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Effects of a Wildfire on Road-stream Connectivity and Road Surface Erosion

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Unpaved roads generate large amounts of sediment per unit area, and the impact of these high erosion rates depends on how much of this sediment is delivered to streams. In the western USA typically around 10-30% of the road length is connected to a stream, and this proportion tends to increase with increasing precipitation. Wildfires can greatly increase surface runoff and erosion rates, but we know of no studies that have evaluated how fires affect road surface erosion and road-stream connectivity. Hence the objective of this study was to quantify how: 1) fire severity affects the amount of road surface rilling, sediment deposition, and road-stream connectivity; and 2) how these effects are modified by road segment characteristics. The study area was 6.8 km of the unpaved Old Flowers Road just west of Fort Collins, Colorado, USA, as the forests along this road had burned in the 2012 High Park fire. Detailed data were collected for 141 hydrologically distinct road segments, including the hillslopes above the road, road segment characteristics, and the drainage features leaving the road.

Nearly all of the road segments had a planar design, and mean segment length and active width were 50 m and 2.4 m, respectively. The road segments below areas burned at high and moderate severity had significantly more and larger rills than road segments below areas burned at low severity, and this can be attributed to the greater surface runoff from upslope. Road segment slope was an increasingly important control on the amount of rilling as burn severity increased, while the flatter segments tended to capture the sediment eroded from upslope. Three-quarters of the road segments had only a single drainage feature, indicating that the road generally collected and concentrated all of the dispersed runoff from upslope. All of the road segments in areas burned at high and moderate severity and 78% of the segments in areas burned at low severity were connected to the stream. These exceptionally high connectivity rates are due to the increased runoff from upslope due to burning, the concentration of this runoff by the road surface to a single drainage point, and the reduced infiltration and trapping capacity of the burned area below the road. These results show: 1) the dramatic effect of burning on road-stream connectivity, and 2) the need to either outslope roads or increase the frequency of constructed drainage features after wildfires, particularly for steeper road segments in areas burned at high or moderate severity.