce some additional environmental problems in the recently burned forest (Wagenbrenner et al., 2015). The main environmental impact of post-fire logging is the effects on soils related to the logging operation (García-Orenes et al., 2017; McIver and Starr, 2001; Wagenbrenner et al., 2015) and this is the focus of our study. Other factors, such as the effects of the forest structure, soil structure ground cover, and wildlife habitat, have been addressed in other studies (García-Orenes et al., 2017; Mciver and Starr, 2001). The effects of the logging activity of greatest hydrological concern include soil

and ground cover disturbance, infiltration capacity, water repellency, soil compaction, runoff, and sediment yield (McIver and Starr, 2001; Wagenbrenner et al., 2015).

Previous studies have shown that heavy logging equipment traffic has several varying impacts on infiltration, surface runoff, and sediment delivery, and soil porosity (Jourgholami et al., 2014; Soltanpour and Jourgholami, 2013), and additionally logging equipment traffic reduces surface cover that increases infiltration, surface runoff and sediment delivery (Ares et al., 2005; Dias et al., 2007; McNabb et al., 2001; Wagenbrenner et al., 2015).

Post-fire salvage logging often induces soil compaction due to decreased micro and macro soil porosity where ground-based logging equipment operated (DeBano, 1981; Soltanpour and Jourgholami, 2013), and high compaction of the soil can further decrease infiltration capacity and increased runoff and erosion (Moody and Martin, 2001; Startsev and McNabb, 2000). The logging equipment creates pressure on the soil, and the pressure reduces the soil porosity and causes compaction (Souch et al., 2004). The compaction can also reduce the proportion of macrospores which further reduces infiltration rates (Soltanpour and Jourgholami, 2013). Previous studies have reported that most of the soil compaction from logging equipment occurred with the initial passes of the equipment and that subsequent machine passes resulted in additional compaction at a diminishing rate (Soltanpour and Jourgholami, 2013). Results of one study on post-fire logging showed that the compaction due to the heavy logging equipment extended to a depth of at least 10 cm, and relatively few passes of the logging equipment resulted in substantial compaction (Wagenbrenner et al., 2015). In at least one study, salvage logging reduced soil water

repellency due to disturbance of the soil in the skid trails in the burned forest (Wagenbrenner et al., 2015).

Soil compaction in unburned areas increases soil bulk density, although the degree of this effect can vary depending on logging equipment traffic (Soltanpour and Jourgholami, 2013). Soil compaction and removal of soil surface layer reduce vegetative regrowth of the plant root systems (Ponder, 1996). These changes in bulk density directly affect infiltration capacity in the unburned logged forest (Ponder, 1996).

Some of the effects of post-fire logging in recently burned areas may be mitigated by applying best management practices. Subsoiling or ripping skid trails can be done to reduce compaction of the soil and increase infiltration rates where logging activities have occurred. Ripping skid trails or forest roads that were used during logging operations can increase infiltration capacity, and decrease sediment delivery and compaction and may increase rates of revegetation (Switalski et al., 2004). However, ripping may produce mixed results in the long term (Switalski et al., 2004). Field saturated hydraulic conductivity (K_{fs}) was lower prior to ripping on road, but K_{fs} was higher after ripping and mulching on skid trails (Luce, 1997).

Goal and objectives

The goal of this study was to evaluate the effects of post-fire salvage logging on soil properties and hillslope-scale sediment yields. The specific objectives were to: (1) determine the effects of specific salvage logging activities on K_{fs} , soil bulk density, and soil water repellency in burned and unburned sites; (2) determine effects of salvage

logging disturbances on hillslope-scale sediment yields; and (3) determine the effectiveness of subsoiling of skid trails.

2. Methods

2.1. Study Areas

We used burned and unburned areas in the 2013 Rim Fire to address our objectives. The Rim fire burned area is located in the western Sierra Nevada near Groveland and Sonora, California (Figure 1). The Rim Fire began on August 17, 2013, and burned 1041 km² ha by September 21, 2013 (USDA Forest Service, 2014). Five study locations were selected in the Rim fire. Four of the areas were burned by the wildfire, and one area was unburned but located within the Rim Fire border. The burned sites were Sawmill, lower and upper Femmons, and Triple-A and the unburned Evergreen site (Figure 2). The Femmons sites were only about 2 km apart but treated as different sites because of differences in soils, vegetation and logging impacts.

The 1955-2010 annual average precipitation was 84 cm at the Mather rain gage which was the closest climate station to Sawmill, Triple-A, and Evergreen (37.89N, 119.86W, 1375 m elevation) (NOAA, 2017). For Femmons sites, the average precipitation for 1955-2010 was 120 cm at the Cherry Valley Dam rain gage (37.974 N, 119.916 W, 1452 m elevation) (NOAA, 2017). The study sites experience moist winters and dry summers and approximately 90 % of the precipitation occurs from October to April. The average temperature for the 2015 water year (October-September) ranged from 12 to 13.7 °C for the study sites (Western Regional Climate Center, 2016). Study site elevations ranged from 1150 to 1450 m and the slope of the study locations ranged from about 10-50%. Elevations less than about 1400 m, precipitation was mostly rain and

dominated by frontal storms. At higher elevations, there was a mix of rain and snow (Western Regional Climate Center, 2016).

The primary pre-fire vegetation in the study areas including the unburned Evergreen site was mixed conifer forest including ponderosa pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), Douglas-fir (*Pseudotsuga menziesii*), incense cedar (*Calocedrus decurrens*), and black oak (*Quercus velutina*) (USDA Forest Service, 2014). The understory was dominated by bear clover (*Chamaebatia foliolosa*), whiteleaf manzanita (*Arctostaphylos manzanita*), and canyon live oak (*Quercus chrysolepis*) (USDA Forest Service, 2014). Some areas, particularly in upper Femmons, had a sparse overstory and the vegetation was dominated by manzanita.

Burned areas consisted of three types of soil families including Holland, Josephine, and Sites and these families have surface soils dominated by loam textures, and these have high infiltration rates in the unburned condition. The upper soil profiles also had between 3-10% rock content in most locations, and the upper Femmons site had the highest amount of rock fragments on the surface. The pre-fire drainage classes in all the sites were mostly well drained (Table 1) (Soil Survey Staff, 2016). In the unburned Evergreen site, the soil family was Wintoner which had a surface layer with a loam texture, and this soil had a slightly higher infiltration capacity (Table 1) (Soil Survey Staff, 2016).

The four burned study sites were selected in areas of high burn severity based on a soil burn severity map and field observations (Parsons et al., 2010) (Figure 2), and similarity in physical attributes, were located within logging units and were within 0.5

km of a road. The unburned site was selected for similarity in climate, vegetation, and physical attributes.

2.2. Experimental Design

After the Rim Fire, ground-based post-fire salvage logging operations were done in the burned areas and ground-based logging was done on the unburned Evergreen site to remove trees infested by insects. The logging operations were completed at different times at the different sites. The salvage logging operations were done in summer 2014 in Sawmill, fall 2014 in Triple-A, spring 2015 in lower Femmons, fall 2015 in upper Femmons, and spring 2016 in unburned Evergreen. Roadside hazard tree removal was completed with tracked feller buncher and rubber tired or tracked skidders (Figure 6) for the Sawmill site. Commercial salvage logging was done with the same types of equipment at Triple-A and upper and lower Femmons, and the amount and size of the trees retained in the commercial units increased with time so that the most recently logged site (upper Femmons) had less impact than the earliest commercial (Triple-A) or roadside hazard tree removal (Sawmill). Larger trees in all sites were hand fell, and all sites had whole-tree skidding to landings where logs were delimbed and loaded on trucks.

The logging equipment induced different levels of disturbance, and we studied the effects of these levels by classifying the disturbance into treatments. Unlogged controls (C) had no logging disturbance and were burned except at the Evergreen site. Logged areas (L) had trees felled but no equipment traffic. Few pass (FP) skid trails had up to three equipment round trips, and many pass (MP) skid trails had 4 or more round trips

(Figure 7). Mix disturbed areas (MX) had a combination of multiple disturbances where the equipment type and a number of passes could not be distinguished (Figure 7). Feller-buncher tracks (FB) had only one pass of a feller-buncher (Figure 7), and skidder tracks (ST) on the Evergreen site had an unknown number of passes.

We established study plots at the hillslope scale (37-95 m²), where plots represented a uniform disturbance. Hillslope plot treatments included controls, logged only, few and many pass skid trails (Figure 8), and plots were identified after logging occurred. In Sawmill, a total of 15 hillslope plots were installed in 2014 in three different groups (Table 2, Figure 3). Each of the four hillslope scale treatments, plus a low-slope control plot used for comparison of the lower slope many-pass skid trail plots, was represented in each of the three areas (Table 2). Lower Femmons had one group of the four hillslope treatments, and upper Femmons had two groups of the four hillslope treatments installed in fall 2015 (Table 2, Figure 4), for a total of 27 hillslope plots.

The use of the hillslope plots in Sawmill and Femmons provided a comparison between the timing of logging relative to the fire as well as an assessment of the differences in soils and other site factors between the locations. We used the hillslope scale plots to compare the effects of the logging treatments on ground cover, soil bulk density, soil water repellency, field saturated hydraulic conductivity (Kfs), and sediment yield.

Small catchments (swales) (0.09-0.74 ha) were monitored in a related study where disturbance treatments were mapped in each swale using a 1-m resolution GPS (Olsen, 2016). The obtained GPS data were corrected and all processed in ArcMap. We used

these additional sites to increase the number of samples for testing the soil properties in areas affected by 5 treatments: controls, feller-buncher tracks, few pass and many pass skid trails, and mixed disturbance.

In Triple-A, we used seven swales, 2 of which were unlogged controls and 5 of which were salvage logged in fall 2014 (Figure 5). Each of the logged swales had all of the five different treatments except that one swale (ASW6) had no mixed disturbance. In lower Femmons, four swales were used, including one control and three that were logged in May 2015 (Figure 4). In upper Femmons, we used two control swales and one swale that was partially logged in September 2015 (Figure 4). At the Femmons sites: one logged swale (FSW9) had only control, feller buncher tracks and many pass skid trails; one logged swale (FSW10) did not include few pass skid trails; and the one logged swale in upper Femmons (FSW13) did not include any feller buncher tracks or mixed disturbance areas. The Evergreen site contained unburned, unlogged controls, few and many pass skid trails, mix disturbed areas, and skidder tracks. In each of the control swales, each treated area in the logged swales, and in four areas for each treatment at Evergreen we measured soil bulk density, soil water repellency, and Kfs. We separated results by water year (1 October to 30 September) for water years ending in 2015 and 2016.

2.3. Measurements

2.3.1. Precipitation

Precipitation was measured by nine tipping bucket rain gauges (Table 3) including five in Sawmill, two in lower Femmons, and two in upper Femmons. Every tip

recorded 0.254 mm of precipitation. The rain gauges were installed so that each plot was within about 50 meters of a rain gauge. Data were downloaded approximately every 6 months. The RainMaxLaz program (R. Brown, US Forest Service, unpublished software) was used to determine the total rainfall (mm), duration of the storm (min), and the 10-min, 30-min, and 60-min maximum rainfall intensities (I_{10} , I_{30} , and I_{60} , respectively, mm h^{-1}) for each storm event. Storm events were separated by a 6-hr period with no rainfall.

2.3.2. Soil Bulk Density

Soil compaction was evaluated by measuring dry bulk density for each treatment in each hillslope plot or disturbed area in the swales and in Evergreen. A soil core sampler was used to obtain bulk density samples. The soil core sampler consisted of a stainless steel housing that enclosed two 5 cm diameter by 5 cm long cylindrical cores, and a slide hammer (Figure 9A). The opening of the housing was tapered so that the outer diameter at the end of the housing was the same as the core diameter. The sampler was inserted into the soil so that the top of the soil being sampled was below the top of the upper core. Bulk density samples were then obtained from the lower of the two cores. Samples were taken at 0-5 cm and 5-10 cm in the mineral soil.

Bulk density sampling was done in all locations except Evergreen in both 2015 and 2016. Samples were taken from the unburned Evergreen site in 2016. All bulk density samples were dried for 24 hours at 105 °C to obtain the dry mass (Shukla et al., 2014) and dry mass was divided by the core volume to attain the bulk density.

2.3.3. Soil Water Repellency

Water repellency was measured at the soil surface and at depths of 1 cm and 3 cm below the mineral soil surface using the water drop penetration time (WDPT) test (DeBano, 1981) (Figure 9B). WDPT tests were completed in each plot and disturbed area in the swales and in Evergreen. The soil surface was cleaned of litter prior to starting the test. At each depth, the WDPT to a maximum of 5 minutes was recorded for eight water droplets. WDPT tests were completed in Sawmill, Triple-A, and lower Femmons in both 2015 and 2016, and in upper Femmons and Evergreen in 2016. WDPT was not measured in upper Femmons in 2015 because the plots were established during the wet period that year.

2.3.4. Field Saturated Hydraulic Conductivity (Kfs)

Infiltration measurements were conducted in 2015 and 2016 using a dual-head ring infiltrometer (Figure 9D) (Nimmo et al., 2009; Reynolds and Elrick, 1990) (Decagon Devices, Pullman, Washington) to determine the field-saturated hydraulic conductivity (Kfs) in all plots and disturbed areas in the swales. The infiltrometer was carefully driven 5 cm into the soil, and we removed any large pieces of bark inside the ring.

The same dual-head infiltrometer settings were used for all measurements. The settings were: seventy-five minutes total runtime, including a soak time of 15 min where the water in the ring was not pressurized, followed by two cycles of the simulated head of 5 cm and 10 cm for 15 min each. Infiltration measurements were completed in areas representing the treatment or disturbance type of the plot or disturbed area in the swale.

In 2016 bentonite clay was mixed with native soil and this mixture was used to seal the soil on the inside of the infiltrometer (Albright, 1995) (Figure 9C).

2.3.5. Ground Cover

Ground cover was measured at 3 locations in each hillslope plot using a 1-m quadrat with a 10-cm grid (Figure 9E). We classified the cover into the following classes: bare soil, litter (dead needles or leaves or wood fragments less than 1 cm in diameter), wood (greater than 1 cm in diameter), gravel (5-75 mm diameter), rock (>7.5 cm diameter), and live vegetation. Data were averaged across the three quadrats to produce a mean cover value for each cover class for each plot.

Ground cover measurements were classified in two categories: interception cover which would intercept rainfall, and surface cover which had contact with the soil surface. Ground cover measurements were made in Sawmill in October 2014, May and September 2015, and June 2016. In lower and upper Femmons, ground cover measurements were completed after plot installation in November 2015 and again in May 2016.

2.3.6. Sediment Production

Sediment production was measured by sediment fences in each hillslope plot at Sawmill, lower and upper Femmons (Robichaud and Brown, 2002) (Figure 8). Hand-dug trenches, approximately 20 cm deep, were used to establish the plots' upslope borders, and the trenches prevented surface runoff from entering from above the plot. The trenches were monitored and cleaned when any sediment or debris accumulated in them. The distance between the top trench and the fences was approximately 15-20 meters, and

all fences were between 3 and 5 m wide. The contributing area of the plots ranged from 37-93 m² (Table 2).

Sediment was removed as much as possible after every sediment-producing rainstorm or snowmelt event with a 20 L bucket, and the total weight of sediment was measured using a portable scale. A subsample from each bucket was taken and combined for each fence to determine water content in the laboratory (Shukla et al., 2014). We adjusted the field measured weights by the fraction of dry sediment in the subsamples, and the dry mass was divided by the contributing area to obtain sediment yield in Mg ha⁻¹.

We attributed the sediment to the precipitation event that occurred between site visits. When more than one event occurred between site visits, we attributed the sediment production to the event with the highest I₁₀ (Wagenbrenner and Robichaud, 2014).

A small amount of sediment (0.008-0.14 Mg ha⁻¹) was measured on 27 September 2014 at Sawmill, and this was excluded from the 2015 annual value because some of the sediment fences in Sawmill had not been installed by this date.

2.3.7. Effectiveness of Subsoiling of Skid Trails

Some of the many pass skid trails were subsoiled (ripped) by logging contractors as part of the logging operation using a winged subsoiler. We evaluated the effectiveness of this practice by assessing 53 subsoiled skid trails near Sawmill, Triple-A, and Femmons (Figure 9F) in summer 2016. Subsoiling occurred in Sawmill in fall 2014 and in Triple-A and Femmons in 2015. The timing of the assessment was selected so that at least one winter season of precipitation had occurred between subsoiling and the assessment. On skid trails where subsoiling occurred, we measured skid trail slope, hill

slope and the presence or absence of rills and gullies. Rills were visible erosion features that had widths and depths less than 10 cm and 10 cm, respectively. The feature was classified as a gully when either the width or depth was larger than these values. The slopes were measured using a clinometer and the lengths were measured using a GPS and flexible tape. We classified the subsoiling as ineffective when we observed rills or gullies.

2.4. Statistical Analysis

We used linear mixed effects models to determine whether differences in the measurements of interest among treatments and years were significant. For bulk density, water repellency, hydraulic conductivity, ground cover and sediment yield, generalized linear mixed effects models were developed in SAS (SAS Institute Inc., 2008). The treatment within the group was a random variable, the year was the period of repetition and an autoregressive covariance structure was used (Littel et al., 2006). In some cases, the differences among untrafficked plots (controls, low-slope controls, and logged only) and trafficked plots (few pass and many pass) were not significant and we compared the treatments using the more general traffic condition. In R software (R Core Team, 2016), a logistic regression model was used to determine the relationship between the slope of the skid trail and the passing or failing (presence or absence of rills or gullies, respectively) of the subsoiling on the skid trails.

In each plot or disturbance location with each swale, the WDPT for the eight drops were averaged for each depth, and these values were used in WDPT analysis.

WDPT, Kfs, and sediment yield residuals showed skew and non-constant variance and we used log- transformations to decrease the variability of the residuals. Pair-wise least-square means (LSMeans) with a Tukey-Kramer adjustment were used to test the significance of differences among mean values for treatments and measurement periods. We present the untransformed data in the figures. The significance level was $\alpha= 0.05$ for all comparisons and confidence intervals. Raw data are listed in Appendices 1-15.

3. Results

3.1. Precipitation

Most of the sediment producing storms and the storms with the largest accumulation occurred between October and March, and these generally were associated with long duration winter frontal storms. Rainfall amounts and intensities had considerable spatial variability in the localized nature of the storms. The minimum precipitation that produced sediment in our hillslope plots was 2.5 mm (Table 4).

A total of 65 storms occurred in Sawmill from 1 October 2014 to 30 September 2015, and total precipitation was 528 mm for the 2015 water year (Figure 10). 101 storms occurred from 1 October 2015 to 24 May 2016, and these storms produced 1012 mm precipitation in the water year 2016, nearly double the value of the water year 2015 (Figure 11 and 12).

The ten storms that were associated with sediment production in the 2015 water year totaled 311 mm of precipitation (Table 4, Figure 10). The first rainfall that produced sediment in the water year 2015 was on 25 October 2014 in Sawmill. Nine of the 10 storms associated with sediment production in Sawmill in 2015 occurred between October and May (Table 4, Figure 10). The largest of these storms was 56.4 mm on 12 December 2014 in Sawmill (Table 4, Figure 11). The HF 4 gauge recorded seven storms in summer 2015 and only the 5.3 mm storm on 20 July 2015 was associated with sediment production. Because of this storm's relatively high intensity (20 mm hr^{-1}), it was the 10th sediment producing storm for 2015 (Table 4). The highest median I_{10} across all the Sawmill gauges was 26 mm hr^{-1} , and that occurred on 8 February 2015 (Table 4).

Additionally, the other I_{10} s at Sawmill in the water year 2015 ranged between 6.1 and 23 mm hr⁻¹ (Table 4, Figure 12).

As in 2015, ten storms were associated with sediment production in Sawmill in 2016 and the total precipitation of these ten storms was 343 mm (Figure 10). On 4 March 2016, the largest rainfall of the water year occurred, and this was 105 mm (Table 4). The highest I_{10} in 2016 was 34 mm hr⁻¹ which occurred on 17 October 2015 (Table 4, Figure 12). The median I_{10} of all storms associated with sediment production at Sawmill in 2016 was 17.5 mm hr⁻¹ (Table 4), and this also was much greater than the median for 2015.

In lower Femmons, 75 storms occurred from 1 October 2015 to 21 May 2016 and the total precipitation amount was 1171 mm in 2016 water year, about 10% more than the total 2016 precipitation in Sawmill (Figure 10). Four storms were associated with sediment production in lower Femmons and these four storms totaled 225 mm of precipitation (Table 5). The first sediment producing storm occurred on 2 November 2015, and this storm also had the highest I_{10} of the four (23 mm hr⁻¹) (Table 5, Figure 12). The highest precipitation of the four sediment-producing storms was 81 mm, and that occurred on 13 March 2016 (Table 5).

Upper Femmons and lower Femmons received very similar precipitation, and a total of 76 precipitation events occurred in upper Femmons from 1 October 2015 to 20 May 2016. The total precipitation for the water year 2016 was 1161 mm (Figure 10). Five of these storms were associated with sediment production and these five totaled 250 mm of precipitation (Table 6). The largest rainfall was 110.2 mm on 4 March 2016 and this storm also had the highest I_{10} (27 mm hr⁻¹) (Table 6, Figure 12).

3.2. Bulk Density

The mean bulk densities at the 0-5 cm depth were 1.13 g cm^{-3} in the controls and low slope controls, and 1.01 g cm^{-3} in the logged only areas in the 2015 water year (Table 7). There was no significant difference in bulk density between controls and logged only areas (“untrafficked”) in all of the burned sites (Table 7). The disturbance from logging equipment caused compaction and the mean bulk densities at the 0-5 cm depth were 1.30 g cm^{-3} in the feller buncher tracks, 1.24 g cm^{-3} in few pass skid trails, 1.33 g cm^{-3} in many pass skid trails and 1.33 in mix disturbed areas (Figure 13). These disturbed values were not significantly different from each other and both the many pass skid trail and mixed disturbance values were significantly greater than the high slope controls or logged only values in 2015 (Table 7). The mean bulk density at the 0-5 cm depth in the feller buncher tracks was significantly greater than the value in the logged only plots (Table 7 and Appendix 16)

As would be expected, the bulk densities were greater at the 5-10 cm depth, where the means were 1.20 g cm^{-3} and 1.12 g cm^{-3} in the controls and logged only plots, respectively and again, this difference was not significant (Table 7). The densities in the skid trail plots were higher, and the mean bulk densities were 1.30 g cm^{-3} in the few pass and 1.46 g cm^{-3} in the many pass in 2015, and the many pass value was significantly higher than the controls and logged only values (Table 7 and Appendix 17). Feller buncher tracks and mix disturbed areas also were slightly more compacted in the deeper soil and the mean of the bulk densities was 1.33 g cm^{-3} and 1.41 g cm^{-3} , respectively.

These values were not significantly different from each other, and the feller buncher value was not different from the controls.

In the 2016 water year, the mean bulk density was 1.09 g cm^{-3} at the 0-5 cm depth across the high slope controls and logged only plots. (Figure 13), and the bulk density did not change significantly from the 2015 mean. The greatest mean bulk density was in the many pass skid trails, where the mean was 1.33 g cm^{-3} , and that was significantly different than the controls, logged only and mix disturbed areas at the 0-5 cm depth (Table 7). Similarly, at the 5-10 cm depth, there were not any differences in bulk density among the controls, low slope controls, and logged only sites between 2015 and 2016 (Figure 14). The many pass skid trails produced the same mean in 2016 as in 2015 and in contrast to the 2015 results, the many pass value (1.33 g cm^{-3}) was not significantly different than other treatments at the 5-10 cm depth (Table 7 and Appendix 17).

In the unburned Evergreen site, control areas had a mean bulk density of 1.06 g cm^{-3} at the 0-5 cm depth (Table 7 and Appendix 16). The highest soil bulk density at 0-5 cm was 1.40 g cm^{-3} in the many pass skid trails, and as with the burned sites, this was significantly different than the mean value in the controls. The mean bulk density at 5-10 cm was 1.04 g cm^{-3} in the controls, and, once again, the mean in the many pass skid trails (1.40 g cm^{-3}) was significantly different than the mean value in the controls (Figure 14) (Table 7 and Appendix 17). However, unlike in the burned areas, there were no significant differences among the controls and the skidder tracks, few pass skid trails and mix disturbed areas (Table 7).

There was no significant difference among any of the same treatments at either depth between the burned and unburned sites in 2016 (Table 7 and Appendix 16 and 17).

3.3. Water Drop Penetration Time (WDPT)

In the burned sites, none of the treatments showed strong water repellency at the surface (Figure 15 and 16). The mean WDPT at the surface in the burned areas was 0.3 seconds in the controls and none of the logging treatments had a significantly different mean water drop penetration time in 2015 (Table 8 and Appendix 18). In 2016 the mean WDPT was 5 s at the surface and all the untrafficked treatments were not significantly different from each other. However, this value was significantly different than the WDPT in the untrafficked areas in 2015. The mean WDPT at the surface in the trafficked areas was 1.3 s in 2016 and the mean WDPT in the many pass was greater than the 2015 value (Table 8 and Appendix 18).

Soils were much more water repellent at 1- and 3-cm depths in the burned sites (Table 8, Figures 15 and 16). The mean WDPT at the 1 cm depth was 47 s in the controls, 41 s in low slope controls, and 1.2 s in the logged only plots in the burned sites in 2015, and these were not significantly different. Across all the trafficked areas, the mean WDPT was 25 s, but only the many pass skid trails had a significantly different WDPT than the low slope controls and controls in 2015 (Table 8 and Appendix 19). The mean WDPT in 2016 was 36 s in the controls 28 s in low slope controls, and 39 s in the logged only plots, and these were not significantly different from each other. The mean WDPT was not significantly different in untrafficked areas between 2015 and 2016 (Table 8).

Also, there were no significant differences between the trafficked and untrafficked areas in 2016. (Table 8 and Appendix 19).

The highest water repellency was observed at 3 cm depth in the burned areas, and the WDPT in the controls, low slope controls, and logged only plots averaged 115, 16, and 113 s in 2015, respectively, and this difference was not significant (Table 8). The controls in 2016 had only half of the mean WDPT of 2015, but this difference was not significant. In the trafficked areas, the mean WDPT was lower and averaged 41 s in 2015 (Table 8), and the WDPT in the few and many pass skid trail plots were significantly different than the controls and logged only plots (Table 8 and Appendix 20). The mean WDPT was 11 s in the trafficked areas in 2016 and there were no significant differences among the trafficked areas (Table 8 and Appendix 20). However, the WDPT at 3 cm depth in the controls and logged only plots was significantly higher than the WDPT in the feller buncher tracks and the few and many pass skid trails in 2016.

The water repellency was much stronger, more persistent across depths, and was less affected by logging disturbance in the unburned Evergreen site (Figure 16). In the unburned site, WDPT was 246 s in the unlogged areas on the surface, and this was significantly greater than the mean value in the burned unlogged areas (Table 8 and Appendix 18).

The highest water repellency was observed at 1 cm depth in unburned untrafficked areas, where the mean WDPT was 291 s and significantly greater than the controls in the burned site (Table 8). Water repellency was 229 s in the trafficked areas at this depth and this value was significantly less than the mean WDPT in the unlogged

areas in the unburned site (Figure 16) (Table 8 and Appendix 19). All unlogged and logged areas in the unburned site had significantly greater mean WDPT than their burned counterparts at the surface and 1 and 3 cm depths (Figure 16) (Table 8 and Appendix 18, 19, and 20).

Surprisingly, the mean WDPT at 3 cm depth was lower in untrafficked areas (150 s) than in the trafficked areas (186 s) in the unburned Evergreen, but these values were not significantly different. Between the trafficked areas, the only significant difference in the unburned site was between the mix disturbed and skidder tracks at the 3-cm depth (Table 8 and Appendix 20).

3.4. Field Saturated Hydraulic Conductivity (Kfs)

Field saturated hydraulic conductivity (Kfs) varied among the disturbance types (Figure 17). In the burned sites in 2015, the mean Kfs was 0.012 cm s^{-1} in the controls, 0.008 cm s^{-1} in the low slope controls, and 0.009 cm s^{-1} in the logged only plots (Table 9). Controls produced 1.5 times higher Kfs than the low slope controls and logged only plots in the 2015 water year. However, the differences among all of these untrafficked areas were not significant (Table 9). The mean Kfs in the few and many pass skid trails, feller buncher tracks, and mix disturbed areas were 0.003, 0.0007, 0.002, and 0.002 cm s^{-1} , respectively (Table 9) and the mean Kfs in these many pass skid trails were significantly lower than the mean in the controls (Table 9 and Appendix 21). The mean in the many pass skid trail plots was significantly lower than few pass skid trails and feller buncher tracks. Also, the value in the many pass skid trails was significantly lower than the means in the other untrafficked areas (Table 9 and Appendix 21).

The mean Kfs did not significantly change between 2015 and 2016 in any of the treatments except for an increase in the mix disturbed areas. (Table 9 and Appendix 21). In 2016, the mean Kfs in the controls was 0.008 cm s^{-1} , and the low slope controls and logged only plots were not significantly different (Table 9 and Appendix 21). The many pass skid trails had 0.0009 cm s^{-1} mean Kfs, which was still significantly lower than the mean in the controls (Table 9 and Appendix 21).

In the unburned site in 2016, the highest mean Kfs occurred in the controls and was 0.01 cm s^{-1} (Figure 17) (Table 9). The Kfs in the few and many pass skid trails, and skidder tracks were significantly different, and the low Kfs in the many pass skid trails (0.0006 cm s^{-1}) was about 10 times lower than the controls (Table 9 and Appendix 21).

The Kfs values in the unburned site were not significantly different than the values in the burned sites for controls or any other comparable treatment (Table 9 and Appendix 21).

3.5. Surface and Interception Cover

In fall 2014, the mean bare soil on the surface of the controls, low slope controls and logged plots were 63%, 52%, and 47%, respectively, and these were not significantly different (Table 10, Figure 18). The few pass had 56% bare soil on the surface, while the highest amount of bare soil was measured on highly trafficked many pass skid trails (87%) and only the many pass skid trail plots had significantly more bare soil than all others in fall 2014 (Table 10).

Bare soil decreased from fall 2014 to spring 2016 in all the plots. In spring 2015, the mean bare soil was 49 % in controls, 33 % in low slope controls, 57 % in logged only,

51 % in few pass and 72 % in many pass skid trails (Table 10). The low slope controls had significantly less bare soil than the controls and logged only plots (Table 10 and Appendix 22). Again, the low slope controls had less bare soil than the few and many pass skid trails, and the differences were significant for both types of skid trail (Table 10 and Appendix 22).

In fall 2015 in the Sawmill site, the mean surface bare soil measured 37% in the controls, 14% in the low slope controls, 35 % in the logged only, 46 % in the few pass and 48 % in the many pass skid trails (Table 10). Again, the low slope controls had significantly less bare soil than the controls (Table 10 and Appendix 22). Also, the low slope controls and logged only plots had significantly less bare soil than the few pass and many pass skid trails (Table 10 and Appendix 22). The decreases from spring 2015 were significant in the many pass skid trail plots and were nearly significant in the low slope control plots ($p=0.0534$).

In spring 2016 in Sawmill, the mean bare soil was 28% in the controls, 6% in the low slope control, 23% in the logged only plots, 37% in the few pass skid trails, and 32% in the many pass skid trails, and the values many pass were significantly less than the fall 2015 values. Also, the amount of bare soil was not significantly different between the few pass and many pass skid trails, and only the low slope controls had significantly less bare soil than the trafficked plots.

In fall 2015 just after installation of the lower Femmons plots, the amount of bare soil at the surface was 83% in the control, 69% in the logged only, 82% in the few pass, and 85% in the many pass skid trail. There were not any significant differences among

the lower Femmons plots, and although we did not compare across sites statistically, the lower Femmons plots had much more bare soil than the Sawmill plots right after logging in fall 2014 or at any time in 2015 (Figure 18). The amount of bare soil decreased significantly in the control, logged only, and few pass skid trail plots in spring 2016 (Table 10 and Appendix 22). In spring 2016, the many pass skid trail had significantly more bare soil than the logged only plot, and the few pass skid trails had significantly more bare soil than the logged only plot (Table 10 and Appendix 22).

In upper Femmons, just after logging in fall 2015 the bare soil at the surface was 60% in the controls, 50% in the logged only plots, 78% in the few pass and 86% in the many pass skid trails. The bare soil decreased significantly only in the control plots from fall 2015 to spring 2016 (Table 10 and Appendix 22). The control and logged only plots had significantly less bare soil on the surface than the few and many pass skid trails in fall 2015 and spring 2016 (Table 10 and Appendix 22).

The mean bare soil at the interception level was generally lower than at the surface, but the mean bare soil amounts were the same for all treatments at the interception level for fall 2014 in Sawmill (Tables 10 and 11, Figure 19). The mean bare soil at the interception level were 63% in the controls, 52% in the low slope controls, 47% in the logged only plots, 56% in the few pass skid trail plots, and 87% in the many pass skid trails in fall 2014 in Sawmill (Figure 19). The mean bare soil was significantly lower in untrafficked plots and few pass skid trails than the many pass skid trails in fall 2014 (Table 11 and Appendix 23). The mean bare soil significantly decreased in controls, low slope controls and many pass skid trail plots from fall 2014 to spring 2015 (Table 11

and Appendix 23). The mean bare soil decreased significantly in the controls, logged only and many pass plots in spring 2016, and by this time the only significant difference among the treatments was between the low slope controls and the many pass skid trail plots (Table 11 and Appendix 23).

In lower Femmons, the amount of bare soil at the interception level measured 51% in control plot, 38% in logged only plot, 78% in few pass, and 80% in many pass skid trail plots in fall 2015. The mean bare soil significantly decreased from fall 2015 to spring 2016 in the logged only and few pass treatments at the interception level (Table 11 and Appendix 23).

In upper Femmons, the mean bare soil at the interception level was 29% in the controls, 32% in the logged only, 72% in the few pass and 85% in the many pass skid trails and the amount of bare soil in the untrafficked plots was significantly lower than in the trafficked plots. The bare soil decreased significantly in the controls fall 2015 to spring 2016 at the interception level (Table 11 and Appendix 23), but this did not change the significance of the differences among the treatments.

3.6. Sediment Yield

The greatest portion of the sediment yield for the 2015 water year occurred in February. The HF 4 rain gauge recorded five storms in February 2015 and the one storm that we associated with sediment yields had an I_{10} of 26 mm hr^{-1} . In the 2015 water year, the average annual sediment yields in untrafficked plots were 3.5 Mg ha^{-1} in controls, 0.47 Mg ha^{-1} in the low slope controls, and 1.6 Mg ha^{-1} in logged only plots (Figure 20). The average annual sediment yields were 5.9 Mg ha^{-1} and 6.7 Mg ha^{-1} in few pass and

many pass skid trails, respectively. There were no significant differences between any of the untrafficked or trafficked plots in 2015 (Table 12 and Appendix 24), and the difference between the untrafficked mean (1.9 Mg ha^{-1}) and the trafficked mean (6.2 Mg ha^{-1}) also was not significant.

For the 2016 water year in Sawmill, controls and many pass skid trail plots produced significantly less sediment (Table 12) than in 2015 despite the greater total precipitation in 2016. Most of the sediment yields occurred in October 2015 and January 2016 during two high-intensity events ($I_{10} = 32$ and 16 mm hr^{-1} , respectively). The average annual sediment yields were 0.24 Mg ha^{-1} in the controls, 0.02 Mg ha^{-1} in low slope controls, and 0.15 Mg ha^{-1} in logged only plots (Figure 20), and there were no differences among these (Figure 20) (Table 12 and Appendix 24). The average annual sediment yields were 2.0 Mg ha^{-1} in the few pass skid trails and 0.42 Mg ha^{-1} in the many pass skid trails in Sawmill (Figure 20). There was no significant difference between the few and many pass skid trails in 2016 (Table 12 and Appendix 24). The difference in sediment yield between the few pass skid trails and the controls was nearly significant in 2016 ($p = 0.051$) (Appendix 24). Additionally, the many pass skid trails produced more sediment than the low slope controls in 2016, and this difference was significant (Table 12 and Appendix 24). Also, when combining the treatments by traffic condition, the untrafficked plots had significantly lower sediment yields (mean = 0.14 Mg ha^{-1}) than the trafficked plots (mean = 1.2 Mg ha^{-1}).

The average annual sediment yields in the untrafficked controls and logged only plots in lower Femmons were 0.36 Mg ha^{-1} and 0.35 Mg ha^{-1} , respectively, in the 2016

water year (Figure 20). The average sediment yields were higher in the few and many pass skid trail plots and measured 7.1 Mg ha^{-1} and 18.1 Mg ha^{-1} , respectively (Figure 20). We attributed highest sediment delivery in lower Femmons to a relatively high-intensity event ($I_{10}=21 \text{ mm hr}^{-1}$) on January 29.

The first sediment production in upper Femmons was attributed to a high-intensity storm ($I_{10}=10.7 \text{ mm hr}^{-1}$) on 15 November 2015. The highest sediment production occurred during January 29 due to high-intensity storm ($I_{10}=18 \text{ mm hr}^{-1}$) in upper Femmons. The untrafficked controls and logged only plots produced 0.56 Mg ha^{-1} and 0.43 Mg ha^{-1} of sediment in 2016, respectively (Figure 20), and this difference was not significant (Table 13 and Appendix 25). The average sediment yields measured 1.0 Mg ha^{-1} in the few pass skid trail plots and 15.5 Mg ha^{-1} in the many pass skid trail plots in the 2016 water year in upper Femmons (Figure 20). The many pass skid trail plots produced significantly more sediment than the controls, logged only plots, and few pass skid trail plots (Figure 20) (Table 13 and Appendix 25).

3.7. Effectiveness of Subsoiling on Skid Trails

Of the 53 segments of subsoiled skid trails, 28 had no signs of rills or gullies while 25 produced rills or gullies. Of the 25 subsoiled skid trails that had erosion features, 25 had gullies and these often had rills present. The slope of the skid trail significantly affected the probability of rills or gullies forming (Figure 21), although we found rills in subsoiled skid trails with slopes as low as 4%. There was a small range of slopes, approximately less than 6% where the probability of success (no rilling or gullying) was high (Figure 21).

4. Discussion

4.1. Effects of Salvage Logging on Soil Compaction

One of the concerns about post-fire salvage logging is soil compaction in the recently burned areas (Wagenbrenner et al., 2015). Logging disturbances can cause compaction and compaction decreases soil porosity (Gayoso and Iroume, 1991), thereby reducing infiltration (Dickerson, 1976) which can lead to higher probability of runoff (Wagenbrenner et al., 2015, Wagenbrenner et al., 2016). In all the study sites, bulk density was greater in the trafficked plots, and sometimes those increases were significant. At least one study in unburned forests has shown that most of the compaction occurs during the first few passes of the logging equipment and that only slightly more compaction occurs with more passage of equipment (Soltanpour and Jourgholami, 2013). In our study results indicated that soil compaction increased with the increasing passage of the logging equipment, although the differences among the traffic levels were not significant. The highest soil compaction was in the many pass skid trails which had more than four round trips, and feller buncher tracks and few pass skid trails had less compaction than the many pass skid trails. The results in the mixed disturbed areas did not fit the trend, as their bulk density was comparable to the many pass skid trails in the first year after logging, and closer to the untrafficked areas in the second year. This result may have been caused by variability of impact within the areas identified as mixed disturbance, or by our inadvertent selection of lesser disturbed areas within the mixed disturbance class in the second year.

A previous study concluded that soil bulk density can increase after fire because organic matter is destroyed (Certini, 2005). However, another previous study indicates that burning did not cause significant changes in soil bulk density (Massman and Frank, 2006). In our study, there was no difference in bulk density between the burned and unburned sites for either the untrafficked or trafficked conditions. Also, regardless of burn condition, the difference in bulk density between the controls and trafficked areas was significant. Based on these results, if the fire induced changes to soil bulk density, they were not detectable and the logging impacts on bulk density were much greater.

4.2. Effects of Salvage Logging on Soil Water Repellency

Previous studies have found that water repellency can be more intense deeper in the soil in burned areas (DeBano, 1981). Our results confirm this and indicated that water repellency was higher at the 3 cm depth than on the surface or at the 1 cm depth in the burned sites.

Previous studies also have shown that salvage logging breaks up soil water repellency (Wagenbrenner et al., 2015; Wagenbrenner et al., 2016). In our study, the lowest soil water repellency was observed in the trafficked skid trails which were disturbed by logging equipment while the undisturbed areas had higher WDPT.

Some studies indicated that water repellency significantly declines with increasing time since burning (MacDonald and Huffman, 2004). However, other studies reported that time since burning was not a significant control on soil water repellency (DeBano, 1981; Huffman et al., 2001). In this study, the water repellency at 1 and 3 cm

depth did not significantly change between 2015 and 2016, respectively two and three years after the fire.

The unburned site had strong water repellency, as has been documented in many other unburned semi-arid systems including pine forests (Doerr et al., 2000). Highly disturbed soil due to many pass skid trail traffic in the unburned site had significantly reduced water repellency on the surface, but the change was smaller than the changes observed at 1 and 3 cm in the burned site. In addition, there was no significant difference at the 1 cm or 3 cm depths among the traffic treatments, except in the skidder tracks at 3 cm depth where the trafficked areas had significantly lower water repellency than the other trafficked and untrafficked areas in the unburned site. One possible explanation for the higher water repellency in the unburned area is that the unburned soil contained more organic matter and a stronger or thicker water repellent layer, which was less affected by the mechanical disturbance.

4.3. Effects of Salvage Logging on Kfs

One of the most important concerns regarding post-fire salvage logging is a further reduction in low post-fire infiltration capacity. Previous research has shown that heavy logging machinery traffic decreased surface infiltration rates by crushing root holes (Wilson, 1999). A recent study showed that greater compaction with increasing traffic from heavy logging equipment in burned areas induced lower infiltration rates and led to more surface runoff and sediment delivery (Wagenbrenner et al., 2016).

Our results indicated that infiltration capacity was very low in the highly compacted skid trails relative to the untrafficked areas. Since water repellency was lower in the trafficked areas than untrafficked areas, soil compaction, and the resultant loss of porosity and capillary connectivity was likely the cause of the lower Kfs values in the burned and trafficked areas. Soil properties, especially infiltration capacity can vary greatly across small spatial scales, and this might explain the lack of significant effects of logging equipment traffic on Kfs (Greacen and Sands 1980; Huang et al. 1996; Rex et al., 2013).

In this study, logging equipment caused highly compacted soil and Kfs was significantly lower than untrafficked plots in many pass skid trails in burned areas, in addition, this significant difference continued in 2016. Also, there was not any significant difference in Kfs between 2015 and 2016 in either untrafficked or trafficked areas, except for in the mixed disturbance areas. We attribute the difference in Kfs between years in the mixed disturbance areas to the high variability of impacts of this disturbance .

The Kfs values in the untrafficked areas in the burned and unburned sites were very close and were not significantly different. As with the burned sites, the Kfs in the unburned trafficked areas was 10 times lower than the Kfs in the untrafficked areas. These results suggest that fire produces less of a change in infiltration capacity than logging equipment traffic.

4.4. Effects of Salvage Logging on Ground Cover

Ground cover measurements were repeated four seasons in Sawmill and two seasons in lower and upper Femmons, and over time the mean bare soil decreased because of vegetative regrowth in all sites. Previous studies reported that salvage logging reduced ground cover (Knapp and Ritchie, 2016). In contrast, a related study found that salvage logging disturbance did not significantly reduce surface cover at the swale scale (Olsen, 2016). In addition, Wagenbrenner et al. (2015) found that total ground cover was not directly affected by logging at the swale scale in several areas, however, they found reduced vegetation in trafficked areas compared to controls.

A recent salvage logging study found that logged areas had significantly less perennial and shrub recovery than unlogged areas 3 years after logging (Knapp and Ritchie, 2016). Wagenbrenner et al. (2015) also found that at the plot scale, salvage logging decreased vegetation and litter ground cover in logging equipment tracks and on skid trails. Another study reported that salvage logged plots in high burn severity areas generally had low vegetative cover while unlogged plots had higher vegetative cover for each year (Morgan et al., 2014). In this study, bare soil amounts were very high in skid trail plots compared to unlogged plots and the bare soil helps explain the higher sediment yields measured in the skid trail plots (Morgan et al., 2014; Robichaud et al., 2013a; Wagenbrenner et al., 2015).

Logging equipment produced more bare soil relative to the controls at all the sites. Even at the Femmons sites, which were logged two years after the fire, the bare soil in

the trafficked plots was very high right after logging as compared to the untrafficked plots (Figure 18 and 19). The difference in mean bare soil between the trafficked and untrafficked plots in fall 2014 at the Sawmill site was slightly less than the comparable difference in fall 2015 at the Femmons sites. These results suggest that the impact of logging equipment traffic on bare soil in the first measurement after logging was not affected by the time of logging relative to the fire.

4.5. Effect of Salvage Logging and Other Factors on Sediment Yields

The amount of sediment production generally showed variation with precipitation, soil bulk density, water repellency, field saturated hydraulic conductivity and surface cover. The highest sediment delivery occurred during winter storms in all plots because most of the precipitation occurred between October and March and long winter storms produced greater sediment delivery than the convective storms that occurred during the summer.

In our study, a great part of the sediment yields occurred with high I_{10} (at least 15 mm hr⁻¹ or more) between January and February 2015 and 2016. However, sediment yields were relatively low in the dry season because of low I_{10} s that occurred (6 mm hr⁻¹ or less). Rainfall intensity is a strong control on post-fire sediment yields Pietraszek, 2006; Spiegel and Robichaud, 2007; Martin and Moody, 2009).

The total precipitation amounts and intensities were close in lower and upper Femmons and similar sediment yields occurred in the untrafficked plots at those two

sites. However, the many pass plots in upper Femmons produced more sediment yield than the many pass plot in lower Femmons. One possible explanation for this difference was the impact of the time of the logging. Both sites were logged in 2015, but the upper Femmons site was logged just before the beginning of the wet season which may have led to the higher erosion rates. There may also have been other factors which increased the sediment yields, such as pre-fire or pre-logging soil conditions, or different impacts of skidding and traffic intensity within the same “many pass” class.,

Some of the previous studies reported that the first two rainy seasons often produce the highest post-fire sediment yields (Benavides-Solorio and MacDonald, 2005). In the Sawmill site, the untrafficked plots had very high sediment yields in 2015 in the second post-fire year, and these decreased in the 2016 in the third post-fire year, even though the total precipitation was much greater. The reduction in sediment yields between 2015 and 2016 was less in the trafficked plots compared to untrafficked plots in Sawmill.

The results from Sawmill show that sediment yields were higher in the first year after the fire and decreased over time. Timing of the logging relative to the fire was another important factor for our study. Logging operations were completed one year after the fire in Sawmill, and about two years after the fire in Femmons. However, it is difficult to compare the year to year differences among sites because of the confounding difference in the amount of rainfall between the two years. In the first year after salvage logging, sediment yields from the skid trail plots were similar in Sawmill (2015) and

upper Femmons (2016), but lower Femmons had about 20% less sediment than both sites in 2016. In Sawmill, sediment yields decreased in trafficked plots in 2016. These results indicated that sediment production is higher in the first year after ground-based salvage logging and that there can be large variation in the effects of logging equipment traffic on sediment yields.

Soil compaction is another important consideration in sediment yields from salvage logged areas (Wagenbrenner et al., 2015). Several studies reported that increasing logging effects on the ground result in increased soil bulk density and sediment yields while decreasing infiltration rates (Croke et al., 2001; Wagenbrenner et al., 2015; Wagenbrenner et al., 2016). In a controlled salvage logging experiment, trafficked and compacted areas induced less infiltration capacity and increased surface runoff and sediment yields (Wagenbrenner et al., 2016). Results of our study supported these previous results whereby our trafficked areas had increased bulk density and higher sediment yields than untrafficked areas, although not all differences were significant. However, it appears the bulk density is not the main factor controlling post-salvage sediment yields, because the bulk density did not significantly change in the trafficked areas in the second year after logging in the Sawmill area whereas there was a significant reduction in sediment yields in these plots. Because of the consistent bulk density results between the two years and the decrease in sediment yields, we cannot attribute all of the affect of logging on sediment yields to the increase in bulk density.

Soil water repellency often is considered a cause of elevated post-fire sediment yields (Moody et al., 2013). In our study, soil water repellency declined with increasing traffic levels, yet areas with low water repellency had high sediment yields. This is because the logging equipment traffic broke up the water repellency, but trafficked plots had more sediment yield than untrafficked areas. These results show that water repellency was not as important in controlling sediment yields as other factors.

Infiltration excess overland flow was a primary runoff generation mechanism in our study, and the amount of overland flow led to the sediment yields on burned and trafficked hillslopes. Decreasing the field saturated hydraulic conductivity in the trafficked areas generated higher runoff and sediment yields than we measured in untrafficked areas. However, as with the effect of compaction, that Kfs did not significantly change from 2015 to 2016 in Sawmill while the sediment yields decreased significantly. These results showed that Kfs was not the main factor controlling sediment yields.

After high severity fire, loss of surface cover and soil sealing increase runoff and sediment yields (Johansen et al., 2001; Neary et al., 1999; Larsen et al., 2009). Logging equipment at the Rim Fire generally removed the surface cover and induced more bare soil which led to increased sediment yields. Many studies have shown that reductions in surface cover increase sediment yields (Morgan et al., 2014; Robichaud et al., 2013a; Wagenbrenner et al., 2015). In one post-fire study, the dominant control on sediment delivery was ground cover because increases in surface cover reduced overland flow

amounts and velocities (Robichaud et al., 2013a). Both sediment yields and ground cover decreased significantly between the two years at the Sawmill site. Because of the previously established importance of ground cover and the lack of correlation between bulk density, soil water repellency, and Kfs and sediment yields, we conclude the bare soil was the most important factor for controlling sediment yields in the salvage logged areas.

4.6. Effectiveness of Subsoiling on Skid Trails in Burned Areas and Mitigating the Sediment Yields

Subsoiling skid trails and roads in unburned areas can decrease runoff and erosion (Luce, 1997). Jasa and Dickey, (1991) found that subsoiling in agricultural areas significantly lowered erosion compared to non-subsoiled areas. Another previous study also reported that subsoiling along the hillslope contour over large areas increases infiltration rates and decreases sediment yields (James, 2014). The same study attributed these changes to increases in downslope surface roughness and reductions in water repellency (James, 2014). We observed rills or gullies in about half of the subsoiled skid trails and attributed the presence of rilling or gullying to preferential flow in the furrows that were oriented down the slope. We found a strong relationship between rill or gully presence and the slope of the skid trail, and in general, higher skid trail slopes produced rills or gullies. Surprisingly, two of the subsoiled skid trails with slopes of 13-14 % had no rills or gullies (Figure 21). We attributed this to high vegetative cover on these skid trails as observed in the field. Despite the exceptions, forest managers should consider excluding subsoiling or ripping on skid trails with slopes above 6%.

Another approach to mitigating sediment yields from the hillslope scale would be to reduce the bare soil in the areas where traffic occurs. Based on our results, the amount of bare soil was the most important factor in controlling sediment yields. A study on post-fire logging in northern California showed that sediment yields in small catchments decreased when bare soil was less than 40% (James, 2014). Another study indicated that sediment yields from salvage logging can decrease when bare soil is decreased in the disturbed area (Chase, 2006). Reducing sediment yields from disturbed areas may be possible by increasing soil cover in the skid trails. Mulching is one method that has been shown to increase cover and reduce sediment yields in burned areas (Robichaud et al., 2013a; Wagenbrenner et al., 2006).

In a related study at the Rim Fire, 15% or more area in trafficked skid trails can increase rill network connectivity to the stream network and sediment yields (Olsen, 2016). Increasing ground cover on the skid trails may also reduce connectivity between the areas of bare soil and the stream networks.

5. Conclusion

This study focused on the effects of ground-based post-fire salvage logging on bulk density, field saturated hydraulic conductivity (Kfs), water repellency, ground cover, and sediment yields in the central Sierra Nevada range in California. Four study sites were burned at high severity and one was unburned. We measured these effects for up to two years after logging.

In highly trafficked skid trails, the bulk density at depths to 10 cm increased relative to untrafficked plots. These direct effects also led to reduced Kfs in the trafficked plots despite the lower soil water repellency in the trafficked plots as compared to the untrafficked plots. Water repellency was very low in the trafficked burned sites, but low water repellency did not increase Kfs or decrease sediment yields from the skid trail plots. There were no significant changes in the bulk density or Kfs between the two years, and the water repellency changed only in the mixed disturbance areas at the soil surface. There were no changes in water repellency over time in the untrafficked areas or in the skid trails at the 1 or 3 cm depths, where the water repellency was the strongest.

Bare soil amount increased with logging equipment traffic and was the most important factor in controlling sediment yields from the hillslope scale. Bare soil generally decreased at a similar rate across treatments over the study period.

Bulk density and Kfs were not significantly different between the burned and unburned sites for the same amount of equipment traffic, suggesting that the effects of salvage logging traffic on bulk density and Kfs were greater than the effects of fire.

Ground-based post-fire salvage logging significantly increased sediment yields in small plots with high levels of equipment traffic compared to burned and untrafficked plots. Sediment yields significantly decreased in all plots between the two years despite more rainfall in the second year. Our combined results infer that the amount of ground cover disturbance was an important factor in sediment yields following fire and ground-based salvage logging. Plots with logging equipment traffic had more bare soil and higher sediment yields compared to untrafficked plots in all study areas, although most of the differences in sediment yields were not significant.

We also assessed subsoiling of skid trails, sometimes across the contour, as a best management practice for post-fire salvage logging. Generally, rilling and gullying were observed when the slope of the subsoiled skid trails exceeded 6%. Use of subsoiling across the contour on skid trails should be restricted to skid trails with low slopes.

These results indicate that logging increased the bare soil amount which led to higher sediment yields, and future post-fire salvage logging efforts should consider implementing treatments which 1) reduce the extent of bare soil caused by equipment traffic and 2) immediately increase the ground cover in areas disturbed by logging equipment.

6. References

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7. Tables and Figures

Table 1: Soil characteristics for the Rim Fire sites, including soil family, texture, drainage class, runoff class, water transmit capacity, and available water storage in profile (Soil Survey Staff, 2016). Every bracket represents each characteristic of the soil types.

Property	Sawmill	Lower Femmons	Upper Femmons	Triple-A	Evergreen
Family	Holland	Holland	Holland, Josephine, Sites	Holland	Wintoner
Texture	Loam (0-3 in), Sandy clay loam (3-60 in)	Loam (0-5 in), Sandy clay loam (5-35 in)]	[Loam (0-10 in), sandy clay loam (10-39 in)], [Gravelly loam (0-5 in), clay loam (5-35 in)], [Gravelly loam (0-7 in), clay (7-37 in)]	Loam (0-3 in), Sandy clay loam (3-60 in)	Loam (3-13 in), clay loam (13-22 in)
Drainage Class	Well drained	Well drained	[Well drained], [Well drained], [Well drained]	Well drained	Well drained
Runoff Class	High	High	[High], [Very high], [Very high]	High	Very high
Capacity of the Most Limiting Layer to Transmit Water	Very low to moderately low (0.00 to 0.14 in/hr)	Very low to moderately low (0.00 to 0.14 in/hr)	[Very low to moderately low (0.00 to 0.14 in/hr)], [Very low to moderately low (0.00 to 0.14 in/hr)], [Very low to moderately low (0.00 to 0.14 in/hr)]	Very low to moderately low (0.00 to 0.14 in/hr)	Moderately high (0.20 to 0.57 in/hr)
Available Water Storage	High (about 9.5 in), Low (about 1.2 in), Very low (about 5.6 in)	Low (about 5.6 in)	[Moderate (about 6.1 in)], [Low (about 5.5 in)], [Low (about 5.6 in)]	High (about 9.5 in)	High (about 9.5 in)

Table 2: Study plots characteristics. Location (Sawmill, lower and upper Femmons), group, treatment, logging date, sediment fence install date, mean slope, and contributing area of each plot. LF is lower Femmons, UF is upper Femmons, and LSC is slope control

Location	Group	Treatment	Logging Date	Sediment Fence Install Date	Mean Slope (%)	Area (m ²)
Sawmill	2	LSC	Jun-Sep 2014	31 Oct 2014	8	58
Sawmill	2	Control	Jun-Sep 2014	22 Sep 2014	24	95
Sawmill	2	Logged	Jun-Sep 2014	20 Sep 2014	26	81
Sawmill	2	Few Pass	Jun-Sep 2014	22 Sep 2014	25	78
Sawmill	2	Many Pass	Jun-Sep 2014	20 Sep 2014	11	76
Sawmill	3	LSC	Jun-Sep 2014	31 Oct 2014	15	37
Sawmill	3	Control	Jun-Sep 2014	18 Sep 2014	25	67
Sawmill	3	Logged	Jun-Sep 2014	19 Sep 2014	25	76
Sawmill	3	Few Pass	Jun-Sep 2014	19 Sep 2014	26	68
Sawmill	3	Many Pass	Jun-Sep 2014	31 Oct 2014	21	75
Sawmill	4	LSC	Jun-Sep 2014	31 Oct 2014	14	75
Sawmill	4	Control	Jun-Sep 2014	18 Sep 2014	28	93
Sawmill	4	Logged	Jun-Sep 2014	18 Sep 2014	27	65
Sawmill	4	Few Pass	Jun-Sep 2014	18 Sep 2014	26	57
Sawmill	4	Many Pass	Jun-Sep 2014	18 Sep 2014	21	76
LF	5	Control	May 2015	13 Nov 2015	26	71
LF	5	Logged	May 2015	13 Nov 2015	23	62
LF	5	Few Pass	May 2015	13 Nov 2015	27	52
LF	5	Many Pass	May 2015	13 Nov 2015	21	57
UF	6	Control	Sep 2015	11 Nov 2015	20	74
UF	6	Logged	Sep 2015	11 Nov 2015	13	50
UF	6	Few Pass	Sep 2015	11 Nov 2015	10	70
UF	6	Many Pass	Sep 2015	11 Nov 2015	15	71
UF	7	Control	Sep 2015	12 Nov 2015	21	93
UF	7	Logged	Sep 2015	12 Nov 2015	23	73
UF	7	Few Pass	Sep 2015	12 Nov 2015	23	71
UF	7	Many Pass	Sep 2015	12 Nov 2015	22	60

Table 3: Tipping bucket rain gauge characteristics, including site, gauge label, nearest fence group, elevation, and installation date for the three sites with hillslope sediment fences.

Site	Label	Nearest Fence Group	Elevation (m)	Installation Date
Sawmill	HFC2	Sawmill 2	1268	19 Sep 2014
Sawmill	HFL2	Sawmill 2	1207	19 Sep 2014
Sawmill	HFC3	Sawmill 3	1243	30 Oct 2014
Sawmill	HFL3	Sawmill 3	1191	30 Oct 2014
Sawmill	HF 4	Sawmill 4	1224	20 Sep 2014
Lower Femmons	FSW10	Lower Femmons 5	1167	12 Sep 2015
Lower Femmons	FSW11	Lower Femmons 5	1166	24 Jul 2015
Upper Femmons	HF7	Upper Femmons 7	1296	22 Nov 2015
Upper Femmons	FSW14	Upper Femmons 6	1318	22 Nov 2015

Table 4: Rainfall characteristics for storms that were associated with sediment accumulation in Sawmill. Storm date, median and range of total rainfall (mm), median storm duration (hr: min), and median and range of 10-min maximum intensity (I_{10} , mm hr⁻¹). Medians and ranges are across all available gauges for each storm. Medians, minima, and maxima are shown across all storms and gauges for each water year (WY). No sediment was produced between 23 April 2016 and the end of WY 2016.

Storm Date	Storm Total (mm)		Median Duration (hr:min)	Storm I_{10} (mm hr ⁻¹)	
	Median	Min-Max		Median	Min-Max
31 Oct 14	32.5	32-32.5	15:34	9.1	9.1-10.7
13 Nov 14	12.7	11.4-13.7	8:53	7.6	6.1-7.6
02 Dec 14	54.9	45.7-60.2	41:47	13.7	12.2-15.2
12 Dec 14	56.4	51-62.2	27:36	9.1	9.1-10.7
08 Feb 15	50.8	46.3-56.1	19:20	26	12.2-32
8 Apr 15	23.1	19.3-23.6	3:14	13.7	9.1-18.3
25 Apr 15	33.6	33.6	18:00	12.2	12.2-12.2
7 May 15	25.1	21.6-28	21:24	13.7	13.7-18.2
23 May 15	3.5	2.5-4.8	00:50	13.7	9.1-22.9
20 Jul 15	6.3	5.3-7.4	4:17	20	13.7-21.3
2015 WY	33	2.5-62.2	16:47	13.7	6.1-32
1 Oct 15	18.5	17.8-19	4:24	24.4	24.4-27.4
17 Oct 15	25.1	23.6-26	5:17	33.5	30.5-44.2
28 Oct 15	9.9	9.9	3:22	32	32-32
2 Nov 15	52.6	47.2-56.9	26:44	13.7	12.2-15.2
16 Jan 16	4.8	3.3-9.1	00:30	18.3	13.7-22.9
19 Jan 16	16.8	16.8	8:17	10.7	10.7-10.7
22 Jan 16	43.7	43.7	20:43	12.2	12.2-12.2
29 Jan 16	29.2	24.1-32	13:11	12.2	12.2-13.7
4 Mar 16	105	90.7-125	42:08	16.8	16.7-19.8
22 Apr 16	37.8	35.6-38.9	12:06	24.4	21.3-33.5
2016 WY	27.1	3.3-125	10:11	17.5	10.7-44.2

Table 5: Rainfall characteristics for storms that were associated with sediment accumulation in lower Femmons. Storm date, median and range of total rainfall (mm), median storm duration (hr:min), and median and range of 10-min maximum intensity (I_{10} mm hr⁻¹). Medians and ranges are across all available gauges for each storm. Medians, minima, and maxima are shown across all storms and gauges for 2016 water year (WY). No sediment was produced between 23 April 2016 and the end of WY 2016.

Storm Date	Storm Total (mm)		Median Duration (hr:min)	Storm I_{10} (mm hr ⁻¹)	
	Median	Min-Max		Median	Min-Max
2 Nov 15	60.6	59-62.2	24:08	22.7	21-24.4
29 Jan 16	35.4	35.3-35.5	8:17	22	21-22.9
13 Mar16	81	81	32:35	16.8	16.8
8 Apr 16	44.1	42-46.2	12:47	14.5	4.6-24.4
2016 WY	62.5	35.3-35.5	18:28	19.4	4.6-16.8

Table 6: Rainfall characteristics for storms that were associated with sediment accumulation in upper Femmons. Storm date, median and range of total rainfall (mm), median storm duration (hr:min), and median and range of 10-min maximum intensity (I_{10} mm hr⁻¹). Medians and ranges are across all available gauges for each storm. Medians, minima, and maxima are shown across all storms and gauges for 2016 water year (WY). No sediment was produced between 23 April 2016 and the end of WY 2016.

Storm Date	Storm Total (mm)		Storm Duration (hr:min)	Storm I_{10} (mm hr ⁻¹)	
	Median	Min-Max		Median	Median
15 Nov 15	23.1	23.1	8:56	10.7	10.7
7 Jan 16	19.5	12.7-26.4	4:41-7:44	11.4	10.7-12.2
29 Jan 16	38.5	38.1-38.9	13:20-13:30	18.3	18.3-18.3
4 Mar 16	107.1	104-110.2	40:43-41:24	26.7	26-27.4
22 Apr 16	27.4	26.4-28.4	15:40-19:26	13.7	12.2-15.2
2016 WY	38.5	12.7-23.1	15:40-19:26	18.3	10.7-10.7

Table 7: Mean bulk density at depths of 0-5 and 5-10 cm for all sites. Different letters indicate within each depth significant differences by treatment and year based on comparison of LSMeans. The Evergreen site was unburned. NA indicates no data.

Treatment	Bulk density at 0-5 cm (g cm ⁻³)		Bulk density at 5-10 cm (g cm ⁻³)	
	2015	2016	2015	2016
Evergreen Control	NA	1.06 ^{CD}	NA	1.04 ^D
Evergreen Few Pass	NA	1.27 ^{ABCD}	NA	1.29 ^{ABCD}
Evergreen Many Pass	NA	1.40 ^A	NA	1.40 ^{AB}
Evergreen Mix Disturbed	NA	1.27 ^{ABC}	NA	1.25 ^{BCD}
Evergreen Skidder Track	NA	1.29 ^{ABC}	NA	1.30 ^{ABCD}
Control	1.11 ^{CD}	1.08 ^{CD}	1.20 ^{CD}	1.16 ^{CD}
Low Slope Control	1.21 ^{ABCD}	1.28 ^{ABC}	1.23 ^{BCD}	1.40 ^{ABC}
Logged Only	1.01 ^D	1.10 ^{CD}	1.12 ^D	1.16 ^{DC}
Feller Buncher Track	1.30 ^{ABC}	1.14 ^{BCD}	1.33 ^{ABC}	1.25 ^{BCD}
Few Pass	1.24 ^{ABCD}	1.21 ^{ABCD}	1.30 ^{BCD}	1.24 ^{BCD}
Many Pass	1.33 ^{AB}	1.33 ^{AB}	1.46 ^A	1.33 ^{AB}
Mix Disturbed	1.33 ^{AB}	1.10 ^{CD}	1.41 ^{AB}	1.16 ^{CD}

Table 8: Mean water drop penetration time (WDPT) on the surface, 1 cm and 3 cm depths by treatment and year for all sites. Different letters within each depth group represent significant differences in the LSMeans of the log-transformed WDPT between treatments and years. The Evergreen site was unburned. NA indicates no data.

Treatment	WDPT (s) at surface		WDPT (s) at 1 cm		WDPT (s) at 3 cm	
	2015	2016	2015	2016	2015	2016
Evergreen Control	NA	246 ^A	NA	291 ^A	NA	150 ^{AB}
Evergreen Few Pass	NA	235 ^A	NA	180 ^A	NA	179 ^{AB}
Evergreen Many Pass	NA	28 ^B	NA	209 ^A	NA	201 ^{ABC}
Evergreen Mixed	NA	254 ^A	NA	274 ^A	NA	291 ^A
Evergreen Skid Track	NA	184 ^A	NA	252 ^A	NA	70 ^{BCDEF}
Control	0.3 ^F	5 ^{CD}	47 ^B	36 ^B	115 ^{ABCD}	53 ^{CDEF}
Low Slope Control	0.4 ^{EF}	3 ^{CD}	41 ^B	28 ^{BC}	16 ^{EDF}	2 ^{EF}
Logged Only	0.2 ^F	8 ^C	1 ^{BC}	39 ^{BC}	113 ^{ABCD}	120 ^{ABCD}
Feller Buncher	0.3 ^F	2 ^{CD}	10 ^{BC}	2 ^{BC}	35 ^{EF}	10 ^{EDF}
Few Pass	0.4 ^{EF}	1 ^{DE}	37 ^{BC}	2 ^{BC}	9 ^{EF}	10 ^{EF}
Many Pass	0.3 ^F	1 ^{DE}	2 ^C	2 ^{BC}	14 ^{EF}	2 ^F
Mixed	0.4 ^{EF}	1 ^{DEF}	63 ^B	15 ^{BC}	128 ^{ABCDE}	30 ^{CDEF}

Table 9: Mean field saturated hydraulic conductivity (Kfs) ($cm\ s^{-1}$) for all treatment types in the burned and unburned sites by water year. The different letters indicate significant differences among LSMeans of the log transformed Kfs values. NA indicates no data

Treatment	Burned Kfs ($cm\ s^{-1}$)		Unburned Kfs ($cm\ s^{-1}$)
	2015	2016	2016
Control	0.012 ^A	0.008 ^{AB}	0.01 ^A
Low Slope Control	0.008 ^{AB}	0.002 ^{BCDEF}	NA
Logged Only	0.009 ^{AB}	0.004 ^{BCDE}	NA
Feller Buncher Track	0.002 ^{CDEF}	0.004 ^{CDEF}	NA
Few Pass	0.003 ^{BCDE}	0.002 ^{EFG}	0.002 ^{CDEFG}
Many Pass	0.0007 ^G	0.0009 ^G	0.0006 ^{FG}
Mix Disturbed	0.002 ^{DEFG}	0.006 ^{ABC}	0.006 ^{ABCD}
Skidder Track	NA	NA	0.001 ^{EFG}

Table 10: Mean bare soil on the surface level for each treatment type and season of measurement at Sawmill, lower Femmons, upper Femmons. Different letters represent significant differences among LSMeans among treatments and seasons for each site. Plots at Femmons sites were not installed until Fall 2015. LSC is low slope control. NA indicates no data.

Site	Treatment	Bare Soil (%)			
		Fall 2014	Spring 2015	Fall 2015	Spring 2016
Sawmill	Control	63 ^B	49 ^{CDE}	37 ^{DEF}	28 ^{GHI}
	LSC	52 ^{BCD}	33 ^{EFGH}	14 ^{GHI}	6 ^I
	Logged Only	47 ^{BCD}	57 ^{BCD}	35 ^{DEFG}	23 ^{HI}
	Few Pass	56 ^{BC}	51 ^{BCD}	46 ^{CDE}	37 ^{EFGH}
	Many Pass	87 ^A	72 ^B	48 ^{CDE}	32 ^{FGH}
Lower Femmons	Control	NA	NA	83 ^A	58 ^{BC}
	Logged Only	NA	NA	69 ^B	18 ^{GHI}
	Few Pass	NA	NA	82 ^A	60 ^{BC}
	Many Pass	NA	NA	85 ^A	71 ^{AB}
Upper Femmons	Control	NA	NA	60 ^{BC}	42 ^D
	Logged Only	NA	NA	50 ^{BCD}	46 ^{CD}
	Few Pass	NA	NA	78 ^A	74 ^{AB}
	Many Pass	NA	NA	86 ^A	76 ^{AB}

Table 11: Mean bare soil on the interception level for each treatment type and season of measurement at Sawmill, lower Femmons, upper Femmons. Different letters represent significant differences among LSMeans among treatments and seasons for each site. Plots at Femmons sites were not installed until Fall 2015. NA indicates no data.

Site	Treatment	Bare Soil (%)			
		Fall 2014	Spring 2015	Fall 2015	Spring 2016
Sawmill	Control	63 ^B	33 ^{CDE}	29 ^{DEF}	1 ^{GHI}
	Low Slope Control	52 ^{BCD}	16 ^{EFGH}	12 ^{GHI}	10 ^I
	Logged Only	47 ^{BCD}	42 ^{BCD}	33 ^{DEFG}	4 ^{HI}
	Few Pass	56 ^{BC}	46 ^{BCD}	45 ^{CDE}	9 ^{EFGH}
	Many Pass	87 ^A	53 ^{BC}	43 ^{CDE}	16 ^{FGH}
Lower Femmons	Control	NA	NA	51 ^{BCD}	25 ^{DEF}
	Logged Only	NA	NA	38 ^{CDE}	6 ^{HI}
	Few Pass	NA	NA	78 ^A	38 ^{CDE}
	Many Pass	NA	NA	80 ^A	55 ^{BA}
Upper Femmons	Control	NA	NA	29 ^{BC}	15 ^D
	Logged Only	NA	NA	32 ^{BCD}	30 ^{CD}
	Few Pass	NA	NA	72 ^A	56 ^{BA}
	Many Pass	NA	NA	85 ^A	55 ^{BA}

Table 12: Mean sediment yield for the Sawmill site. Different letters indicate significant differences in LSMeans of the log-transformed values. The untrafficked (controls, low slope controls, and logged only) and trafficked (few pass and many pass) results were from a separate analysis using the same data and statistical model but with treatments collapsed into two groups.

Treatment	Sediment Yield (Mg ha ⁻¹)	
	2015 Water Year	2016 Water Year
Control	3.5 ^{AB}	0.24 ^{CD}
Low Slope Control	0.47 ^{ABC}	0.02 ^D
Logged Only	1.6 ^{ABC}	0.15 ^{BCD}
Few Pass	5.9 ^{AB}	2.0 ^{ABC}
Many Pass	6.7 ^A	0.42 ^{ABC}
Untrafficked	1.9 ^{XY}	0.14 ^Z
Trafficked	6.2 ^X	1.2 ^Y

Table 13: Mean sediment yields at the Femmons sites in WY 2016. Different letters indicate significant differences between LSMeans of the log-transformed values. The untrafficked (controls, low slope controls, and logged only) and trafficked (few pass and many pass) statistical analysis used the same data and mixed effects model but with treatments collapsed into two groups. Lower Femmons treatment data were not statistically analyzed because there was only one plot per treatment.

Treatment	Sediment Yield (Mg ha ⁻¹)	
	Upper Femmons	Lower Femmons
Control	0.56 ^B	0.36
Logged only	0.43 ^B	0.35
Few Pass	1.0 ^B	7.1
Many Pass	15.5 ^A	18.1
Untrafficked	0.50 ^X	0.35 ^N
Trafficked	8.3 ^Y	12.6 ^M

Figure 1: Map of the Rim Fire burned area in California (Google Maps, 2013)

Figure 3: Hillslope plots (fences) and rain gauge locations in the Sawmill site within the Rim Fire burned area. Bulk density, WDPT, Kfs and sediment measurements were made in each plot. LiDAR DEM from Stavros et al. (2016) and California Forest State Institute, California Institute of Technology, Jet Propulsion Laboratory CA (NASA JPL).

Figure 4: Swales, hillslope plots (fences) and rain gauge locations in the upper (left) and lower (right) Femmons within the Rim Fire burned area. Bulk density, WDPT, Kfs and sediment measurements were made in disturbed areas in each plot and bulk density, WDPT, and Kfs measurements were made in disturbed areas in each swale. LiDAR DEM from Stavros et al. (2016) and California Forest State Institute, California Institute of Technology, Jet Propulsion Laboratory CA (NASA JPL)

Figure 5: Swales and rain gauge locations in the Triple-A site within the Rim Fire burned area. Bulk density, K_{fs} , and WDPT measurements were made in disturbed areas in each swale. LiDAR DEM from Stavros et al. (2016) and California Forest State Institute, California Institute of Technology, Jet Propulsion Laboratory CA (NASA JPL).

Figure 6: Logging equipment in the Rim Fire area. Feller buncher (A), tracked and wheeled log skidders (B, C), and bulldozers equipped with winged shanks for subsoiling (D). (Photo credits Will Olsen (A, B, C) and Curtis Kwamme (D))

Figure 7: Photos of soil disturbance categories, tracks and skid trails: many pass skid trail (A), few pass skid trail (B), feller buncher track (C), and mix disturbed areas(D). Red arrows indicate downslope direction. (Photo credits Will Olsen (A, B, C, and D))

Figure 8: Photos of sediment fences in Sawmill site. Control HF2 (A), low slope control HF2 (B), logged only HF3 (C), few pass HF2 (D), and many pass (E). Red arrows indicate downslope direction. (Photo credit Will Olsen (B) and Nate Ashmead (C))

Figure 9: Photos of measurements. Bulk density core (A), WDPT measurement at 1 cm depth (B), DualHead infiltrometer, with bentonite seal around the inside edge (C), infiltration measurement in many pass HF7 (D), cover measurement with quadrat (E), and subsoiled skid trail with gullies (F). Red arrows represent downslope direction.

Figure 10: Monthly total rainfall at each study site or subset of sites. Each bar represents one rain gauge.

Figure 11: Total precipitation amounts associated with sediment yields in the three sites by water year. Gauges were installed in lower and upper Femmons sites in July and November 2015, respectively.

Figure 12: 10-minute maximum rainfall intensity (I_{10}) for each rainfall that was associated with sediment production between October 2014 and May 2016 in Sawmill and from October 2015 to May 2016 in Femmons sites. Gauges were installed in lower and upper Femmons sites in July and November 2015, respectively.

Figure 13: Soil bulk density at depth of 0-5 cm for each treatment class, site, and year. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). Box plots represent median (horizontal black bar), 25th and 75th quantiles (box bounds), and 1.5 times the interquartile range (whiskers). Dots are individual values.

Figure 14: Soil bulk density at depth of 5-10 cm for each treatment class, site, and year. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). Box plots represent median (horizontal black bar), 25th and 75th quantiles (box bounds), and 1.5 times the interquartile range (whiskers). Dots are individual values.

Figure 15: Mean WDPT at the mineral surface (0 cm), 1 cm, and 3 cm depths in burned sites for each treatment type in 2015. Measurements were not made in Upper Femmons and unburned Evergreen sites in 2015. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), few pass (FP), many pass (MP), and mix disturbed (MX).

Figure 16: Mean WDPT at the mineral surface (0 cm), 1 cm, and 3 cm depths in burned and unburned (Evergreen) sites for each treatment type in 2016. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST).

Figure 17: Field saturated hydraulic conductivity (Kfs) for each disturbance type in unburned (Evergreen) and burned sites in 2015 and 2016 water years. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). Box plots represent median (horizontal black bar), 25th and 75th quantiles (box bounds), and 1.5 times the interquartile range (whiskers). Dots are individual values.

Figure 18: Mean surface cover in hillslope plots by cover type, treatment, measurement season, and site.

Figure 19: Mean interception cover in hillslope plots by cover type, treatment, measurement season, and site.

Figure 20: Mean sediment yields for each season, treatment type, water year, and site. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), few pass (FP), and many pass (MP).

Figure 21: Binomial fit of skid trail condition versus skid trail slope. “Pass” indicates no rills or gullies and “fail” indicates rill or gullies were present. Data represent 53 skid trails across the three burned sites and were recorded in summer 2016, at least one year after subsoiling. Shaded areas represent 95% confidence interval.

8. Appendices

Appendix 1: Rainfall events between November 2014 and May 2016 in HF 2 control in Sawmill. The table shows storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively).

Date	Time	Duration (min)	Amount (mm)	I_{10} (mm hr ⁻¹)	I_{30} (mm hr ⁻¹)	I_{60} (mm hr ⁻¹)
11/13/2014	3:12	544	11.43	6.096	5.08	4.318
11/14/2014	10:21	1	0.254	1.524	0.508	0.254
11/20/2014	5:33	1	0.254	1.524	0.508	0.254
11/20/2014	17:30	649	7.112	6.096	4.064	2.54
11/22/2014	8:10	464	15.24	12.192	6.096	4.318
11/22/2014	22:46	1	0.254	1.524	0.508	0.254
11/29/2014	12:26	545	9.398	4.572	3.048	2.032
11/30/2014	15:17	175	4.318	4.572	3.048	2.286
12/1/2014	7:35	1	0.254	1.524	0.508	0.254
12/2/2014	9:50	2507	52.324	13.716	7.112	4.826
12/12/2014	0:13	1724	51.054	9.144	8.636	8.382
12/15/2014	17:58	908	12.446	7.62	6.096	5.08
12/16/2014	23:53	1030	12.192	6.096	4.572	3.556
12/18/2014	7:16	1	0.254	1.524	0.508	0.254
12/19/2014	16:34	928	8.382	3.048	2.032	1.524
12/20/2014	14:12	545	2.54	3.048	1.524	1.016
12/24/2014	17:07	369	10.922	12.192	6.096	4.318
1/27/2015	4:41	313	3.81	3.048	1.524	1.016
2/6/2015	18:56	1547	44.45	16.764	15.748	14.224
2/8/2015	10:38	1164	50.8	25.908	15.748	11.684
2/11/2015	10:54	1	0.254	1.524	0.508	0.254
2/22/2015	7:30	213	2.794	3.048	2.032	1.27
2/23/2015	1:42	1	0.254	1.524	0.508	0.254
2/27/2015	19:59	37	1.27	4.572	2.032	1.27
2/28/2015	2:41	1003	4.826	4.572	3.048	1.524
3/2/2015	9:03	393	6.858	7.62	6.604	4.572
3/3/2015	1:07	1	0.254	1.524	0.508	0.254
3/11/2015	10:22	122	2.032	3.048	1.524	1.27
3/22/2015	22:50	63	0.508	1.524	0.508	0.254
3/23/2015	9:46	1	0.254	1.524	0.508	0.254
4/5/2015	18:22	1051	16.51	6.096	6.096	4.572
4/7/2015	15:05	173	6.858	9.144	6.604	5.08
4/8/2015	12:42	247	23.622	13.716	11.684	9.906
4/20/2015	12:47	1	0.254	1.524	0.508	0.254

4/23/2015	16:50	47	1.016	3.048	1.016	1.016
4/25/2015	2:45	1068	33.274	10.668	9.652	7.62
5/7/2015	7:14	1296	25.146	18.288	11.176	6.604
5/14/2015	14:55	225	1.778	1.524	1.016	0.762
5/15/2015	5:37	1	0.254	1.524	0.508	0.254
5/15/2015	14:51	129	2.032	3.048	1.524	1.27
5/17/2015	19:15	60	2.794	12.192	5.08	2.794
5/18/2015	8:16	1	0.254	1.524	0.508	0.254
5/21/2015	18:36	1	0.254	1.524	0.508	0.254
5/23/2015	12:37	102	0.508	1.524	0.508	0.254
5/23/2015	20:27	50	4.826	22.86	8.636	4.826
6/5/2015	16:51	55	1.016	1.524	1.016	1.016
7/2/2015	21:03	20	0.762	3.048	1.524	0.762
7/3/2015	6:02	23	2.54	7.62	5.08	2.54
7/9/2015	6:48	208	1.016	1.524	0.508	0.508
7/10/2015	7:50	1	0.254	1.524	0.508	0.254
7/20/2015	18:13	297	6.858	18.288	10.16	5.08
7/21/2015	19:03	24	1.016	3.048	2.032	1.016
9/14/2015	18:49	689	1.016	1.524	0.508	0.508
10/1/2015	10:27	408	18.796	24.384	15.24	13.462
10/15/2015	20:38	1	0.254	1.524	0.508	0.254
10/16/2015	17:17	67	1.524	3.048	1.524	1.27
10/17/2015	9:21	288	25.146	30.48	19.812	10.922
10/18/2015	14:18	1	0.254	1.524	0.508	0.254
10/28/2015	6:19	222	6.858	4.572	3.556	2.794
10/28/2015	16:04	200	7.62	18.288	12.7	6.604
10/29/2015	5:48	1	0.254	1.524	0.508	0.254
11/2/2015	2:18	1420	53.848	13.716	10.16	8.382
11/3/2015	9:58	308	2.032	7.62	3.556	1.778
11/4/2015	1:38	1	0.254	1.524	0.508	0.254
11/8/2015	22:12	333	15.494	12.192	7.62	4.572
11/9/2015	12:29	248	4.572	4.572	3.048	2.286
11/9/2015	23:12	1	0.254	1.524	0.508	0.254
11/10/2015	10:58	216	4.826	6.096	4.064	3.556
11/15/2015	9:02	389	15.494	7.62	5.588	4.826
11/16/2015	11:21	324	5.08	4.572	2.54	2.032
11/17/2015	10:47	581	6.096	6.096	3.556	2.54
11/24/2015	13:53	144	9.144	9.144	6.604	5.842
11/25/2015	11:00	13	0.508	1.524	1.016	0.508
11/26/2015	10:32	279	1.016	1.524	0.508	0.508
11/27/2015	9:29	363	1.778	1.524	1.016	0.508
11/28/2015	12:04	147	1.778	1.524	1.016	1.016
11/29/2015	12:05	170	1.778	3.048	1.524	1.016

11/30/2015	11:22	444	2.286	1.524	1.016	1.016
12/1/2015	11:00	119	0.508	1.524	0.508	0.254
12/3/2015	18:16	190	5.334	4.572	4.064	3.302
12/10/2015	7:44	851	17.78	9.144	5.588	4.572
12/11/2015	12:25	450	9.652	10.668	6.096	4.318
12/12/2015	12:02	1668	29.21	7.62	6.096	6.096
12/14/2015	12:12	219	1.524	3.048	2.032	1.016
12/15/2015	12:57	159	1.016	1.524	0.508	0.508
12/16/2015	12:29	147	2.032	1.524	1.524	1.016
12/17/2015	10:17	566	7.366	3.048	2.032	1.778
12/18/2015	10:41	1848	26.162	6.096	5.08	4.064
12/20/2015	11:24	2983	91.44	7.62	6.604	6.096
12/23/2015	1:45	381	1.27	1.524	0.508	0.508
12/23/2015	16:42	1	0.254	1.524	0.508	0.254
12/25/2015	13:45	28	1.778	6.096	3.556	1.778
12/26/2015	12:53	132	2.286	1.524	1.524	1.27
12/27/2015	12:13	422	3.048	3.048	2.032	1.524
12/28/2015	11:53	241	1.016	1.524	0.508	0.508
12/29/2015	13:46	101	0.762	1.524	0.508	0.508
12/30/2015	11:52	175	2.286	3.048	1.524	1.27
12/31/2015	12:45	142	1.524	1.524	1.524	1.016
1/1/2016	13:54	1	0.254	1.524	0.508	0.254
1/2/2016	8:40	374	2.286	1.524	1.016	0.508
1/4/2016	14:25	242	0.762	1.524	1.016	0.508
1/5/2016	0:55	924	28.448	10.668	9.144	6.858
1/6/2016	11:11	1063	4.064	3.048	1.524	1.524
1/7/2016	11:21	798	9.652	3.048	2.54	1.778
1/8/2016	12:05	394	6.35	3.048	2.54	2.286
1/9/2016	10:20	2073	26.416	3.048	2.032	2.032
1/11/2016	10:58	265	2.286	1.524	1.016	0.762
1/12/2016	10:05	1	0.254	1.524	0.508	0.254
1/13/2016	6:55	309	2.794	3.048	2.54	1.778
1/14/2016	17:49	1057	14.732	12.192	8.128	5.334
1/16/2016	2:32	366	5.334	6.096	3.556	2.286
1/16/2016	15:59	26	3.302	13.716	6.604	3.302
1/17/2016	21:55	726	28.956	9.144	7.112	6.096
1/19/2016	5:26	547	19.812	10.668	8.128	6.858
1/22/2016	10:16	1242	38.608	10.668	8.128	6.858
1/23/2016	17:28	127	1.27	4.572	2.032	1.016
1/24/2016	10:20	26	0.508	1.524	1.016	0.508
1/29/2016	2:43	1	0.254	1.524	0.508	0.254
1/29/2016	23:40	801	32.004	12.192	9.652	7.112
1/31/2016	0:57	42	0.762	1.524	1.016	0.762

2/1/2016	12:06	320	4.318	1.524	1.524	1.524
2/2/2016	10:27	448	4.826	1.524	1.016	1.016
2/3/2016	10:55	588	9.398	4.572	3.048	2.794
2/4/2016	10:14	409	5.842	1.524	1.524	1.524
2/5/2016	9:50	199	1.016	1.524	0.508	0.508
2/17/2016	20:55	184	11.684	10.668	9.144	7.366
2/18/2016	7:50	876	22.352	12.192	7.112	3.81
2/19/2016	9:09	309	4.318	3.048	2.032	1.778
3/3/2016	20:37	42	4.064	9.144	6.096	4.064
3/4/2016	9:11	1	0.254	1.524	0.508	0.254
3/4/2016	15:44	2536	108.712	16.764	11.684	11.176
3/6/2016	19:35	481	3.302	3.048	2.54	1.778
3/7/2016	9:45	567	10.668	9.144	5.08	4.064
3/11/2016	8:57	336	24.892	12.192	9.144	8.128
3/11/2016	20:45	938	14.732	7.62	6.604	5.334
3/13/2016	0:43	2057	51.054	10.668	6.604	4.572
3/21/2016	11:44	733	20.828	9.144	6.096	5.08
3/22/2016	9:26	41	1.524	3.048	2.54	1.524
3/28/2016	16:50	129	0.762	1.524	0.508	0.508
4/8/2016	13:43	2398	47.498	9.144	6.604	5.588
4/10/2016	19:15	1	0.254	1.524	0.508	0.254
4/11/2016	2:36	1	0.254	1.524	0.508	0.254
4/22/2016	12:02	719	38.862	33.528	21.336	14.986
4/23/2016	6:19	1	0.254	1.524	0.508	0.254
4/24/2016	19:44	1	0.254	1.524	0.508	0.254
4/25/2016	13:18	13	1.016	4.572	2.032	1.016
4/28/2016	15:03	49	1.778	6.096	2.54	1.778
5/1/2016	14:00	131	16.51	32.004	20.32	14.732
5/6/2016	4:10	18	1.016	3.048	2.032	1.016
5/6/2016	14:07	337	1.27	1.524	1.016	0.508
5/7/2016	3:48	625	5.08	3.048	2.032	1.524
5/20/2016	20:02	31	0.762	3.048	1.016	0.762
5/21/2016	15:54	174	5.588	7.62	5.08	4.064
5/22/2016	4:25	1	0.254	1.524	0.508	0.254
5/24/2016	13:09	56	2.286	4.572	3.048	2.286

Appendix 2: Rainfall events between September 2014 and May 2016 in HF 2 logged only in Sawmill. Most of the rainfall was recorded between October and March. The table show storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively).

Begin	Time	Duration (min)	Amount (mm)	I_{10} (mm hr⁻¹)	I_{30} (mm hr⁻¹)	I_{60} (mm hr⁻¹)
9/27/2014	15:49	1673	23.622	15.24	10.668	7.112
10/25/2014	16:06	141	3.048	3.048	2.032	1.524
10/31/2014	18:22	934	32.512	10.668	5.08	4.318
11/2/2014	8:16	8	0.508	3.048	1.016	0.508
11/13/2014	0:44	600	12.192	6.096	5.588	4.572
11/20/2014	16:29	491	7.366	6.096	5.08	2.54
11/22/2014	6:55	563	16.51	12.192	6.096	4.826
11/29/2014	11:19	545	11.938	6.096	3.556	2.286
11/30/2014	13:59	350	5.334	4.572	3.048	2.54
12/1/2014	4:36	1	0.254	1.524	0.508	0.254
12/2/2014	8:36	2625	60.198	13.716	9.652	6.096
12/11/2014	23:07	1656	56.388	10.668	9.652	9.144
12/14/2014	9:13	1	0.254	1.524	0.508	0.254
12/15/2014	16:22	1197	14.224	9.144	7.112	5.334
12/16/2014	22:56	1037	12.954	6.096	4.572	3.81
12/18/2014	2:48	1	0.254	1.524	0.508	0.254
12/19/2014	13:04	1086	9.398	3.048	2.032	1.778
12/20/2014	13:19	424	2.54	3.048	2.032	1.27
12/22/2014	8:15	1	0.254	1.524	0.508	0.254
12/24/2014	16:07	370	12.192	13.716	7.62	5.08
12/27/2014	9:30	1	0.254	1.524	0.508	0.254
1/27/2015	3:41	409	4.318	3.048	1.524	1.27
2/6/2015	17:57	1549	50.8	18.288	16.256	15.24
2/8/2015	6:05	1378	56.134	28.956	18.288	12.446
2/9/2015	11:18	1	0.254	1.524	0.508	0.254
2/10/2015	8:51	1	0.254	1.524	0.508	0.254
2/22/2015	5:51	233	3.556	3.048	2.032	1.27
2/24/2015	8:43	1	0.254	1.524	0.508	0.254
2/27/2015	18:51	63	2.032	6.096	3.048	1.778
2/28/2015	1:57	980	7.366	4.572	3.048	3.048
3/1/2015	8:38	1	0.254	1.524	0.508	0.254
3/2/2015	4:53	454	7.112	12.192	9.144	4.826
3/3/2015	8:35	91	0.508	1.524	0.508	0.254
3/5/2015	8:40	1	0.254	1.524	0.508	0.254
3/11/2015	9:18	137	2.54	3.048	2.032	1.524
3/22/2015	21:54	78	0.762	1.524	1.016	0.508

4/5/2015	17:22	926	16.002	7.62	5.588	5.08
4/7/2015	9:10	408	11.43	10.668	7.112	5.588
4/8/2015	10:56	194	23.368	9.144	9.144	8.89
4/23/2015	15:57	34	0.762	1.524	1.016	0.762
4/25/2015	1:46	1080	33.528	12.192	9.144	7.112
4/26/2015	5:20	1	0.254	1.524	0.508	0.254
5/2/2015	15:12	1	0.254	1.524	0.508	0.254
5/7/2015	6:27	1305	26.162	13.716	9.144	5.334
5/14/2015	13:49	363	2.286	3.048	1.524	1.016
5/15/2015	5:23	1	0.254	1.524	0.508	0.254
5/15/2015	13:49	277	2.794	4.572	2.54	1.778
5/17/2015	18:14	17	2.794	12.192	5.588	2.794
5/18/2015	0:55	355	0.508	1.524	0.508	0.254
5/23/2015	11:26	111	0.508	1.524	0.508	0.254
5/23/2015	19:23	43	4.826	22.86	9.144	4.826
5/24/2015	3:20	1	0.254	1.524	0.508	0.254
6/5/2015	15:47	55	1.016	1.524	1.016	1.016
7/2/2015	20:04	70	1.016	3.048	1.524	0.762
7/3/2015	5:05	80	2.286	7.62	4.064	2.032
7/9/2015	5:48	181	1.016	1.524	1.016	0.508
7/10/2015	6:39	1	0.254	1.524	0.508	0.254
7/20/2015	19:28	257	7.366	21.336	10.668	5.588
7/21/2015	18:09	17	0.762	3.048	1.524	0.762
9/12/2015	11:30	1	0.254	1.524	0.508	0.254
9/14/2015	17:49	356	1.016	3.048	1.016	0.762
9/15/2015	8:23	1	0.254	1.524	0.508	0.254
10/1/2015	9:27	266	19.05	24.384	14.732	12.954
10/2/2015	6:28	1	0.254	1.524	0.508	0.254
10/15/2015	19:31	13	0.508	1.524	1.016	0.508
10/16/2015	16:24	60	2.032	6.096	3.048	2.032
10/17/2015	7:39	341	25.908	32.004	24.384	12.954
10/28/2015	5:20	177	7.874	4.572	3.556	3.302
10/28/2015	15:05	383	8.128	18.288	12.7	6.858
10/29/2015	4:00	1	0.254	1.524	0.508	0.254
11/2/2015	1:15	1731	56.896	13.716	10.668	9.144
11/3/2015	13:51	16	2.286	10.668	4.572	2.286
11/4/2015	8:18	248	0.762	3.048	1.016	0.508
11/8/2015	22:14	335	16.256	13.716	8.636	4.826
11/9/2015	12:30	318	5.842	4.572	4.064	2.794
11/10/2015	3:41	1	0.254	1.524	0.508	0.254
11/10/2015	9:53	90	5.08	12.192	7.112	4.318
11/11/2015	8:44	13	0.508	1.524	1.016	0.508
11/15/2015	8:59	834	23.368	9.144	7.62	6.604

11/16/2015	9:15	345	9.652	4.572	3.048	2.794
11/17/2015	8:44	76	0.508	1.524	0.508	0.254
11/24/2015	13:53	567	13.462	12.192	10.16	7.62
11/25/2015	10:47	317	2.794	4.572	2.54	1.778
11/26/2015	9:33	426	10.16	6.096	3.556	3.048
11/27/2015	9:59	127	0.762	1.524	0.508	0.508
11/29/2015	9:05	1	0.254	1.524	0.508	0.254
12/3/2015	18:14	244	6.096	6.096	4.572	3.556
12/4/2015	10:49	1	0.254	1.524	0.508	0.254
12/10/2015	7:35	1064	22.86	7.62	5.588	4.826
12/11/2015	10:09	513	20.066	6.096	5.08	4.572
12/12/2015	9:53	908	13.462	6.096	4.064	3.81
12/13/2015	8:44	417	14.478	7.62	5.588	5.334
12/14/2015	10:40	319	11.43	7.62	5.588	4.826
12/15/2015	10:06	329	3.302	3.048	1.016	1.016
12/16/2015	10:27	168	1.27	1.524	1.016	0.508
12/19/2015	5:08	880	17.018	7.62	5.588	4.572
12/20/2015	10:10	3191	93.726	7.62	6.604	6.096
12/23/2015	1:50	437	1.524	1.524	0.508	0.508
12/23/2015	16:40	1	0.254	1.524	0.508	0.254
12/24/2015	15:52	1	0.508	3.048	1.016	0.508
12/25/2015	12:05	299	11.938	10.668	7.112	5.842
12/26/2015	10:20	292	5.08	3.048	2.032	1.778
12/27/2015	10:48	1	0.254	1.524	0.508	0.254
12/31/2015	9:48	1	0.254	1.524	0.508	0.254
1/4/2016	14:45	95	0.508	1.524	0.508	0.254
1/4/2016	22:32	1071	32.258	12.192	9.652	7.62
1/6/2016	9:38	1	0.254	1.524	0.508	0.254
1/6/2016	16:10	1	0.254	1.524	0.508	0.254
1/7/2016	10:21	551	19.05	6.096	5.08	4.572
1/8/2016	9:40	488	13.97	4.572	3.556	3.302
1/9/2016	9:39	417	4.318	1.524	1.524	1.016
1/10/2016	2:01	198	2.032	3.048	2.032	1.016
1/11/2016	9:18	1	0.508	3.048	1.016	0.508
1/13/2016	6:41	325	3.556	4.572	3.048	2.032
1/14/2016	17:36	893	14.732	10.668	7.112	4.318
1/16/2016	2:31	406	5.588	6.096	3.048	2.032
1/16/2016	16:02	152	4.318	18.288	8.128	4.064
1/17/2016	8:57	36	0.508	1.524	0.508	0.508
1/17/2016	22:51	854	30.226	9.144	7.62	6.604
1/19/2016	5:26	490	20.32	10.668	8.128	7.62
1/20/2016	9:03	1	0.254	1.524	0.508	0.254
1/22/2016	10:19	1321	41.148	10.668	8.128	7.112

1/23/2016	17:30	114	1.27	4.572	2.032	1.016
1/24/2016	9:10	25	0.508	1.524	1.016	0.508
1/26/2016	9:02	1	0.254	1.524	0.508	0.254
1/29/2016	2:48	1	0.254	1.524	0.508	0.254
1/29/2016	23:37	860	31.242	13.716	9.144	6.858
1/31/2016	0:56	88	1.778	3.048	2.032	1.524
1/31/2016	11:02	438	3.302	1.524	1.016	0.762
2/1/2016	10:38	378	17.272	9.144	5.08	4.826
2/2/2016	9:46	394	3.81	3.048	1.524	1.27
2/3/2016	10:20	1	0.254	1.524	0.508	0.254
2/17/2016	20:50	1145	40.894	13.716	10.668	8.128
2/19/2016	8:37	1	0.254	1.524	0.508	0.254
3/3/2016	20:39	49	4.064	7.62	6.096	4.064
3/4/2016	15:27	4820	124.46	15.24	12.192	11.176
3/8/2016	11:01	1	0.254	1.524	0.508	0.254
3/11/2016	8:56	1551	43.18	12.192	10.16	9.652
3/13/2016	0:39	1897	52.324	12.192	7.112	4.826
3/15/2016	8:47	1	0.254	1.524	0.508	0.254
3/21/2016	11:47	737	19.304	9.144	6.096	4.826
3/22/2016	6:07	188	2.032	3.048	2.032	1.524
3/23/2016	8:53	1	0.254	1.524	0.508	0.254
3/28/2016	16:27	13	0.508	1.524	1.016	0.508
3/29/2016	8:52	1	0.254	1.524	0.508	0.254
4/8/2016	13:47	2528	47.244	9.144	6.096	5.588
4/10/2016	19:21	242	0.508	1.524	0.508	0.254
4/22/2016	12:05	726	38.862	27.432	20.828	14.986
4/23/2016	8:01	1	0.254	1.524	0.508	0.254
4/25/2016	13:02	52	1.778	4.572	3.048	1.778
4/28/2016	15:05	116	2.032	7.62	3.048	1.778
5/1/2016	14:03	407	12.954	22.86	14.732	11.176
5/6/2016	3:55	82	3.048	7.62	4.572	2.794
5/6/2016	14:13	1327	7.112	3.048	2.032	1.524
5/20/2016	20:03	27	1.27	4.572	2.54	1.27
5/21/2016	15:57	173	7.874	10.668	7.112	5.334
5/22/2016	7:40	22	0.508	1.524	1.016	0.508
5/24/2016	13:17	59	2.794	4.572	3.048	2.794

Appendix 3: Rainfall events between October 2014 and May 2016 in HF 3 control in Sawmill. Most of the rainfall was recorded between October and March. The table shows storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively).

Date	Time	Duration (min)	Amount (mm)	I_{10} (mm hr ⁻¹)	I_{30} (mm hr ⁻¹)	I_{60} (mm hr ⁻¹)
10/31/2014	18:22	918	29.972	9.144	5.588	4.572
11/1/2014	17:36	1	0.254	1.524	0.508	0.254
11/13/2014	3:11	452	12.446	7.62	5.08	4.318
11/19/2014	18:48	1	0.254	1.524	0.508	0.254
11/20/2014	17:29	369	6.604	4.572	3.556	2.794
11/22/2014	8:06	507	15.748	12.192	7.112	5.08
11/29/2014	12:22	475	11.176	6.096	4.064	2.286
11/30/2014	14:58	487	4.572	4.572	2.54	2.032
12/2/2014	9:45	2519	45.72	12.192	6.096	4.318
12/12/2014	0:13	1600	51.816	9.144	8.128	7.874
12/15/2014	17:56	924	11.43	7.62	5.588	4.318
12/17/2014	0:06	1019	9.652	4.572	3.048	2.54
12/18/2014	5:00	1	0.254	1.524	0.508	0.254
12/19/2014	17:27	875	9.144	3.048	2.032	1.778
12/20/2014	14:30	274	2.54	3.048	2.032	1.016
12/24/2014	17:04	196	11.176	12.192	6.604	4.826
12/27/2014	10:44	1	0.254	1.524	0.508	0.254
1/27/2015	5:20	259	3.302	3.048	1.524	1.016
2/6/2015	18:55	924	34.29	15.24	13.208	11.938
2/7/2015	17:40	184	2.794	7.62	3.048	2.54
2/8/2015	10:47	1149	46.228	25.908	17.78	10.922
2/10/2015	15:17	1	0.254	1.524	0.508	0.254
2/22/2015	7:22	191	2.286	3.048	1.524	1.27
2/27/2015	19:47	72	1.27	3.048	1.524	1.016
2/28/2015	3:16	946	4.318	3.048	2.54	1.524
3/1/2015	10:00	1	0.254	1.524	0.508	0.254
3/2/2015	9:13	269	5.08	13.716	7.112	3.81
3/11/2015	9:23	116	2.032	1.524	1.524	1.27
3/22/2015	23:00	1	0.254	1.524	0.508	0.254
4/5/2015	17:17	971	13.208	6.096	4.064	3.81
4/7/2015	8:50	365	9.906	7.62	5.08	4.064
4/8/2015	12:02	186	19.304	18.288	12.192	10.16
4/23/2015	15:40	44	1.524	4.572	1.524	1.524
4/24/2015	6:33	1	0.254	1.524	0.508	0.254
4/25/2015	1:44	1063	34.544	12.192	10.16	8.128
5/7/2015	6:21	1284	22.606	13.716	10.16	6.35

5/14/2015	13:51	213	2.286	4.572	1.524	1.016
5/15/2015	3:28	176	0.508	1.524	0.508	0.254
5/15/2015	13:52	124	3.302	4.572	3.048	2.286
5/17/2015	17:34	94	1.778	4.572	2.54	1.524
5/18/2015	6:47	1	0.254	1.524	0.508	0.254
5/22/2015	7:29	1	0.254	1.524	0.508	0.254
5/23/2015	19:21	38	3.048	12.192	5.588	3.048
6/5/2015	15:44	133	1.524	3.048	1.524	1.27
7/2/2015	20:00	24	1.016	3.048	2.032	1.016
7/3/2015	5:07	55	1.524	6.096	2.54	1.524
7/9/2015	5:49	166	1.016	1.524	1.016	0.762
7/10/2015	6:22	148	0.508	1.524	0.508	0.254
7/20/2015	17:04	295	5.842	19.812	7.112	3.556
7/21/2015	18:15	15	0.508	1.524	1.016	0.508
7/31/2015	17:12	5	1.016	6.096	2.032	1.016
10/15/2015	19:22	279	1.016	3.048	1.524	0.762
10/16/2015	16:33	42	0.508	1.524	0.508	0.508
10/17/2015	6:08	407	23.622	33.528	23.876	12.7
10/28/2015	5:19	174	6.35	4.572	3.048	2.54
10/28/2015	15:07	199	9.144	32.004	16.764	8.636
10/29/2015	9:00	1	0.254	1.524	0.508	0.254
11/2/2015	1:14	1394	47.244	13.716	8.128	6.858
11/3/2015	7:35	1	0.254	1.524	0.508	0.254
11/3/2015	13:43	23	2.032	7.62	4.064	2.032
11/4/2015	8:48	1	0.254	1.524	0.508	0.254
11/8/2015	22:12	332	13.97	10.668	6.604	4.318
11/9/2015	12:31	250	4.572	4.572	3.048	2.286
11/9/2015	23:32	1	0.254	1.524	0.508	0.254
11/10/2015	9:38	180	4.318	4.572	3.048	2.286
11/15/2015	9:01	812	14.224	6.096	5.08	3.81
11/16/2015	10:11	322	6.096	3.048	2.032	2.032
11/17/2015	9:56	143	1.016	1.524	0.508	0.508
11/24/2015	13:55	147	10.16	9.144	7.62	6.35
11/25/2015	12:12	261	1.778	1.524	1.016	0.762
11/26/2015	10:26	367	6.604	3.048	2.032	1.778
11/27/2015	10:13	314	2.032	1.524	1.016	0.762
11/28/2015	10:56	181	1.016	1.524	0.508	0.508
12/3/2015	18:00	198	5.334	4.572	4.064	3.302
12/10/2015	7:48	475	14.986	7.62	5.588	4.826
12/10/2015	21:52	26	0.508	1.524	1.016	0.508
12/11/2015	9:56	563	16.256	15.24	9.652	7.62
12/12/2015	10:20	1016	11.684	4.572	3.556	3.048
12/13/2015	9:19	434	12.192	7.62	5.08	4.572

12/14/2015	12:06	255	6.096	9.144	4.572	3.81
12/15/2015	11:38	293	2.286	1.524	1.016	1.016
12/16/2015	11:32	276	2.794	4.572	2.032	1.27
12/17/2015	11:04	323	4.318	3.048	1.524	1.27
12/18/2015	10:39	211	2.032	1.524	1.016	0.762
12/19/2015	5:06	752	12.954	6.096	4.064	3.302
12/20/2015	11:42	2984	86.614	7.62	6.096	5.842
12/22/2015	22:22	595	1.27	1.524	0.508	0.254
12/23/2015	16:30	1	0.254	1.524	0.508	0.254
12/25/2015	12:39	225	5.334	3.048	2.54	2.286
12/26/2015	10:40	325	5.588	6.096	3.556	2.54
12/27/2015	11:25	243	3.302	3.048	2.032	1.524
12/28/2015	11:33	267	0.762	1.524	0.508	0.254
12/29/2015	12:25	149	1.016	1.524	0.508	0.508
12/30/2015	10:50	261	1.27	1.524	0.508	0.508
1/4/2016	14:51	1	0.254	1.524	0.508	0.254
1/4/2016	23:42	1003	27.432	10.668	7.62	6.096
1/6/2016	11:23	1950	26.67	18.288	6.604	5.334
1/8/2016	10:46	432	9.906	3.048	3.048	2.794
1/9/2016	9:49	1633	12.954	3.048	2.032	1.524
1/12/2016	11:53	1	0.254	1.524	0.508	0.254
1/13/2016	7:11	175	1.778	3.048	2.032	1.27
1/14/2016	17:45	724	12.7	7.62	5.588	3.556
1/16/2016	2:29	422	6.096	6.096	3.556	2.286
1/16/2016	16:00	19	9.144	47.244	18.288	9.144
1/17/2016	4:52	1	0.254	1.524	0.508	0.254
1/17/2016	22:55	631	29.21	10.668	8.128	6.858
1/19/2016	5:32	476	16.256	10.668	7.112	5.842
1/22/2016	10:21	1238	38.354	10.668	8.636	7.62
1/23/2016	17:28	131	1.778	6.096	3.048	1.524
1/25/2016	12:50	1	0.254	1.524	0.508	0.254
1/29/2016	3:40	1	0.254	1.524	0.508	0.254
1/29/2016	23:54	779	24.13	12.192	7.112	5.334
1/31/2016	0:43	73	1.016	1.524	1.016	0.762
1/31/2016	16:53	49	0.508	1.524	0.508	0.508
2/1/2016	11:31	349	10.414	4.572	4.064	3.556
2/2/2016	11:43	358	6.604	3.048	3.048	2.794
2/3/2016	11:15	338	4.318	3.048	2.032	1.524
2/17/2016	20:59	183	10.414	12.192	8.636	6.858
2/18/2016	6:04	851	20.828	4.572	4.064	3.81
2/19/2016	9:35	72	0.508	1.524	0.508	0.254
2/20/2016	9:20	1	0.254	1.524	0.508	0.254
3/3/2016	20:40	41	3.302	6.096	5.08	3.302

3/4/2016	9:21	1	0.254	1.524	0.508	0.254
3/4/2016	16:02	2503	90.678	16.764	10.16	8.636
3/6/2016	19:46	1378	11.684	4.572	3.556	3.302
3/11/2016	9:05	1609	33.782	9.144	7.112	6.858
3/13/2016	0:48	1906	48.514	10.668	6.096	4.318
3/21/2016	11:50	735	18.034	9.144	6.604	5.334
3/22/2016	6:04	198	1.016	1.524	1.016	0.762
3/28/2016	16:28	1	0.254	1.524	0.508	0.254
4/8/2016	13:54	2372	44.704	10.668	8.636	7.112
4/10/2016	19:29	1	0.254	1.524	0.508	0.254
4/11/2016	18:40	1	0.254	1.524	0.508	0.254
4/22/2016	12:06	1044	35.56	21.336	17.272	13.208
4/25/2016	13:08	12	0.508	1.524	1.016	0.508
4/28/2016	15:06	132	1.778	6.096	2.032	1.524
5/1/2016	14:05	120	9.144	15.24	9.144	7.874
5/6/2016	3:45	925	3.81	6.096	3.048	2.032
5/7/2016	3:29	500	4.318	3.048	1.524	1.27
5/8/2016	2:46	1	0.254	1.524	0.508	0.254
5/20/2016	20:08	19	1.016	4.572	2.032	1.016
5/21/2016	16:00	216	7.62	9.144	6.096	4.572
5/24/2016	13:29	93	2.286	3.048	2.54	2.032

Appendix 4: Rainfall events between October 2014 and May 2016 in HF 3 logged only in Sawmill. Most of the rainfall was recorded between October and March. The table shows storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively).

Date	Time	Duration (min)	Amount (mm)	I_{10} (mm hr ⁻¹)	I_{30} (mm hr ⁻¹)	I_{60} (mm hr ⁻¹)
10/31/2014	18:22	918	31.75	9.144	5.08	4.572
11/1/2014	17:31	1	0.254	1.524	0.508	0.254
11/2/2014	9:49	1	0.254	1.524	0.508	0.254
11/13/2014	1:58	528	12.954	7.62	5.588	4.572
11/20/2014	2:42	1	0.254	1.524	0.508	0.254
11/20/2014	17:29	361	6.858	6.096	4.572	2.794
11/21/2014	6:54	1	0.254	1.524	0.508	0.254
11/22/2014	8:02	504	16.764	13.716	7.112	5.334
11/23/2014	2:04	1	0.254	1.524	0.508	0.254
11/29/2014	12:24	535	14.224	7.62	4.572	3.302
11/30/2014	14:54	304	5.08	4.572	3.048	2.286
12/2/2014	9:34	2466	54.864	13.716	8.636	5.588
12/12/2014	0:05	1667	58.166	9.144	9.144	8.636
12/15/2014	18:00	919	11.938	9.144	6.604	4.572
12/17/2014	0:03	1023	10.668	4.572	3.556	3.048
12/19/2014	16:30	929	9.906	3.048	2.54	2.032
12/20/2014	14:09	277	2.286	3.048	2.032	1.016
12/24/2014	17:04	209	11.176	13.716	7.112	5.08
12/27/2014	10:23	1	0.254	1.524	0.508	0.254
1/27/2015	5:03	277	3.81	3.048	1.524	1.27
2/6/2015	18:50	1875	47.752	18.288	16.256	14.986
2/8/2015	10:46	1150	52.07	32.004	20.32	11.938
2/10/2015	10:01	1	0.254	1.524	0.508	0.254
2/22/2015	6:47	207	3.048	1.524	1.524	1.27
2/23/2015	10:02	1	0.254	1.524	0.508	0.254
2/27/2015	19:43	46	1.524	4.572	2.54	1.524
2/28/2015	2:49	1021	6.604	4.572	3.048	2.794
3/1/2015	10:37	1	0.254	1.524	0.508	0.254
3/2/2015	9:00	242	5.588	6.096	5.08	3.048
3/3/2015	10:10	1	0.254	1.524	0.508	0.254
3/11/2015	9:13	117	2.286	3.048	2.032	1.524
3/12/2015	10:09	1	0.254	1.524	0.508	0.254
3/22/2015	22:50	39	0.508	1.524	0.508	0.508
4/5/2015	17:19	868	16.256	7.62	5.588	5.334
4/7/2015	9:08	290	12.7	7.62	7.62	6.604
4/8/2015	11:14	172	23.114	15.24	12.7	11.176

4/23/2015	15:48	168	1.016	3.048	1.016	0.762
4/25/2015	1:41	1060	37.084	13.716	9.652	7.62
4/26/2015	3:34	1	0.254	1.524	0.508	0.254
5/2/2015	16:40	1	0.254	1.524	0.508	0.254
5/7/2015	10:22	1224	27.94	15.24	9.144	6.35
5/14/2015	16:48	201	2.286	4.572	2.032	1.27
5/15/2015	6:19	182	0.508	1.524	0.508	0.254
5/15/2015	16:50	275	3.302	4.572	2.54	2.032
5/17/2015	21:13	20	2.54	10.668	5.08	2.54
5/18/2015	8:40	1	0.254	1.524	0.508	0.254
5/23/2015	22:21	61	3.556	13.716	6.096	3.302
5/24/2015	13:14	1	0.254	1.524	0.508	0.254
6/5/2015	18:44	69	1.27	1.524	1.016	1.016
7/2/2015	23:02	58	1.016	3.048	1.524	1.016
7/3/2015	8:07	16	1.27	6.096	2.54	1.27
7/9/2015	8:52	65	0.762	1.524	0.508	0.508
7/10/2015	9:20	146	0.508	1.524	0.508	0.254
7/20/2015	22:23	370	6.35	19.812	8.128	4.064
7/21/2015	21:14	19	0.508	1.524	1.016	0.508
9/14/2015	20:45	353	1.016	3.048	1.016	0.762
10/1/2015	12:20	264	18.542	24.384	14.224	12.954
10/15/2015	22:27	17	0.508	1.524	1.016	0.508
10/16/2015	19:28	63	1.27	4.572	2.032	1.016
10/17/2015	11:24	294	25.146	44.196	27.94	14.732
10/28/2015	8:19	179	6.858	4.572	3.048	2.794
10/28/2015	18:07	277	9.398	30.48	16.764	8.636
10/29/2015	11:23	1	0.254	1.524	0.508	0.254
11/2/2015	5:14	1742	52.578	15.24	9.652	8.636
11/3/2015	17:48	18	2.286	9.144	4.572	2.286
11/4/2015	12:34	1	0.254	1.524	0.508	0.254
11/8/2015	12:01	-221	0.508	3.048	1.016	0.508
11/8/2015	22:10	426	15.494	13.716	8.636	4.826
11/9/2015	12:40	240	5.334	4.572	4.064	2.794
11/9/2015	23:36	1	0.254	1.524	0.508	0.254
11/10/2015	9:51	91	5.08	10.668	7.112	4.572
11/12/2015	8:32	1	0.254	1.524	0.508	0.254
11/15/2015	9:02	539	22.606	10.668	8.636	7.112
11/16/2015	0:36	1	0.254	1.524	0.508	0.254
11/16/2015	9:20	327	7.874	4.572	3.556	3.048
11/17/2015	9:08	1	0.254	1.524	0.508	0.254
11/24/2015	13:54	596	12.192	9.144	8.128	6.858
11/25/2015	12:49	219	3.302	6.096	3.048	2.54
11/26/2015	9:50	360	8.128	6.096	3.556	2.794

11/27/2015	10:13	57	0.508	1.524	0.508	0.508
12/3/2015	18:15	407	6.096	6.096	4.064	3.81
12/10/2015	7:41	1055	21.082	7.62	5.588	4.826
12/11/2015	9:34	446	26.162	7.62	7.112	6.604
12/12/2015	10:15	547	9.906	4.572	3.556	3.048
12/13/2015	1:23	925	14.478	7.62	5.08	4.826
12/14/2015	11:17	263	11.938	6.096	5.08	4.572
12/15/2015	11:01	271	1.778	1.524	1.016	0.762
12/19/2015	5:00	846	16.764	7.62	6.096	4.826
12/20/2015	10:30	3059	99.314	9.144	7.112	6.858
12/23/2015	1:49	406	1.524	1.524	1.016	0.508
12/23/2015	16:30	19	0.508	1.524	1.016	0.508
12/26/2015	12:38	230	3.81	3.048	2.032	1.778
12/27/2015	10:23	285	4.318	3.048	2.032	1.524
12/28/2015	11:25	139	1.27	1.524	1.016	0.762
12/29/2015	10:31	265	1.778	1.524	1.016	0.508
1/1/2016	9:35	1	0.254	1.524	0.508	0.254
1/4/2016	14:53	1	0.254	1.524	0.508	0.254
1/4/2016	22:30	1384	33.782	13.716	9.652	7.62
1/6/2016	13:52	467	1.524	1.524	1.016	0.508
1/7/2016	11:03	757	21.336	7.62	6.604	6.096
1/8/2016	10:37	420	11.43	3.048	3.048	2.794
1/9/2016	8:59	531	3.81	1.524	1.016	0.762
1/10/2016	2:08	184	1.27	3.048	1.524	0.762
1/11/2016	9:38	1	0.254	1.524	0.508	0.254
1/13/2016	6:46	320	3.048	3.048	2.54	1.778
1/14/2016	17:41	739	14.224	9.144	6.096	3.81
1/16/2016	2:26	422	6.096	6.096	3.048	2.032
1/16/2016	15:59	84	4.826	22.86	9.144	4.572
1/17/2016	22:02	723	31.75	10.668	8.636	7.366
1/19/2016	5:26	476	19.812	10.668	8.128	7.366
1/22/2016	10:17	1243	43.688	12.192	9.144	7.874
1/23/2016	17:26	16	1.778	7.62	3.556	1.778
1/24/2016	1:34	1	0.254	1.524	0.508	0.254
1/25/2016	9:06	1	0.254	1.524	0.508	0.254
1/26/2016	9:20	1	0.254	1.524	0.508	0.254
1/29/2016	5:30	1	0.254	1.524	0.508	0.254
1/29/2016	23:50	781	27.178	12.192	8.636	6.35
1/31/2016	0:47	76	1.524	3.048	1.524	1.27
1/31/2016	9:53	558	0.762	1.524	0.508	0.254
2/1/2016	11:25	336	14.224	6.096	4.064	3.81
2/2/2016	10:50	390	4.826	3.048	2.032	1.524
2/3/2016	10:19	129	1.016	1.524	0.508	0.508

2/17/2016	20:50	1034	36.576	13.716	10.16	7.874
3/3/2016	20:33	48	4.064	6.096	5.588	4.064
3/4/2016	15:37	2528	105.41	19.812	12.7	10.668
3/6/2016	19:49	1329	14.732	4.572	4.064	3.556
3/8/2016	8:45	1	0.254	1.524	0.508	0.254
3/11/2016	8:53	1544	42.418	12.192	9.652	9.398
3/12/2016	23:34	1953	51.816	12.192	7.112	4.572
3/21/2016	10:43	747	18.796	10.668	6.604	5.334
3/22/2016	5:11	186	1.524	1.524	1.016	0.762
3/28/2016	15:27	1	0.254	1.524	0.508	0.254
3/30/2016	8:41	1	0.254	1.524	0.508	0.254
4/8/2016	12:47	2367	46.482	9.144	6.604	5.334
4/10/2016	18:00	34	0.762	1.524	1.016	0.762
4/11/2016	3:16	1	0.254	1.524	0.508	0.254
4/22/2016	10:59	716	37.846	24.384	19.304	14.478
4/24/2016	18:36	1	0.254	1.524	0.508	0.254
4/25/2016	11:57	20	1.016	3.048	2.032	1.016
4/28/2016	13:57	112	2.286	9.144	3.556	2.032
5/1/2016	12:55	124	10.668	16.764	12.192	9.398
5/6/2016	2:40	167	3.048	9.144	4.572	2.794
5/6/2016	12:50	1456	6.096	3.048	1.524	1.27
5/20/2016	18:56	28	1.778	6.096	3.556	1.778
5/21/2016	14:48	246	7.366	9.144	5.588	4.572
5/22/2016	8:05	1	0.254	1.524	0.508	0.254

Appendix 5: Rainfall events between September 2014 and May 2016 in HF 4 logged only in Sawmill. Most of the rainfall was recorded between October and March. The table shows storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively).

Date	Time	Duration (min)	Amount (mm)	I_{10} (mm hr ⁻¹)	I_{30} (mm hr ⁻¹)	I_{60} (mm hr ⁻¹)
9/20/2014	17:54	284	1.524	3.048	2.54	1.27
9/27/2014	15:51	798	21.844	12.192	10.16	7.112
9/28/2014	13:50	89	2.54	4.572	3.048	2.286
10/25/2014	16:10	142	3.048	3.048	2.032	1.778
10/31/2014	18:20	982	32.512	9.144	6.604	5.08
11/1/2014	17:34	215	0.508	1.524	0.508	0.254
11/2/2014	9:07	1	0.254	1.524	0.508	0.254
11/13/2014	1:47	598	13.716	7.62	5.588	4.572
11/16/2014	9:09	1	0.254	1.524	0.508	0.254
11/19/2014	16:32	149	0.508	1.524	0.508	0.254
11/20/2014	17:25	554	7.366	6.096	4.064	2.794
11/22/2014	7:46	526	17.526	13.716	7.62	5.334
11/23/2014	9:18	1	0.254	1.524	0.508	0.254
11/29/2014	12:25	474	11.684	4.572	4.064	2.794
11/30/2014	14:55	215	5.334	4.572	3.048	2.54
12/1/2014	5:53	1	0.254	1.524	0.508	0.254
12/2/2014	9:37	2528	59.436	15.24	8.128	5.588
12/12/2014	0:06	1613	62.23	10.668	9.652	9.144
12/14/2014	10:24	1	0.254	1.524	0.508	0.254
12/15/2014	17:59	966	12.954	7.62	6.096	4.572
12/16/2014	22:27	1347	11.684	4.572	3.048	2.794
12/19/2014	16:29	954	10.16	3.048	2.032	1.778
12/20/2014	15:06	197	2.54	3.048	2.032	1.524
12/21/2014	7:39	1	0.254	1.524	0.508	0.254
12/24/2014	17:06	254	12.446	13.716	8.128	5.842
12/25/2014	11:43	1	0.254	1.524	0.508	0.254
1/13/2015	10:40	1	0.254	1.524	0.508	0.254
1/27/2015	5:21	263	3.81	3.048	2.032	1.524
1/28/2015	7:55	1	0.254	1.524	0.508	0.254
2/6/2015	18:54	1550	44.45	16.764	13.716	12.7
2/8/2015	3:29	1	0.254	1.524	0.508	0.254
2/8/2015	10:50	1234	54.102	25.908	17.78	10.922
2/10/2015	9:28	1	0.254	1.524	0.508	0.254
2/22/2015	6:36	245	3.556	3.048	2.54	1.778
2/27/2015	19:51	50	1.778	4.572	3.048	1.778
2/28/2015	2:59	964	5.842	4.572	3.048	2.54

3/1/2015	9:02	1	0.254	1.524	0.508	0.254
3/2/2015	5:47	458	6.35	13.716	8.636	4.318
3/3/2015	9:05	1	0.254	1.524	0.508	0.254
3/5/2015	8:54	1	0.254	1.524	0.508	0.254
3/11/2015	10:19	170	2.54	3.048	2.032	1.524
3/22/2015	23:41	15	0.508	1.524	1.016	0.508
3/23/2015	7:12	1	0.254	1.524	0.508	0.254
4/5/2015	18:21	924	14.986	6.096	4.572	4.064
4/7/2015	10:13	474	11.43	12.192	8.128	6.35
4/8/2015	11:11	325	22.352	13.716	10.668	9.906
4/23/2015	16:42	173	2.794	10.668	4.064	2.54
4/25/2015	2:45	1077	36.068	10.668	9.652	8.382
5/7/2015	7:14	829	21.59	13.716	9.652	5.842
5/8/2015	4:35	28	0.508	1.524	1.016	0.508
5/14/2015	13:51	196	2.286	4.572	2.032	1.27
5/15/2015	2:07	265	0.762	1.524	0.508	0.254
5/15/2015	13:51	276	3.81	7.62	3.556	3.048
5/17/2015	17:34	57	1.778	6.096	3.048	1.778
5/23/2015	19:22	52	2.54	9.144	4.064	2.54
6/5/2015	15:45	63	1.778	3.048	2.032	1.524
7/2/2015	20:01	22	1.016	3.048	2.032	1.016
7/3/2015	5:03	20	2.032	9.144	4.064	2.032
7/9/2015	5:45	90	1.27	3.048	1.524	0.762
7/10/2015	6:35	299	0.508	1.524	0.508	0.254
7/20/2015	17:03	403	5.334	13.716	6.096	3.048
7/23/2015	17:02	1	0.254	1.524	0.508	0.254
7/31/2015	17:13	8	1.778	10.668	3.556	1.778
9/12/2015	9:12	1	0.254	1.524	0.508	0.254
9/14/2015	17:51	699	1.27	1.524	1.016	0.508
10/1/2015	9:28	263	17.78	27.432	17.272	13.462
10/15/2015	19:16	45	1.524	6.096	2.54	1.524
10/16/2015	16:27	58	0.762	1.524	1.016	0.762
10/17/2015	8:22	281	23.114	27.432	22.352	11.938
10/19/2015	8:15	1	0.254	1.524	0.508	0.254
10/28/2015	5:20	171	6.604	4.572	3.048	2.794
10/28/2015	15:07	202	9.906	32.004	18.288	9.398
10/29/2015	4:26	1	0.254	1.524	0.508	0.254
11/2/2015	1:14	1604	47.752	12.192	8.636	7.62
11/3/2015	13:38	28	2.286	7.62	4.572	2.286
11/4/2015	7:55	1	0.254	1.524	0.508	0.254
11/8/2015	23:13	334	14.478	12.192	7.62	4.318
11/9/2015	13:31	663	5.588	4.572	3.048	2.54
11/10/2015	9:49	87	3.302	4.572	2.54	2.286

11/11/2015	9:25	1	0.254	1.524	0.508	0.254
11/15/2015	9:56	816	17.78	10.668	7.112	5.334
11/16/2015	9:47	294	7.62	4.572	3.556	2.794
11/17/2015	9:29	122	0.762	1.524	0.508	0.508
11/24/2015	14:53	149	11.176	9.144	7.62	6.35
11/25/2015	12:00	342	2.794	1.524	1.524	1.016
11/26/2015	10:26	298	7.112	3.048	2.54	2.286
11/27/2015	9:49	343	1.778	1.524	1.016	0.508
11/28/2015	11:14	144	0.508	1.524	0.508	0.254
12/3/2015	19:13	199	5.334	4.572	3.556	3.048
12/10/2015	8:29	886	17.78	7.62	5.588	4.572
12/11/2015	12:14	339	14.986	10.668	5.588	4.826
12/12/2015	11:06	948	13.97	4.572	3.048	3.048
12/13/2015	10:18	383	14.732	7.62	6.096	5.842
12/14/2015	11:45	290	6.858	3.048	2.54	2.286
12/15/2015	11:45	187	2.286	1.524	1.016	1.016
12/16/2015	11:19	243	3.302	1.524	1.524	1.27
12/17/2015	10:58	252	3.556	1.524	1.524	1.27
12/18/2015	10:27	1	0.254	1.524	0.508	0.254
12/19/2015	6:05	759	13.97	6.096	4.572	3.556
12/20/2015	11:27	3056	96.774	7.62	6.096	6.096
12/23/2015	2:36	413	1.27	1.524	0.508	0.254
12/23/2015	17:27	7	0.508	3.048	1.016	0.508
12/24/2015	21:17	1	0.254	1.524	0.508	0.254
12/27/2015	14:35	180	2.54	3.048	2.032	1.524
12/28/2015	13:21	121	2.032	3.048	2.032	1.524
12/29/2015	11:28	250	2.794	3.048	1.524	1.27
12/30/2015	11:34	363	3.302	1.524	1.524	1.016
12/31/2015	11:57	196	2.286	1.524	1.016	1.016
1/1/2016	11:39	180	1.016	1.524	0.508	0.508
1/2/2016	10:47	209	1.27	1.524	0.508	0.508
1/4/2016	15:45	101	0.508	1.524	0.508	0.254
1/5/2016	1:59	925	27.178	9.144	8.636	7.366
1/6/2016	11:51	1008	9.906	3.048	2.54	2.54
1/7/2016	11:09	631	17.78	6.096	5.588	5.08
1/8/2016	11:10	444	8.382	3.048	2.54	2.286
1/9/2016	10:01	1679	14.478	3.048	2.54	2.032
1/13/2016	7:35	335	2.794	3.048	2.032	1.524
1/14/2016	18:51	715	14.478	7.62	5.588	3.556
1/16/2016	3:25	400	5.842	6.096	3.048	2.032
1/16/2016	16:57	30	5.08	19.812	10.16	5.08
1/17/2016	10:05	1	0.254	1.524	0.508	0.254
1/17/2016	23:48	613	27.432	9.144	7.112	5.842

1/19/2016	6:13	497	16.764	10.668	7.62	6.096
1/20/2016	10:20	1	0.254	1.524	0.508	0.254
1/22/2016	11:19	1240	38.354	9.144	8.128	7.112
1/23/2016	18:28	319	1.778	6.096	3.048	1.524
1/24/2016	20:17	1	0.254	1.524	0.508	0.254
1/26/2016	9:29	7	0.508	3.048	1.016	0.508
1/29/2016	3:44	1	0.254	1.524	0.508	0.254
1/30/2016	0:37	1037	26.924	10.668	7.62	5.588
1/31/2016	2:03	68	1.27	1.524	1.524	1.016
1/31/2016	17:53	243	1.016	1.524	0.508	0.254
2/1/2016	10:51	486	11.938	6.096	4.064	3.048
2/2/2016	12:38	288	4.572	3.048	2.032	1.524
2/3/2016	11:11	352	4.826	1.524	1.524	1.524
2/17/2016	21:52	188	12.954	13.716	10.668	7.874
2/18/2016	7:04	624	21.844	6.096	5.08	4.572
2/19/2016	9:47	72	0.508	1.524	0.508	0.254
3/3/2016	21:37	101	3.302	6.096	5.08	3.048
3/4/2016	16:43	2527	99.06	16.764	11.176	9.652
3/6/2016	20:45	1337	11.938	4.572	4.064	3.556
3/8/2016	8:42	1	0.254	1.524	0.508	0.254
3/11/2016	9:58	1545	33.528	9.144	6.604	6.096
3/13/2016	1:54	1925	49.276	12.192	6.604	4.572
3/21/2016	12:45	1259	21.844	9.144	7.112	5.334
3/28/2016	17:26	10	0.508	3.048	1.016	0.508
4/8/2016	14:45	2336	46.482	16.764	10.668	8.382
4/10/2016	20:21	304	0.508	1.524	0.508	0.254
4/22/2016	13:02	965	37.338	24.384	17.272	13.208
4/24/2016	21:45	1	0.254	1.524	0.508	0.254
4/25/2016	14:03	13	0.508	1.524	1.016	0.508
4/28/2016	15:59	47	1.524	7.62	2.54	1.524
4/29/2016	11:17	1	0.254	1.524	0.508	0.254
5/1/2016	15:00	117	9.906	19.812	11.684	8.636
5/6/2016	4:44	61	1.778	4.572	2.54	1.524
5/6/2016	14:50	1318	7.366	4.572	2.54	1.524
5/20/2016	21:00	30	1.524	4.572	3.048	1.524
5/21/2016	16:57	222	8.636	10.668	7.112	5.588
5/24/2016	14:28	53	1.778	3.048	2.032	1.778

Appendix 6: Rainfall events between September 2015 and May 2016 in FSW 10 in lower Femmons. Most of the rainfall was recorded between October and March. The table shows storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively). The gauge was installed in July 2015.

Date	Time	Duration (min)	Amount (mm)	I_{10} (mm hr⁻¹)	I_{30} (mm hr⁻¹)	I_{60} (mm hr⁻¹)
10/1/2015	8:59	294	22.098	13.716	11.684	9.144
10/17/2015	7:46	261	2.54	10.668	3.556	1.778
10/28/2015	1:58	409	9.906	6.096	4.064	3.556
10/28/2015	15:17	38	3.81	16.764	7.112	3.81
11/2/2015	2:01	1437	58.674	21.336	13.716	10.668
11/3/2015	14:21	11	0.508	1.524	1.016	0.508
11/8/2015	22:33	459	20.828	9.144	8.128	7.112
11/9/2015	15:04	462	5.588	4.572	3.048	2.032
11/10/2015	9:28	225	9.906	7.62	4.572	3.81
11/15/2015	9:52	539	21.844	9.144	5.588	4.826
11/16/2015	10:01	372	8.382	3.048	2.032	2.032
11/17/2015	10:01	59	0.508	1.524	0.508	0.508
11/24/2015	15:03	264	10.414	9.144	6.604	6.096
11/25/2015	11:56	273	3.048	3.048	1.524	1.27
11/26/2015	10:23	225	2.794	1.524	1.016	1.016
12/3/2015	19:11	100	4.318	4.572	3.556	3.048
12/4/2015	4:52	1	0.254	1.524	0.508	0.254
12/10/2015	7:40	924	26.924	10.668	8.128	6.858
12/11/2015	6:48	672	18.034	7.62	7.62	6.858
12/12/2015	10:13	1885	23.114	4.572	4.064	3.556
12/14/2015	10:34	349	7.62	4.572	3.048	2.54
12/15/2015	11:22	357	2.54	1.524	1.016	1.016
12/16/2015	11:30	226	1.524	1.524	0.508	0.508
12/17/2015	10:22	1	0.254	1.524	0.508	0.254
12/19/2015	5:46	858	17.018	7.62	5.588	3.81
12/20/2015	12:27	1	0.254	1.524	0.508	0.254
12/20/2015	20:15	2543	188.722	12.192	9.144	9.144
12/23/2015	0:35	361	0.762	1.524	0.508	0.254
12/23/2015	16:26	1	0.254	1.524	0.508	0.254
12/26/2015	15:57	1	0.254	1.524	0.508	0.254
12/27/2015	11:26	364	6.096	3.048	2.032	1.778
12/28/2015	12:36	238	2.032	1.524	1.524	1.016
12/29/2015	11:16	289	2.794	1.524	1.016	0.762
12/30/2015	10:47	270	2.032	1.524	1.016	0.762

12/31/2015	10:13	193	0.762	1.524	0.508	0.254
1/4/2016	16:51	33	0.508	1.524	0.508	0.508
1/5/2016	3:13	835	27.686	6.096	5.588	5.08
1/6/2016	12:20	1869	33.274	15.24	7.62	7.112
1/8/2016	10:34	394	10.668	3.048	3.048	2.794
1/9/2016	9:47	1223	9.144	3.048	1.524	1.27
1/13/2016	7:37	286	4.318	4.572	2.032	2.032
1/14/2016	18:50	892	23.622	12.192	9.652	7.874
1/16/2016	3:11	1034	9.144	10.668	4.064	2.032
1/18/2016	0:55	527	26.162	7.62	6.096	5.588
1/19/2016	6:17	632	26.162	10.668	8.636	6.858
1/20/2016	7:21	1	0.254	1.524	0.508	0.254
1/22/2016	11:23	1223	38.862	15.24	9.144	8.636
1/23/2016	18:21	7	0.508	3.048	1.016	0.508
1/24/2016	4:06	1	0.254	1.524	0.508	0.254
1/29/2016	3:24	1	0.254	1.524	0.508	0.254
1/29/2016	12:42	1	0.254	1.524	0.508	0.254
1/30/2016	0:19	798	35.56	21.336	12.192	9.398
1/31/2016	1:37	70	1.778	3.048	2.032	1.524
2/1/2016	10:41	428	12.446	10.668	5.08	3.048
2/2/2016	11:10	361	4.826	3.048	2.032	1.524
2/3/2016	10:56	197	1.778	1.524	1.016	0.762
2/17/2016	22:54	1139	30.734	7.62	4.572	4.064
2/19/2016	9:16	1	0.254	1.524	0.508	0.254
3/3/2016	20:42	61	2.286	7.62	3.556	2.032
3/4/2016	17:24	2593	102.616	15.24	11.176	9.398
3/6/2016	21:26	448	4.318	4.572	3.556	2.54
3/7/2016	20:10	1	0.254	1.524	0.508	0.254
3/13/2016	15:43	1004	115.824	79.248	73.152	63.5
3/21/2016	10:21	866	20.32	6.096	5.08	4.826
3/22/2016	6:52	125	1.778	3.048	2.032	1.524
4/8/2016	14:46	2602	41.656	4.572	3.048	3.048
4/10/2016	19:12	191	0.762	1.524	0.508	0.254
4/22/2016	12:11	2807	22.86	3.048	2.032	1.778
4/24/2016	22:10	1	0.254	1.524	0.508	0.254
4/25/2016	21:25	1	0.254	1.524	0.508	0.254
5/1/2016	16:11	443	0.762	1.524	0.508	0.254
5/7/2016	4:05	1	0.254	1.524	0.508	0.254
5/7/2016	14:20	435	0.762	1.524	0.508	0.254

Appendix 7: Rainfall events between July 2015 and May 2016 in FSW 11 in lower Femmons. Most of the rainfall was recorded between October and March. The table shows storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively). The rain gauge was installed in July 2015.

Date	Time	Duration (min)	Amount (mm)	I_{10} (mm hr ⁻¹)	I_{30} (mm hr ⁻¹)	I_{60} (mm hr ⁻¹)
7/31/2015	4:32	7	0.762	4.572	1.524	0.762
9/14/2015	22:02	1	0.254	1.524	0.508	0.254
9/15/2015	4:35	1	0.254	1.524	0.508	0.254
10/1/2015	9:02	289	22.352	13.716	12.192	9.652
10/17/2015	7:43	237	2.032	9.144	3.048	1.524
10/18/2015	9:51	1	0.254	1.524	0.508	0.254
10/28/2015	1:55	401	10.414	6.096	4.064	3.556
10/28/2015	15:16	224	2.032	6.096	3.048	1.778
11/2/2015	0:58	1459	62.23	24.384	14.732	11.938
11/3/2015	13:20	11	0.508	1.524	1.016	0.508
11/8/2015	21:30	348	21.59	10.668	8.128	7.112
11/9/2015	14:00	466	6.604	4.572	3.556	2.032
11/10/2015	8:16	222	9.906	6.096	4.572	4.064
11/15/2015	8:47	536	23.114	10.668	6.096	5.334
11/16/2015	8:43	377	8.382	3.048	2.54	2.286
11/17/2015	9:04	98	0.762	1.524	0.508	0.508
11/24/2015	14:03	264	10.16	9.144	7.112	6.858
11/25/2015	10:49	295	1.778	1.524	1.016	0.762
11/26/2015	9:30	210	3.048	1.524	1.524	1.27
12/3/2015	18:09	110	4.064	3.048	3.048	2.54
12/10/2015	6:39	931	26.924	13.716	8.128	7.62
12/11/2015	10:11	363	23.368	9.144	7.62	6.604
12/12/2015	9:12	977	12.446	4.572	3.556	2.794
12/13/2015	7:35	542	10.922	4.572	4.064	3.556
12/14/2015	1:28	1	0.254	1.524	0.508	0.254
12/14/2015	9:07	384	8.89	3.048	3.048	2.54
12/15/2015	10:36	160	1.524	1.524	1.016	0.762
12/16/2015	10:07	175	1.27	1.524	0.508	0.508
12/19/2015	4:33	856	18.542	7.62	6.096	4.064
12/20/2015	10:35	59	0.508	1.524	0.508	0.508
12/20/2015	19:23	2537	198.628	12.192	9.652	9.652
12/22/2015	23:34	551	0.762	1.524	0.508	0.254
12/23/2015	18:32	1	0.254	1.524	0.508	0.254
12/25/2015	15:14	1	0.254	1.524	0.508	0.254
12/26/2015	10:31	253	6.35	4.572	3.048	2.54

12/27/2015	9:56	307	6.096	3.048	2.54	2.286
12/28/2015	10:34	284	1.524	1.524	1.524	0.762
12/29/2015	11:10	116	0.762	1.524	0.508	0.508
1/4/2016	15:43	36	0.508	1.524	0.508	0.508
1/5/2016	2:09	1140	29.718	7.62	6.096	5.08
1/6/2016	10:21	1911	29.21	6.096	5.588	5.08
1/8/2016	9:03	448	11.684	4.572	3.556	3.302
1/9/2016	9:19	1192	10.922	3.048	1.524	1.524
1/13/2016	6:38	284	4.318	3.048	2.032	2.032
1/14/2016	17:52	906	23.622	12.192	10.16	8.128
1/16/2016	2:21	407	7.112	6.096	3.048	1.778
1/16/2016	15:20	30	2.286	12.192	4.572	2.286
1/17/2016	23:31	550	26.162	7.62	6.096	5.842
1/19/2016	5:04	509	27.432	10.668	8.636	7.112
1/20/2016	1:53	1	0.254	1.524	0.508	0.254
1/22/2016	10:22	1220	40.386	16.764	9.652	8.89
1/23/2016	17:15	63	0.508	1.524	0.508	0.254
1/24/2016	8:29	33	0.508	1.524	0.508	0.508
1/29/2016	23:15	740	35.306	22.86	12.7	9.906
1/31/2016	0:36	937	10.414	3.048	2.032	2.032
2/1/2016	9:21	428	10.16	6.096	3.556	2.54
2/2/2016	11:13	295	2.286	1.524	1.016	1.016
2/17/2016	21:56	1184	33.528	7.62	5.08	4.318
2/19/2016	8:30	92	1.016	1.524	1.016	0.762
3/3/2016	19:56	60	2.286	7.62	4.064	2.286
3/4/2016	16:26	2594	108.966	16.764	13.208	9.906
3/6/2016	19:57	1006	15.494	9.144	6.604	4.826
3/7/2016	21:17	1	0.254	1.524	0.508	0.254
3/11/2016	9:02	1569	41.148	9.144	7.62	7.112
3/13/2016	0:01	1955	81.026	16.764	7.112	5.842
3/21/2016	9:53	1371	22.352	12.192	8.128	6.096
3/28/2016	15:33	1	0.254	1.524	0.508	0.254
4/8/2016	14:55	2283	46.228	24.384	18.796	11.176
4/10/2016	18:56	173	1.016	1.524	1.016	0.508
4/22/2016	11:52	935	30.226	15.24	12.192	8.636
4/24/2016	19:16	35	1.016	3.048	1.524	1.016
5/1/2016	15:05	76	1.016	4.572	1.524	0.762
5/7/2016	4:04	612	2.54	3.048	2.032	1.27
5/20/2016	19:36	63	0.762	1.524	1.016	0.508

Appendix 8: Rainfall events between November 2015 and May 2016 in HF 7 in upper Femmons. Most of the rainfall was recorded between October and March. The table shows storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively). The gauge was installed November 2015.

Date	Time	Duration (min)	Amount (mm)	I_{10} (mm hr ⁻¹)	I_{30} (mm hr ⁻¹)	I_{60} (mm hr ⁻¹)
11/22/2015	13:29	85	1.524	6.096	2.032	1.016
11/24/2015	14:09	107	7.366	7.62	6.096	5.334
11/25/2015	16:26	51	1.016	3.048	1.524	1.016
11/26/2015	8:55	410	6.35	6.096	3.048	1.778
11/27/2015	9:46	1	0.254	1.524	0.508	0.254
12/3/2015	18:18	123	4.826	4.572	4.064	3.302
12/10/2015	6:47	510	28.956	12.192	9.652	8.89
12/10/2015	21:24	42	0.508	1.524	0.508	0.508
12/11/2015	15:42	292	5.588	13.716	6.604	4.064
12/12/2015	8:27	1689	29.718	7.62	5.588	4.826
12/14/2015	8:44	456	13.208	6.096	4.064	3.302
12/15/2015	10:16	324	3.81	3.048	1.524	1.27
12/16/2015	10:07	321	2.286	1.524	1.016	0.762
12/19/2015	4:52	621	13.716	4.572	3.556	2.794
12/20/2015	12:09	3200	203.2	12.192	10.16	9.652
12/23/2015	0:05	1	0.254	1.524	0.508	0.254
12/23/2015	15:16	45	1.524	3.048	2.54	1.524
12/25/2015	11:56	363	7.112	7.62	4.064	3.048
12/26/2015	9:42	390	3.81	3.048	1.524	1.016
12/27/2015	9:52	281	2.54	1.524	1.016	0.762
12/28/2015	11:10	88	0.508	1.524	0.508	0.254
12/29/2015	10:25	163	0.508	1.524	0.508	0.254
1/4/2016	15:59	24	0.508	1.524	1.016	0.508
1/4/2016	23:20	1012	30.988	9.144	6.604	5.334
1/7/2016	12:24	281	12.7	10.668	5.08	4.064
1/8/2016	9:16	531	25.908	7.62	6.096	5.842
1/9/2016	9:43	1573	15.24	3.048	2.032	2.032
1/13/2016	6:53	337	6.35	4.572	3.048	2.032
1/14/2016	19:23	950	24.638	9.144	7.112	5.08
1/16/2016	2:43	982	10.414	9.144	4.572	2.286
1/17/2016	23:47	548	25.654	9.144	7.112	5.588
1/19/2016	5:34	536	28.702	12.192	9.652	7.874
1/22/2016	10:27	1224	43.434	16.764	9.652	8.89

1/23/2016	15:42	115	1.27	4.572	2.032	1.016
1/24/2016	8:57	1	0.508	3.048	1.016	0.508
1/29/2016	2:31	170	0.508	1.524	0.508	0.254
1/29/2016	12:45	1	0.254	1.524	0.508	0.254
1/29/2016	23:26	800	38.862	18.288	13.208	10.922
1/31/2016	1:11	1	0.254	1.524	0.508	0.254
1/31/2016	19:41	43	0.762	3.048	1.016	0.762
2/1/2016	8:39	488	12.192	9.144	5.08	3.556
2/2/2016	12:25	223	3.048	4.572	2.032	1.524
2/3/2016	12:36	1	0.508	3.048	1.016	0.508
2/17/2016	22:05	103	6.096	6.096	4.572	3.556
2/18/2016	12:17	367	19.05	18.288	9.652	6.858
2/19/2016	0:54	1	0.254	1.524	0.508	0.254
2/19/2016	8:32	239	3.302	1.524	1.524	1.524
3/3/2016	19:55	129	2.54	6.096	4.064	2.286
3/4/2016	17:00	2443	110.236	25.908	12.7	11.43
3/6/2016	22:30	302	2.54	4.572	2.032	1.27
3/7/2016	11:54	179	11.684	19.812	11.684	8.636
3/11/2016	9:15	250	11.43	6.096	5.588	5.08
3/12/2016	8:36	389	28.702	21.336	10.668	8.89
3/12/2016	23:17	1998	81.788	10.668	7.112	6.096
3/21/2016	10:50	863	19.812	10.668	7.112	5.588
3/22/2016	9:32	19	0.762	3.048	1.524	0.762
4/8/2016	14:52	2268	38.1	9.144	6.096	4.826
4/11/2016	5:29	1	0.254	1.524	0.508	0.254
4/22/2016	12:04	940	26.416	12.192	10.16	7.874
4/25/2016	7:30	1	0.254	1.524	0.508	0.254
5/1/2016	15:09	93	3.048	4.572	3.556	2.286
5/7/2016	4:19	562	3.048	3.048	2.032	1.524
5/20/2016	20:37	6	0.508	3.048	1.016	0.508

Appendix 9: Rainfall events between November 2015 and May 2016 in FSW 14 in upper Femmons. Most of the rainfall was recorded between October and March. The table shows storm begin date and time, duration, amount and 10-minute, 30-minute, and 60-minute maximum intensities (I_{10} , I_{30} , and I_{60} , respectively). The gauge was installed November 2015.

Date	Time	Duration (min)	Amount (mm)	I_{10} (mm hr ⁻¹)	I_{30} (mm hr ⁻¹)	I_{60} (mm hr ⁻¹)
11/24/2015	14:08	108	6.858	7.62	5.08	4.826
11/25/2015	16:14	252	0.762	1.524	1.016	0.508
11/26/2015	9:26	338	6.35	3.048	2.032	1.778
11/27/2015	10:29	270	1.016	1.524	0.508	0.508
12/3/2015	18:14	123	4.826	6.096	4.064	3.302
12/10/2015	6:45	923	27.686	10.668	8.636	7.62
12/11/2015	23:51	57	0.762	3.048	1.016	0.762
12/12/2015	9:40	1923	29.21	7.62	5.588	5.08
12/14/2015	10:50	366	12.446	12.192	6.604	5.08
12/15/2015	9:54	359	5.334	3.048	2.032	1.778
12/16/2015	10:23	257	3.556	1.524	1.524	1.524
12/17/2015	11:26	1	0.254	1.524	0.508	0.254
12/19/2015	4:49	617	12.7	4.572	3.048	2.286
12/20/2015	12:51	3018	191.262	10.668	9.652	9.144
12/22/2015	23:46	1	0.254	1.524	0.508	0.254
12/23/2015	6:47	1	0.254	1.524	0.508	0.254
12/23/2015	15:21	33	1.27	3.048	2.032	1.27
12/25/2015	12:51	202	4.064	3.048	2.54	2.032
12/26/2015	9:44	391	6.604	3.048	2.54	2.032
12/27/2015	9:31	321	3.302	3.048	2.032	1.524
12/28/2015	10:02	169	1.016	1.524	0.508	0.508
12/28/2015	22:17	1	0.254	1.524	0.508	0.254
12/29/2015	11:30	172	1.016	1.524	0.508	0.508
1/4/2016	15:52	28	0.508	1.524	1.016	0.508
1/5/2016	2:03	845	29.21	9.144	6.604	5.08
1/7/2016	22:30	2	1.778	10.668	3.556	1.778
1/8/2016	9:40	464	26.416	12.192	8.128	6.096
1/9/2016	9:21	1584	16.002	3.048	2.54	2.032
1/13/2016	7:47	215	4.318	4.572	2.54	2.286
1/14/2016	19:20	956	22.86	7.62	5.588	4.064
1/16/2016	2:27	795	9.906	10.668	5.588	2.794
1/17/2016	23:30	553	25.654	7.62	6.604	5.588
1/19/2016	5:26	526	27.686	12.192	8.636	7.366

1/19/2016	23:00	1	0.254	1.524	0.508	0.254
1/22/2016	10:20	1252	42.418	16.764	10.16	9.144
1/23/2016	17:18	99	1.016	4.572	1.524	0.762
1/29/2016	2:25	176	0.508	1.524	0.508	0.254
1/29/2016	23:09	810	38.1	18.288	12.7	10.414
1/31/2016	1:06	1	0.254	1.524	0.508	0.254
1/31/2016	14:44	268	3.048	3.048	2.54	1.778
2/1/2016	10:24	534	8.89	9.144	6.096	4.572
2/2/2016	9:32	411	3.81	1.524	1.524	1.27
2/3/2016	10:14	179	1.524	1.524	1.016	0.508
2/17/2016	21:54	103	5.842	4.572	4.064	3.556
2/18/2016	11:04	449	20.828	7.62	6.604	5.588
2/19/2016	8:07	291	5.08	3.048	2.032	1.778
3/3/2016	19:43	109	2.286	6.096	3.556	2.032
3/4/2016	16:42	2484	103.632	27.432	13.716	11.43
3/6/2016	20:15	412	1.778	1.524	1.016	0.762
3/7/2016	11:41	132	10.16	19.812	11.176	8.128
3/11/2016	9:01	250	10.414	6.096	5.08	4.826
3/12/2016	2:04	817	26.924	7.62	5.588	5.334
3/12/2016	23:05	2042	78.232	12.192	6.604	5.588
3/21/2016	10:36	847	19.812	9.144	7.112	5.08
3/22/2016	9:01	31	1.27	4.572	2.032	1.27
4/8/2016	14:33	2296	37.084	7.62	5.588	4.826
4/10/2016	20:57	1	0.254	1.524	0.508	0.254
4/22/2016	11:47	1166	28.448	15.24	11.176	8.128
5/1/2016	14:50	94	2.54	4.572	2.54	2.032
5/7/2016	4:21	835	2.794	3.048	2.032	1.524
5/20/2016	19:37	45	0.508	1.524	0.508	0.508

Appendix 10: Bulk density values for each year, site, treatment, and depth. LF is lower Femmons, UF is upper Femmons, LSC is low slope control, Mixed is mixed disturbance.

Year	Site	Plot	Treatment	Bulk Density at 0-5 cm (g cm⁻³)	Bulk Density at 5-10 cm (g cm⁻³)
2015	Sawmill	HF2	Control	1.19	1.17
2015	Sawmill	HF2	LSC	1.29	1.18
2015	Sawmill	HF2	Few Pass	0.99	1.15
2015	Sawmill	HF2	Logged Only	1.05	1.17
2015	Sawmill	HF2	Many Pass	1.35	1.43
2015	Sawmill	HF3	Control	0.98	1.05
2015	Sawmill	HF3	LSC	1.35	1.35
2015	Sawmill	HF3	Few Pass	1.34	1.33
2015	Sawmill	HF3	Logged Only	1.04	0.98
2015	Sawmill	HF3	Many Pass	1.50	1.49
2015	Sawmill	HF4	Control	1.18	1.32
2015	Sawmill	HF4	LSC	0.99	1.17
2015	Sawmill	HF4	Few Pass	1.26	1.18
2015	Sawmill	HF4	Logged Only	0.98	1.25
2015	Sawmill	HF4	Many Pass	1.53	1.72
2015	Triple-A	ASW 1	Many Pass	0.97	1.42
2015	Triple-A	ASW 1	Few Pass	1.21	1.26
2015	Triple-A	ASW 1	Feller Buncher	1.27	1.15
2015	Triple-A	ASW 1	Mixed	1.36	1.39
2015	Triple-A	ASW 1	Control	1.23	1.31
2015	Triple-A	ASW 2	Control	1.28	1.39
2015	Triple-A	ASW 3	Many Pass	1.33	1.49
2015	Triple-A	ASW 3	Few Pass	1.21	1.42
2015	Triple-A	ASW 3	Feller Buncher	1.36	1.31
2015	Triple-A	ASW 3	Mixed	1.31	1.46
2015	Triple-A	ASW 3	Control	1.08	1.20
2015	Triple-A	ASW 4	Many Pass	1.22	1.69
2015	Triple-A	ASW 4	Few Pass	1.46	1.50
2015	Triple-A	ASW 4	Feller Buncher	1.45	1.40
2015	Triple-A	ASW 4	Mixed	1.45	1.55
2015	Triple-A	ASW 4	Control	1.13	1.21
2015	Triple-A	ASW 5	Many Pass	1.68	1.65
2015	Triple-A	ASW 5	Few Pass	1.50	1.62
2015	Triple-A	ASW 5	Feller Buncher	1.41	1.39
2015	Triple-A	ASW 5	Mixed	1.60	1.58
2015	Triple-A	ASW 5	Control	1.24	1.26
2015	Triple-A	ASW 6	Many Pass	1.50	1.59

2015	Triple-A	ASW 6	Few Pass	1.28	1.36
2015	Triple-A	ASW 6	Feller Buncher	1.27	1.39
2015	Triple-A	ASW 6	Control	1.20	1.17
2015	Triple-A	ASW 7	Control	1.12	1.22
2015	LF	FSW 8	Control	1.20	1.20
2015	LF	FSW 9	Many Pass	1.59	1.55
2015	LF	FSW 9	Feller Buncher	1.18	1.44
2015	LF	FSW 9	Control	1.15	1.08
2015	LF	FSW 10	Many Pass	1.38	1.38
2015	LF	FSW 10	Feller Buncher	NA	1.27
2015	LF	FSW 10	Mixed	1.11	1.25
2015	LF	FSW 10	Control	1.15	1.19
2015	LF	FSW 11	Many Pass	1.15	1.23
2015	LF	FSW 11	Few Pass	1.01	1.12
2015	LF	FSW 11	Feller Buncher	1.17	1.34
2015	LF	FSW 11	Mixed	1.16	1.23
2015	LF	FSW 11	Control	1.01	1.26
2015	LF	HF5	Control	1.03	1.24
2015	LF	HF5	Logged Only	1.08	1.18
2015	LF	HF5	Few Pass	1.41	1.40
2015	LF	HF5	Many Pass	1.44	1.57
2015	UF	HF6	Control	0.82	1.07
2015	UF	HF6	Logged Only	0.99	1.03
2015	UF	HF6	Few Pass	1.12	1.19
2015	UF	HF6	Many Pass	1.01	1.19
2015	UF	HF7	Control	0.97	1.09
2015	UF	HF7	Logged Only	0.94	1.10
2015	UF	HF7	Few Pass	1.18	1.36
2015	UF	HF7	Many Pass	1.16	1.31
2015	UF	FSW 13	Few Pass	1.12	1.07
2015	UF	FSW 13	Many Pass	1.13	1.28
2016	Sawmill	HF2	LSC	1.18	1.30
2016	Sawmill	HF2	Control	0.97	1.24
2016	Sawmill	HF2	Logged Only	1.26	1.31
2016	Sawmill	HF2	Few Pass	1.19	1.21
2016	Sawmill	HF2	Many Pass	1.43	1.48
2016	Sawmill	HF3	LSC	1.40	1.65
2016	Sawmill	HF3	Control	1.10	1.06
2016	Sawmill	HF3	Logged Only	1.10	1.12
2016	Sawmill	HF3	Few Pass	1.28	1.31
2016	Sawmill	HF3	Many Pass	1.52	1.66
2016	Sawmill	HF4	LSC	1.25	1.25
2016	Sawmill	HF4	Control	1.15	1.12

2016	Sawmill	HF4	Logged Only	1.18	0.94
2016	Sawmill	HF4	Few Pass	1.33	1.12
2016	Sawmill	HF4	Many Pass	1.49	1.37
2016	LF	HF5	Control	1.33	1.29
2016	LF	HF5	Logged Only	1.11	1.33
2016	LF	HF5	Few Pass	1.46	1.38
2016	LF	HF5	Many Pass	1.49	0.89
2016	UF	HF6	Control	1.20	1.07
2016	UF	HF6	Logged Only	0.94	1.07
2016	UF	HF6	Few Pass	1.49	1.54
2016	UF	HF6	Many Pass	1.19	1.20
2016	UF	HF7	Control	1.07	1.03
2016	UF	HF7	Logged Only	1.04	1.19
2016	UF	HF7	Few Pass	1.06	1.23
2016	UF	HF7	Many Pass	1.18	1.27
2016	Triple-A	ASW 1	Many Pass	1.21	1.22
2016	Triple-A	ASW 1	Few Pass	1.22	1.26
2016	Triple-A	ASW 1	Feller Buncher	NA	NA
2016	Triple-A	ASW 1	Mixed	0.99	0.95
2016	Triple-A	ASW 1	Control	1.13	1.29
2016	Triple-A	ASW 2	Control	1.15	1.16
2016	Triple-A	ASW 3	Control	0.96	1.22
2016	Triple-A	ASW 3	Many Pass	1.20	1.49
2016	Triple-A	ASW 3	Few Pass	1.11	1.21
2016	Triple-A	ASW 3	Feller Buncher	1.05	1.19
2016	Triple-A	ASW 3	Mixed	0.79	1.03
2016	Triple-A	ASW 4	Control	1.13	1.20
2016	Triple-A	ASW 4	Many Pass	1.33	1.45
2016	Triple-A	ASW 4	Few Pass	0.90	1.40
2016	Triple-A	ASW 4	Feller Buncher	1.03	1.40
2016	Triple-A	ASW 4	Mixed	1.13	1.14
2016	Triple-A	ASW 5	Control	1.24	1.25
2016	Triple-A	ASW 5	Many Pass	1.74	1.67
2016	Triple-A	ASW 5	Few Pass	1.40	1.18
2016	Triple-A	ASW 5	Feller Buncher	1.29	1.33
2016	Triple-A	ASW 5	Mixed	1.49	1.30
2016	Triple-A	ASW 6	Control	1.04	1.12
2016	Triple-A	ASW 6	Many Pass	1.41	1.57
2016	Triple-A	ASW 6	Few Pass	1.07	1.08
2016	Triple-A	ASW 6	Feller Buncher	1.21	1.20
2016	Triple-A	ASW 6	Mixed	NA	NA
2016	Triple-A	ASW 7	Control	0.87	1.03
2016	LF	FSW 8	Control	1.07	1.13

2016	LF	FSW 9	Feller Buncher	1.17	1.34
2016	LF	FSW 9	Many Pass	1.25	1.02
2016	LF	FSW 9	Control	1.25	1.28
2016	LF	FSW 10	Control	0.98	1.07
2016	LF	FSW 10	Many Pass	1.12	1.28
2016	LF	FSW 10	Few Pass	NA	NA
2016	LF	FSW 10	Feller Buncher	1.02	1.04
2016	LF	FSW 10	Mixed	0.95	1.18
2016	LF	FSW 11	Mixed	1.23	1.35
2016	LF	FSW 11	Feller Buncher	1.22	1.26
2016	LF	FSW 11	Control	0.97	1.17
2016	LF	FSW 11	Many Pass	1.36	1.36
2016	LF	FSW 11	Few Pass	1.15	1.07
2016	UF	FSW 12	Control	0.90	1.04
2016	UF	FSW 13	Control	0.94	1.29
2016	UF	FSW 13	Many Pass	1.08	1.06
2016	UF	FSW 13	Few Pass	1.14	1.09
2016	UF	FSW 14	Control	1.15	1.13
2016	Evergreen	EC1	Control	1.10	1.16
2016	Evergreen	EMP1	Many Pass	1.41	1.52
2016	Evergreen	EST1	Skidder Track	1.34	1.29
2016	Evergreen	EFP1	Few Pass	1.11	1.24
2016	Evergreen	EMX1	Mixed	1.33	1.30
2016	Evergreen	EC2	Control	1.03	0.94
2016	Evergreen	EMP2	Many Pass	1.21	1.28
2016	Evergreen	EST2	Skidder Track	1.10	1.21
2016	Evergreen	EFP2	Few Pass	1.38	1.32
2016	Evergreen	EMX2	Mixed	1.17	1.03
2016	Evergreen	EC3	Control	1.01	1.08
2016	Evergreen	EMP3	Many Pass	1.38	1.27
2016	Evergreen	EST3	Skidder Track	1.51	1.52
2016	Evergreen	EFP3	Few Pass	1.44	1.46
2016	Evergreen	EMX3	Mixed	1.21	1.33
2016	Evergreen	EC4	Control	1.08	0.97
2016	Evergreen	EMP4	Many Pass	1.57	1.50
2016	Evergreen	EST4	Skidder Track	1.22	1.17
2016	Evergreen	EFP4	Few Pass	1.13	1.16
2016	Evergreen	EMX4	Mixed	1.36	1.33

Appendix 11: Water drop penetration time (WDPT) by year, site, treatment, and depth. Data are the averages of eight drops at each depth and location.

119	Year	Site	Plot	Treatment	Depth (cm)	WDPT (s)
	2016	Triple-A	ASW 1	Mixed Disturbed	0	1
	2016	Triple-A	ASW 1	Mixed Disturbed	1	1.875
	2016	Triple-A	ASW 1	Mixed Disturbed	3	2.25
	2016	Triple-A	ASW 1	Many Pass	0	1.125
	2016	Triple-A	ASW 1	Many Pass	1	1.625
	2016	Triple-A	ASW 1	Many Pass	3	1.25
	2016	Triple-A	ASW 1	Few Pass	0	1.625
	2016	Triple-A	ASW 1	Few Pass	1	1.625
	2016	Triple-A	ASW 1	Few Pass	3	2.75
	2016	Triple-A	ASW 1	Control	0	1.25
	2016	Triple-A	ASW 1	Control	1	43.125
	2016	Triple-A	ASW 1	Control	3	3.75
	2016	Triple-A	ASW 1	Feller Buncher	0	1.25
	2016	Triple-A	ASW 1	Feller Buncher	1	6.125
	2016	Triple-A	ASW 1	Feller Buncher	3	3.375
	2016	Triple-A	ASW 2	Control	0	1
	2016	Triple-A	ASW 2	Control	1	61.125
	2016	Triple-A	ASW 2	Control	3	2.125
	2016	Triple-A	ASW 3	Mixed Disturbed	0	1
	2016	Triple-A	ASW 3	Mixed Disturbed	1	1.625
	2016	Triple-A	ASW 3	Mixed Disturbed	3	1.75
	2016	Triple-A	ASW 3	Few Pass	0	1.75
	2016	Triple-A	ASW 3	Few Pass	1	3.25
	2016	Triple-A	ASW 3	Few Pass	3	2.125

2016	Triple-A	ASW 3	Feller Buncher	0	1
2016	Triple-A	ASW 3	Feller Buncher	1	2.25
2016	Triple-A	ASW 3	Feller Buncher	3	2.875
2016	Triple-A	ASW 3	Control	0	1
2016	Triple-A	ASW 3	Control	1	5.125
2016	Triple-A	ASW 3	Control	3	272.5
2016	Triple-A	ASW 3	Many Pass	0	1
2016	Triple-A	ASW 3	Many Pass	1	1.25
2016	Triple-A	ASW 3	Many Pass	3	1
2016	Triple-A	ASW 4	Many Pass	0	1.125
2016	Triple-A	ASW 4	Many Pass	1	1.5
2016	Triple-A	ASW 4	Many Pass	3	1.75
2016	Triple-A	ASW 4	Control	0	1
2016	Triple-A	ASW 4	Control	1	1.38
2016	Triple-A	ASW 4	Control	3	7.13
2016	Triple-A	ASW 4	Mixed Disturbed	0	1
2016	Triple-A	ASW 4	Mixed Disturbed	1	6
2016	Triple-A	ASW 4	Mixed Disturbed	3	38.38
2016	Triple-A	ASW 4	Feller Buncher	0	1
2016	Triple-A	ASW 4	Feller Buncher	1	1.38
2016	Triple-A	ASW 4	Feller Buncher	3	1.75
2016	Triple-A	ASW 4	Few Pass	0	1
2016	Triple-A	ASW 4	Few Pass	1	1.63
2016	Triple-A	ASW 4	Few Pass	3	1.88
2016	Triple-A	ASW 5	Feller Buncher	0	1.75
2016	Triple-A	ASW 5	Feller Buncher	1	1
2016	Triple-A	ASW 5	Feller Buncher	3	1
2016	Triple-A	ASW 5	Few Pass	0	1
2016	Triple-A	ASW 5	Few Pass	1	1

2016	Triple-A	ASW 5	Few Pass	3	1
2016	Triple-A	ASW 5	Many Pass	0	1.125
2016	Triple-A	ASW 5	Many Pass	1	1
2016	Triple-A	ASW 5	Many Pass	3	1
2016	Triple-A	ASW 5	Control	0	2.625
2016	Triple-A	ASW 5	Control	1	7.125
2016	Triple-A	ASW 5	Control	3	1
2016	Triple-A	ASW 5	Mixed Disturbed	0	1
2016	Triple-A	ASW 5	Mixed Disturbed	1	4.25
2016	Triple-A	ASW 5	Mixed Disturbed	3	150.75
2016	Triple-A	ASW 6	Control	0	3.88
2016	Triple-A	ASW 6	Control	1	64.13
2016	Triple-A	ASW 6	Control	3	245.13
2016	Triple-A	ASW 6	Many Pass	0	1
2016	Triple-A	ASW 6	Many Pass	1	1.38
2016	Triple-A	ASW 6	Many Pass	3	1.38
2016	Triple-A	ASW 6	Few Pass	0	1.63
2016	Triple-A	ASW 6	Few Pass	1	2.5
2016	Triple-A	ASW 6	Few Pass	3	120.38
2016	Triple-A	ASW 6	Feller Buncher	0	1.125
2016	Triple-A	ASW 6	Feller Buncher	1	1.625
2016	Triple-A	ASW 6	Feller Buncher	3	3.375
2016	Triple-A	ASW 7	Control	0	76.88
2016	Triple-A	ASW 7	Control	1	248.5
2016	Triple-A	ASW 7	Control	3	63.13
2016	Lower Femmons	FSW 10	Many Pass	0	1
2016	Lower Femmons	FSW 10	Many Pass	1	1.875
2016	Lower Femmons	FSW 10	Many Pass	3	1.5
2016	Lower Femmons	FSW 10	Mixed Disturbed	0	1

2016	Lower Femmons	FSW 10	Mixed Disturbed	1	2.5
2016	Lower Femmons	FSW 10	Mixed Disturbed	3	1.25
2016	Lower Femmons	FSW 10	Feller Buncher	0	1.5
2016	Lower Femmons	FSW 10	Feller Buncher	1	1.5
2016	Lower Femmons	FSW 10	Feller Buncher	3	1.5
2016	Lower Femmons	FSW 10	Few Pass	0	1
2016	Lower Femmons	FSW 10	Few Pass	1	2.75
2016	Lower Femmons	FSW 10	Few Pass	3	1.63
2016	Lower Femmons	FSW 10	Control	0	1.25
2016	Lower Femmons	FSW 10	Control	1	152.13
2016	Lower Femmons	FSW 10	Control	3	2.25
2016	Lower Femmons	FSW 11	Mixed Disturbed	0	1.25
2016	Lower Femmons	FSW 11	Mixed Disturbed	1	1.13
2016	Lower Femmons	FSW 11	Mixed Disturbed	3	1
2016	Lower Femmons	FSW 11	Few Pass	0	1
2016	Lower Femmons	FSW 11	Few Pass	1	3
2016	Lower Femmons	FSW 11	Few Pass	3	1.125
2016	Lower Femmons	FSW 11	Many Pass	0	1
2016	Lower Femmons	FSW 11	Many Pass	1	2.125
2016	Lower Femmons	FSW 11	Many Pass	3	2.375
2016	Lower Femmons	FSW 11	Feller Buncher	0	1.63
2016	Lower Femmons	FSW 11	Feller Buncher	1	1
2016	Lower Femmons	FSW 11	Feller Buncher	3	1.5
2016	Lower Femmons	FSW 11	Control	0	1
2016	Lower Femmons	FSW 11	Control	1	8.38
2016	Lower Femmons	FSW 11	Control	3	40.5
2016	Upper Femmons	FSW 12	Control	0	1
2016	Upper Femmons	FSW 12	Control	1	1
2016	Upper Femmons	FSW 12	Control	3	1.63

2016	Upper Femmons	FSW 13	Mixed Disturbed	0	1
2016	Upper Femmons	FSW 13	Mixed Disturbed	1	99.25
2016	Upper Femmons	FSW 13	Mixed Disturbed	3	38.88
2016	Upper Femmons	FSW 13	Many Pass	0	1
2016	Upper Femmons	FSW 13	Many Pass	1	1
2016	Upper Femmons	FSW 13	Many Pass	3	1
2016	Upper Femmons	FSW 13	Few Pass	0	1
2016	Upper Femmons	FSW 13	Few Pass	1	1
2016	Upper Femmons	FSW 13	Few Pass	3	1
2016	Upper Femmons	FSW 13	Control	0	1
2016	Upper Femmons	FSW 13	Control	1	1
2016	Upper Femmons	FSW 13	Control	3	1.88
2016	Upper Femmons	FSW 13	Feller Buncher	0	1
2016	Upper Femmons	FSW 13	Feller Buncher	1	1.38
2016	Upper Femmons	FSW 13	Feller Buncher	3	77.13
2016	Upper Femmons	FSW 14	Control	0	2.5
2016	Upper Femmons	FSW 14	Control	1	23.25
2016	Upper Femmons	FSW 14	Control	3	82
2016	Lower Femmons	FSW 8	Control	0	1.75
2016	Lower Femmons	FSW 8	Control	1	3.125
2016	Lower Femmons	FSW 8	Control	3	3.5
2016	Lower Femmons	FSW 9	Few Pass	0	1
2016	Lower Femmons	FSW 9	Few Pass	1	2.875
2016	Lower Femmons	FSW 9	Few Pass	3	1.625
2016	Lower Femmons	FSW 9	Many Pass	0	1.5
2016	Lower Femmons	FSW 9	Many Pass	1	3.5
2016	Lower Femmons	FSW 9	Many Pass	3	1.75
2016	Lower Femmons	FSW 9	Mixed Disturbed	0	1.25
2016	Lower Femmons	FSW 9	Mixed Disturbed	1	5.875

2016	Lower Femmons	FSW 9	Mixed Disturbed	3	3.875
2016	Lower Femmons	FSW 9	Feller Buncher	0	4.75
2016	Lower Femmons	FSW 9	Feller Buncher	1	1.25
2016	Lower Femmons	FSW 9	Feller Buncher	3	1.5
2016	Lower Femmons	FSW 9	Control	0	1.875
2016	Lower Femmons	FSW 9	Control	1	1.5
2016	Lower Femmons	FSW 9	Control	3	38.5
2016	Sawmill	HF 2	Many Pass	0	1.38
2016	Sawmill	HF 2	Many Pass	1	1.25
2016	Sawmill	HF 2	Many Pass	3	1
2016	Sawmill	HF 2	Low Slope Control	0	2.625
2016	Sawmill	HF 2	Low Slope Control	1	1.125
2016	Sawmill	HF 2	Low Slope Control	3	1.25
2016	Sawmill	HF 2	Logged Only	0	1
2016	Sawmill	HF 2	Logged Only	1	1.125
2016	Sawmill	HF 2	Logged Only	3	1
2016	Sawmill	HF 2	Few Pass	0	1.5
2016	Sawmill	HF 2	Few Pass	1	1.125
2016	Sawmill	HF 2	Few Pass	3	1
2016	Sawmill	HF 2	Control	0	1
2016	Sawmill	HF 2	Control	1	1
2016	Sawmill	HF 2	Control	3	1
2016	Sawmill	HF 3	Control	0	2.75
2016	Sawmill	HF 3	Control	1	1.25
2016	Sawmill	HF 3	Control	3	3
2016	Sawmill	HF 3	Few Pass	0	1
2016	Sawmill	HF 3	Few Pass	1	1.125
2016	Sawmill	HF 3	Few Pass	3	6.25
2016	Sawmill	HF 3	Logged Only	0	1.38

2016	Sawmill	HF 3	Logged Only	1	1.13
2016	Sawmill	HF 3	Logged Only	3	158.75
2016	Sawmill	HF 3	Low Slope Control	0	1.25
2016	Sawmill	HF 3	Low Slope Control	1	1.13
2016	Sawmill	HF 3	Low Slope Control	3	1.38
2016	Sawmill	HF 3	Many Pass	0	2.38
2016	Sawmill	HF 3	Many Pass	1	1.5
2016	Sawmill	HF 3	Many Pass	3	2.75
2016	Sawmill	HF 4	Logged Only	0	1.75
2016	Sawmill	HF 4	Logged Only	1	1.25
2016	Sawmill	HF 4	Logged Only	3	3.75
2016	Sawmill	HF 4	Control	0	1.125
2016	Sawmill	HF 4	Control	1	86.625
2016	Sawmill	HF 4	Control	3	115
2016	Sawmill	HF 4	Few Pass	0	1
2016	Sawmill	HF 4	Few Pass	1	1.375
2016	Sawmill	HF 4	Few Pass	3	1.25
2016	Sawmill	HF 4	Low Slope Control	0	3.875
2016	Sawmill	HF 4	Low Slope Control	1	81.5
2016	Sawmill	HF 4	Low Slope Control	3	2
2016	Sawmill	HF 4	Many Pass	0	1
2016	Sawmill	HF 4	Many Pass	1	1.25
2016	Sawmill	HF 4	Many Pass	3	1.125
2016	Lower Femmons	HF 5	Many Pass	0	2
2016	Lower Femmons	HF 5	Many Pass	1	2.5
2016	Lower Femmons	HF 5	Many Pass	3	4.25
2016	Lower Femmons	HF 5	Control	0	1.375
2016	Lower Femmons	HF 5	Control	1	1.5
2016	Lower Femmons	HF 5	Control	3	1.625

2016	Lower Femmons	HF 5	Few Pass	0	1.875
2016	Lower Femmons	HF 5	Few Pass	1	1
2016	Lower Femmons	HF 5	Few Pass	3	2
2016	Lower Femmons	HF 5	Logged Only	0	1.25
2016	Lower Femmons	HF 5	Logged Only	1	79.875
2016	Lower Femmons	HF 5	Logged Only	3	65
2016	Upper Femmons	HF 6	Many Pass	0	1
2016	Upper Femmons	HF 6	Many Pass	1	1.25
2016	Upper Femmons	HF 6	Many Pass	3	1.25
2016	Upper Femmons	HF 6	Few Pass	0	1
2016	Upper Femmons	HF 6	Few Pass	1	1
2016	Upper Femmons	HF 6	Few Pass	3	1.25
2016	Upper Femmons	HF 6	Logged Only	0	1
2016	Upper Femmons	HF 6	Logged Only	1	1
2016	Upper Femmons	HF 6	Logged Only	3	226
2016	Upper Femmons	HF 6	Control	0	1.38
2016	Upper Femmons	HF 6	Control	1	1
2016	Upper Femmons	HF 6	Control	3	118.25
2016	Upper Femmons	HF 7	Many Pass	0	1
2016	Upper Femmons	HF 7	Many Pass	1	1
2016	Upper Femmons	HF 7	Many Pass	3	1.38
2016	Upper Femmons	HF 7	Control	0	2.25
2016	Upper Femmons	HF 7	Control	1	4
2016	Upper Femmons	HF 7	Control	3	50.88
2016	Upper Femmons	HF 7	Logged Only	0	38.63
2016	Upper Femmons	HF 7	Logged Only	1	152.25
2016	Upper Femmons	HF 7	Logged Only	3	262.63
2016	Upper Femmons	HF 7	Few Pass	0	1
2016	Upper Femmons	HF 7	Few Pass	1	4.5

2016	Upper Femmons	HF 7	Few Pass	3	2.13
2016	Evergreen	EC 1	Control	0	83.25
2016	Evergreen	EC 1	Control	1	300
2016	Evergreen	EC 1	Control	3	300
2016	Evergreen	EC 2	Control	0	300
2016	Evergreen	EC 2	Control	1	263.75
2016	Evergreen	EC 2	Control	3	146.25
2016	Evergreen	EC 3	Control	0	300
2016	Evergreen	EC 3	Control	1	300
2016	Evergreen	EC 3	Control	3	104.875
2016	Evergreen	EFP 1	Control	0	300
2016	Evergreen	EC 4	Control	1	300
2016	Evergreen	EC 4	Control	3	50.25
2016	Evergreen	EFP 1	Few Pass	0	53.375
2016	Evergreen	EFP 1	Few Pass	1	300
2016	Evergreen	EFP 1	Few Pass	3	300
2016	Evergreen	EFP 2	Few Pass	0	300
2016	Evergreen	EFP 2	Few Pass	1	60.25
2016	Evergreen	EFP 2	Few Pass	3	17.75
2016	Evergreen	EFP 3	Few Pass	0	286.25
2016	Evergreen	EFP 3	Few Pass	1	61.25
2016	Evergreen	EFP 3	Few Pass	3	99.125
2016	Evergreen	EFP 4	Few Pass	0	300
2016	Evergreen	EFP 4	Few Pass	1	300
2016	Evergreen	EFP 4	Few Pass	3	300
2016	Evergreen	EMP 1	Many Pass	0	42
2016	Evergreen	EMP 1	Many Pass	1	300
2016	Evergreen	EMP 1	Many Pass	3	300
2016	Evergreen	EMP 2	Many Pass	0	2.5

2016	Evergreen	EMP 2	Many Pass	1	14.75
2016	Evergreen	EMP 2	Many Pass	3	1.375
2016	Evergreen	EMP 3	Many Pass	0	66.375
2016	Evergreen	EMP 3	Many Pass	1	300
2016	Evergreen	EMP 3	Many Pass	3	300
2016	Evergreen	EMP 4	Many Pass	0	2.25
2016	Evergreen	EMP 4	Many Pass	1	222.75
2016	Evergreen	EMP 4	Many Pass	3	204.375
2016	Evergreen	ES 1	Skidder Tracks	0	80.25
2016	Evergreen	ES 1	Skidder Tracks	1	152.125
2016	Evergreen	ES 1	Skidder Tracks	3	263.125
2016	Evergreen	ES 2	Skidder Tracks	0	95.875
2016	Evergreen	ES 2	Skidder Tracks	1	300
2016	Evergreen	ES 2	Skidder Tracks	3	12.875
2016	Evergreen	ES 3	Skidder Tracks	0	258.75
2016	Evergreen	ES 3	Skidder Tracks	1	255
2016	Evergreen	ES 3	Skidder Tracks	3	3.75
2016	Evergreen	ES 4	Skidder Tracks	0	300
2016	Evergreen	ES 4	Skidder Tracks	1	300
2016	Evergreen	ES 4	Skidder Tracks	3	2.5
2016	Evergreen	EMX 1	Mixed Disturbed	0	300
2016	Evergreen	EMX 1	Mixed Disturbed	1	203
2016	Evergreen	EMX 1	Mixed Disturbed	3	300
2016	Evergreen	EMX 2	Mixed Disturbed	0	300
2016	Evergreen	EMX 2	Mixed Disturbed	1	300
2016	Evergreen	EMX 2	Mixed Disturbed	3	300
2016	Evergreen	EMX 3	Mixed Disturbed	0	300
2016	Evergreen	EMX 3	Mixed Disturbed	1	300
2016	Evergreen	EMX 3	Mixed Disturbed	3	300

2016	Evergreen	EMX 4	Mixed Disturbed	0	116
2016	Evergreen	EMX 4	Mixed Disturbed	1	292.5
2016	Evergreen	EMX 4	Mixed Disturbed	3	266.25
2015	Sawmill	HF 2	Control	0	0.125
2015	Sawmill	HF 2	Control	1	7.375
2015	Sawmill	HF 2	Control	3	134.25
2015	Sawmill	HF 2	Low Slope Control	0	0.25
2015	Sawmill	HF 2	Low Slope Control	1	0.125
2015	Sawmill	HF 2	Low Slope Control	3	0.375
2015	Sawmill	HF 3	Control	0	0
2015	Sawmill	HF 3	Control	1	133.375
2015	Sawmill	HF 3	Control	3	39.5
2015	Sawmill	HF 3	Low Slope Control	0	0.5
2015	Sawmill	HF 3	Low Slope Control	1	36.75
2015	Sawmill	HF 3	Low Slope Control	3	45.75
2015	Sawmill	HF 4	Control	0	1.25
2015	Sawmill	HF 4	Control	1	3.625
2015	Sawmill	HF 4	Control	3	46.75
2015	Sawmill	HF 4	Low Slope Control	0	0.5
2015	Sawmill	HF 4	Low Slope Control	1	87.125
2015	Sawmill	HF 4	Low Slope Control	3	2.5
2015	Triple-A	ASW 3	Feller Buncher	0	0
2015	Triple-A	ASW 3	Feller Buncher	1	0
2015	Triple-A	ASW 3	Feller Buncher	3	0
2015	Triple-A	ASW 4	Feller Buncher	0	0
2015	Triple-A	ASW 4	Feller Buncher	1	1.75
2015	Triple-A	ASW 4	Feller Buncher	3	0
2015	Triple-A	ASW 5	Feller Buncher	0	0
2015	Triple-A	ASW 5	Feller Buncher	1	58.5

2015	Triple-A	ASW 5	Feller Buncher	3	92.125
2015	Triple-A	ASW 6	Feller Buncher	0	0
2015	Triple-A	ASW 6	Feller Buncher	1	11.25
2015	Triple-A	ASW 6	Feller Buncher	3	182.5
2015	Lower Femmons	FSW 9	Feller Buncher	0	0
2015	Lower Femmons	FSW 9	Feller Buncher	1	0.875
2015	Lower Femmons	FSW 9	Feller Buncher	3	0
2015	Lower Femmons	FSW 10	Feller Buncher	0	0
2015	Lower Femmons	FSW 10	Feller Buncher	1	2
2015	Lower Femmons	FSW 10	Feller Buncher	3	0.25
2015	Lower Femmons	FSW 11	Feller Buncher	0	2.375
2015	Lower Femmons	FSW 11	Feller Buncher	1	6.375
2015	Lower Femmons	FSW 11	Feller Buncher	3	0.5
2015	Triple-A	ASW 1	Few Pass	0	0.75
2015	Triple-A	ASW 1	Few Pass	1	112.875
2015	Triple-A	ASW 1	Few Pass	3	2.25
2015	Triple-A	ASW 3	Few Pass	0	0
2015	Triple-A	ASW 3	Few Pass	1	0
2015	Triple-A	ASW 3	Few Pass	3	0
2015	Triple-A	ASW 4	Few Pass	0	1
2015	Triple-A	ASW 4	Few Pass	1	2.625
2015	Triple-A	ASW 4	Few Pass	3	1
2015	Triple-A	ASW 5	Few Pass	0	0
2015	Triple-A	ASW 5	Few Pass	1	20
2015	Triple-A	ASW 5	Few Pass	3	0
2015	Triple-A	ASW 6	Few Pass	0	1
2015	Triple-A	ASW 6	Few Pass	1	156.125
2015	Triple-A	ASW 6	Few Pass	3	39
2015	Lower Femmons	FSW 11	Feller Buncher	0	0

2015	Lower Femmons	FSW 11	Feller Buncher	1	1.125
2015	Lower Femmons	FSW 11	Feller Buncher	3	1.625
2015	Sawmill	HF 2	Few Pass	0	0
2015	Sawmill	HF 2	Few Pass	1	0.125
2015	Sawmill	HF 2	Few Pass	3	0
2015	Sawmill	HF 3	Few Pass	0	0.75
2015	Sawmill	HF 3	Few Pass	1	0.875
2015	Sawmill	HF 3	Few Pass	3	1.625
2015	Sawmill	HF 4	Few Pass	0	0
2015	Sawmill	HF 4	Few Pass	1	3.25
2015	Sawmill	HF 4	Few Pass	3	24.875
2015	Sawmill	HF 2	Logged Only	0	0
2015	Sawmill	HF 2	Logged Only	1	0.375
2015	Sawmill	HF 2	Logged Only	3	48.25
2015	Sawmill	HF 3	Logged Only	0	0.5
2015	Sawmill	HF 3	Logged Only	1	0.5
2015	Sawmill	HF 3	Logged Only	3	272.625
2015	Sawmill	HF 4	Logged Only	0	0
2015	Sawmill	HF 4	Logged Only	1	2.75
2015	Sawmill	HF 4	Logged Only	3	17.625
2015	Triple-A	ASW 1	Many Pass	0	1.25
2015	Triple-A	ASW 1	Many Pass	1	3.5
2015	Triple-A	ASW 1	Many Pass	3	85.75
2015	Triple-A	ASW 3	Many Pass	0	0
2015	Triple-A	ASW 3	Many Pass	1	0
2015	Triple-A	ASW 3	Many Pass	3	0
2015	Triple-A	ASW 4	Many Pass	0	0
2015	Triple-A	ASW 4	Many Pass	1	0.5
2015	Triple-A	ASW 4	Many Pass	3	6.25

2015	Triple-A	ASW 5	Many Pass	0	0
2015	Triple-A	ASW 5	Many Pass	1	0.75
2015	Triple-A	ASW 5	Many Pass	3	1
2015	Triple-A	ASW 6	Many Pass	0	0
2015	Triple-A	ASW 6	Many Pass	1	0.5
2015	Triple-A	ASW 6	Many Pass	3	6.25
2015	Lower Femmons	FSW 9	Many Pass	0	0
2015	Lower Femmons	FSW 9	Many Pass	1	4.75
2015	Lower Femmons	FSW 9	Many Pass	3	3.625
2015	Lower Femmons	FSW 10	Many Pass	0	1
2015	Lower Femmons	FSW 10	Many Pass	1	6.625
2015	Lower Femmons	FSW 10	Many Pass	3	43.625
2015	Lower Femmons	FSW 11	Many Pass	0	0
2015	Lower Femmons	FSW 11	Many Pass	1	0
2015	Lower Femmons	FSW 11	Many Pass	3	0.375
2015	Sawmill	HF 2	Many Pass	0	0
2015	Sawmill	HF 2	Many Pass	1	0
2015	Sawmill	HF 2	Many Pass	3	0.375
2015	Sawmill	HF 3	Many Pass	0	0.75
2015	Sawmill	HF 3	Many Pass	1	0.75
2015	Sawmill	HF 3	Many Pass	3	1.75
2015	Sawmill	HF 4	Many Pass	0	0
2015	Sawmill	HF 4	Many Pass	1	0.375
2015	Sawmill	HF 4	Many Pass	3	0.25
2015	Triple-A	ASW 1	Mixed Disturbed	0	0.25
2015	Triple-A	ASW 1	Mixed Disturbed	1	1.25
2015	Triple-A	ASW 1	Mixed Disturbed	3	10.625
2015	Triple-A	ASW 3	Mixed Disturbed	0	1
2015	Triple-A	ASW 3	Mixed Disturbed	1	2.25

2015	Triple-A	ASW 3	Mixed Disturbed	3	41.75
2015	Triple-A	ASW 4	Mixed Disturbed	0	0
2015	Triple-A	ASW 4	Mixed Disturbed	1	150
2015	Triple-A	ASW 4	Mixed Disturbed	3	267.5
2015	Triple-A	ASW 5	Mixed Disturbed	0	0
2015	Triple-A	ASW 5	Mixed Disturbed	1	0
2015	Triple-A	ASW 5	Mixed Disturbed	3	288.75
2015	Triple-A	ASW 6	Mixed Disturbed	0	0
2015	Triple-A	ASW 6	Mixed Disturbed	1	282.5
2015	Triple-A	ASW 6	Mixed Disturbed	3	285
2015	Lower Femmons	FSW 10	Mixed Disturbed	0	1.375
2015	Lower Femmons	FSW 10	Mixed Disturbed	1	0.875
2015	Lower Femmons	FSW 10	Mixed Disturbed	3	1.5
2015	Lower Femmons	FSW 11	Mixed Disturbed	0	0
2015	Lower Femmons	FSW 11	Mixed Disturbed	1	4.75
2015	Lower Femmons	FSW 11	Mixed Disturbed	3	3.125
2015	Triple-A	ASW 1	Control	0	0
2015	Triple-A	ASW 1	Control	1	35.75
2015	Triple-A	ASW 1	Control	3	270
2015	Triple-A	ASW 2	Control	0	0.125
2015	Triple-A	ASW 2	Control	1	37.5
2015	Triple-A	ASW 2	Control	3	300
2015	Triple-A	ASW 2	Control	0	1
2015	Triple-A	ASW 2	Control	1	8.25
2015	Triple-A	ASW 2	Control	3	3.625
2015	Triple-A	ASW 2	Control	0	1
2015	Triple-A	ASW 2	Control	1	83.125
2015	Triple-A	ASW 2	Control	3	262.625
2015	Triple-A	ASW 3	Control	0	0

2015	Triple-A	ASW 3	Control	1	0
2015	Triple-A	ASW 3	Control	3	156.25
2015	Triple-A	ASW 4	Control	0	1
2015	Triple-A	ASW 4	Control	1	1.125
2015	Triple-A	ASW 4	Control	3	283.375
2015	Triple-A	ASW 5	Control	0	0
2015	Triple-A	ASW 5	Control	1	232.25
2015	Triple-A	ASW 5	Control	3	42.5
2015	Triple-A	ASW 6	Control	0	0
2015	Triple-A	ASW 6	Control	1	68.75
2015	Triple-A	ASW 6	Control	3	81.875
2015	Triple-A	ASW 7	Control	0	0
2015	Triple-A	ASW 7	Control	1	171
2015	Triple-A	ASW 7	Control	3	76.5
2015	Triple-A	ASW 7	Control	0	0
2015	Triple-A	ASW 7	Control	1	0
2015	Triple-A	ASW 7	Control	3	220.625
2015	Triple-A	ASW 7	Control	0	0
2015	Triple-A	ASW 7	Control	1	48.25
2015	Triple-A	ASW 7	Control	3	300
2015	Lower Femmons	FSW 8	Control	0	0
2015	Lower Femmons	FSW 8	Control	1	18.5
2015	Lower Femmons	FSW 8	Control	3	4.625
2015	Lower Femmons	FSW 8	Control	0	1.375
2015	Lower Femmons	FSW 8	Control	1	0
2015	Lower Femmons	FSW 8	Control	3	7.25
2015	Lower Femmons	FSW 8	Control	0	0
2015	Lower Femmons	FSW 8	Control	1	2.125
2015	Lower Femmons	FSW 8	Control	3	1.875

2015	Lower Femmons	FSW 9	Control	0	0
2015	Lower Femmons	FSW 9	Control	1	84.375
2015	Lower Femmons	FSW 9	Control	3	19.5
2015	Lower Femmons	FSW 10	Control	0	0.375
2015	Lower Femmons	FSW 10	Control	1	0
2015	Lower Femmons	FSW 10	Control	3	40.375
2015	Lower Femmons	FSW 11	Control	0	0
2015	Lower Femmons	FSW 11	Control	1	8.875
2015	Lower Femmons	FSW 11	Control	3	2

Appendix 12: Field saturated hydraulic conductivity (Kfs) and errors for each year, site, plot, and treatment.

	Year	Site	Plot	Treatment	Kfs	Kfs Error
					(cm s ⁻¹)	(cm s ⁻¹)
136	2015	Lower Femmons	FSW8	Control	0.00766	0.00014
	2015	Lower Femmons	FSW9	Control	0.0118	0.00053
	2015	Lower Femmons	FSW10	Control	0.012	0.00236
	2015	Lower Femmons	FSW11	Control	0.0047	0.0312
	2015	Lower Femmons	FSW9	Feller Buncher	0.0017	9.1E-05
	2015	Lower Femmons	FSW10	Feller Buncher	0.00167	5.5E-05
	2015	Lower Femmons	FSW11	Feller Buncher	0.00322	6.1E-05
	2015	Triple-A	ASW1	Control	0.0104	0.00064
	2015	Triple-A	ASW2	Control	0.00868	0.00013
	2015	Triple-A	ASW3	Control	0.00546	4.7E-05
	2015	Triple-A	ASW4	Control	0.0057	9.7E-05
	2015	Triple-A	ASW5	Control	0.01	0.00015
	2015	Triple-A	ASW6	Control	0.0134	0.00026
	2015	Triple-A	ASW7	Control	0.00694	0.00108
	2015	Triple-A	ASW1	Feller Buncher	0.00484	0.00327
	2015	Triple-A	ASW3	Feller Buncher	0.00026	4.3E-05
	2015	Triple-A	ASW4	Feller Buncher	0.00345	0.0002
	2015	Triple-A	ASW5	Feller Buncher	0.00324	4.7E-05
	2015	Triple-A	ASW6	Feller Buncher	0.00245	0.00048
	2015	Triple-A	ASW1	Few Pass	0.00127	4.9E-05
	2015	Triple-A	ASW3	Few Pass	0.00417	0.00107
	2015	Triple-A	ASW4	Few Pass	0.00467	0.00193
	2015	Triple-A	ASW5	Few Pass	0.00756	0.00041

2015	Triple-A	ASW6	Few Pass	0.00326	8.5E-05
2015	Triple-A	ASW1	Many Pass	0.0017	0.00113
2015	Triple-A	ASW3	Many Pass	0.00028	3.9E-05
2015	Triple-A	ASW4	Many Pass	0.00078	4.6E-05
2015	Triple-A	ASW5	Many Pass	0.00047	4.2E-05
2015	Triple-A	ASW6	Many Pass	0.00027	4.8E-05
2015	Triple-A	ASW1	Mix Disturbed	0.00393	8.6E-05
2015	Triple-A	ASW3	Mix Disturbed	0.0021	4.8E-05
2015	Triple-A	ASW4	Mix Disturbed	0.0012	3.2E-05
2015	Triple-A	ASW5	Mix Disturbed	0.00037	4E-05
2015	Sawmill	HFC2	Control	0.0124	0.00027
2015	Sawmill	HFC3	Control	0.0114	0.00014
2015	Sawmill	HFC4	Control	0.00622	0.00012
2015	Sawmill	HFFP2	Few Pass	0.0017	0.0001
2015	Sawmill	HFFP3	Few Pass	0.00303	0.00016
2015	Sawmill	HFFP4	Few Pass	0.00244	9.7E-05
2015	Sawmill	HFL2	Logged Only	0.00698	0.00023
2015	Sawmill	HFL3	Logged Only	0.00715	0.00046
2015	Sawmill	HFL4	Logged Only	0.012	0.00034
2015	Lower Femmons	FSW11	Few Pass	0.00036	0.00019
2015	Lower Femmons	FSW9	Many Pass	0.00011	4.9E-05
2015	Lower Femmons	FSW10	Many Pass	0.00034	5.7E-05
2015	Lower Femmons	FSW11	Many Pass	0.00036	6.9E-05
2015	Lower Femmons	FSW10	Mix Disturbed	0.00069	7.9E-05
2015	Lower Femmons	FSW11	Mix Disturbed	0.00149	4.6E-05
2015	Sawmill	HFLC2	Low Slope Control	0.00987	0.00081
2015	Sawmill	HFLC3	Low Slope Control	0.0108	0.00016

2015	Sawmill	HFLC4	Low Slope Control	0.00601	0.0001
2015	Sawmill	HFMP2	Many Pass	0.00079	9.5E-05
2015	Sawmill	HFMP3	Many Pass	0.00082	5.5E-05
2015	Sawmill	HFMP4	Many Pass	0.00136	5.7E-05
2016	Lower Femmons	FSW8	Control	0.0126	8.6E-05
2016	Lower Femmons	FSW9	Control	0.0109	0.00028
2016	Lower Femmons	FSW10	Control	0.00193	4.7E-05
2016	Lower Femmons	FSW11	Control	0.00406	5.9E-05
2016	Lower Femmons	HFC5	Control	0.0048	0.00069
2016	Lower Femmons	FSW9	Feller Buncher	0.0016	3.2E-05
2016	Sawmill	HFC2	Control	0.00133	8.4E-05
2016	Sawmill	HFC3	Control	0.01	0.0002
2016	Sawmill	HFC4	Control	0.00393	3.3E-05
2016	Sawmill	HFFP2	Few Pass	0.00064	2.3E-05
2016	Sawmill	HFFP3	Few Pass	0.00173	7.7E-05
2016	Sawmill	HFFP4	Few Pass	0.00106	6.2E-05
2016	Lower Femmons	FSW10	Feller Buncher	0.0144	0.00034
2016	Lower Femmons	FSW11	Feller Buncher	0.00034	6.5E-05
2016	Lower Femmons	FSW11	Few Pass	0.00108	4.9E-05
2016	Lower Femmons	HFFP5	Few Pass	0.0002	7.8E-05
2016	Lower Femmons	HFL5	Logged Only	0.00258	7.5E-05
2016	Lower Femmons	FSW9	Many Pass	6.1E-05	4.4E-05
2016	Lower Femmons	FSW10	Many Pass	0.00024	4.7E-05
2016	Lower Femmons	FSW11	Many Pass	0.00035	2.7E-05
2016	Upper Femmons	FSW12	Control	0.0034	8.5E-05
2016	Upper Femmons	FSW12	Control	0.00983	0.00014
2016	Upper Femmons	FSW13	Control	0.00455	0.00013

2016	Upper Femmons	FSW14	Control	0.0293	0.00103
2016	Upper Femmons	FSW14	Control	0.0272	0.00052
2016	Upper Femmons	HFC6	Control	0.00588	0.00043
2016	Upper Femmons	HFC7	Control	0.0106	0.00012
2016	Lower Femmons	HFMP5	Many Pass	0.00041	2.9E-05
2016	Lower Femmons	FSW10	Mix Disturbed	0.00703	0.00012
2016	Upper Femmons	FSW13	Few Pass	0.00328	0.00164
2016	Upper Femmons	HFFP6	Few Pass	0.00064	5.7E-05
2016	Upper Femmons	HFFP7	Few Pass	0.00279	5E-05
2016	Upper Femmons	HFL6	Logged Only	0.00384	0.00243
2016	Upper Femmons	HFL7	Logged Only	0.0141	0.00059
2016	Upper Femmons	FSW13	Many Pass	0.00224	0.00014
2016	Upper Femmons	HFMP6	Many Pass	0.00087	4.3E-05
2016	Upper Femmons	HFMP7	Many Pass	0.0028	6.5E-05
2016	Sawmill	HFL2	Logged Only	0.00343	3.1E-05
2016	Sawmill	HFL3	Logged Only	0.0005	4.8E-05
2016	Sawmill	HFL4	Logged Only	0.00064	3.1E-05
2016	Sawmill	HFLSC2	Low Slope Control	0.0036	0.00069
2016	Sawmill	HFLSC3	Low Slope Control	0.00192	0.00085
2016	Sawmill	HFLSC4	Low Slope Control	0.00206	0.00074
2016	Sawmill	HFMP2	Many Pass	0.0004	6.2E-05
2016	Sawmill	HFMP3	Many Pass	0.0003	2.5E-05
2016	Sawmill	HFMP4	Many Pass	0.00045	4.8E-05
2016	Triple-A	ASW1	Control	0.00321	0.00013
2016	Triple-A	ASW2	Control	0.00691	0.00103
2016	Triple-A	ASW3	Control	0.00941	0.0009
2016	Triple-A	ASW4	Control	0.0132	0.00094

2016	Triple-A	ASW5	Control	0.00323	9.9E-05
2016	Triple-A	ASW6	Control	0.00474	7.5E-05
2016	Triple-A	ASW7	Control	0.01	0.00011
2016	Triple-A	ASW1	Feller Buncher	0.00552	0.00097
2016	Triple-A	ASW3	Feller Buncher	3.5E-05	0.0001
2016	Triple-A	ASW4	Feller Buncher	0.00261	7.4E-05
2016	Triple-A	ASW5	Feller Buncher	0.00167	5.6E-05
2016	Triple-A	ASW6	Feller Buncher	0.00585	0.00235
2016	Triple-A	ASW1	Few Pass	0.00181	4.1E-05
2016	Triple-A	ASW3	Few Pass	0.00074	0.00014
2016	Triple-A	ASW4	Few Pass	0.00011	0.00024
2016	Triple-A	ASW5	Few Pass	0.00368	0.0001
2016	Triple-A	ASW6	Few Pass	0.005	0.00399
2016	Triple-A	ASW1	Many Pass	0.00192	2.9E-05
2016	Triple-A	ASW3	Many Pass	0.00092	7.5E-05
2016	Triple-A	ASW4	Many Pass	0.00014	6.9E-05
2016	Triple-A	ASW5	Many Pass	2.6E-05	7.7E-05
2016	Triple-A	ASW6	Many Pass	0.00249	0.00018
2016	Triple-A	ASW1	Mix Disturbed	0.00406	0.00014
2016	Triple-A	ASW3	Mix Disturbed	0.00098	8.5E-05
2016	Triple-A	ASW4	Mix Disturbed	0.0169	0.00037
2016	Triple-A	ASW5	Mix Disturbed	0.00182	6.3E-05
2016	Evergreen	EC1	Control	0.0244	0.0584
2016	Evergreen	EC3	Control	0.0101	0.00037
2016	Evergreen	EC4	Control	0.00581	0.0013
2016	Evergreen	EFP1	Few Pass	0.00155	0.00045
2016	Evergreen	EFP2	Few Pass	0.00074	3.1E-05

2016	Evergreen	EFP3	Few Pass	0.00047	0.00017
2016	Evergreen	EFP4	Few Pass	0.00425	0.00066
2016	Evergreen	EMP1	Many Pass	0.00072	7.1E-05
2016	Evergreen	EMP2	Many Pass	0.00106	0.00094
2016	Evergreen	EMP3	Many Pass	0.00045	4.3E-05
2016	Evergreen	EMP4	Many Pass	0.00032	3.5E-05
2016	Evergreen	EMX1	Mix Disturbed	0.00862	0.00303
2016	Evergreen	EMX2	Mix Disturbed	0.0104	0.00067
2016	Evergreen	EMX3	Mix Disturbed	0.00314	0.00081
2016	Evergreen	EMX4	Mix Disturbed	0.00076	2.4E-05
2016	Evergreen	EST1	Skidder Track	0.00169	5.8E-05
2016	Evergreen	EST2	Skidder Track	0.00069	0.00015
2016	Evergreen	EST3	Skidder Track	0.00015	5.4E-05
2016	Evergreen	EST4	Skidder Track	0.00301	0.00062

Appendix 13: Mean ground cover for each year, season, site, treatment, and cover level. The interception level is the first layer that a rain drop would impact while the surface level is in contact with the ground. LF is lower Femmons, UF is upper Femmons, and LSC is low slope control. Data are means for each cover class of three quadrats per plot and all plots per treatment (n=6 except LSC n=3).

	Year and Season	Site	Treatment	Level	Bare Soil (%)	Gravel (%)	Vegetation (%)	Wood (%)	Litter (%)	Rock (%)
142	2014 Fall	Sawmill	Control	Surface	62.9	4.6	20.1	1.7	10.3	0.4
	2014 Fall	Sawmill	Logged only	Surface	47.3	0.2	4.3	29.6	18.6	0
	2014 Fall	Sawmill	Few pass	Surface	55.93	0.1	3.27	23.77	16.7	0.23
	2014 Fall	Sawmill	Many pass	Surface	86.8	0.33	0.33	7.67	4.77	0.1
	2014 Fall	Sawmill	LSC	Surface	52.3	2	15.6	1	29.1	0
	2015 Spring	Sawmill	Control	Surface	48.67	1.33	34.3	2.23	12.47	1
	2015 Spring	Sawmill	Logged only	Surface	56.8	0.5	11.5	15.7	15.5	0
	2015 Spring	Sawmill	Few pass	Surface	50.8	0.33	7.2	18.6	23.07	0.57
	2015 Spring	Sawmill	Many pass	Surface	71.6	0.3	14.1	6.23	7.2	0
	2015 Spring	Sawmill	LSC	Surface	32.9	0.5	55.1	0.7	10.8	0
	2015 Fall	Sawmill	Control	Surface	36.97	0.33	22.24	2.43	37.23	0.8
	2015 Fall	Sawmill	Logged only	Surface	35.5	1	11	16.5	36	0
	2015 Fall	Sawmill	Few pass	Surface	46	3.7	0.7	17.9	31.3	0.4
	2015 Fall	Sawmill	Many pass	Surface	47.7	1.4	7.3	8.6	34.4	0.6
	2015 Fall	Sawmill	LSC	Surface	14.3	0.77	46	0.33	38.6	0
	2015 Fall	LF	Control	Surface	82.7	0	2.7	0.3	14.3	0
	2015 Fall	LF	Logged only	Surface	69	0	6.3	2	22.7	0
	2015 Fall	LF	Few pass	Surface	81.3	0	0.7	12.7	5.3	0
	2015 Fall	LF	Many pass	Surface	85.3	0	0.4	10	4.3	0
	2015 Fall	UF	Control	Surface	59.6	3.65	3.65	9.55	17.7	5.85
	2015 Fall	UF	Logged only	Surface	49.65	2.2	4.5	6.85	34.5	1.35

2015 Fall	UF	Few pass	Surface	77.85	3.15	1.15	2.2	14.3	1.5
2015 Fall	UF	Many pass	Surface	86.15	2.3	0.2	1	8.85	2.3
2016 Spring	Sawmill	Control	Surface	27.6	0	44.3	7.7	18.83	1.57
2016 Spring	Sawmill	Logged only	Surface	22.8	0.1	32.2	17.1	27.7	0.1
2016 Spring	Sawmill	Few pass	Surface	36.8	0.67	11.5	22.4	27.6	1.03
2016 Spring	Sawmill	Many pass	Surface	32.2	1	41	9.5	15.5	0.8
2016 Spring	Sawmill	LSC	Surface	5.7	0.3	85.41	1.7	6.77	0.12
2016 Spring	LF	Control	Surface	58.3	0	28.7	1.3	11.7	0
2016 Spring	LF	Logged only	Surface	18	0	71	2.7	8.3	0
2016 Spring	LF	Few pass	Surface	60.3	0	3.7	12	23.7	0.3
2016 Spring	LF	Many pass	Surface	70.7	0	6	12	11	0.3
2016 Spring	UF	Control	Surface	42.45	0.5	26.35	11.5	12.55	6.65
2016 Spring	UF	Logged only	Surface	46	0.2	13	10.8	24.35	5.65
2016 Spring	UF	Few pass	Surface	74.35	0.5	6.5	2.3	10.5	5.85
2016 Spring	UF	Many pass	Surface	76.25	1.5	0	2.85	13.85	5.55
2014 Fall	Sawmill	Control	Interception	62.9	4.56	20.1	1.67	10.44	0.33
2014 Fall	Sawmill	Few Pass	Interception	55.8	0.12	3.26	23.9	16.7	0.22
2014 Fall	Sawmill	Logged Only	Interception	47.3	0.22	4.36	29.52	18.6	0
2014 Fall	Sawmill	LSC	Interception	52.06	2	15.5	1.14	29.3	0
2014 Fall	Sawmill	Many Pass	Interception	86.8	0.33	0.33	7.65	4.78	0.11
2015 Spring	Sawmill	Control	Interception	33.3	1.3	50	2.4	12	1
2015 Spring	Sawmill	Few Pass	Interception	45	0.34	12.36	19.8	22.5	0
2015 Spring	Sawmill	Logged Only	Interception	42	0.44	25	18	14.56	0
2015 Spring	Sawmill	LSC	Interception	15.64	0.44	74	0.67	9.25	0
2015 Spring	Sawmill	Many Pass	Interception	53.5	0.33	32	6.7	6.9	0.57
2015 Fall	Sawmill	Control	Interception	29.4	0.33	35.1	2.4	32.1	0.67
2015 Fall	Sawmill	Few Pass	Interception	45	3.6	3.07	19	29	0.33

2015 Fall	Sawmill	Logged Only	Interception	32.6	1	15.6	16.3	34.5	0
2015 Fall	Sawmill	LSC	Interception	12.2	1.1	52.4	2.1	32.2	0
2015 Fall	Sawmill	Many Pass	Interception	42.67	1.44	13	8.55	33.78	0.56
2015 Fall	LF	Control	Interception	51.7	0	34.3	0.33	13.67	0
2015 Fall	LF	Few Pass	Interception	77.7	0	2.7	14.3	5.3	0
2015 Fall	LF	Logged Only	Interception	38.3	0	39	2	20.7	0
2015 Fall	LF	Many Pass	Interception	80	0	5.7	10	4.3	0
2015 Fall	UF	Control	Interception	28.7	3.7	34.2	11.5	16.2	5.7
2015 Fall	UF	Few Pass	Interception	72.5	3.2	6.3	2.3	14.4	1.3
2015 Fall	UF	Logged Only	Interception	31.1	2.7	23	8.7	31.8	2.7
2015 Fall	UF	Many Pass	Interception	85.5	2.4	0.8	1	8.8	1.5
2016 Spring	Sawmill	Control	Interception	1	0	85.5	8	5	0.5
2016 Spring	Sawmill	Few Pass	Interception	9	2	45.7	27	15.3	1
2016 Spring	Sawmill	Logged Only	Interception	4.44	0.11	76.6	12.9	5.95	0
2016 Spring	Sawmill	LSC	Interception	10.3	0	88.3	1.4	0	0
2016 Spring	Sawmill	Many Pass	Interception	16.3	0.9	59.5	10.3	12.5	0.5
2016 Spring	LF	Control	Interception	25.7	0	65.67	0.33	8.3	0
2016 Spring	LF	Few Pass	Interception	38	0	21.7	18.3	21.7	0.3
2016 Spring	LF	Logged Only	Interception	13	0	82	1.67	3.33	0
2016 Spring	LF	Many Pass	Interception	55	0	22	12	10.67	0.33
2016 Spring	UF	Control	Interception	15.4	0.5	57.2	10.1	11.8	5
2016 Spring	UF	Few Pass	Interception	56	0.5	24.5	2.3	11	5.7
2016 Spring	UF	Logged Only	Interception	30.1	0.7	31.5	12	20	5.7
2016 Spring	UF	Many Pass	Interception	55	1.5	20.5	3	14.5	5.5

Appendix 14: Event sediment yields by water year, site, plot, and treatment. Event date is precipitation occurrence date. Cleanout date is when sediment was removed from the sediment fence. NA indicates logging had occurred, but sediment fences were not yet installed. In lower and upper Femmons sediment monitoring began in 2016 water year.

	Water Year	Site	Plot	Treatment	Event Date	Cleanout Date	Sediment Yield (kg ha ⁻¹)
145	2015	Sawmill	HF2	Low Slope Control	27-Sep-14	29-Sep-14	NA
	2015	Sawmill	HF2	Control	27-Sep-14	29-Sep-14	20.1
	2015	Sawmill	HF2	Logged Only	27-Sep-14	29-Sep-14	0
	2015	Sawmill	HF2	Few Pass	27-Sep-14	29-Sep-14	8.1
	2015	Sawmill	HF2	Many Pass	27-Sep-14	29-Sep-14	12.5
	2015	Sawmill	HF3	Low Slope Control	27-Sep-14	29-Sep-14	NA
	2015	Sawmill	HF3	Control	27-Sep-14	29-Sep-14	146.3
	2015	Sawmill	HF3	Logged Only	27-Sep-14	29-Sep-14	9
	2015	Sawmill	HF3	Few Pass	27-Sep-14	29-Sep-14	131.7
	2015	Sawmill	HF3	Many Pass	27-Sep-14	29-Sep-14	NA
	2015	Sawmill	HF4	Low Slope Control	27-Sep-14	29-Sep-14	NA
	2015	Sawmill	HF4	Control	27-Sep-14	29-Sep-14	13.6
	2015	Sawmill	HF4	Logged Only	27-Sep-14	29-Sep-14	0
	2015	Sawmill	HF4	Few Pass	27-Sep-14	29-Sep-14	21.3
	2015	Sawmill	HF4	Many Pass	27-Sep-14	29-Sep-14	36.4
	2015	Sawmill	HF2	Low Slope Control	31-Oct-14	3-Nov-14	17.4
	2015	Sawmill	HF2	Control	31-Oct-14	3-Nov-14	16.1
	2015	Sawmill	HF2	Logged Only	31-Oct-14	3-Nov-14	49.6
	2015	Sawmill	HF2	Few Pass	31-Oct-14	3-Nov-14	5
	2015	Sawmill	HF2	Many Pass	31-Oct-14	3-Nov-14	7.4
	2015	Sawmill	HF3	Low Slope Control	31-Oct-14	3-Nov-14	35.5
	2015	Sawmill	HF3	Control	31-Oct-14	3-Nov-14	26

2015	Sawmill	HF3	Logged Only	31-Oct-14	3-Nov-14	7.4
2015	Sawmill	HF3	Few Pass	31-Oct-14	3-Nov-14	50
2015	Sawmill	HF3	Many Pass	31-Oct-14	3-Nov-14	97.6
2015	Sawmill	HF4	Low Slope Control	31-Oct-14	3-Nov-14	14.5
2015	Sawmill	HF4	Control	31-Oct-14	3-Nov-14	9.2
2015	Sawmill	HF4	Logged Only	31-Oct-14	3-Nov-14	0
2015	Sawmill	HF4	Few Pass	31-Oct-14	3-Nov-14	13.7
2015	Sawmill	HF4	Many Pass	31-Oct-14	3-Nov-14	15.9
2015	Sawmill	HF2	Low Slope Control	13-Nov-14	14-Nov-14	10.6
2015	Sawmill	HF2	Control	13-Nov-14	14-Nov-14	11.9
2015	Sawmill	HF2	Logged Only	13-Nov-14	14-Nov-14	15.5
2015	Sawmill	HF2	Few Pass	13-Nov-14	14-Nov-14	0
2015	Sawmill	HF2	Many Pass	13-Nov-14	14-Nov-14	1.7
2015	Sawmill	HF3	Low Slope Control	13-Nov-14	14-Nov-14	16.3
2015	Sawmill	HF3	Control	13-Nov-14	14-Nov-14	8.7
2015	Sawmill	HF3	Logged Only	13-Nov-14	14-Nov-14	3.8
2015	Sawmill	HF3	Few Pass	13-Nov-14	14-Nov-14	6.4
2015	Sawmill	HF3	Many Pass	13-Nov-14	14-Nov-14	31.7
2015	Sawmill	HF4	Low Slope Control	13-Nov-14	14-Nov-14	6.4
2015	Sawmill	HF4	Control	13-Nov-14	14-Nov-14	5.2
2015	Sawmill	HF4	Logged Only	13-Nov-14	14-Nov-14	0
2015	Sawmill	HF4	Few Pass	13-Nov-14	14-Nov-14	3.3
2015	Sawmill	HF4	Many Pass	13-Nov-14	14-Nov-14	6.5
2015	Sawmill	HF2	Low Slope Control	2-Dec-14	6-Dec-14	82.2
2015	Sawmill	HF2	Control	2-Dec-14	6-Dec-14	56.2
2015	Sawmill	HF2	Logged Only	2-Dec-14	6-Dec-14	175.1
2015	Sawmill	HF2	Few Pass	2-Dec-14	6-Dec-14	14.4
2015	Sawmill	HF2	Many Pass	2-Dec-14	6-Dec-14	124
2015	Sawmill	HF3	Low Slope Control	2-Dec-14	6-Dec-14	66.4

2015	Sawmill	HF3	Control	2-Dec-14	6-Dec-14	961.7
2015	Sawmill	HF3	Logged Only	2-Dec-14	6-Dec-14	42.7
2015	Sawmill	HF3	Few Pass	2-Dec-14	6-Dec-14	687.3
2015	Sawmill	HF3	Many Pass	2-Dec-14	6-Dec-14	147.6
2015	Sawmill	HF4	Low Slope Control	2-Dec-14	6-Dec-14	115.9
2015	Sawmill	HF4	Control	2-Dec-14	6-Dec-14	92.4
2015	Sawmill	HF4	Logged Only	2-Dec-14	6-Dec-14	4.8
2015	Sawmill	HF4	Few Pass	2-Dec-14	6-Dec-14	36.5
2015	Sawmill	HF4	Many Pass	2-Dec-14	6-Dec-14	0
2015	Sawmill	HF2	Low Slope Control	12-Dec-14	7-Jan-15	51.8
2015	Sawmill	HF2	Control	12-Dec-14	7-Jan-15	63.8
2015	Sawmill	HF2	Logged Only	12-Dec-14	7-Jan-15	195.3
2015	Sawmill	HF2	Few Pass	12-Dec-14	7-Jan-15	32.5
2015	Sawmill	HF2	Many Pass	12-Dec-14	7-Jan-15	323.5
2015	Sawmill	HF3	Low Slope Control	12-Dec-14	7-Jan-15	55.5
2015	Sawmill	HF3	Control	12-Dec-14	7-Jan-15	1334.3
2015	Sawmill	HF3	Logged Only	12-Dec-14	7-Jan-15	166.4
2015	Sawmill	HF3	Few Pass	12-Dec-14	7-Jan-15	1317.1
2015	Sawmill	HF3	Many Pass	12-Dec-14	7-Jan-15	958.4
2015	Sawmill	HF4	Low Slope Control	12-Dec-14	7-Jan-15	215.8
2015	Sawmill	HF4	Control	12-Dec-14	7-Jan-15	139.1
2015	Sawmill	HF4	Logged Only	12-Dec-14	7-Jan-15	0
2015	Sawmill	HF4	Few Pass	12-Dec-14	7-Jan-15	58.7
2015	Sawmill	HF4	Many Pass	12-Dec-14	7-Jan-15	244.7
2015	Sawmill	HF2	Low Slope Control	8-Feb-15	11-Feb-15	66.6
2015	Sawmill	HF2	Control	8-Feb-15	11-Feb-15	123.1
2015	Sawmill	HF2	Logged Only	8-Feb-15	11-Feb-15	470.8
2015	Sawmill	HF2	Few Pass	8-Feb-15	11-Feb-15	69.1
2015	Sawmill	HF2	Many Pass	8-Feb-15	11-Feb-15	8580.9

2015	Sawmill	HF3	Low Slope Control	8-Feb-15	11-Feb-15	44.3
2015	Sawmill	HF3	Control	8-Feb-15	11-Feb-15	6033.9
2015	Sawmill	HF3	Logged Only	8-Feb-15	11-Feb-15	2271.8
2015	Sawmill	HF3	Few Pass	8-Feb-15	11-Feb-15	9901.8
2015	Sawmill	HF3	Many Pass	8-Feb-15	11-Feb-15	6651.4
2015	Sawmill	HF4	Low Slope Control	8-Feb-15	11-Feb-15	491.1
2015	Sawmill	HF4	Control	8-Feb-15	11-Feb-15	422.6
2015	Sawmill	HF4	Logged Only	8-Feb-15	11-Feb-15	7.1
2015	Sawmill	HF4	Few Pass	8-Feb-15	11-Feb-15	185.3
2015	Sawmill	HF4	Many Pass	8-Feb-15	11-Feb-15	1462.3
2015	Sawmill	HF2	Low Slope Control	8-Apr-15	2-May-15	0
2015	Sawmill	HF2	Control	8-Apr-15	2-May-15	0
2015	Sawmill	HF2	Logged Only	25-Apr-15	2-May-15	0
2015	Sawmill	HF2	Few Pass	25-Apr-15	2-May-15	0
2015	Sawmill	HF2	Many Pass	25-Apr-15	2-May-15	39.9
2015	Sawmill	HF3	Low Slope Control	8-Apr-15	2-May-15	0
2015	Sawmill	HF3	Control	8-Apr-15	2-May-15	21
2015	Sawmill	HF3	Logged Only	8-Apr-15	2-May-15	0
2015	Sawmill	HF3	Few Pass	8-Apr-15	2-May-15	56
2015	Sawmill	HF3	Many Pass	8-Apr-15	2-May-15	0
2015	Sawmill	HF4	Low Slope Control	8-Apr-15	2-May-15	0
2015	Sawmill	HF4	Control	8-Apr-15	2-May-15	0
2015	Sawmill	HF4	Logged Only	8-Apr-15	2-May-15	0
2015	Sawmill	HF4	Few Pass	8-Apr-15	2-May-15	0
2015	Sawmill	HF4	Many Pass	8-Apr-15	2-May-15	0
2015	Sawmill	HF2	Low Slope Control	7-May-15	15-May-15	0
2015	Sawmill	HF2	Control	7-May-15	15-May-15	0
2015	Sawmill	HF2	Logged Only	7-May-15	15-May-15	0
2015	Sawmill	HF2	Few Pass	7-May-15	15-May-15	0

2015	Sawmill	HF2	Many Pass	7-May-15	15-May-15	24.9
2015	Sawmill	HF3	Low Slope Control	7-May-15	15-May-15	0
2015	Sawmill	HF3	Control	7-May-15	15-May-15	0
2015	Sawmill	HF3	Logged Only	7-May-15	15-May-15	0
2015	Sawmill	HF3	Few Pass	7-May-15	15-May-15	75.5
2015	Sawmill	HF3	Many Pass	7-May-15	15-May-15	24.2
2015	Sawmill	HF4	Low Slope Control	7-May-15	15-May-15	0
2015	Sawmill	HF4	Control	7-May-15	15-May-15	0
2015	Sawmill	HF4	Logged Only	7-May-15	15-May-15	0
2015	Sawmill	HF4	Few Pass	7-May-15	15-May-15	0
2015	Sawmill	HF4	Many Pass	7-May-15	15-May-15	0
2015	Sawmill	HF2	Low Slope Control	23-May-15	18-Jul-15	0
2015	Sawmill	HF2	Control	23-May-15	18-Jul-15	0
2015	Sawmill	HF2	Logged Only	23-May-15	18-Jul-15	0
2015	Sawmill	HF2	Few Pass	23-May-15	18-Jul-15	25.4
2015	Sawmill	HF2	Many Pass	23-May-15	18-Jul-15	0
2015	Sawmill	HF3	Low Slope Control	23-May-15	18-Jul-15	0
2015	Sawmill	HF3	Control	23-May-15	18-Jul-15	0
2015	Sawmill	HF3	Logged Only	23-May-15	18-Jul-15	0
2015	Sawmill	HF3	Few Pass	23-May-15	18-Jul-15	0
2015	Sawmill	HF3	Many Pass	23-May-15	18-Jul-15	0
2015	Sawmill	HF4	Low Slope Control	23-May-15	18-Jul-15	0
2015	Sawmill	HF4	Control	23-May-15	18-Jul-15	0
2015	Sawmill	HF4	Logged Only	23-May-15	18-Jul-15	0
2015	Sawmill	HF4	Few Pass	23-May-15	18-Jul-15	0
2015	Sawmill	HF4	Many Pass	23-May-15	18-Jul-15	0
2015	Sawmill	HF2	Low Slope Control	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF2	Control	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF2	Logged Only	20-Jul-15	24-Jul-15	0

2015	Sawmill	HF2	Few Pass	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF2	Many Pass	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF3	Low Slope Control	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF3	Control	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF3	Logged Only	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF3	Few Pass	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF3	Many Pass	20-Jul-15	24-Jul-15	19.9
2015	Sawmill	HF4	Low Slope Control	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF4	Control	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF4	Logged Only	20-Jul-15	24-Jul-15	0
2015	Sawmill	HF4	Few Pass	20-Jul-15	24-Jul-15	7.3
2015	Sawmill	HF4	Many Pass	20-Jul-15	24-Jul-15	11.5
2015	Sawmill	HF2	Control	17-Oct-15	7-Nov-15	25.4
2015	Sawmill	HF2	Few Pass	17-Oct-15	7-Nov-15	95.9
2015	Sawmill	HF2	Logged Only	17-Oct-15	7-Nov-15	164.4
2015	Sawmill	HF2	Low Slope Control	17-Oct-15	7-Nov-15	19.1
2015	Sawmill	HF2	Many Pass	17-Oct-15	7-Nov-15	387.4
2015	Sawmill	HF3	Control	17-Oct-15	7-Nov-15	855.8
2015	Sawmill	HF3	Few Pass	17-Oct-15	7-Nov-15	4365.4
2015	Sawmill	HF3	Logged Only	17-Oct-15	7-Nov-15	1254.8
2015	Sawmill	HF3	Low Slope Control	17-Oct-15	7-Nov-15	0
2015	Sawmill	HF3	Many Pass	17-Oct-15	7-Nov-15	118.6
2015	Sawmill	HF4	Control	28-Oct-15	7-Nov-15	0
2015	Sawmill	HF4	Few Pass	28-Oct-15	7-Nov-15	171.7
2015	Sawmill	HF4	Logged Only	28-Oct-15	7-Nov-15	20.1
2015	Sawmill	HF4	Low Slope Control	28-Oct-15	7-Nov-15	98.2
2015	Sawmill	HF4	Many Pass	28-Oct-15	7-Nov-15	642.3
2015	Sawmill	HF2	Control	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF2	Low Slope Control	8-Nov-15	19-Nov-15	0

2015	Sawmill	HF2	Logged Only	8-Nov-15	19-Nov-15	14.9
2015	Sawmill	HF2	Few Pass	8-Nov-15	19-Nov-15	2.9
2015	Sawmill	HF2	Many Pass	8-Nov-15	19-Nov-15	24.8
2015	Sawmill	HF3	Control	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF3	Low Slope Control	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF3	Logged Only	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF3	Few Pass	8-Nov-15	19-Nov-15	17.6
2015	Sawmill	HF3	Many Pass	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF4	Control	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF4	Low Slope Control	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF4	Logged Only	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF4	Few Pass	8-Nov-15	19-Nov-15	0
2015	Sawmill	HF4	Many Pass	8-Nov-15	19-Nov-15	0
2016	Lower Femmons	HF5	Control	2-Nov-15	23-Nov-15	4.8
2016	Lower Femmons	HF5	Logged Only	2-Nov-15	23-Nov-15	6
2016	Lower Femmons	HF5	Few Pass	2-Nov-15	23-Nov-15	121.9
2016	Lower Femmons	HF5	Many Pass	2-Nov-15	23-Nov-15	122.2
2016	Upper Femmons	HF6	Control	15-Nov-15	23-Nov-15	0
2016	Upper Femmons	HF6	Logged Only	15-Nov-15	23-Nov-15	0
2016	Upper Femmons	HF6	Few Pass	15-Nov-15	23-Nov-15	0
2016	Upper Femmons	HF6	Many Pass	15-Nov-15	23-Nov-15	0
2016	Upper Femmons	HF7	Control	15-Nov-15	23-Nov-15	0
2016	Upper Femmons	HF7	Logged Only	15-Nov-15	23-Nov-15	0
2016	Upper Femmons	HF7	Few Pass	15-Nov-15	23-Nov-15	0
2016	Upper Femmons	HF7	Many Pass	15-Nov-15	23-Nov-15	46.9
2016	Sawmill	HF2	Control	16-Jan-16	20-Jan-16	0
2016	Sawmill	HF2	Low Slope Control	16-Jan-16	20-Jan-16	0
2016	Sawmill	HF2	Logged Only	16-Jan-16	20-Jan-16	162.8
2016	Sawmill	HF2	Few Pass	16-Jan-16	20-Jan-16	0

2016	Sawmill	HF2	Many Pass	16-Jan-16	20-Jan-16	617.1
2016	Sawmill	HF3	Control	16-Jan-16	20-Jan-16	667.5
2016	Sawmill	HF3	Low Slope Control	16-Jan-16	20-Jan-16	0
2016	Sawmill	HF3	Logged Only	16-Jan-16	20-Jan-16	56.3
2016	Sawmill	HF3	Few Pass	16-Jan-16	20-Jan-16	5094.2
2016	Sawmill	HF3	Many Pass	16-Jan-16	20-Jan-16	151.9
2016	Sawmill	HF4	Control	16-Jan-16	20-Jan-16	16.6
2016	Sawmill	HF4	Low Slope Control	16-Jan-16	20-Jan-16	27.3
2016	Sawmill	HF4	Logged Only	16-Jan-16	20-Jan-16	6.5
2016	Sawmill	HF4	Few Pass	16-Jan-16	20-Jan-16	199.1
2016	Sawmill	HF4	Many Pass	16-Jan-16	20-Jan-16	250.6
2016	Lower Femmons	HF5	Control	6-Jan-16	21-Jan-16	138.8
2016	Lower Femmons	HF5	Logged Only	6-Jan-16	21-Jan-16	126.2
2016	Lower Femmons	HF5	Few Pass	6-Jan-16	21-Jan-16	3612.4
2016	Lower Femmons	HF5	Many Pass	6-Jan-16	21-Jan-16	10110.3
2016	Upper Femmons	HF6	Control	29-Jan-16	3-Feb-16	421.5
2016	Upper Femmons	HF6	Logged Only	29-Jan-16	3-Feb-16	12.7
2016	Upper Femmons	HF6	Few Pass	29-Jan-16	3-Feb-16	123.6
2016	Upper Femmons	HF6	Many Pass	29-Jan-16	3-Feb-16	8086.6
2016	Upper Femmons	HF7	Control	29-Jan-16	4-Feb-16	342.2
2016	Upper Femmons	HF7	Logged Only	29-Jan-16	4-Feb-16	24.2
2016	Upper Femmons	HF7	Few Pass	29-Jan-16	4-Feb-16	884.8
2016	Upper Femmons	HF7	Many Pass	29-Jan-16	4-Feb-16	12032
2016	Lower Femmons	HF5	Control	29-Jan-16	9-Feb-16	59
2016	Lower Femmons	HF5	Logged Only	29-Jan-16	9-Feb-16	34.8
2016	Lower Femmons	HF5	Few Pass	29-Jan-16	9-Feb-16	1269.9
2016	Lower Femmons	HF5	Many Pass	29-Jan-16	9-Feb-16	1866.8
2016	Sawmill	HF2	Control	29-Jan-16	10-Feb-16	0
2016	Sawmill	HF2	Low Slope Control	29-Jan-16	10-Feb-16	0

2016	Sawmill	HF2	Logged Only	29-Jan-16	10-Feb-16	52.1
2016	Sawmill	HF2	Few Pass	29-Jan-16	10-Feb-16	3.8
2016	Sawmill	HF2	Many Pass	29-Jan-16	10-Feb-16	7.4
2016	Sawmill	HF3	Control	29-Jan-16	10-Feb-16	17
2016	Sawmill	HF3	Low Slope Control	29-Jan-16	10-Feb-16	5.7
2016	Sawmill	HF3	Logged Only	29-Jan-16	10-Feb-16	7.3
2016	Sawmill	HF3	Few Pass	29-Jan-16	10-Feb-16	87.7
2016	Sawmill	HF3	Many Pass	29-Jan-16	10-Feb-16	7.5
2016	Sawmill	HF4	Control	19-Jan-16	10-Feb-16	1.9
2016	Sawmill	HF4	Low Slope Control	19-Jan-16	10-Feb-16	4.4
2016	Sawmill	HF4	Logged Only	19-Jan-16	10-Feb-16	1.6
2016	Sawmill	HF4	Few Pass	19-Jan-16	10-Feb-16	6.6
2016	Sawmill	HF4	Many Pass	19-Jan-16	10-Feb-16	6.1
2016	Sawmill	HF2	Control	4-Mar-16	20-Mar-16	0
2016	Sawmill	HF2	Low Slope Control	4-Mar-16	20-Mar-16	6.8
2016	Sawmill	HF2	Logged Only	4-Mar-16	20-Mar-16	170.1
2016	Sawmill	HF2	Few Pass	4-Mar-16	20-Mar-16	231.8
2016	Sawmill	HF2	Many Pass	4-Mar-16	20-Mar-16	198.2
2016	Sawmill	HF3	Control	4-Mar-16	20-Mar-16	11.6
2016	Sawmill	HF3	Low Slope Control	4-Mar-16	20-Mar-16	0
2016	Sawmill	HF3	Logged Only	4-Mar-16	20-Mar-16	8.9
2016	Sawmill	HF3	Few Pass	4-Mar-16	20-Mar-16	346
2016	Sawmill	HF3	Many Pass	4-Mar-16	20-Mar-16	11.1
2016	Sawmill	HF4	Control	4-Mar-16	20-Mar-16	5.4
2016	Sawmill	HF4	Low Slope Control	4-Mar-16	20-Mar-16	11.1
2016	Sawmill	HF4	Logged Only	4-Mar-16	20-Mar-16	0
2016	Sawmill	HF4	Few Pass	4-Mar-16	20-Mar-16	48.6
2016	Sawmill	HF4	Many Pass	4-Mar-16	20-Mar-16	15.4
2016	Lower Femmons	HF5	Control	13-Mar-16	29-Mar-16	153

2016	Lower Femmons	HF5	Logged Only	13-Mar-16	29-Mar-16	184.5
2016	Lower Femmons	HF5	Few Pass	13-Mar-16	29-Mar-16	1984.3
2016	Lower Femmons	HF5	Many Pass	13-Mar-16	29-Mar-16	5247.9
2016	Upper Femmons	HF6	Control	4-Mar-16	7-Apr-16	164.4
2016	Upper Femmons	HF6	Logged Only	4-Mar-16	7-Apr-16	768.9
2016	Upper Femmons	HF6	Few Pass	4-Mar-16	7-Apr-16	42.9
2016	Upper Femmons	HF6	Many Pass	4-Mar-16	7-Apr-16	4273.2
2016	Upper Femmons	HF7	Control	4-Mar-16	7-Apr-16	174.6
2016	Upper Femmons	HF7	Logged Only	4-Mar-16	7-Apr-16	26
2016	Upper Femmons	HF7	Few Pass	4-Mar-16	7-Apr-16	889.9
2016	Upper Femmons	HF7	Many Pass	4-Mar-16	7-Apr-16	5490.4
2016	Sawmill	HF2	Control	22-Apr-16	24-May-16	0
2016	Sawmill	HF2	Low Slope Control	22-Apr-16	24-May-16	0
2016	Sawmill	HF2	Logged Only	22-Apr-16	24-May-16	0
2016	Sawmill	HF2	Few Pass	22-Apr-16	24-May-16	0
2016	Sawmill	HF2	Many Pass	22-Apr-16	24-May-16	0
2016	Sawmill	HF3	Control	22-Apr-16	24-May-16	0
2016	Sawmill	HF3	Low Slope Control	22-Apr-16	24-May-16	0
2016	Sawmill	HF3	Logged Only	22-Apr-16	24-May-16	0
2016	Sawmill	HF3	Few Pass	22-Apr-16	24-May-16	110.3
2016	Sawmill	HF3	Many Pass	22-Apr-16	24-May-16	0
2016	Sawmill	HF4	Control	22-Apr-16	24-May-16	0
2016	Sawmill	HF4	Low Slope Control	22-Apr-16	24-May-16	0
2016	Sawmill	HF4	Logged Only	22-Apr-16	24-May-16	0
2016	Sawmill	HF4	Few Pass	22-Apr-16	24-May-16	0
2016	Sawmill	HF4	Many Pass	22-Apr-16	24-May-16	0
2016	Lower Femmons	HF5	Control	8-Apr-16	21-May-16	0
2016	Lower Femmons	HF5	Logged Only	8-Apr-16	21-May-16	0
2016	Lower Femmons	HF5	Few Pass	8-Apr-16	21-May-16	115.6

2016	Lower Femmons	HF5	Many Pass	8-Apr-16	21-May-16	789.2
2016	Upper Femmons	HF6	Control	22-Apr-16	21-May-16	4.2
2016	Upper Femmons	HF6	Control	22-Apr-16	21-May-16	15
2016	Upper Femmons	HF6	Few Pass	22-Apr-16	21-May-16	25.7
2016	Upper Femmons	HF6	Many Pass	22-Apr-16	21-May-16	155.6
2016	Upper Femmons	HF7	Logged Only	22-Apr-16	21-May-16	37.8
2016	Upper Femmons	HF7	Logged Only	22-Apr-16	21-May-16	0
2016	Upper Femmons	HF7	Few Pass	22-Apr-16	21-May-16	103.5
2016	Upper Femmons	HF7	Many Pass	22-Apr-16	21-May-16	920.9

Appendix 15: Subsoiled skid trail location, skid trail number, condition, skid trail slope, and erosion feature width and depth. Width and depth were measured at four locations: top and bottom of skid trail plus two equally spaced locations within the length of each subsoiled skid trail. Rills had width and depth up to 10 cm; gullies had at least one dimension greater than 10 cm

Site	Skid Trail Number	Condition	Slope (%)	Width (cm)	Depth (cm)
Sawmill	1	Gully	15	20	5
Sawmill	1	Gully	15	15	7
Sawmill	1	Gully	15	17	4
Sawmill	1	Gully	15	12	6
Sawmill	2	Gully	16	14	6
Sawmill	2	Gully	16	10	8
Sawmill	2	Rill	16	9	7
Sawmill	2	Gully	16	13	10
Sawmill	3	Gully	14	10	6
Sawmill	3	Rill	14	9	3
Sawmill	3	Gully	14	16	9
Sawmill	3	Gully	14	14	12
Sawmill	4	Unchanged	9	0	0
Sawmill	4	Unchanged	9	0	0
Sawmill	4	Unchanged	9	0	0
Sawmill	4	Unchanged	9	0	0
Sawmill	5	Unchanged	5	0	0
Sawmill	5	Unchanged	5	0	0
Sawmill	5	Unchanged	5	0	0
Sawmill	5	Unchanged	5	0	0
Sawmill	6	Unchanged	4	0	0
Sawmill	6	Unchanged	4	0	0
Sawmill	6	Unchanged	4	0	0
Sawmill	6	Unchanged	4	0	0
Sawmill	7	Unchanged	4	0	0
Sawmill	7	Unchanged	4	0	0
Sawmill	7	Unchanged	4	0	0
Sawmill	7	Unchanged	4	0	0
Sawmill	8	Unchanged	6	0	0
Sawmill	8	Unchanged	6	0	0
Sawmill	8	Unchanged	6	0	0
Sawmill	8	Unchanged	6	0	0

Sawmill	9	Unchanged	4	0	0
Sawmill	9	Unchanged	4	0	0
Sawmill	9	Unchanged	4	0	0
Sawmill	9	Unchanged	4	0	0
Sawmill	10	Gully	12	45	25
Sawmill	10	Gully	12	40	30
Sawmill	10	Gully	12	37	15
Sawmill	10	Gully	12	34	12
Sawmill	11	Unchanged	3	0	0
Sawmill	11	Unchanged	3	0	0
Sawmill	11	Unchanged	3	0	0
Sawmill	11	Unchanged	3	0	0
Sawmill	12	Gully	20	40	15
Sawmill	12	Gully	20	25	12
Sawmill	12	Gully	20	15	7
Sawmill	12	Gully	20	13	4
Sawmill	13	Unchanged	3	0	0
Sawmill	13	Unchanged	3	0	0
Sawmill	13	Unchanged	3	0	0
Sawmill	13	Unchanged	3	0	0
Sawmill	14	Unchanged	14	0	0
Sawmill	14	Unchanged	14	0	0
Sawmill	14	Unchanged	14	0	0
Sawmill	14	Unchanged	14	0	0
Sawmill	15	Unchanged	5	0	0
Sawmill	15	Unchanged	5	0	0
Sawmill	15	Unchanged	5	0	0
Sawmill	15	Unchanged	5	0	0
Sawmill	16	Unchanged	6	0	0
Sawmill	16	Unchanged	6	0	0
Sawmill	16	Unchanged	6	0	0
Sawmill	16	Unchanged	6	0	0
Sawmill	17	Gully	15	18	6
Sawmill	17	Gully	15	15	7
Sawmill	17	Rill	15	9	4
Sawmill	17	Gully	15	10	7
Sawmill	18	Gully	19	25	10
Sawmill	18	Gully	19	13	6
Sawmill	18	Gully	19	20	6

Sawmill	18	Gully	19	10	4
Sawmill	19	Unchanged	7	0	0
Sawmill	19	Unchanged	7	0	0
Sawmill	19	Unchanged	7	0	0
Sawmill	19	Unchanged	7	0	0
Sawmill	20	Unchanged	7	0	0
Sawmill	20	Unchanged	7	0	0
Sawmill	20	Unchanged	7	0	0
Sawmill	20	Unchanged	7	0	0
Sawmill	21	Gully	9	45	20
Sawmill	21	Gully	9	30	9
Sawmill	21	Gully	9	37	12
Sawmill	21	Gully	9	20	10
Sawmill	22	Unchanged	9	0	0
Sawmill	22	Unchanged	9	0	0
Sawmill	22	Unchanged	9	0	0
Sawmill	22	Unchanged	9	0	0
Sawmill	23	Gully	16	13	6
Sawmill	23	Rill	16	7	5
Sawmill	23	Rill	16	5	4
Sawmill	23	Rill	16	8	6
Sawmill	24	Gully	16	30	25
Sawmill	24	Gully	16	50	22
Sawmill	24	Gully	16	13	35
Sawmill	24	Gully	16	28	30
Sawmill	25	Gully	16	10	3
Sawmill	25	Rill	16	9	3
Sawmill	25	Rill	16	6	6
Sawmill	25	Rill	16	6	3
Sawmill	26	Gully	17	18	3
Sawmill	26	Gully	17	17	15
Sawmill	26	Gully	17	14	13
Sawmill	26	Gully	17	13	9
Sawmill	27	Unchanged	6	0	0
Sawmill	27	Unchanged	6	0	0
Sawmill	27	Unchanged	6	0	0
Sawmill	27	Unchanged	6	0	0
Sawmill	28	Gully	17	320	90
Sawmill	28	Gully	17	230	100

Sawmill	28	Gully	17	280	120
Sawmill	28	Gully	17	60	40
Sawmill	29	Gully	14	45	13
Sawmill	29	Gully	14	40	25
Sawmill	29	Gully	14	39	20
Sawmill	29	Gully	14	33	15
Sawmill	30	Gully	6	60	20
Sawmill	30	Gully	6	53	30
Sawmill	30	Gully	6	45	30
Sawmill	30	Gully	6	45	13
Sawmill	31	Gully	10	12	6
Sawmill	31	Gully	10	15	9
Sawmill	31	Rill	10	8	5
Sawmill	31	Gully	10	11	7
Sawmill	32	Unchanged	6	0	0
Sawmill	32	Unchanged	6	0	0
Sawmill	32	Unchanged	6	0	0
Sawmill	32	Unchanged	6	0	0
Sawmill	33	Gully	10	17	5
Sawmill	33	Gully	10	13	8
Sawmill	33	Gully	10	18	4
Sawmill	33	Rill	10	7	7
Sawmill	34	Unchanged	13	0	0
Sawmill	34	Unchanged	13	0	0
Sawmill	34	Unchanged	13	0	0
Sawmill	34	Unchanged	13	0	0
Sawmill	35	Gully	4	20	7
Sawmill	35	Gully	4	27	20
Sawmill	35	Gully	4	30	8
Sawmill	35	Gully	4	40	24
Sawmill	36	Unchanged	8	0	0
Sawmill	36	Unchanged	8	0	0
Sawmill	36	Unchanged	8	0	0
Sawmill	36	Unchanged	8	0	0
Sawmill	37	Unchanged	9	0	0
Sawmill	37	Unchanged	9	0	0
Sawmill	37	Unchanged	9	0	0
Sawmill	37	Unchanged	9	0	0
Sawmill	38	Unchanged	7	0	0

Sawmill	38	Unchanged	7	0	0
Sawmill	38	Unchanged	7	0	0
Sawmill	38	Unchanged	7	0	0
Sawmill	39	Unchanged	6	0	0
Sawmill	39	Unchanged	6	0	0
Sawmill	39	Unchanged	6	0	0
Sawmill	39	Unchanged	6	0	0
Triple-A	40	Unchanged	7	0	0
Triple-A	40	Unchanged	7	0	0
Triple-A	40	Unchanged	7	0	0
Triple-A	40	Unchanged	7	0	0
Triple-A	41	Unchanged	3	0	0
Triple-A	41	Unchanged	3	0	0
Triple-A	41	Unchanged	3	0	0
Triple-A	41	Unchanged	3	0	0
Triple-A	42	Rill	17	5	3
Triple-A	42	Gully	17	14	5
Triple-A	42	Gully	17	13	7
Triple-A	42	Gully	17	15	5
Triple-A	43	Gully	14	20	12
Triple-A	43	Gully	14	15	7
Triple-A	43	Gully	14	17	9
Triple-A	43	Gully	14	13	7
Triple-A	44	Gully	12	20	14
Triple-A	44	Gully	12	23	7
Triple-A	44	Gully	12	13	5
Triple-A	44	Rill	12	6	6
Triple-A	45	Gully	13	10	7
Triple-A	45	Gully	13	12	5
Triple-A	45	Gully	13	20	8
Triple-A	45	Gully	13	28	8
Triple-A	46	Gully	8	30	15
Triple-A	46	Rill	8	4	7
Triple-A	46	Gully	8	10	10
Triple-A	46	Gully	8	20	15
Triple-A	47	Unchanged	3	0	0
Triple-A	47	Unchanged	3	0	0
Triple-A	47	Unchanged	3	0	0
Triple-A	47	Unchanged	3	0	0

Triple-A	48	Unchanged	6	0	0
Triple-A	48	Unchanged	6	0	0
Triple-A	48	Unchanged	6	0	0
Triple-A	48	Unchanged	6	0	0
Triple-A	49	Gully	15	14	7
Triple-A	49	Gully	15	30	10
Triple-A	49	Gully	15	30	18
Triple-A	49	Gully	15	25	16
Upper Femmons	50	Gully	13	15	5
Upper Femmons	50	Gully	13	21	10
Upper Femmons	50	Gully	13	13	6
Upper Femmons	50	Rill	13	4	6
Upper Femmons	51	Unchanged	8	0	0
Upper Femmons	51	Unchanged	8	0	0
Upper Femmons	51	Unchanged	8	0	0
Upper Femmons	51	Unchanged	8	0	0
Upper Femmons	52	Unchanged	5	0	0
Upper Femmons	52	Unchanged	5	0	0
Upper Femmons	52	Unchanged	5	0	0
Upper Femmons	52	Unchanged	5	0	0
Upper Femmons	53	Unchanged	6	0	0
Upper Femmons	53	Unchanged	6	0	0
Upper Femmons	53	Unchanged	6	0	0
Upper Femmons	53	Unchanged	6	0	0

Appendix 16: Differences in LSMeans of log transformed bulk density at 0-5 cm depth between year and treatment combinations and associated p-values. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). E is abbreviation of the treatments in the unburned Evergreen site.

Year	Treatment	Year	Treatment	Estimate	P Value
2015	C	2016	C	0.01906	0.7565
2015	C	2016	EC	0.04278	0.6876
2015	C	2016	EFP	-0.1419	0.187
2015	C	2016	EMP	-0.3015	0.007
2015	C	2016	EMX	-0.1723	0.1112
2015	C	2016	EST	-0.1842	0.0892
2015	C	2015	FB	-0.1868	0.0329
2015	C	2016	FB	-0.04725	0.5796
2015	C	2015	FP	-0.1109	0.1174
2015	C	2016	FP	-0.1148	0.1053
2015	C	2015	L	0.08838	0.3093
2015	C	2016	L	-0.00206	0.981
2015	C	2015	LSC	-0.09926	0.3989
2015	C	2016	LSC	-0.1812	0.127
2015	C	2015	MP	-0.2243	0.0018
2015	C	2016	MP	-0.2223	0.002
2015	C	2015	MX	-0.2402	0.0095
2015	C	2016	MX	0.003744	0.9665
2016	C	2016	EC	0.02372	0.8211
2016	C	2016	EFP	-0.161	0.131
2016	C	2016	EMP	-0.3206	0.004
2016	C	2016	EMX	-0.1913	0.0745
2016	C	2016	EST	-0.2033	0.0588
2016	C	2015	FB	-0.2058	0.0173
2016	C	2016	FB	-0.06631	0.4285
2016	C	2015	FP	-0.1299	0.0604
2016	C	2016	FP	-0.1339	0.0533
2016	C	2015	L	0.06933	0.4153
2016	C	2016	L	-0.02112	0.8035
2016	C	2015	LSC	-0.1183	0.3104
2016	C	2016	LSC	-0.2002	0.0893
2016	C	2015	MP	-0.2434	0.0006
2016	C	2016	MP	-0.2414	0.0006
2016	C	2015	MX	-0.2592	0.0047

2016	C	2016	MX	-0.01531	0.8612
2016	EC	2016	EFP	-0.1847	0.1773
2016	EC	2016	EMP	-0.3443	0.0146
2016	EC	2016	EMX	-0.215	0.1178
2016	EC	2016	EST	-0.227	0.0994
2016	EC	2015	FB	-0.2296	0.0601
2016	EC	2016	FB	-0.09003	0.452
2016	EC	2015	FP	-0.1536	0.1635
2016	EC	2016	FP	-0.1576	0.1532
2016	EC	2015	L	0.0456	0.7048
2016	EC	2016	L	-0.04485	0.7094
2016	EC	2015	LSC	-0.142	0.3265
2016	EC	2016	LSC	-0.224	0.125
2016	EC	2015	MP	-0.2671	0.0168
2016	EC	2016	MP	-0.2651	0.0175
2016	EC	2015	MX	-0.283	0.0249
2016	EC	2016	MX	-0.03904	0.7495
2016	EFP	2016	EMP	-0.1596	0.2421
2016	EFP	2016	EMX	-0.03035	0.8224
2016	EFP	2016	EST	-0.04234	0.7543
2016	EFP	2015	FB	-0.04488	0.707
2016	EFP	2016	FB	0.09464	0.4294
2016	EFP	2015	FP	0.03105	0.7756
2016	EFP	2016	FP	0.0271	0.8035
2016	EFP	2015	L	0.2303	0.0606
2016	EFP	2016	L	0.1398	0.2485
2016	EFP	2015	LSC	0.04263	0.7672
2016	EFP	2016	LSC	-0.03928	0.785
2016	EFP	2015	MP	-0.08241	0.4447
2016	EFP	2016	MP	-0.08045	0.4555
2016	EFP	2015	MX	-0.09828	0.4231
2016	EFP	2016	MX	0.1456	0.2374
2016	EMP	2016	EMX	0.1293	0.3419
2016	EMP	2016	EST	0.1173	0.388
2016	EMP	2015	FB	0.1147	0.339
2016	EMP	2016	FB	0.2543	0.0382
2016	EMP	2015	FP	0.1907	0.0858
2016	EMP	2016	FP	0.1867	0.0923
2016	EMP	2015	L	0.3899	0.0022
2016	EMP	2016	L	0.2995	0.0161

2016	EMP	2015	LSC	0.2023	0.1648
2016	EMP	2016	LSC	0.1203	0.405
2016	EMP	2015	MP	0.07722	0.4737
2016	EMP	2016	MP	0.07917	0.4627
2016	EMP	2015	MX	0.06135	0.6161
2016	EMP	2016	MX	0.3053	0.016
2016	EMX	2016	EST	-0.01199	0.9293
2016	EMX	2015	FB	-0.01453	0.9031
2016	EMX	2016	FB	0.125	0.2981
2016	EMX	2015	FP	0.0614	0.5735
2016	EMX	2016	FP	0.05745	0.5983
2016	EMX	2015	L	0.2606	0.0347
2016	EMX	2016	L	0.1702	0.1617
2016	EMX	2015	LSC	0.07299	0.6126
2016	EMX	2016	LSC	-0.00892	0.9506
2016	EMX	2015	MP	-0.05205	0.6285
2016	EMX	2016	MP	-0.0501	0.6414
2016	EMX	2015	MX	-0.06792	0.579
2016	EMX	2016	MX	0.176	0.155
2016	EST	2015	FB	-0.00254	0.983
2016	EST	2016	FB	0.137	0.2548
2016	EST	2015	FP	0.07339	0.5014
2016	EST	2016	FP	0.06944	0.5246
2016	EST	2015	L	0.2726	0.0275
2016	EST	2016	L	0.1822	0.1348
2016	EST	2015	LSC	0.08497	0.5557
2016	EST	2016	LSC	0.003063	0.983
2016	EST	2015	MP	-0.04007	0.7094
2016	EST	2016	MP	-0.03811	0.7229
2016	EST	2015	MX	-0.05594	0.6475
2016	EST	2016	MX	0.188	0.1294
2015	FB	2016	FB	0.1395	0.1517
2015	FB	2015	FP	0.07593	0.3921
2015	FB	2016	FP	0.07198	0.417
2015	FB	2015	L	0.2752	0.0092
2015	FB	2016	L	0.1847	0.0749
2015	FB	2015	LSC	0.08752	0.499
2015	FB	2016	LSC	0.005607	0.9654
2015	FB	2015	MP	-0.03752	0.6651
2015	FB	2016	MP	-0.03557	0.6816

2015	FB	2015	MX	-0.05339	0.6094
2015	FB	2016	MX	0.1905	0.073
2016	FB	2015	FP	-0.0636	0.4728
2016	FB	2016	FP	-0.06755	0.446
2016	FB	2015	L	0.1356	0.1877
2016	FB	2016	L	0.04519	0.6583
2016	FB	2015	LSC	-0.05201	0.6873
2016	FB	2016	LSC	-0.1339	0.3025
2016	FB	2015	MP	-0.177	0.0458
2016	FB	2016	MP	-0.1751	0.0482
2016	FB	2015	MX	-0.1929	0.0695
2016	FB	2016	MX	0.051	0.6254
2015	FP	2016	FP	-0.00395	0.9552
2015	FP	2015	L	0.1992	0.0297
2015	FP	2016	L	0.1088	0.2281
2015	FP	2015	LSC	0.01159	0.9228
2015	FP	2016	LSC	-0.07032	0.5571
2015	FP	2015	MP	-0.1135	0.1178
2015	FP	2016	MP	-0.1115	0.124
2015	FP	2015	MX	-0.1293	0.1652
2015	FP	2016	MX	0.1146	0.2178
2016	FP	2015	L	0.2032	0.0267
2016	FP	2016	L	0.1127	0.2119
2016	FP	2015	LSC	0.01554	0.8966
2016	FP	2016	LSC	-0.06637	0.5793
2016	FP	2015	MP	-0.1095	0.1307
2016	FP	2016	MP	-0.1075	0.1376
2016	FP	2015	MX	-0.1254	0.1782
2016	FP	2016	MX	0.1185	0.2026
2015	L	2016	L	-0.09045	0.3457
2015	L	2015	LSC	-0.1876	0.1531
2015	L	2016	LSC	-0.2696	0.0422
2015	L	2015	MP	-0.3127	0.0007
2015	L	2016	MP	-0.3107	0.0008
2015	L	2015	MX	-0.3286	0.0028
2015	L	2016	MX	-0.08464	0.4236
2016	L	2015	LSC	-0.0972	0.456
2016	L	2016	LSC	-0.1791	0.1723
2016	L	2015	MP	-0.2222	0.014
2016	L	2016	MP	-0.2203	0.0148

2016	L	2015	MX	-0.2381	0.0274
2016	L	2016	MX	0.005809	0.9561
2015	LSC	2016	LSC	-0.08191	0.5713
2015	LSC	2015	MP	-0.125	0.2932
2015	LSC	2016	MP	-0.1231	0.3007
2015	LSC	2015	MX	-0.1409	0.2879
2015	LSC	2016	MX	0.103	0.436
2016	LSC	2015	MP	-0.04313	0.7155
2016	LSC	2016	MP	-0.04117	0.7278
2016	LSC	2015	MX	-0.059	0.6548
2016	LSC	2016	MX	0.1849	0.165
2015	MP	2016	MP	0.001956	0.9766
2015	MP	2015	MX	-0.01587	0.8609
2015	MP	2016	MX	0.228	0.0148
2016	MP	2015	MX	-0.01783	0.8439
2016	MP	2016	MX	0.2261	0.0157
2015	MX	2016	MX	0.2439	0.019

Appendix 17: Differences in LSMeans of log transformed bulk density at 5-10 cm depth between year and treatment combinations and associated p-values. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). E is abbreviation of the treatments in the unburned Evergreen site.

Year	Treatment	Year	Treatment	Estimate	P Value
2015	C	2016	C	0.03521	0.5451
2015	C	2016	EC	0.1528	0.1377
2015	C	2016	EFP	-0.08217	0.4197
2015	C	2016	EMP	-0.2164	0.0384
2015	C	2016	EMX	-0.06359	0.5316
2015	C	2016	EST	-0.09136	0.3701
2015	C	2015	FB	-0.1382	0.0822
2015	C	2016	FB	-0.05191	0.5225
2015	C	2015	FP	-0.07723	0.2482
2015	C	2016	FP	-0.04417	0.5067
2015	C	2015	L	0.07963	0.3325
2015	C	2016	L	0.03438	0.6746
2015	C	2015	LSC	-0.03626	0.7446
2015	C	2016	LSC	-0.1829	0.1052
2015	C	2015	MP	-0.2854	<.0001
2015	C	2016	MP	-0.1144	0.081
2015	C	2015	MX	-0.2159	0.0138
2015	C	2016	MX	0.03296	0.6973
2016	C	2016	EC	0.1176	0.2445
2016	C	2016	EFP	-0.1174	0.2455
2016	C	2016	EMP	-0.2516	0.0159
2016	C	2016	EMX	-0.0988	0.327
2016	C	2016	EST	-0.1266	0.2112
2016	C	2015	FB	-0.1734	0.0278
2016	C	2016	FB	-0.08712	0.276
2016	C	2015	FP	-0.1124	0.0865
2016	C	2016	FP	-0.07938	0.222
2016	C	2015	L	0.04442	0.5804
2016	C	2016	L	-0.00083	0.9917
2016	C	2015	LSC	-0.07147	0.5172
2016	C	2016	LSC	-0.2181	0.0525
2016	C	2015	MP	-0.3206	<.0001
2016	C	2016	MP	-0.1496	0.0205

2016	C	2015	MX	-0.2511	0.004
2016	C	2016	MX	-0.00225	0.9784
2016	EC	2016	EFP	-0.235	0.0749
2016	EC	2016	EMP	-0.3692	0.0066
2016	EC	2016	EMX	-0.2164	0.0998
2016	EC	2016	EST	-0.2442	0.0647
2016	EC	2015	FB	-0.2911	0.0125
2016	EC	2016	FB	-0.2048	0.0776
2016	EC	2015	FP	-0.2301	0.0316
2016	EC	2016	FP	-0.197	0.0636
2016	EC	2015	L	-0.07321	0.5226
2016	EC	2016	L	-0.1185	0.3028
2016	EC	2015	LSC	-0.1891	0.172
2016	EC	2016	LSC	-0.3357	0.0178
2016	EC	2015	MP	-0.4382	0.0001
2016	EC	2016	MP	-0.2672	0.0125
2016	EC	2015	MX	-0.3688	0.0028
2016	EC	2016	MX	-0.1199	0.306
2016	EFP	2016	EMP	-0.1342	0.3017
2016	EFP	2016	EMX	0.01859	0.8854
2016	EFP	2016	EST	-0.00919	0.9432
2016	EFP	2015	FB	-0.05603	0.616
2016	EFP	2016	FB	0.03026	0.7901
2016	EFP	2015	FP	0.004942	0.962
2016	EFP	2016	FP	0.038	0.7144
2016	EFP	2015	L	0.1618	0.1615
2016	EFP	2016	L	0.1166	0.3105
2016	EFP	2015	LSC	0.04592	0.7374
2016	EFP	2016	LSC	-0.1007	0.4633
2016	EFP	2015	MP	-0.2032	0.0532
2016	EFP	2016	MP	-0.03219	0.7535
2016	EFP	2015	MX	-0.1338	0.2541
2016	EFP	2016	MX	0.1151	0.3252
2016	EMX	2016	EMX	0.1528	0.2407
2016	EMX	2016	EST	0.125	0.3356
2016	EMX	2015	FB	0.07819	0.4848
2016	EMX	2016	FB	0.1645	0.1534
2016	EMX	2015	FP	0.1392	0.185
2016	EMX	2016	FP	0.1722	0.103
2016	EMX	2015	L	0.296	0.0125

2016	EMX	2016	L	0.2508	0.0326
2016	EMX	2015	LSC	0.1801	0.1927
2016	EMX	2016	LSC	0.0335	0.8067
2016	EMX	2015	MP	-0.06899	0.5019
2016	EMX	2016	MP	0.102	0.3225
2016	EMX	2015	MX	0.000463	0.9968
2016	EMX	2016	MX	0.2494	0.0371
2016	EMX	2016	EST	-0.02778	0.8295
2016	EMX	2015	FB	-0.07462	0.5048
2016	EMX	2016	FB	0.01168	0.9182
2016	EMX	2015	FP	-0.01365	0.8954
2016	EMX	2016	FP	0.01942	0.8516
2016	EMX	2015	L	0.1432	0.2141
2016	EMX	2016	L	0.09796	0.3932
2016	EMX	2015	LSC	0.02733	0.8418
2016	EMX	2016	LSC	-0.1193	0.3856
2016	EMX	2015	MP	-0.2218	0.0357
2016	EMX	2016	MP	-0.05078	0.6207
2016	EMX	2015	MX	-0.1523	0.1951
2016	EMX	2016	MX	0.09655	0.4086
2016	EST	2015	FB	-0.04684	0.6749
2016	EST	2016	FB	0.03945	0.7287
2016	EST	2015	FP	0.01413	0.8917
2016	EST	2016	FP	0.04719	0.6496
2016	EST	2015	L	0.171	0.1395
2016	EST	2016	L	0.1257	0.2744
2016	EST	2015	LSC	0.05511	0.6875
2016	EST	2016	LSC	-0.09153	0.5048
2016	EST	2015	MP	-0.194	0.0644
2016	EST	2016	MP	-0.023	0.8224
2016	EST	2015	MX	-0.1246	0.2877
2016	EST	2016	MX	0.1243	0.2886
2015	FB	2016	FB	0.0863	0.3324
2015	FB	2015	FP	0.06097	0.4533
2015	FB	2016	FP	0.09404	0.2497
2015	FB	2015	L	0.2178	0.0241
2015	FB	2016	L	0.1726	0.0713
2015	FB	2015	LSC	0.102	0.3997
2015	FB	2016	LSC	-0.04469	0.7111
2015	FB	2015	MP	-0.1472	0.0693

2015	FB	2016	MP	0.02384	0.7639
2015	FB	2015	MX	-0.07773	0.4228
2015	FB	2016	MX	0.1712	0.0818
2016	FB	2015	FP	-0.02532	0.7629
2016	FB	2016	FP	0.007739	0.9265
2016	FB	2015	L	0.1315	0.1772
2016	FB	2016	L	0.08629	0.3736
2016	FB	2015	LSC	0.01565	0.8983
2016	FB	2016	LSC	-0.131	0.2881
2016	FB	2015	MP	-0.2335	0.0066
2016	FB	2016	MP	-0.06246	0.4494
2016	FB	2015	MX	-0.164	0.1028
2016	FB	2016	MX	0.08487	0.3934
2015	FP	2016	FP	0.03306	0.6162
2015	FP	2015	L	0.1569	0.0683
2015	FP	2016	L	0.1116	0.1912
2015	FP	2015	LSC	0.04098	0.718
2015	FP	2016	LSC	-0.1057	0.3537
2015	FP	2015	MP	-0.2082	0.0036
2015	FP	2016	MP	-0.03713	0.5854
2015	FP	2015	MX	-0.1387	0.1178
2015	FP	2016	MX	0.1102	0.2118
2016	FP	2015	L	0.1238	0.1479
2016	FP	2016	L	0.07855	0.3558
2016	FP	2015	LSC	0.007915	0.9444
2016	FP	2016	LSC	-0.1387	0.2249
2016	FP	2015	MP	-0.2412	0.0009
2016	FP	2016	MP	-0.07019	0.3046
2016	FP	2015	MX	-0.1718	0.0544
2016	FP	2016	MX	0.07713	0.38
2015	L	2016	L	-0.04525	0.6102
2015	L	2015	LSC	-0.1159	0.3485
2015	L	2016	LSC	-0.2625	0.0369
2015	L	2015	MP	-0.365	<.0001
2015	L	2016	MP	-0.194	0.0228
2015	L	2015	MX	-0.2956	0.0044
2015	L	2016	MX	-0.04667	0.6402
2016	L	2015	LSC	-0.07063	0.5667
2016	L	2016	LSC	-0.2173	0.0821
2016	L	2015	MP	-0.3198	0.0003

2016	L	2016	MP	-0.1487	0.0778
2016	L	2015	MX	-0.2503	0.0147
2016	L	2016	MX	-0.00142	0.9887
2015	LSC	2016	LSC	-0.1466	0.2803
2015	LSC	2015	MP	-0.2491	0.0305
2015	LSC	2016	MP	-0.07811	0.4875
2015	LSC	2015	MX	-0.1797	0.1551
2015	LSC	2016	MX	0.06922	0.5804
2016	LSC	2015	MP	-0.1025	0.3632
2016	LSC	2016	MP	0.06853	0.5422
2016	LSC	2015	MX	-0.03304	0.7916
2016	LSC	2016	MX	0.2159	0.0892
2015	MP	2016	MP	0.171	0.0078
2015	MP	2015	MX	0.06945	0.4207
2015	MP	2016	MX	0.3184	0.0005
2016	MP	2015	MX	-0.1016	0.2409
2016	MP	2016	MX	0.1473	0.0916
2015	MX	2016	MX	0.2489	0.0108

Appendix 18: Differences in LSMeans of the log transformed WDPT at the surface level between combinations of year and treatment and associated p-values. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). E is abbreviation of the treatments in the unburned Evergreen site.

Year	Treatment	Year	Treatment	Estimate	P Value
2016	EFP	2016	EMP	1.1653	<.0001
2016	EFP	2016	EMX	-0.08383	0.5796
2016	EFP	2016	EST	0.1005	0.5068
2016	EFP	2015	LSC	2.1419	<.0001
2016	EFP	2016	LSC	1.7732	<.0001
2016	EFP	2016	EC	-0.0502	0.7398
2016	EFP	2015	FP	2.2247	<.0001
2016	EFP	2016	FB	1.8998	<.0001
2016	EFP	2015	FP	2.1615	<.0001
2016	EFP	2016	FP	1.9563	<.0001
2016	EFP	2015	MP	2.2146	<.0001
2016	EFP	2016	MP	1.952	<.0001
2016	EFP	2015	MX	2.1873	<.0001
2016	EFP	2016	MX	1.9805	<.0001
2016	EFP	2015	C	2.1979	<.0001
2016	EFP	2016	C	1.8239	<.0001
2016	EFP	2015	L	2.2392	<.0001
2016	EFP	2016	L	1.7374	<.0001
2016	EMP	2016	EMX	-1.2491	<.0001
2016	EMP	2016	EST	-1.0648	<.0001
2016	EMP	2015	LSC	0.9766	<.0001
2016	EMP	2016	LSC	0.6079	0.0005
2016	EMP	2016	EC	-1.2155	<.0001
2016	EMP	2015	FB	1.0595	<.0001
2016	EMP	2016	FB	0.7346	<.0001
2016	EMP	2015	FP	0.9963	<.0001
2016	EMP	2016	FP	0.7911	<.0001
2016	EMP	2015	MP	1.0493	<.0001
2016	EMP	2016	MP	0.7867	<.0001
2016	EMP	2015	MX	1.022	<.0001
2016	EMP	2016	MX	0.8152	<.0001
2016	EMP	2015	C	1.0326	<.0001
2016	EMP	2016	C	0.6587	<.0001
2016	EMP	2015	L	1.0739	<.0001

2016	EMP	2016	L	0.5722	0.0001
2016	EMX	2016	EST	0.1843	0.2258
2016	EMX	2015	LSC	2.2257	<.0001
2016	EMX	2016	LSC	1.857	<.0001
2016	EMX	2016	EC	0.03362	0.8239
2016	EMX	2015	FB	2.3086	<.0001
2016	EMX	2016	FB	1.9837	<.0001
2016	EMX	2015	FP	2.2454	<.0001
2016	EMX	2016	FP	2.0401	<.0001
2016	EMX	2015	MP	2.2984	<.0001
2016	EMX	2016	MP	2.0358	<.0001
2016	EMX	2015	MX	2.2711	<.0001
2016	EMX	2016	MX	2.0643	<.0001
2016	EMX	2015	C	2.2817	<.0001
2016	EMX	2016	C	1.9078	<.0001
2016	EMX	2015	L	2.323	<.0001
2016	EMX	2016	L	1.8213	<.0001
2016	EST	2015	LSC	2.0414	<.0001
2016	EST	2016	LSC	1.6727	<.0001
2016	EST	2016	EC	-0.1507	0.3209
2016	EST	2015	FB	2.1242	<.0001
2016	EST	2016	FB	1.7993	<.0001
2016	EST	2015	FP	2.061	<.0001
2016	EST	2016	FP	1.8558	<.0001
2016	EST	2015	MP	2.1141	<.0001
2016	EST	2016	MP	1.8515	<.0001
2016	EST	2015	MX	2.0867	<.0001
2016	EST	2016	MX	1.88	<.0001
2016	EST	2015	C	2.0973	<.0001
2016	EST	2016	C	1.7234	<.0001
2016	EST	2015	L	2.1387	<.0001
2016	EST	2016	L	1.6369	<.0001
2015	LSC	2016	LSC	-0.3687	0.0436
2015	LSC	2016	EC	-2.1921	<.0001
2015	LSC	2015	FB	0.08284	0.5703
2015	LSC	2016	FB	-0.2421	0.0969
2015	LSC	2015	FP	0.01965	0.8927
2015	LSC	2016	FP	-0.1856	0.1773
2015	LSC	2015	MP	0.07271	0.605
2015	LSC	2016	MP	-0.1899	0.1675

2015	LSC	2015	MX	0.04538	0.7603
2015	LSC	2016	MX	-0.1614	0.2729
2015	LSC	2015	C	0.05597	0.6747
2015	LSC	2016	C	-0.318	0.0202
2015	LSC	2015	L	0.09729	0.5815
2015	LSC	2016	L	-0.4044	0.0106
2016	LSC	2016	EC	-1.8234	<.0001
2016	LSC	2015	FB	0.4515	0.003
2016	LSC	2016	FB	0.1266	0.3807
2016	LSC	2015	FP	0.3883	0.0099
2016	LSC	2016	FP	0.1831	0.1829
2016	LSC	2015	MP	0.4414	0.0026
2016	LSC	2016	MP	0.1788	0.1933
2016	LSC	2015	MX	0.4141	0.0072
2016	LSC	2016	MX	0.2073	0.1606
2016	LSC	2015	C	0.4247	0.0023
2016	LSC	2016	C	0.05074	0.7038
2016	LSC	2015	L	0.466	0.0104
2016	LSC	2016	L	-0.03574	0.8162
2016	EC	2015	FB	2.2749	<.0001
2016	EC	2016	FB	1.95	<.0001
2016	EC	2015	FP	2.2117	<.0001
2016	EC	2016	FP	2.0065	<.0001
2016	EC	2015	MP	2.2648	<.0001
2016	EC	2016	MP	2.0022	<.0001
2016	EC	2015	MX	2.2375	<.0001
2016	EC	2016	MX	2.0307	<.0001
2016	EC	2015	C	2.2481	<.0001
2016	EC	2016	C	1.8741	<.0001
2016	EC	2015	L	2.2894	<.0001
2016	EC	2016	L	1.7877	<.0001
2015	FB	2016	FB	-0.3249	0.0031
2015	FB	2015	FP	-0.06319	0.5548
2015	FB	2016	FP	-0.2684	0.0059
2015	FB	2015	MP	-0.01014	0.9188
2015	FB	2016	MP	-0.2727	0.0052
2015	FB	2015	MX	-0.03747	0.7354
2015	FB	2016	MX	-0.2442	0.0268
2015	FB	2015	C	-0.02687	0.7629
2015	FB	2016	C	-0.4008	<.0001

2015	FB	2015	L	0.01445	0.921
2015	FB	2016	L	-0.4873	0.0001
2016	FB	2015	FP	0.2617	0.0149
2016	FB	2016	FP	0.05649	0.5346
2016	FB	2015	MP	0.3148	0.0019
2016	FB	2016	MP	0.05216	0.5663
2016	FB	2015	MX	0.2874	0.0103
2016	FB	2016	MX	0.08065	0.4449
2016	FB	2015	C	0.298	0.001
2016	FB	2016	C	-0.0759	0.3807
2016	FB	2015	L	0.3393	0.0215
2016	FB	2016	L	-0.1624	0.1624
2015	FP	2016	FP	-0.2052	0.0337
2015	FP	2015	MP	0.05305	0.5939
2015	FP	2016	MP	-0.2095	0.029
2015	FP	2015	MX	0.02573	0.8165
2015	FP	2016	MX	-0.1811	0.0972
2015	FP	2015	C	0.03632	0.6836
2015	FP	2016	C	-0.3376	0.0004
2015	FP	2015	L	0.07764	0.5947
2015	FP	2016	L	-0.4241	0.0006
2016	MP	2015	MP	0.2583	0.0036
2016	FP	2016	MP	-0.00434	0.9558
2016	FP	2015	MX	0.2309	0.0219
2016	FP	2016	MX	0.02416	0.7985
2016	FP	2015	C	0.2415	0.0016
2016	FP	2016	C	-0.1324	0.074
2016	FP	2015	L	0.2829	0.042
2016	FP	2016	L	-0.2189	0.0416
2015	MP	2016	MP	-0.2626	0.0034
2015	MP	2015	MX	-0.02733	0.7921
2015	MP	2016	MX	-0.2341	0.0228
2015	MP	2015	C	-0.01673	0.8343
2015	MP	2016	C	-0.3907	<.0001
2015	MP	2015	L	0.02459	0.861
2015	MP	2016	L	-0.4771	<.0001
2016	MX	2015	MX	0.2353	0.0197
2016	MP	2016	MX	0.02849	0.7634
2016	MP	2015	C	0.2459	0.0014
2016	MP	2016	C	-0.1281	0.0836

2016	MP	2015	L	0.2872	0.039
2016	MP	2016	L	-0.2145	0.0457
2015	MX	2016	MX	-0.2068	0.0722
2015	MX	2015	C	0.0106	0.9101
2015	MX	2016	C	-0.3633	0.0003
2015	MX	2015	L	0.05191	0.7271
2015	MX	2016	L	-0.4498	0.0004
2016	MX	2015	C	0.2174	0.0188
2016	MX	2016	C	-0.1566	0.0872
2016	MX	2015	L	0.2587	0.0814
2016	MX	2016	L	-0.243	0.0433
2015	C	2016	C	-0.3739	<.0001
2015	C	2015	L	0.04132	0.7566
2015	C	2016	L	-0.4604	<.0001
2016	C	2015	L	0.4152	0.0029
2016	C	2016	L	-0.08648	0.397
2015	L	2016	L	-0.5017	0.0019

Appendix 19: Differences in LSMeans of the log transformed WDPT at the 1 cm depth between combinations of year and treatment and associated p-values. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). E is abbreviation of the treatments in the unburned Evergreen site.

Year	Treatment	Year	Treatment	Estimate	P Value
2016	EFP	2016	EMP	0.009302	0.9829
2016	EFP	2016	EMX	-0.2938	0.499
2016	EFP	2016	EST	-0.2476	0.5684
2016	EFP	2015	LSC	0.9615	0.0447
2016	EFP	2016	LSC	1.2665	0.0092
2016	EFP	2016	EC	-0.3256	0.4539
2016	EFP	2015	FB	1.4862	0.0003
2016	EFP	2016	FB	1.7034	<.0001
2016	EFP	2015	FP	1.2488	0.0017
2016	EFP	2016	FP	1.6898	<.0001
2016	EFP	2015	MP	1.8421	<.0001
2016	EFP	2016	MP	1.7368	<.0001
2016	EFP	2015	MX	1.2063	0.0029
2016	EFP	2016	MX	1.3592	0.0007
2016	EFP	2015	C	0.9945	0.0048
2016	EFP	2016	C	1.1434	0.0014
2016	EFP	2015	L	1.837	0.0003
2016	EFP	2016	L	1.2312	0.0029
2016	EMP	2016	EMX	-0.3031	0.4855
2016	EMP	2016	EST	-0.2569	0.554
2016	EMP	2015	LSC	0.9522	0.0467
2016	EMP	2016	LSC	1.2572	0.0097
2016	EMP	2016	EC	-0.3349	0.4412
2016	EMP	2015	FB	1.4769	0.0003
2016	EMP	2016	FB	1.6941	<.0001
2016	EMP	2015	FP	1.2394	0.0019
2016	EMP	2016	FP	1.6805	<.0001
2016	EMP	2015	MP	1.8328	<.0001
2016	EMP	2016	MP	1.7275	<.0001
2016	EMP	2015	MX	1.197	0.0031
2016	EMP	2016	MX	1.3499	0.0007
2016	EMP	2015	C	0.9852	0.0052
2016	EMP	2016	C	1.1341	0.0015

2016	EMP	2015	L	1.8276	0.0003
2016	EMP	2016	L	1.2219	0.0031
2016	EMX	2016	EST	0.04613	0.9152
2016	EMX	2015	LSC	1.2552	0.0098
2016	EMX	2016	LSC	1.5603	0.0016
2016	EMX	2016	EC	-0.03183	0.9414
2016	EMX	2015	FB	1.78	<.0001
2016	EMX	2016	FB	1.9972	<.0001
2016	EMX	2015	FP	1.5425	0.0002
2016	EMX	2016	FP	1.9836	<.0001
2016	EMX	2015	MP	2.1358	<.0001
2016	EMX	2016	MP	2.0306	<.0001
2016	EMX	2015	MX	1.5001	0.0003
2016	EMX	2016	MX	1.653	<.0001
2016	EMX	2015	C	1.2883	0.0004
2016	EMX	2016	C	1.4371	<.0001
2016	EMX	2015	L	2.1307	<.0001
2016	EMX	2016	L	1.525	0.0003
2016	EST	2015	LSC	1.2091	0.0126
2016	EST	2016	LSC	1.5141	0.0022
2016	EST	2016	EC	-0.07797	0.8572
2016	EST	2015	FB	1.7338	<.0001
2016	EST	2016	FB	1.951	<.0001
2016	EST	2015	FP	1.4964	0.0002
2016	EST	2016	FP	1.9374	<.0001
2016	EST	2015	MP	2.0897	<.0001
2016	EST	2016	MP	1.9844	<.0001
2016	EST	2015	MX	1.454	0.0004
2016	EST	2016	MX	1.6069	<.0001
2016	EST	2015	C	1.2422	0.0006
2016	EST	2016	C	1.391	0.0002
2016	EST	2015	L	2.0846	<.0001
2016	EST	2016	L	1.4788	0.0004
2015	LSC	2016	LSC	0.3051	0.5436
2015	LSC	2016	EC	-1.2871	0.0082
2015	LSC	2015	FB	0.5248	0.2105
2015	LSC	2016	FB	0.7419	0.0745
2015	LSC	2015	FP	0.2873	0.4904
2015	LSC	2016	FP	0.7283	0.0652
2015	LSC	2015	MP	0.8806	0.0316

2015	LSC	2016	MP	0.7753	0.0503
2015	LSC	2015	MX	0.2449	0.5638
2015	LSC	2016	MX	0.3978	0.3405
2015	LSC	2015	C	0.03307	0.9307
2015	LSC	2016	C	0.1819	0.6325
2015	LSC	2015	L	0.8755	0.0854
2015	LSC	2016	L	0.2697	0.5344
2016	LSC	2016	EC	-1.5921	0.0013
2016	LSC	2015	FB	0.2197	0.5975
2016	LSC	2016	FB	0.4369	0.2884
2016	LSC	2015	FP	-0.01777	0.9659
2016	LSC	2016	FP	0.4233	0.2783
2016	LSC	2015	MP	0.5755	0.1543
2016	LSC	2016	MP	0.4703	0.2291
2016	LSC	2015	MX	-0.06019	0.887
2016	LSC	2016	MX	0.09272	0.8234
2016	LSC	2015	C	-0.272	0.4753
2016	LSC	2016	C	-0.1231	0.746
2016	LSC	2015	L	0.5704	0.2582
2016	LSC	2016	L	-0.03532	0.935
2016	EC	2015	FB	1.8118	<.0001
2016	EC	2016	FB	2.029	<.0001
2016	EC	2015	FP	1.5744	0.0001
2016	EC	2016	FP	2.0154	<.0001
2016	EC	2015	MP	2.1677	<.0001
2016	EC	2016	MP	2.0624	<.0001
2016	EC	2015	MX	1.5319	0.0002
2016	EC	2016	MX	1.6848	<.0001
2016	EC	2015	C	1.3201	0.0003
2016	EC	2016	C	1.469	<.0001
2016	EC	2015	L	2.1626	<.0001
2016	EC	2016	L	1.5568	0.0002
2015	FB	2016	FB	0.2172	0.4683
2015	FB	2015	FP	-0.2375	0.4411
2015	FB	2016	FP	0.2036	0.4503
2015	FB	2015	MP	0.3559	0.2166
2015	FB	2016	MP	0.2506	0.3537
2015	FB	2015	MX	-0.2799	0.3807
2015	FB	2016	MX	-0.127	0.6794
2015	FB	2015	C	-0.4917	0.0612

2015	FB	2016	C	-0.3428	0.1867
2015	FB	2015	L	0.3507	0.4007
2015	FB	2016	L	-0.255	0.4421
2016	FB	2015	FP	-0.4547	0.1325
2016	FB	2016	FP	-0.0136	0.9581
2016	FB	2015	MP	0.1387	0.6159
2016	FB	2016	MP	0.03339	0.8974
2016	FB	2015	MX	-0.4971	0.1131
2016	FB	2016	MX	-0.3442	0.2516
2016	FB	2015	C	-0.7089	0.0059
2016	FB	2016	C	-0.56	0.027
2016	FB	2015	L	0.1335	0.7444
2016	FB	2016	L	-0.4722	0.1472
2015	FP	2016	FP	0.4411	0.1058
2015	FP	2015	MP	0.5933	0.0425
2015	FP	2016	MP	0.488	0.0749
2015	FP	2015	MX	-0.04243	0.8938
2015	FP	2016	MX	0.1105	0.7191
2015	FP	2015	C	-0.2542	0.3255
2015	FP	2016	C	-0.1054	0.6821
2015	FP	2015	L	0.5882	0.1615
2015	FP	2016	L	-0.01756	0.9577
2016	FP	2015	MP	0.1523	0.533
2016	FP	2016	MP	0.04699	0.8339
2016	FP	2015	MX	-0.4835	0.0905
2016	FP	2016	MX	-0.3306	0.222
2016	FP	2015	C	-0.6953	0.0018
2016	FP	2016	C	-0.5464	0.0121
2016	FP	2015	L	0.1471	0.7049
2016	FP	2016	L	-0.4586	0.1246
2015	MP	2016	MP	-0.1053	0.6665
2015	MP	2015	MX	-0.6357	0.0367
2015	MP	2016	MX	-0.4828	0.0952
2015	MP	2015	C	-0.8475	0.0006
2015	MP	2016	C	-0.6987	0.004
2015	MP	2015	L	-0.00511	0.9898
2015	MP	2016	L	-0.6109	0.0532
2016	MP	2015	MX	-0.5305	0.0642
2016	MP	2016	MX	-0.3776	0.1641
2016	MP	2015	C	-0.7423	0.001

2016	MP	2016	C	-0.5934	0.0068
2016	MP	2015	L	0.1002	0.7965
2016	MP	2016	L	-0.5056	0.0912
2015	MX	2016	MX	0.1529	0.6309
2015	MX	2015	C	-0.2118	0.4339
2015	MX	2016	C	-0.06295	0.8155
2015	MX	2015	L	0.6306	0.1412
2015	MX	2016	L	0.02487	0.9418
2016	MX	2015	C	-0.3647	0.1599
2016	MX	2016	C	-0.2159	0.4022
2016	MX	2015	L	0.4777	0.2535
2016	MX	2016	L	-0.128	0.6988
2015	L	2016	C	0.1488	0.4457
2015	C	2015	L	0.8424	0.0307
2015	C	2016	L	0.2367	0.4075
2016	C	2015	L	0.6936	0.0729
2016	C	2016	L	0.08782	0.7579
2015	L	2016	L	-0.6058	0.1654

Appendix 20: Differences in LSMeans of the log transformed WDPT at the 3 cm depth between combinations of year and treatment and associated p-values. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). E is abbreviation of the treatments in the unburned Evergreen site.

Year	Treatment	Year	Treatment	Estimate	P Value
2016	EFP	2016	EMP	0.1369	0.8143
2016	EFP	2016	EMX	-0.3437	0.5564
2016	EFP	2016	EST	0.8814	0.1372
2016	EFP	2015	LSC	1.4377	0.0251
2016	EFP	2016	LSC	1.6465	0.0111
2016	EFP	2016	EC	0.02497	0.9658
2016	EFP	2015	FB	1.4899	0.0054
2016	EFP	2016	FB	1.3738	0.008
2016	EFP	2015	FP	1.6074	0.0029
2016	EFP	2016	FP	1.5377	0.0021
2016	EFP	2015	MP	1.4787	0.0039
2016	EFP	2016	MP	1.7358	0.0006
2016	EFP	2015	MX	0.6753	0.1946
2016	EFP	2016	MX	1.0456	0.0419
2016	EFP	2015	C	0.4466	0.3284
2016	EFP	2016	C	0.9748	0.0374
2016	EFP	2015	L	0.2672	0.6669
2016	EFP	2016	L	0.5116	0.3267
2016	EMP	2016	EMX	-0.4806	0.412
2016	EMP	2016	EST	0.7444	0.2071
2016	EMP	2015	LSC	1.3008	0.0414
2016	EMP	2016	LSC	1.5096	0.019
2016	EMP	2016	EC	-0.112	0.8477
2016	EMP	2015	FB	1.353	0.0107
2016	EMP	2016	FB	1.2369	0.016
2016	EMP	2015	FP	1.4704	0.0059
2016	EMP	2016	FP	1.4008	0.0045
2016	EMP	2015	MP	1.3417	0.0081
2016	EMP	2016	MP	1.5988	0.0014
2016	EMP	2015	MX	0.5384	0.299
2016	EMP	2016	MX	0.9086	0.075
2016	EMP	2015	C	0.3097	0.4963
2016	EMP	2016	C	0.8378	0.0711

2016	EMP	2015	L	0.1302	0.8337
2016	EMP	2016	L	0.3747	0.4713
2016	EMX	2016	EST	1.225	0.0419
2016	EMX	2015	LSC	1.7814	0.0063
2016	EMX	2016	LSC	1.9902	0.0026
2016	EMX	2016	EC	0.3686	0.5283
2016	EMX	2015	FB	1.8336	0.0009
2016	EMX	2016	FB	1.7175	0.0012
2016	EMX	2015	FP	1.951	0.0004
2016	EMX	2016	FP	1.8814	0.0003
2016	EMX	2015	MP	1.8223	0.0005
2016	EMX	2016	MP	2.0794	<.0001
2016	EMX	2015	MX	1.019	0.0539
2016	EMX	2016	MX	1.3892	0.0081
2016	EMX	2015	C	0.7903	0.0887
2016	EMX	2016	C	1.3185	0.0061
2016	EMX	2015	L	0.6108	0.3276
2016	EMX	2016	L	0.8553	0.1049
2016	EST	2015	LSC	0.5564	0.3721
2016	EST	2016	LSC	0.7652	0.2219
2016	EST	2016	EC	-0.8564	0.1483
2016	EST	2015	FB	0.6085	0.2326
2016	EST	2016	FB	0.4925	0.32
2016	EST	2015	FP	0.726	0.1562
2016	EST	2016	FP	0.6564	0.1627
2016	EST	2015	MP	0.5973	0.2186
2016	EST	2016	MP	0.8544	0.072
2016	EST	2015	MX	-0.206	0.6891
2016	EST	2016	MX	0.1642	0.7422
2016	EST	2015	C	-0.4348	0.3412
2016	EST	2016	C	0.09343	0.8364
2016	EST	2015	L	-0.6142	0.3249
2016	EST	2016	L	-0.3697	0.4771
2015	LSC	2016	LSC	0.2088	0.7367
2015	LSC	2016	EC	-1.4128	0.0275
2015	LSC	2015	FB	0.05216	0.924
2015	LSC	2016	FB	-0.06393	0.905
2015	LSC	2015	FP	0.1696	0.7566
2015	LSC	2016	FP	0.09999	0.8444
2015	LSC	2015	MP	0.04093	0.9378

2015	LSC	2016	MP	0.298	0.5592
2015	LSC	2015	MX	-0.7624	0.1753
2015	LSC	2016	MX	-0.3922	0.4707
2015	LSC	2015	C	-0.9911	0.0532
2015	LSC	2016	C	-0.463	0.3566
2015	LSC	2015	L	-1.1706	0.0793
2015	LSC	2016	L	-0.9261	0.1032
2016	LSC	2016	EC	-1.6216	0.0122
2016	LSC	2015	FB	-0.1566	0.7747
2016	LSC	2016	FB	-0.2727	0.6111
2016	LSC	2015	FP	-0.03917	0.9429
2016	LSC	2016	FP	-0.1088	0.8309
2016	LSC	2015	MP	-0.1679	0.7492
2016	LSC	2016	MP	0.08925	0.8609
2016	LSC	2015	MX	-0.9712	0.0864
2016	LSC	2016	MX	-0.601	0.2709
2016	LSC	2015	C	-1.1999	0.0205
2016	LSC	2016	C	-0.6717	0.1835
2016	LSC	2015	L	-1.3794	0.04
2016	LSC	2016	L	-1.1349	0.0474
2016	EC	2015	FB	1.4649	0.0061
2016	EC	2016	FB	1.3488	0.0091
2016	EC	2015	FP	1.5824	0.0033
2016	EC	2016	FP	1.5128	0.0024
2016	EC	2015	MP	1.4537	0.0044
2016	EC	2016	MP	1.7108	0.0007
2016	EC	2015	MX	0.6504	0.2112
2016	EC	2016	MX	1.0206	0.0467
2016	EC	2015	C	0.4216	0.3558
2016	EC	2016	C	0.9498	0.0422
2016	EC	2015	L	0.2422	0.6964
2016	EC	2016	L	0.4867	0.3505
2015	FB	2016	FB	-0.1161	0.7607
2015	FB	2015	FP	0.1175	0.7752
2015	FB	2016	FP	0.04784	0.8942
2015	FB	2015	MP	-0.01123	0.9765
2015	FB	2016	MP	0.2459	0.4953
2015	FB	2015	MX	-0.8146	0.0602
2015	FB	2016	MX	-0.4443	0.2755
2015	FB	2015	C	-1.0433	0.0047

2015	FB	2016	C	-0.5151	0.1421
2015	FB	2015	L	-1.2227	0.0298
2015	FB	2016	L	-0.9783	0.0264
2016	FB	2015	FP	0.2335	0.5558
2016	FB	2016	FP	0.1639	0.6318
2016	FB	2015	MP	0.1049	0.7735
2016	FB	2016	MP	0.362	0.2927
2016	FB	2015	MX	-0.6985	0.0928
2016	FB	2016	MX	-0.3282	0.4003
2016	FB	2015	C	-0.9272	0.0073
2016	FB	2016	C	-0.399	0.2266
2016	FB	2015	L	-1.1067	0.0435
2016	FB	2016	L	-0.8622	0.0413
2015	FP	2016	FP	-0.06962	0.8423
2015	FP	2015	MP	-0.1287	0.7357
2015	FP	2016	MP	0.1284	0.7211
2015	FP	2015	MX	-0.932	0.0327
2015	FP	2016	MX	-0.5618	0.1698
2015	FP	2015	C	-1.1607	0.0019
2015	FP	2016	C	-0.6326	0.0736
2015	FP	2015	L	-1.3402	0.0178
2015	FP	2016	L	-1.0957	0.0134
2016	FP	2015	MP	-0.05906	0.8557
2016	FP	2016	MP	0.198	0.5091
2016	FP	2015	MX	-0.8624	0.0255
2016	FP	2016	MX	-0.4922	0.1669
2016	FP	2015	C	-1.0911	0.0005
2016	FP	2016	C	-0.5629	0.0525
2016	FP	2015	L	-1.2706	0.0159
2016	FP	2016	L	-1.0261	0.0091
2015	MP	2016	MP	0.2571	0.4126
2015	MP	2015	MX	-0.8033	0.047
2015	MP	2016	MX	-0.4331	0.2503
2015	MP	2015	C	-1.0321	0.002
2015	MP	2016	C	-0.5039	0.1093
2015	MP	2015	L	-1.2115	0.0249
2015	MP	2016	L	-0.967	0.0188
2016	MP	2015	MX	-1.0604	0.0068
2016	MP	2016	MX	-0.6902	0.0551
2016	MP	2015	C	-1.2892	<.0001

2016	MP	2016	C	-0.761	0.0102
2016	MP	2015	L	-1.4686	0.0058
2016	MP	2016	L	-1.2241	0.0021
2015	MX	2016	MX	0.3702	0.3556
2015	MX	2015	C	-0.2287	0.5279
2015	MX	2016	C	0.2995	0.4076
2015	MX	2015	L	-0.4082	0.4644
2015	MX	2016	L	-0.1637	0.7101
2016	MX	2015	C	-0.599	0.0832
2016	MX	2016	C	-0.07078	0.8339
2016	MX	2015	L	-0.7784	0.1556
2016	MX	2016	L	-0.5339	0.2093
2015	L	2016	C	0.5282	0.0475
2015	C	2015	L	-0.1794	0.7202
2015	C	2016	L	0.06502	0.8594
2016	C	2015	L	-0.7076	0.1614
2016	C	2016	L	-0.4632	0.2093
2015	L	2016	L	0.2445	0.6515

Appendix 21: Differences in the LSMeans of the fourth-root transformed Kfs for combinations of treatment and year and their associated p-values. Treatment abbreviations: control (C), low slope control (LSC), logged only (L), feller buncher track (FB), few pass (FP), many pass (MP), mix disturbed (MX), and skidder track (ST). E is abbreviation of the treatments in the unburned Evergreen site.

Treatment	Year	Treatment	Year	Estimate	P Value
LSC	2015	FB	2015	0.08743	0.0179
LSC	2015	FP	2015	0.07964	0.0275
LSC	2015	MP	2015	0.1518	<.0001
LSC	2015	MX	2015	0.1137	0.0036
LSC	2015	C	2015	-0.00093	0.978
LSC	2015	L	2015	0.00107	0.9803
LSC	2015	EFP	2016	0.1124	0.0075
LSC	2015	EMP	2016	0.1489	0.0006
LSC	2015	EMX	2016	0.04854	0.2321
LSC	2015	EST	2016	0.1265	0.0029
LSC	2015	LSC	2016	0.08156	0.0612
LSC	2015	EC	2016	-0.02497	0.5621
LSC	2015	FB	2016	0.08764	0.0176
LSC	2015	FP	2016	0.1151	0.0013
LSC	2015	MP	2016	0.1497	<.0001
LSC	2015	MX	2016	0.04693	0.2266
LSC	2015	C	2016	0.01536	0.6366
LSC	2015	L	2016	0.07607	0.0451
FB	2015	FP	2015	-0.00779	0.7617
FB	2015	MP	2015	0.06438	0.0118
FB	2015	MX	2015	0.02632	0.3583
FB	2015	C	2015	-0.08835	0.0005
FB	2015	L	2015	-0.08636	0.0193
FB	2015	EFP	2016	0.02494	0.4422
FB	2015	EMP	2016	0.06147	0.063
FB	2015	EMX	2016	-0.03888	0.2333
FB	2015	EST	2016	0.03907	0.2312
FB	2015	LSC	2016	-0.00587	0.8695
FB	2015	EC	2016	-0.1124	0.0028
FB	2015	FB	2016	0.00022	0.9935
FB	2015	FP	2016	0.02769	0.2473
FB	2015	MP	2016	0.06228	0.0099
FB	2015	MX	2016	-0.0405	0.1827

FB	2015	C	2016	-0.07207	0.002
FB	2015	L	2016	-0.01136	0.6895
FP	2015	MP	2015	0.07217	0.0038
FP	2015	MX	2015	0.03411	0.2238
FP	2015	C	2015	-0.08056	0.0009
FP	2015	L	2015	-0.07857	0.0297
FP	2015	EFP	2016	0.03273	0.3052
FP	2015	EMP	2016	0.06927	0.0337
FP	2015	EMX	2016	-0.03109	0.3297
FP	2015	EST	2016	0.04686	0.1448
FP	2015	LSC	2016	0.00192	0.9564
FP	2015	EC	2016	-0.1046	0.0044
FP	2015	FB	2016	0.00801	0.7553
FP	2015	FP	2016	0.03548	0.1246
FP	2015	MP	2016	0.07007	0.0028
FP	2015	MX	2016	-0.0327	0.2695
FP	2015	C	2016	-0.06427	0.0035
FP	2015	L	2016	-0.00356	0.8976
MP	2015	MX	2015	-0.03806	0.16
MP	2015	C	2015	-0.1527	<.0001
MP	2015	L	2015	-0.1507	<.0001
MP	2015	EFP	2016	-0.03944	0.2053
MP	2015	EMP	2016	-0.0029	0.925
MP	2015	EMX	2016	-0.1033	0.0017
MP	2015	EST	2016	-0.02531	0.4135
MP	2015	LSC	2016	-0.07024	0.0457
MP	2015	EC	2016	-0.1768	<.0001
MP	2015	FB	2016	-0.06416	0.0121
MP	2015	FP	2016	-0.03668	0.0954
MP	2015	MP	2016	-0.00209	0.9204
MP	2015	MX	2016	-0.1049	0.0006
MP	2015	C	2016	-0.1364	<.0001
MP	2015	L	2016	-0.07573	0.0062
MX	2015	C	2015	-0.1147	<.0001
MX	2015	L	2015	-0.1127	0.0039
MX	2015	EFP	2016	-0.00138	0.9677
MX	2015	EMP	2016	0.03516	0.3049
MX	2015	EMX	2016	-0.0652	0.0609
MX	2015	EST	2016	0.01275	0.7082
MX	2015	LSC	2016	-0.03219	0.39

MX	2015	EC	2016	-0.1387	0.0005
MX	2015	FB	2016	-0.0261	0.3622
MX	2015	FP	2016	0.00137	0.9579
MX	2015	MP	2016	0.03596	0.1628
MX	2015	MX	2016	-0.06682	0.039
MX	2015	C	2016	-0.09838	0.0002
MX	2015	L	2016	-0.03767	0.2176
C	2015	L	2015	0.00199	0.9527
C	2015	EFP	2016	0.1133	0.0005
C	2015	EMP	2016	0.1498	<.0001
C	2015	EMX	2016	0.04947	0.1043
C	2015	EST	2016	0.1274	0.0001
C	2015	LSC	2016	0.08249	0.0174
C	2015	EC	2016	-0.02405	0.4742
C	2015	FB	2016	0.08857	0.0005
C	2015	FP	2016	0.116	<.0001
C	2015	MP	2016	0.1506	<.0001
C	2015	MX	2016	0.04786	0.0868
C	2015	C	2016	0.01629	0.3704
C	2015	L	2016	0.077	0.0039
L	2015	EFP	2016	0.1113	0.0081
L	2015	EMP	2016	0.1478	0.0006
L	2015	EMX	2016	0.04748	0.2426
L	2015	EST	2016	0.1254	0.0031
L	2015	LSC	2016	0.08049	0.0666
L	2015	EC	2016	-0.02604	0.5458
L	2015	FB	2016	0.08658	0.019
L	2015	FP	2016	0.1141	0.0014
L	2015	MP	2016	0.1486	<.0001
L	2015	MX	2016	0.04587	0.2374
L	2015	C	2016	0.0143	0.6603
L	2015	L	2016	0.07501	0.0469
EFP	2016	EMP	2016	0.03654	0.3303
EFP	2016	EMX	2016	-0.06382	0.093
EFP	2016	EST	2016	0.01413	0.7051
EFP	2016	LSC	2016	-0.03081	0.446
EFP	2016	EC	2016	-0.1373	0.0013
EFP	2016	FB	2016	-0.02472	0.4462
EFP	2016	FP	2016	0.00275	0.9272
EFP	2016	MP	2016	0.03734	0.2131

EFP	2016	MX	2016	-0.06544	0.0696
EFP	2016	C	2016	-0.097	0.0016
EFP	2016	L	2016	-0.03629	0.288
EMP	2016	EMX	2016	-0.1004	0.01
EMP	2016	EST	2016	-0.0224	0.549
EMP	2016	LSC	2016	-0.06734	0.1
EMP	2016	EC	2016	-0.1739	<.0001
EMP	2016	FB	2016	-0.06126	0.0639
EMP	2016	FP	2016	-0.03378	0.2664
EMP	2016	MP	2016	0.00081	0.9783
EMP	2016	MX	2016	-0.102	0.0058
EMP	2016	C	2016	-0.1335	<.0001
EMP	2016	L	2016	-0.07283	0.0363
EMX	2016	EST	2016	0.07795	0.0419
EMX	2016	LSC	2016	0.03302	0.4143
EMX	2016	EC	2016	-0.07352	0.073
EMX	2016	FB	2016	0.0391	0.2308
EMX	2016	FP	2016	0.06658	0.0321
EMX	2016	MP	2016	0.1012	0.0014
EMX	2016	MX	2016	-0.00161	0.9636
EMX	2016	C	2016	-0.03318	0.2515
EMX	2016	L	2016	0.02753	0.4191
EST	2016	LSC	2016	-0.04494	0.2681
EST	2016	EC	2016	-0.1515	0.0005
EST	2016	FB	2016	-0.03885	0.2337
EST	2016	FP	2016	-0.01138	0.7063
EST	2016	MP	2016	0.02321	0.4362
EST	2016	MX	2016	-0.07957	0.0287
EST	2016	C	2016	-0.1111	0.0004
EST	2016	L	2016	-0.05043	0.1421
LSC	2016	EC	2016	-0.1065	0.0165
LSC	2016	FB	2016	0.00609	0.8648
LSC	2016	FP	2016	0.03356	0.3231
LSC	2016	MP	2016	0.06815	0.0458
LSC	2016	MX	2016	-0.03463	0.3706
LSC	2016	C	2016	-0.0662	0.0463
LSC	2016	L	2016	-0.00549	0.8827
EC	2016	FB	2016	0.1126	0.0027
EC	2016	FP	2016	0.1401	0.0001
EC	2016	MP	2016	0.1747	<.0001

EC	2016	MX	2016	0.0719	0.0663
EC	2016	C	2016	0.04034	0.2171
EC	2016	L	2016	0.101	0.0086
FB	2016	FP	2016	0.02748	0.2509
FB	2016	MP	2016	0.06206	0.0101
FB	2016	MX	2016	-0.04071	0.1804
FB	2016	C	2016	-0.07228	0.0019
FB	2016	L	2016	-0.01157	0.6839
FP	2016	MP	2016	0.03459	0.0892
FP	2016	MX	2016	-0.06819	0.0171
FP	2016	C	2016	-0.09976	<.0001
FP	2016	L	2016	-0.03905	0.1357
MP	2016	MX	2016	-0.1028	0.0004
MP	2016	C	2016	-0.1343	<.0001
MP	2016	L	2016	-0.07364	0.0051
MX	2016	C	2016	-0.03157	0.2308
MX	2016	L	2016	0.02914	0.3618
C	2016	L	2016	0.06071	0.0146

Appendix 22: Differences in the LSMeans of bare soil at the surface for combinations of treatment and season. The treatment abbreviations are: C for control, LSC for low slope control, L for logged only, FP for few pass and MP for many pass. The season values are 1 for fall 2014, 2 for spring 2015, 3 for fall 2015 and 4 for spring 2016.

Treatment	Season	Treatment	Season	Estimate	P Value
C	1	C	2	20.9315	0.0004
C	1	C	3	28.6381	<.0001
C	1	C	4	53.1345	<.0001
C	1	FP	1	1.8249	0.8748
C	1	FP	2	10.4143	0.3698
C	1	FP	3	12.6389	0.2511
C	1	FP	4	32.5557	0.0044
C	1	L	1	18.4813	0.1151
C	1	L	2	17.6868	0.1307
C	1	L	3	34.0604	0.0032
C	1	L	4	55.3118	<.0001
C	1	LSC	1	20.6489	0.1064
C	1	LSC	2	49.1069	0.0004
C	1	LSC	3	60.5029	<.0001
C	1	LSC	4	71.3202	<.0001
C	1	MP	1	-31.2715	0.0092
C	1	MP	2	-6.5602	0.5712
C	1	MP	3	8.9240	0.4158
C	1	MP	4	31.8235	0.0053
C	2	C	3	7.7066	0.1761
C	2	C	4	32.2030	<.0001
C	2	FP	1	-19.1067	0.1033
C	2	FP	2	-10.5172	0.3646
C	2	FP	3	-8.2927	0.4486
C	2	FP	4	11.6241	0.2869
C	2	L	1	-2.4503	0.8322
C	2	L	2	-3.2448	0.7788
C	2	L	3	13.1288	0.2329
C	2	L	4	34.3802	0.0028
C	2	LSC	1	-0.2826	0.9820
C	2	LSC	2	28.1753	0.0327
C	2	LSC	3	39.5714	0.0036
C	2	LSC	4	50.3887	0.0003
C	2	MP	1	-52.2031	<.0001
C	2	MP	2	-27.4918	0.0207
C	2	MP	3	-12.0076	0.2745
C	2	MP	4	10.8919	0.3179
C	3	C	4	24.4964	<.0001

C	3	FP	1	-26.8132	0.0179
C	3	FP	2	-18.2238	0.1006
C	3	FP	3	-15.9992	0.1247
C	3	FP	4	3.9176	0.6998
C	3	L	1	-10.1568	0.3549
C	3	L	2	-10.9513	0.3183
C	3	L	3	5.4223	0.5966
C	3	L	4	26.6737	0.0126
C	3	LSC	1	-7.9892	0.5055
C	3	LSC	2	20.4688	0.1009
C	3	LSC	3	31.8648	0.0131
C	3	LSC	4	42.6821	0.0011
C	3	MP	1	-59.9096	<.0001
C	3	MP	2	-35.1983	0.0024
C	3	MP	3	-19.7141	0.0610
C	3	MP	4	3.1854	0.7538
C	4	FP	1	-51.3097	<.0001
C	4	FP	2	-42.7202	0.0003
C	4	FP	3	-40.4957	0.0003
C	4	FP	4	-20.5789	0.0481
C	4	L	1	-34.6533	0.0026
C	4	L	2	-35.4477	0.0021
C	4	L	3	-19.0742	0.0676
C	4	L	4	2.1772	0.8289
C	4	LSC	1	-32.4856	0.0099
C	4	LSC	2	-4.0276	0.7402
C	4	LSC	3	7.3684	0.5449
C	4	LSC	4	18.1857	0.1336
C	4	MP	1	-84.4061	<.0001
C	4	MP	2	-59.6948	<.0001
C	4	MP	3	-44.2105	0.0001
C	4	MP	4	-21.3111	0.0411
FP	1	FP	2	8.5894	0.1347
FP	1	FP	3	10.8140	0.1011
FP	1	FP	4	30.7308	<.0001
FP	1	L	1	16.6564	0.1546
FP	1	L	2	15.8619	0.1743
FP	1	L	3	32.2355	0.0050
FP	1	L	4	53.4869	<.0001
FP	1	LSC	1	18.8240	0.1398
FP	1	LSC	2	47.2820	0.0007
FP	1	LSC	3	58.6780	<.0001
FP	1	LSC	4	69.4954	<.0001
FP	1	MP	1	-33.0964	0.0060

FP	1	MP	2	-8.3851	0.4696
FP	1	MP	3	7.0991	0.5167
FP	1	MP	4	29.9986	0.0083
FP	2	FP	3	2.2246	0.6950
FP	2	FP	4	22.1413	0.0006
FP	2	L	1	8.0669	0.4865
FP	2	L	2	7.2725	0.5298
FP	2	L	3	23.6461	0.0352
FP	2	L	4	44.8975	0.0002
FP	2	LSC	1	10.2346	0.4166
FP	2	LSC	2	38.6926	0.0043
FP	2	LSC	3	50.0886	0.0004
FP	2	LSC	4	60.9059	<.0001
FP	2	MP	1	-41.6858	0.0007
FP	2	MP	2	-16.9745	0.1462
FP	2	MP	3	-1.4903	0.8913
FP	2	MP	4	21.4091	0.0538
FP	3	FP	4	19.9168	<.0001
FP	3	L	1	5.8424	0.5933
FP	3	L	2	5.0479	0.6439
FP	3	L	3	21.4215	0.0428
FP	3	L	4	42.6729	0.0002
FP	3	LSC	1	8.0100	0.5044
FP	3	LSC	2	36.4680	0.0052
FP	3	LSC	3	47.8640	0.0004
FP	3	LSC	4	58.6814	<.0001
FP	3	MP	1	-43.9104	0.0002
FP	3	MP	2	-19.1991	0.0842
FP	3	MP	3	-3.7149	0.7165
FP	3	MP	4	19.1846	0.0661
FP	4	L	1	-14.0744	0.1994
FP	4	L	2	-14.8689	0.1752
FP	4	L	3	1.5047	0.8821
FP	4	L	4	22.7561	0.0300
FP	4	LSC	1	-11.9068	0.3207
FP	4	LSC	2	16.5512	0.1792
FP	4	LSC	3	27.9472	0.0272
FP	4	LSC	4	38.7646	0.0026
FP	4	MP	1	-63.8272	<.0001
FP	4	MP	2	-39.1159	0.0008
FP	4	MP	3	-23.6317	0.0255
FP	4	MP	4	-0.7322	0.9421
L	1	L	2	-0.7945	0.8893
L	1	L	3	15.5791	0.0189

L	1	L	4	36.8305	<.0001
L	1	LSC	1	2.1677	0.8629
L	1	LSC	2	30.6256	0.0211
L	1	LSC	3	42.0216	0.0021
L	1	LSC	4	52.8390	0.0002
L	1	MP	1	-49.7528	<.0001
L	1	MP	2	-25.0415	0.0344
L	1	MP	3	-9.5573	0.3838
L	1	MP	4	13.3422	0.2233
L	2	L	3	16.3736	0.0046
L	2	L	4	37.6250	<.0001
L	2	LSC	1	2.9621	0.8134
L	2	LSC	2	31.4201	0.0181
L	2	LSC	3	42.8161	0.0018
L	2	LSC	4	53.6334	0.0001
L	2	MP	1	-48.9583	<.0001
L	2	MP	2	-24.2470	0.0401
L	2	MP	3	-8.7628	0.4235
L	2	MP	4	14.1367	0.1969
L	3	L	4	21.2514	<.0001
L	3	LSC	1	-13.4115	0.2668
L	3	LSC	2	15.0465	0.2230
L	3	LSC	3	26.4425	0.0367
L	3	LSC	4	37.2599	0.0038
L	3	MP	1	-65.3319	<.0001
L	3	MP	2	-40.6206	0.0006
L	3	MP	3	-25.1364	0.0188
L	3	MP	4	-2.2369	0.8256
L	4	LSC	1	-34.6629	0.0063
L	4	LSC	2	-6.2049	0.6099
L	4	LSC	3	5.1911	0.6693
L	4	LSC	4	16.0085	0.1848
L	4	MP	1	-86.5833	<.0001
L	4	MP	2	-61.8720	<.0001
L	4	MP	3	-46.3878	<.0001
L	4	MP	4	-23.4883	0.0254
LSC	1	LSC	2	28.4580	<.0001
LSC	1	LSC	3	39.8540	<.0001
LSC	1	LSC	4	50.6713	<.0001
LSC	1	MP	1	-51.9204	0.0002
LSC	1	MP	2	-27.2091	0.0356
LSC	1	MP	3	-11.7249	0.3305
LSC	1	MP	4	11.1745	0.3509
LSC	2	LSC	3	11.3960	0.0534

LSC	2	LSC	4	22.2133	0.0020
LSC	2	MP	1	-80.3784	<.0001
LSC	2	MP	2	-55.6671	<.0001
LSC	2	MP	3	-40.1829	0.0023
LSC	2	MP	4	-17.2834	0.1612
LSC	3	LSC	4	10.8173	0.0656
LSC	3	MP	1	-91.7744	<.0001
LSC	3	MP	2	-67.0631	<.0001
LSC	3	MP	3	-51.5789	0.0002
LSC	3	MP	4	-28.6795	0.0237
LSC	4	MP	1	-102.59	<.0001
LSC	4	MP	2	-77.8805	<.0001
LSC	4	MP	3	-62.3962	<.0001
LSC	4	MP	4	-39.4968	0.0022
MP	1	MP	2	24.7113	<.0001
MP	1	MP	3	40.1955	<.0001
MP	1	MP	4	63.0950	<.0001
MP	2	MP	3	15.4842	0.0073
MP	2	MP	4	38.3837	<.0001
MP	3	MP	4	22.8995	<.0001

Appendix 23: Differences in the LSMeans of bare soil at the interception level for combinations of treatment and season. The treatment abbreviations are: C for control, LSC for low slope control, L for logged only, FP for few pass and MP for many pass. The season values are 1 for fall 2014, 2 for spring 2015, 3 for fall 2015 and 4 for spring 2016.

Treatment	Season	Treatment	Season	Estimate	P Value
C	1	C	2	20.9315	0.0004
C	1	C	3	28.6381	<.0001
C	1	C	4	53.1345	<.0001
C	1	FP	1	1.8249	0.8748
C	1	FP	2	10.4143	0.3698
C	1	FP	3	12.6389	0.2511
C	1	FP	4	32.5557	0.0044
C	1	L	1	18.4813	0.1151
C	1	L	2	17.6868	0.1307
C	1	L	3	34.0604	0.0032
C	1	L	4	55.3118	<.0001
C	1	LSC	1	20.6489	0.1064
C	1	LSC	2	49.1069	0.0004
C	1	LSC	3	60.5029	<.0001
C	1	LSC	4	71.3202	<.0001
C	1	MP	1	-31.2715	0.0092
C	1	MP	2	-6.5602	0.5712
C	1	MP	3	8.9240	0.4158
C	1	MP	4	31.8235	0.0053
C	2	C	3	7.7066	0.1761
C	2	C	4	32.2030	<.0001
C	2	FP	1	-19.1067	0.1033
C	2	FP	2	-10.5172	0.3646
C	2	FP	3	-8.2927	0.4486
C	2	FP	4	11.6241	0.2869
C	2	L	1	-2.4503	0.8322
C	2	L	2	-3.2448	0.7788
C	2	L	3	13.1288	0.2329
C	2	L	4	34.3802	0.0028
C	2	LSC	1	-0.2826	0.9820
C	2	LSC	2	28.1753	0.0327
C	2	LSC	3	39.5714	0.0036
C	2	LSC	4	50.3887	0.0003
C	2	MP	1	-52.2031	<.0001
C	2	MP	2	-27.4918	0.0207
C	2	MP	3	-12.0076	0.2745
C	2	MP	4	10.8919	0.3179
C	3	C	4	24.4964	<.0001

C	3	FP	1	-26.8132	0.0179
C	3	FP	2	-18.2238	0.1006
C	3	FP	3	-15.9992	0.1247
C	3	FP	4	3.9176	0.6998
C	3	L	1	-10.1568	0.3549
C	3	L	2	-10.9513	0.3183
C	3	L	3	5.4223	0.5966
C	3	L	4	26.6737	0.0126
C	3	LSC	1	-7.9892	0.5055
C	3	LSC	2	20.4688	0.1009
C	3	LSC	3	31.8648	0.0131
C	3	LSC	4	42.6821	0.0011
C	3	MP	1	-59.9096	<.0001
C	3	MP	2	-35.1983	0.0024
C	3	MP	3	-19.7141	0.0610
C	3	MP	4	3.1854	0.7538
C	4	FP	1	-51.3097	<.0001
C	4	FP	2	-42.7202	0.0003
C	4	FP	3	-40.4957	0.0003
C	4	FP	4	-20.5789	0.0481
C	4	L	1	-34.6533	0.0026
C	4	L	2	-35.4477	0.0021
C	4	L	3	-19.0742	0.0676
C	4	L	4	2.1772	0.8289
C	4	LSC	1	-32.4856	0.0099
C	4	LSC	2	-4.0276	0.7402
C	4	LSC	3	7.3684	0.5449
C	4	LSC	4	18.1857	0.1336
C	4	MP	1	-84.4061	<.0001
C	4	MP	2	-59.6948	<.0001
C	4	MP	3	-44.2105	0.0001
C	4	MP	4	-21.3111	0.0411
FP	1	FP	2	8.5894	0.1347
FP	1	FP	3	10.8140	0.1011
FP	1	FP	4	30.7308	<.0001
FP	1	L	1	16.6564	0.1546
FP	1	L	2	15.8619	0.1743
FP	1	L	3	32.2355	0.0050
FP	1	L	4	53.4869	<.0001
FP	1	LSC	1	18.8240	0.1398
FP	1	LSC	2	47.2820	0.0007
FP	1	LSC	3	58.6780	<.0001
FP	1	LSC	4	69.4954	<.0001
FP	1	MP	1	-33.0964	0.0060

FP	1	MP	2	-8.3851	0.4696
FP	1	MP	3	7.0991	0.5167
FP	1	MP	4	29.9986	0.0083
FP	2	FP	3	2.2246	0.6950
FP	2	FP	4	22.1413	0.0006
FP	2	L	1	8.0669	0.4865
FP	2	L	2	7.2725	0.5298
FP	2	L	3	23.6461	0.0352
FP	2	L	4	44.8975	0.0002
FP	2	LSC	1	10.2346	0.4166
FP	2	LSC	2	38.6926	0.0043
FP	2	LSC	3	50.0886	0.0004
FP	2	LSC	4	60.9059	<.0001
FP	2	MP	1	-41.6858	0.0007
FP	2	MP	2	-16.9745	0.1462
FP	2	MP	3	-1.4903	0.8913
FP	2	MP	4	21.4091	0.0538
FP	3	FP	4	19.9168	<.0001
FP	3	L	1	5.8424	0.5933
FP	3	L	2	5.0479	0.6439
FP	3	L	3	21.4215	0.0428
FP	3	L	4	42.6729	0.0002
FP	3	LSC	1	8.0100	0.5044
FP	3	LSC	2	36.4680	0.0052
FP	3	LSC	3	47.8640	0.0004
FP	3	LSC	4	58.6814	<.0001
FP	3	MP	1	-43.9104	0.0002
FP	3	MP	2	-19.1991	0.0842
FP	3	MP	3	-3.7149	0.7165
FP	3	MP	4	19.1846	0.0661
FP	4	L	1	-14.0744	0.1994
FP	4	L	2	-14.8689	0.1752
FP	4	L	3	1.5047	0.8821
FP	4	L	4	22.7561	0.0300
FP	4	LSC	1	-11.9068	0.3207
FP	4	LSC	2	16.5512	0.1792
FP	4	LSC	3	27.9472	0.0272
FP	4	LSC	4	38.7646	0.0026
FP	4	MP	1	-63.8272	<.0001
FP	4	MP	2	-39.1159	0.0008
FP	4	MP	3	-23.6317	0.0255
FP	4	MP	4	-0.7322	0.9421
L	1	L	2	-0.7945	0.8893
L	1	L	3	15.5791	0.0189

L	1	L	4	36.8305	<.0001
L	1	LSC	1	2.1677	0.8629
L	1	LSC	2	30.6256	0.0211
L	1	LSC	3	42.0216	0.0021
L	1	LSC	4	52.8390	0.0002
L	1	MP	1	-49.7528	<.0001
L	1	MP	2	-25.0415	0.0344
L	1	MP	3	-9.5573	0.3838
L	1	MP	4	13.3422	0.2233
L	2	L	3	16.3736	0.0046
L	2	L	4	37.6250	<.0001
L	2	LSC	1	2.9621	0.8134
L	2	LSC	2	31.4201	0.0181
L	2	LSC	3	42.8161	0.0018
L	2	LSC	4	53.6334	0.0001
L	2	MP	1	-48.9583	<.0001
L	2	MP	2	-24.2470	0.0401
L	2	MP	3	-8.7628	0.4235
L	2	MP	4	14.1367	0.1969
L	3	L	4	21.2514	<.0001
L	3	LSC	1	-13.4115	0.2668
L	3	LSC	2	15.0465	0.2230
L	3	LSC	3	26.4425	0.0367
L	3	LSC	4	37.2599	0.0038
L	3	MP	1	-65.3319	<.0001
L	3	MP	2	-40.6206	0.0006
L	3	MP	3	-25.1364	0.0188
L	3	MP	4	-2.2369	0.8256
L	4	LSC	1	-34.6629	0.0063
L	4	LSC	2	-6.2049	0.6099
L	4	LSC	3	5.1911	0.6693
L	4	LSC	4	16.0085	0.1848
L	4	MP	1	-86.5833	<.0001
L	4	MP	2	-61.8720	<.0001
L	4	MP	3	-46.3878	<.0001
L	4	MP	4	-23.4883	0.0254
LSC	1	LSC	2	28.4580	<.0001
LSC	1	LSC	3	39.8540	<.0001
LSC	1	LSC	4	50.6713	<.0001
LSC	1	MP	1	-51.9204	0.0002
LSC	1	MP	2	-27.2091	0.0356
LSC	1	MP	3	-11.7249	0.3305
LSC	1	MP	4	11.1745	0.3509
LSC	2	LSC	3	11.3960	0.0534

LSC	2	LSC	4	22.2133	0.0020
LSC	2	MP	1	-80.3784	<.0001
LSC	2	MP	2	-55.6671	<.0001
LSC	2	MP	3	-40.1829	0.0023
LSC	2	MP	4	-17.2834	0.1612
LSC	3	LSC	4	10.8173	0.0656
LSC	3	MP	1	-91.7744	<.0001
LSC	3	MP	2	-67.0631	<.0001
LSC	3	MP	3	-51.5789	0.0002
LSC	3	MP	4	-28.6795	0.0237
LSC	4	MP	1	-102.59	<.0001
LSC	4	MP	2	-77.8805	<.0001
LSC	4	MP	3	-62.3962	<.0001
LSC	4	MP	4	-39.4968	0.0022
MP	1	MP	2	24.7113	<.0001
MP	1	MP	3	40.1955	<.0001
MP	1	MP	4	63.0950	<.0001
MP	2	MP	3	15.4842	0.0073
MP	2	MP	4	38.3837	<.0001
MP	3	MP	4	22.8995	<.0001

Appendix 24: Differences in LSMeans of log-transformed sediment yield for combinations of treatment and water year and their associated p-values at the Sawmill site. The treatment abbreviations are: C for control, LSC for low slope control, L for logged only, FP for few pass and MP for many pass.

Treatmen t	Water Year	Treatment	Water Year	Estimate	P Value
C	2015	C	2016	1.6898	0.0002
C	2015	FP	2015	-0.00489	0.9942
C	2015	FP	2016	0.2589	0.7019
C	2015	L	2015	0.3932	0.5626
C	2015	L	2016	1.2990	0.0727
C	2015	LSC	2015	0.5328	0.4354
C	2015	LSC	2016	1.9831	0.0110
C	2015	MP	2015	-0.6533	0.3420
C	2015	MP	2016	0.5742	0.4016
C	2016	FP	2015	-1.6947	0.0247
C	2016	FP	2016	-1.4309	0.0510
C	2016	L	2015	-1.2966	0.0731
C	2016	L	2016	-0.3908	0.5650
C	2016	LSC	2015	-1.1570	0.1052
C	2016	LSC	2016	0.2933	0.6648
C	2016	MP	2015	-2.3431	0.0040
C	2016	MP	2016	-1.1156	0.1169
FP	2015	FP	2016	0.2638	0.4072
FP	2015	L	2015	0.3981	0.5578
FP	2015	L	2016	1.3039	0.0717
FP	2015	LSC	2015	0.5377	0.4314
FP	2015	LSC	2016	1.9880	0.0108
FP	2015	MP	2015	-0.6484	0.3455
FP	2015	MP	2016	0.5791	0.3977
FP	2016	L	2015	0.1343	0.8423
FP	2016	L	2016	1.0401	0.1412
FP	2016	LSC	2015	0.2739	0.6856
FP	2016	LSC	2016	1.7242	0.0227
FP	2016	MP	2015	-0.9122	0.1923
FP	2016	MP	2016	0.3153	0.6416
L	2015	L	2016	0.9058	0.0140
L	2015	LSC	2015	0.1396	0.8361
L	2015	LSC	2016	1.5899	0.0330
L	2015	MP	2015	-1.0464	0.1390
L	2015	MP	2016	0.1810	0.7886
L	2016	LSC	2015	-0.7662	0.2685
L	2016	LSC	2016	0.6841	0.3206
L	2016	MP	2015	-1.9523	0.0120

L	2016	MP	2016	-0.7248	0.2939
LSC	2015	LSC	2016	1.4503	0.0008
LSC	2015	MP	2015	-1.1861	0.0976
LSC	2015	MP	2016	0.04141	0.9510
LSC	2016	MP	2015	-2.6364	0.0018
LSC	2016	MP	2016	-1.4089	0.0542
MP	2015	MP	2016	1.2275	0.0024

Appendix 25: Differences in LSMeans of log-transformed sediment yield for combinations of treatment in the 2016 water year and their associated p-values at the upper Femmons site. The treatment abbreviations are: C for control, L for logged only, FP for few pass and MP for many pass.

Treatment		Estimate	P Value
C	FP	-0.4542	0.2691
C	L	0.2196	0.5817
C	MP	-1.5247	0.0040
FP	L	0.6738	0.1162
FP	MP	-1.0705	0.0233
L	MP	-1.7443	0.0019