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Water Boards

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Subject: Inspection of Sierra Pacific Industries' Ponderosa Post-Fire Sediment Study, Shasta County, California

Background: On 6 December, 2012, Central Valley Water Board (Water Board) staff inspected Sierra Pacific Industries' (SPI) Ponderosa Post-Fire Sediment Study in the headwaters of Rock Creek, Battle Creek watershed, Shasta County, California. The field visit was instigated by a large series of storms, which subjected the study area to significant amounts of rainfall over a 5-day period. Since rainfall intensity and magnitude is an important determinant of post-fire erosion rates, and the storm events were significant, staff determined it was necessary to visit the sites to observe erosional response from the large storm event.

SPI designed the experiment in collaboration with Dr. Lee MacDonald, Colorado State University. The study is designed to determine the effect of various post-fire treatments on hillslope erosion. Hillslope treatments were implemented on 10 convergent hillslopes (i.e., swales) subjected to moderate to high severity wildfire. Sediment fences were constructed along the axis of the swale to capture hillslope sediments. In addition, a weather station was constructed on the ridgetop directly adjacent to the experimental swales.

Although no study design has been received from SPI, hillslope treatments can be summarized as the following:

1. **Control** - Swales with no logging operations;
2. **Logged and Standard Salvage** - Swales were logged with ground-based equipment. Only merchantable trees were cut and removed in the operations;

3. **Logged and Clearcut** - Swales were logged with ground-based equipment. All trees were cut and removed in the operations;
4. **Logged, Standard Salvage, and Contour Ripping** – Swales were logged with ground based equipment. Only merchantable trees were cut and removed in the operations. After logging the swales were contour ripped. Sub-merchantable material was sometimes pushed over during ripping activities.

Water Board staff first had a chance to see the study sites on October 4th, when Drew Coe (Central Valley Water Board), Stacy Stanish (California Department of Fish and Game), and Don Lindsay (California Geological Survey) were invited by Dr. Cajun James (SPI) to look at the study site. During this site visit the attendees walked to every swale, and discussed the study design with Dr. James. The contour ripping had yet to be performed on the some of the swales. It was occularly estimated during this visit that the hillslopes of the control swales were approximately 10 to 15 percent steeper than the logged sites. Also, the controls were more convergent than the logged sites and on slightly different aspects. These differences may result in more erosion potential for the controls as steeper hillslopes and more convergent topography can result in more erosive runoff. Aspect can be an important factor since the prevailing wind direction and wind speed can affect the rainfall energy applied to the hillslope. Further focus should be placed on determining whether the differences in site conditions are significant enough to confound differences between the various hillslope treatments.

<u>Inspection:</u> I contacted Dr. James to obtain permission to visit the site after the large storms that occurred from 28 November to 2 December, 2012. Weather stations around the area indicated that over 5 inches of rain fell over the storm period, with 2 to 3 hour rainfall intensities exceeding a 5 to 6 year return interval. Watersheds draining into Shasta Lake Reservoir received over 20 inches of rain, indicating high spatial variability in rainfall at a regional scale. Details of a site visit were arranged via email and telephone on the 4th and 5th of December. I met with Dr. James in Shingletown on the morning of 6th December, 2012. Dr. James transported me to the study site, where I witnessed a crew of field technicians and laborers preparing materials for the excavation of the sediment fences. We immediately started walking to fence #10, where I witnessed the following:

Fence #10 (Control): I estimated the mass of sediment in the fence at several thousand pounds (Figure 1). The eroded material appears to be primarily from extensive rilling and channel incision (Figures 2, 3, 4).

Figure 1. Sediment deposition in fence #10.

Figure 2. Depositional lobe at the front of fence #10. Channel incision is evident in the axis of the swale directly above the center of the deposit.

Figure 3. Converging rill networks at the head of the swale above fence #10. Channel incision occurs below the point of convergence.

Figure 4. Rill erosion and channel incision above fence #10.

Fence #9 (Control) - I estimated the mass of sediment in the fence at several thousand pounds (Figure 5). The eroded material appears to be primarily from extensive rilling and channel incision (Figures 2, 3, 4).

Figure 5. Laborers excavating sediment from fence #9.

Figure 6. Extensive rill erosion above fence #9.

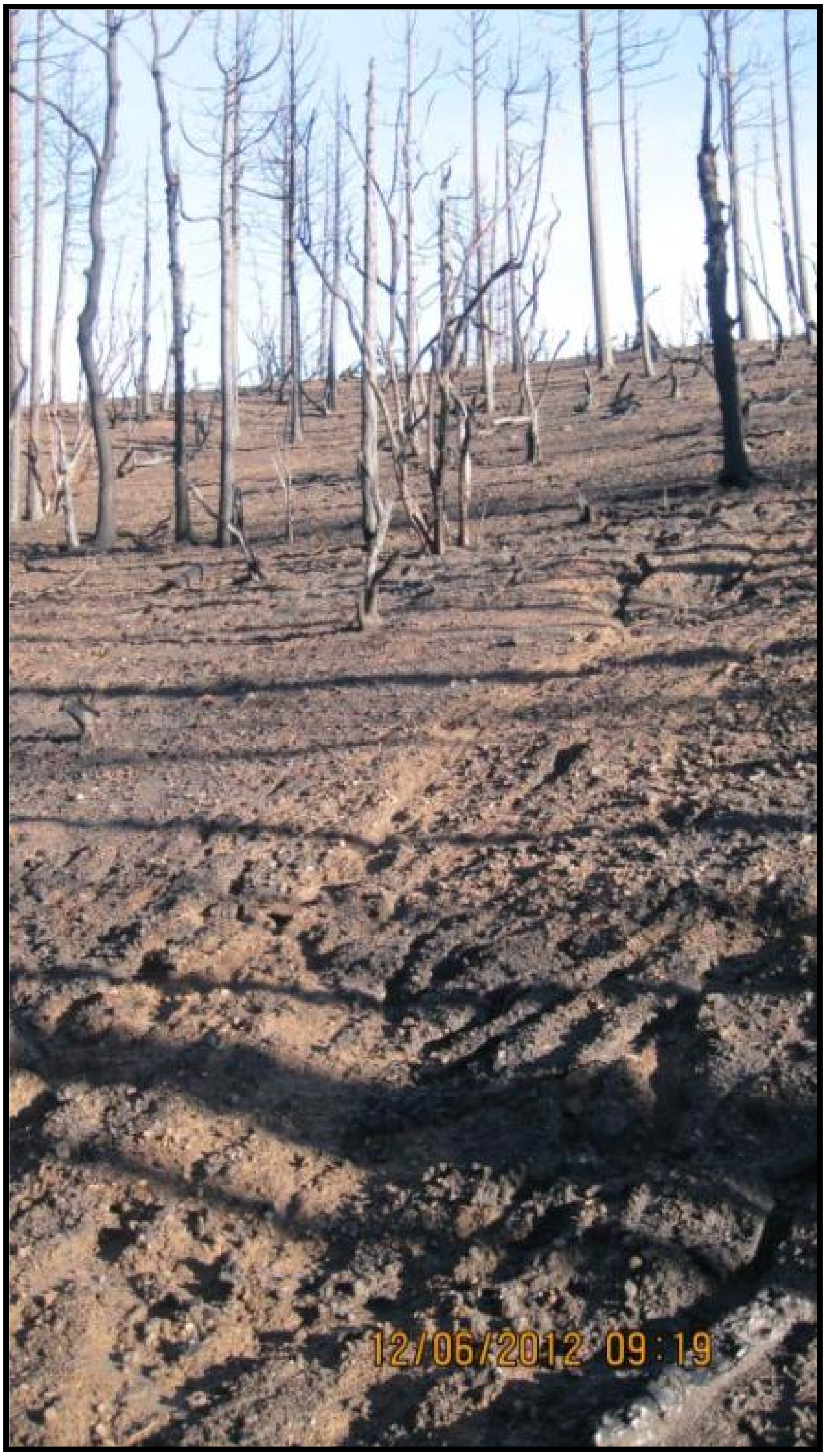

Figure 7. Rilling above fence #9. Note the coarsening of the hillslope surface due to sheetwash erosion.

Fence #8 (Control) - The fence was excavated prior to my arrival due to the near overtopping and buckling of the fence during the storms. The excavated material had been wrapped in sediment fence fabric and appeared to be several thousand pounds worth of material (Figure 8). The eroded material appears to be primarily from extensive rilling and channel incision (Figures 9, 10, 11, 12).

Figure 8. Excavated material from fence #8 wrapped in sediment fence fabric.

Figure 9. Channel incision and extensive rilling above fence #8.

Figure 10. Rill erosion above fence #8

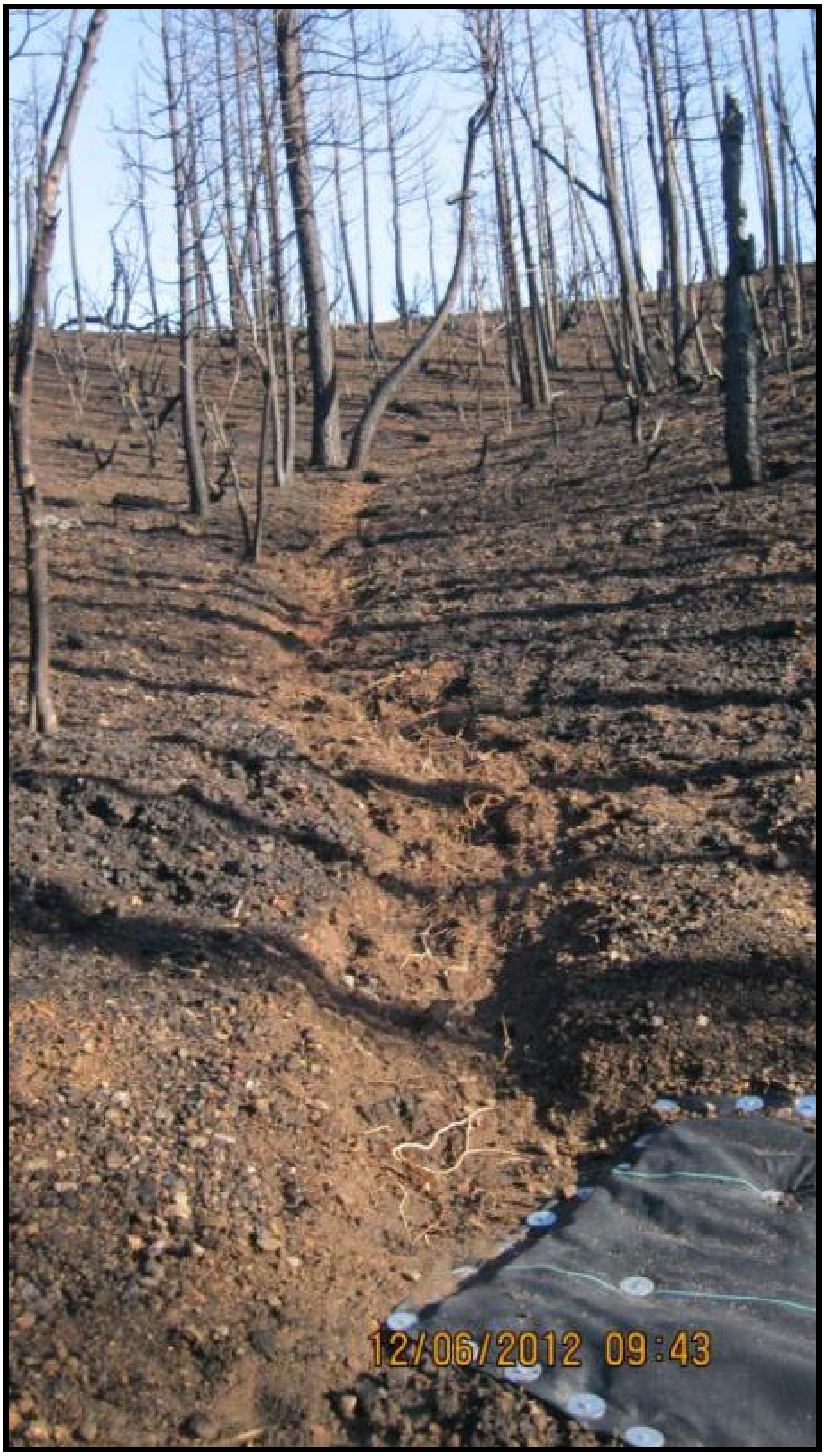

Figure 11. Channel incision above fence #8.

Figure 12. Rill erosion above fence #8.

Fence #7 (Logged, Standard Salvage, and Contour Ripped) – The deposited material in the fence was estimated at approximately 100 pounds (Figures 13 and 14), and the grain size of the deposited material was noticeably finer than the material in the control fences. The limited amount of erosion appears to be due to flowpath modification and increased roughness from the contour ripping. Contour ripping limited slope length, which in turn reduced the likelihood of rill erosion (Figure 15). Much of the material eroded via sheetwash was deposited in the contour furrows (Figure 16). Since the ripping was not done exactly on contour, runoff from furrows was directed to the axis of the swale. This resulted in limited channel incision in the lower part of the swale.

Figure 13. Sediment deposition in fence #7.

Figure 14. Sediment deposition in fence #7.

Figure 15. Contour ripping above fence #7.

Figure 16. A contour furrow above fence #7. Sheetwash from the hillslope was deposited in the furrow. Very limited rilling was observed between furrows.

Fence #6 (Logged and Standard Salvage) - It was difficult to estimate the mass of deposited material in the fence due to ponded water (Figures 17 and 18). However, after probing the ponded water with a stick, I estimated the relatively shallow depth of deposition to indicate several hundred pounds of sediment. Despite the fact that the swale was logged with ground-based equipment, there were relatively few tracks from the equipment (Figure 19), indicating that surface roughness was not significantly enhanced by the logging equipment. The relatively low mass of sediment in the fence can be attributed to the lower rates of rill erosion and channel incision (Figure 20).

Figure 17. Looking down at fence #6. Note the ponded water in the sediment fence.

Figure 18. Ponded water at fence #6. Probing with the stick indicated a relatively small mass of deposited sediment.

Figure 19. Equipment tracks from ground-based logging.

Figure 20. Hillslopes above fence #6. Note the relative lack of rilling and channel incision.

Fence #5 (**Logged, Standard Salvage, and Contour Ripped) -** The deposited material in the fence was estimated at approximately 100 pounds (Figures 21). The limited amount of erosion appears to be due to flowpath modification and increased roughness from the contour ripping (Figure 22 and 23).

Figure 21. Deposited sediment in fence #5.

Figure 22. Contour ripping above fence #5.

Figure 23. Contour ripping above fence #5.

Fence #4 (Logged and Clearcut) - The mass of deposited material in the fence was estimated at more than several hundred pounds (Figures 24). The hillslopes above the fence were more disturbed by logging equipment than fence #6 (Figure 25). I also observed more rill erosion on the steeper hillslopes directly adjacent to the fence (Figure 24). The tracks of the logging equipment appeared to disrupt the flowpaths on the hillslopes at the head of the swale. There were fewer equipment tracks on the steeper hillslopes at the base of the swale, and the ones observed went down the fall line of the hillslope (Figure 26).

Figure 24. Deposited sediment in fence #4. Note the rilling on the hillslope directly above sediment deposit.

Figure 25. Equipment tracks on the upper portion of the swale draining to fence #4.

Figure 26. Limited skidding occurred on the steeper, lower portion of the swale. Rill erosion is observable on these hillslopes and may account for the majority of deposited sediment in the fence.

Fence #3 (Logged, Standard Salvage, Contour Ripped) - The deposited material in the fence was estimated between 100-200 pounds (Figures 27). The limited amount of erosion appears to be due to flowpath modification and increased roughness from the contour ripping.

Figure 27. Sediment deposition in fence #3.

Figure 28. Contour ripping in the lower portion of the swale draining to fence #3.

Figure 29. Contour ripping in the upper portion of the swale draining to fence #3.

Fence #2 (Logged and Standard Salvage) – The mass of deposited material in the fence was estimated at several hundred pounds (Figures 30). The hillslopes above the fence were appeared to be minimally disturbed by logging equipment (Figures 31 and 32), and I did not observe significant alteration of hillslope flowpaths from equipment tracks. I observed mostly sheetwash erosion and some minor channel incision.

Figure 30. Sediment deposition in fence #2.

Figure 31. The upper portion of the swale draining to fence #2.

Figure 32. The lower portion of the swale draining to fence #2.

Fence #1 (Logged and Ripped) - The deposited material in the fence was estimated between 100-200 pounds (Figure 33). The limited amount of erosion appears to be due to flowpath modification and increased roughness from the contour ripping (Figure 34).

Figure 33. Sediment deposition in fence #1.

Figure 34. Contour ripped swale above fence #1.

Overall Observations: My overall observations from the inspection indicate that logged, salvaged, and ripped sites produce an order of magnitude less sediment than the unlogged controls. Despite some of the differences in site conditions, it is apparent in the field that contour ripping fundamentally changes the arrangement and length of flowpaths on the hillslope and therefore alters the dominant erosion process from rilling and channel incision to sheetwash. The additional surface roughness also provides a depositional environment on the hillslope.

It is less clear whether logging without ripping results in erosion reduction relative to unlogged areas. While the logged and unripped sites produced less sediment than the controls, the gentler slopes, less convergent topography, and different aspect may be responsible for some of the differences in observed erosion. Observations indicate that equipment tracks from logging machinery were relatively infrequent and did not provide strong visual evidence of modifying surface flowpaths and/or surface roughness. However, logging may have resulted in significant differences in surface cover, which is known to be an important control on post-fire erosion. Therefore, it is critical to review the data characterizing each swale to see if there are significant differences between the site scale variables critical for controlling erosion (e.g., drainage area, slope, degree of convergence, aspect) before the efficacy of the treatments can be fully evaluated.