Appendix B

Risk of Cumulative Watershed Effects

Analysis Methods

The degree to which a watershed or subwatershed responds to a management activity or a natural disaster is considered when determining the risk of cumulative watershed effects. The inherent sensitivity of the watershed allows one to more clearly understand how a watershed may react to any proposed activity on the watershed. The sensitivity of each watershed was determined by analyzing each watershed for road density, road impact index, hydrologic soil group, mass movement hazard, erosion potential, compaction potential and slope. Each of these components were then assigned a coefficient based on the relative importance of each in determining the risk of cumulative watershed effects.

Road Densities and Road Impact Index

Roads have numerous impacts to the hydrologic function of a watershed. Roads can increase the drainage density of a watershed, acting as a preferential pathway for surface water runoff over the land surface. This decreases the volume of overland flow that infiltrates into the ground water or soil water storage. Runoff traveling down road beds can be highly erosive as it travels over a non-vegetated surface. The increased drainage density within a watershed due to roads increases the rate at which runoff leaves a basin, resulting in higher peak flows in times of snow melt or rainfall and reduced stream flows in the later summer months.

Roads may directly alter streams by increasing erosion and sedimentation, which in turn may result in altered stream channel morphology, and roads may alter the natural drainage characteristics of channels and subsequently change the runoff characteristics of watersheds (Furniss, et al. 1991). Roads can serve as a link between sediment source areas and streams, and often account for most of the sediment problems in a watershed. Water, sediment, and chemical runoff generated from the road prism can enter the natural stream channel network when the road is hydrologically connected to the stream channel. Some of the ways in which roads are hydrologically connected to the stream channel are at road-stream crossings, where discharge is sufficiently high to create a gully in the inboard ditch, and where the fillslope of the road encroaches on the stream.

Road densities are used as a measure of the overall hydrologic function of a watershed. According to ICEBMP watersheds with 1.7 (mi/mi^2) or less of road were functioning appropriately. Watersheds with 1.7 - 4.7 (mi/mi^2) of road were functioning appropriately, but at risk. And watersheds with greater than 4.7 (mi/mi^2) of road were functioning inappropriately.

Road Impact Index (RII) is a relative measure of the connectivity between roads and streams that exists within a watershed (Rosgen, 1996). Watersheds with a RII of less than 1 were functioning appropriately. Watersheds with a RII of 1 - 2.5 were functioning appropriately, but at risk. And watersheds with a RII greater than 2.5 were functioning inappropriately.

Hydrologic Capability of Soils
The soils that make up each watershed were broken into hydrologic soil groups that indicate the general infiltration and water movement ability of the soil and bedrock materials (Wenzel, 1979). Generally, hydrologic soil groups C and D are likely to generate stream flow. Hydrologic soil group A is made up of soils having high infiltration rates, when thoroughly wetted, these soils consist chiefly of deep, well to excessively drained sands and/or gravels. These soils have a high rate of water transmission and would result in low runoff potential. Hydrologic soil group B is characterized by soils with moderate infiltration rates when thoroughly wetted, these soils consist primarily of moderately deep to deep, moderately well to well drained soils, with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. The soils in hydrologic group C have a slow rate of water transmission and are characterized by slow infiltration rates when wetted. Group C consists of (1) soils with a layer that impedes the downward movement of water or (2) soils that with moderately fine to fine texture and a slow infiltration rate. Hydrologic soil group D is characterized by soils with a very slow rate of water transmission and very slow infiltration rates when wetted. Group D consists of (1) clay soils with high swelling potential, (2) soils with high permanent water table, (3) soils with clay pan or clay layer at or near the surface, and (4) shallow soils over nearly impervious materials. The percent of the subwatershed area that consists of soil group C and D were reported as they are streamflow generation areas.

The different soil groups are given an index factor that weights their relative contribution to surface runoff and sediment delivery within the watershed. The number of acres for hydrologic soil group C and D is multiplied by and index factor of 0.4 and 0.8, respectively in order to generate an index total. The index total was then converted to a percent of the subwatershed area and rated for overall sensitivity. Watersheds were rated high, moderate and low for greater than 40%, greater than 15% and less than or equal to 40%, and less than or equal to 15%, respectively.

Erosion, Compaction and Mass Movement Hazard
Soil mapping units are characterized in the Fremont LRMP (1989) into soil capability areas. These soil capability areas are further described as having a low, moderate or high potential for erosion, compaction and mass movement. Watersheds were described by the percentage of the watershed rated as low, moderate and high. And given an overall rating for each category based on the potential in the majority of the watershed.

Hoof action on soils may result in localized compaction and displacement. Compacted soils reduce infiltration and increase overland flow, increasing the potential for erosion and loss of displaced soils. In this manner, the resistance of the soil to compaction and erosion relates to the resiliency of the watershed to cattle grazing. However, the resistance of the soil to compaction and erosion does not directly relate to the likelihood of hoof shear along streambanks. The occurrence of hoof shear is a function of soil saturation, vegetation type and amount, bank angle, channel material and type.

Slope

Slope can have a magnifying effect on sensitive areas within a watershed. For example, a soil type that is prone to mass movement will have a greater likelihood failure if it is located on a steep slope. Additionally, mid-slope roads have a greater potential to accelerate the runoff from a watershed than roads located on level ground. For this analysis, the percentage of a watershed that had greater than 20% slope was calculated. Watersheds were rated high, moderate and low for greater than 50% of the watershed, greater than 20% and less than or equal to 50% of the watershed, and less than or equal to 20% of the watershed, respectively.

Prepared by:___________________________

Jill Ralston
South Zone Hydrologist
Fremont-Winema National Forest

Literature Cited

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. American Fisheries Society Special Publication. 19:297-323.

Interior Columbia Basin Ecosystem Management Project (ICBEMP). 1997.
Evaluation of the EIS Alternatives by the Science Interaction Team: Volume II. USDA Forest Service and USDI Bureau of Land Management. Gen Tech. Rep. PNW-GTR-406.

Rosgen, D.L 1996. Applied River Morphology. Wildland Hydrology. Lakewood, Colorado.

Strahler, A.N. 1964. Part II Quantitative geomorphology of drainage basins and channel networks, In: Ed. Ven Te Chow) Handbook of Applied Hydrology. McGraw-Hill Book Co. New York, N.Y.

USDA Forest Service. 1989. Land and resource management plan. Fremont National Forest. Lakeview, Oregon.

Wenzel, D.L. 1979. Soil Resource Inventory, Fremont National Forest. USDA Forest Service.