Geologic and Geomorphic Evaluation

Salt Timber Harvest and Fuel Hazard Reduction Project

Shasta-Trinity National Forest

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Salt Timber Sale
Geology, Geomorphology and Mass Wasting Features
3/7/06

Affected Geologic Environment

The Salt project area lies within the Rattlesnake Creek terrane which forms part of the western Paleozoic and Triassic belt of the southern Klamath Mountains. The Rattlesnake Creek terrane is named after Rattlesnake Creek, which crosscuts much of that terrane in the Pickett Peak and Dubakella Mountain quadrangles.

In a *regional* perspective, Irwin (1972) has described this terrane as consisting predominantly of: serpentinized ultramafic rocks, gabbro, diabase, pillow lavas and other mafic volcanic rocks, phyllite, thin-bedded chert, discontinuous lenses of limestone and locally interbedded sandstone and pebble conglomerate. These rocks are generally considerably disarrayed by folding and faulting. The prevailing character of the terrane is that of a dismembered ophiolite suite (melange). Plutons that range from hornblende diorite to biotite-hornblende-quarts diorite are sparsely scattered throughout the terrane.

Most ultramafic rocks associated with rocks of the Rattlesnake Creek plate lie within the plate, but some are present along the northwest-trending wrench faults that locally border the thrust plate. These ultramafic rocks can occur as sporadic sheared lenses or as more extensive masses generally trending northwest. The larger bodies are serpentinized peridotite with sheared margins, while the smaller bodies appear to be largely serpentinite.

Locally within the project area the dominant rock types are meta-volcanic or terrigenous phyllites, and peridotite which has been locally sheared to serpentinite along its margins and along fault zones. Several faults are postulated to separate the larger peridotite and serpentinite units from the meta-volcanic units.

Mass Wasting Features

Due to the nature of the rocks mass wasting occurs naturally within this area. Mass wasting has played a dominant role in shaping the geomorphology. In a couple of instances the processes which contribute to mass wasting are presently active (such as in section 8) in most however these are dormant (refer to geomorphic maps filed together with this report).

By far the greatest occurrences of mass wasting features within the project area are dormant rotational/translational slides of Pleistocene age (1056/1076)[1]. This type of slide is characterized by movement of a coherent mass over a discrete, broadly concave failure surface. Most slides have occurred in association with at least one of the following:

[1] These numbers are geomorphic codes employed in the geomorphic mapping.

serpentinized shear zones, faults, lithologic contacts or especially wet zones such as inner gorges.

Internested rotational landslides (1250) occur in proximity to perennial and some ephemeral drainages. Such slides commonly creep gradually, but where undercut by a road or drainage will slide out rapidly.

Valley inner gorges (1260) are defined as those slopes adjacent to channel margins having gradients in excess of sixty-five percent. Fundamentally, the valley inner gorge is formed through mass wasting triggered by channel downcutting, oversteepening and undercutting. Small scale valley inner gorges occur throughout the project area.

Critical Questions:

Since *the resource objective is to maintain geomorphic process at natural levels*, the areas of each Alternative were evaluated for its potential to increase, maintain or decrease natural landslide process rates. To help guide the evaluation several critical questions initially were asked of the investigation:

- Is there evidence of, or potential for mass wasting in these areas?
- What mass wasting *processes* are active?
- What areas of the landscape or infrastructure are susceptible to slope instability?
- How are mass wasting *features* distributed?
- What are the physical characteristics associated with these features (i.e., cause). Are the *features* active?
- Do/will landslides deliver sediment to stream channels or other waters?
- Do, or will proposed management activities create or contribute to instability?
- Will avoidance, prevention or corrections of unstable features be most practical with respect to the described "purpose and need" for the project.
- Where correction is required, what is the amount of remediation needed to maintain stability for reasonably foreseeable future conditions?

Methods

Mass Wasting Hazard Zonation: Levels of Analysis

A mass wasting hazard[2] zonation consists of two different aspects: assessing the susceptibility of the terrain for slope failure, and determining the probability of a specific triggering event occurring.

Several levels of evaluation were incorporated. First a broad-scale level of analysis encompassing the project area was used based upon aerial photo interpretation and initial field review. Mass movement features associated in time and space with logging or roading activities are assumed to be caused by forest practices.

At this stage of analysis the distribution and density of mass wasting features are first mapped[3] on 1944 (B&W) 1970, 1980, 1983 (color infrared) and 2003 vintage aerial photos and the mass wasting processes identified. Analysis of the area during various decades was performed to better identify the distribution, timing, and relative size of mass wasting processes and their relationship with forest practices. The 1944 aerial photo set essentially depicts pre-logging conditions. The 1970 set depicts conditions after major logging operations of the late sixties. These photo sets also capture the major wet years of 1952-53/1955-56/1964-65/1969-70/1971-72/1973-74/1994-95/1997-98. Scale of photography ranged from 1:15840 to 1:60000.

An interpretation of the mass wasting hazard potential is then made by associating the occurrence of landslides with geologic, hydrologic or terrain features.[4] Other (extrinsic) factors included in the analysis are: (1) location of harvest *and* fuel break units as related to terrain features; (2) total acreage of proposed disturbed area; (3) proposed harvest methods; (4) unit silvicultural prescription; and (5) amount of temp road construction or reconstruction. *This latter factor also included slope positions of roads and the amount and size of landings.*

Because the spatial distribution of the variables within a given area usually determines the spatial distribution of relative landslide susceptibility, these associations form the basis for the mapping of mass wasting hazard map units in the watershed. Potential mass wasting map units are drawn for each area with similar mass wasting characteristics and triggering mechanisms. These mechanisms are the specific processes that appear to contribute to mass wasting. Unique units are created if the mass wasting processes are

[2]"Mass wasting hazard" used herein uses the definition of Varnes (1984) as being the probability that a potential damaging phenomenon may occur within a given area in a given period of time. Probability is a relative indicator of risk and can also be used to estimate probable consequences. Studies done on **clear cuts** indicate that this time period can extent up to twenty years, with the highest probability occurring 4 to 10 years after logging. The potential decreases with time with the concurrent revegetation. After twenty years the occurrence of landslides returns to pre-logging levels. Megahan et. al.,1978). There are no definitive time studies for partial cutting.

[3] This includes the nature, size, location and history.

[4] Specifically these can include: mass wasting features, bedrock type, structure, geotechnical properties or behavior, slope range, position and aspect, hydrologic and seismic conditions ,run-out behavior, slide location with respect to the nearest drainage system (intrinsic variables) and, probably most importantly rainfall and climate, (extrinsic variables).

similar (i.e., shallow debris flows) but the triggering mechanisms are different (i.e., roads versus loss of root strength on hillslopes).

No one of the factors delineated are used by themselves, but are evaluated in conjunction guided by the landslide distribution, and geomorphologic analysis. The mass wasting potential for the units are thus qualitatively rated, guided by criteria based on the foregoing information *and* field evidence according to the likelihood of occurrence. These ratings determine the level of "potential hazard".

Overall, a high level of confidence in mapping accuracy can be applied to the study area, nevertheless this is a subjective and relative rating meant only to *compare* different mass wasting features within the area and guides the subsequent site specific analysis.

Extreme hazards are defined for all active slides, regardless of their type. Some of the features in Section 8 were rated in this category, along with all valley inner gorges.

Moderate to high hazards are defined for some translational/rotational areas. Within these areas it is judged that there can be a relative probability of initiating some category 1,000 cubic-yard landslides through intensive management if proper mitigation was not maintained.

Moderate to low hazards are defined for crown scarp areas of translational and rotational type landslides in addition to most debris slide prone slopes. Perennial streams are common in these areas and ephemeral channels also carry significant seasonal flows. Most mass wasting processes are presently dormant and should remain so until the inner gorge zone migrates into these.

It should be noted that this zonation method is generalized. The possibility thus exists of differing hazard levels occurring within these general zones at a scale that cannot be totally captured by this scale of analysis. These latter are later incorporated at the site-specific scale of analysis.

Assumptions

During this assessment the following assumptions were made:

- The past actions within similar terrain and geology (specifically within the current project area) should be indicative of future consequences
- The main conditions that cause landsliding can be identified
- The degree of instability hazard can be closely estimated using the foregoing information *and* field evidence

- Greater projected mass wasting hazard levels should be indicative of potentially greater impacts to site productivity and water quality

- The greatest cause of accelerated landslide activity is road construction, and the major influence of road construction on instability is the volume of excavation required for construction which is directly proportional to road standard[5]

- Different logging systems and harvest prescriptions affect the environment to a greater or lesser extent and in varied ways

With respect to the latter factor, research has commonly concluded that a very important effect of forest disturbance on slope stability is loss of cohesive soil strength when reinforcing roots die and decay (Burroughs, 1984; Sidle, 1992; Dietrich et al., 1995). Keim and Skaugset (2003) also found that maximum intensities of precipitation were generally reduced under forest canopies due to the effects of "smoothing" by these canopies.[6] Modeling soil water pore-pressure responses of a hypothetical hillslope to field data resulted in estimates of slope stability that were generally greater under forest canopy than for the same hillslope without forest canopy. A study by Megahan et. al., (1978) seems to indicate that landslide frequency increases only slightly as over-story crown cover is reduced from 100% to 11%, but for crown cover reduced below 11% a major increase in landsliding occurs[7].

Thinning prescriptions for harvest units for this project are anticipated to retain a *minimum* of fifty-percent crown canopy, and no treatment would occur within perennial fish-bearing Riparian Reserves, nor within inner gorge areas, or within an estimated 50 feet of the high water mark of intermittent and ephemeral Riparian Reserves; essentially avoiding potential debris flow hazard zones.

Environmental Consequences

A *secondary* site-specific level of analysis was incorporated whereby all harvest and fuel break units were individually ground surveyed and evaluated. At this stage a detailed field analysis addresses the specific problems identified at the previous level. Specifically the relationships between proposed

[5] Megahan (1978) page 131, found that slide density approximately doubles for each step in road standard above the terminal road standard.

[6] As a whole the forest canopy reduces the action of climatic agents on the natural mass in a manner favorable to the slope stability by: 1) intercepting and protecting the mass from the action of rain (2) retaining a considerable amount of rain water by wetting the large surface made up of leaves, branches, trunks and associated epiphytes and eliminating the water as vapor (3) eliminating, as vapor, a large amount of water from the mass by evapotranspiration (4) vegetal debris on the forest floor also immobilizes a large amount of water and cuts down on runoff and erosion.

[7] Megahan et.al (1978) figure 9, page 132.

land use activities and landslide processes are identified more accurately and precisely and with greater spatial resolution.

All areas and road locations demonstrating instability or potential instability were identified, flagged **and deleted from further consideration.**

The project design within the project area resulted in excluding all unstable or potentially unstable areas through individual unit layout, prescription, and road location modification. **No direct or indirect effects[8] to land stability are therefore anticipated from the action alternatives**.

Cumulative Effects on Land Stability

Geographic Bounding:

The cumulative analysis provided for this project considered the project area. It did not evaluate cumulative effects on a broader area landscape.

The rational for bounding at the project scale is because *the direct and indirect impacts to slope instability occur at that scale.*

Since no direct effects are expected, no cumulative effects are anticipated.

[8] As defined "indirect effects" are caused by the action and are later in time or farther removed in distance, but still reasonably foreseeable. This analysis has reviewed not only the chances that a landslide may form at a particular place (unit, proposed road, etc) but also the chances that an action from further upslope may form a landslide downslope or that a landslide from farther upslope may strike further downslope. Direct impacts can be measured in terms of soil losses at the slide source or in the cost of repairing road fill failures, road stabilization or of removing landslide material. Indirect impacts can include the blocking of downstream culverts which can in turn cause the road to wash out or deposition of slide material in a stream channel which can divert the flow and cause stream bank erosion. In other instances downstream sedimentation may cause reservoirs to be filled and damage aquatic ecosystems.

Literature Cited

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1/29/07

Salt Proposed Timber Sale
Geology Notes per Unit
Current to 7/20/06

Unit

1 Checked. No instability.

2 SMZ flagged along Ditch Creek. Some ancient landslides in evidence here, these were flagged out. SMZ between unit 2 and 3 flagged to road 30N07. Five additional unnamed ephemeral draws flagged. Two wet boggy areas flagged out; one adjacent to highway 36 and an ephemeral draw, and another adjacent to power line.

3 Checked. No instability

4 Checked. Ephemeral creek flagged out along eastern boundary.

5 Western ½ of unit flagged out due to potential instability (wet, boggy, ancient nested landslides). This latter area should be designated a Riparian Reserve.

6 Checked. No geologic concerns

7 No instability

8 Wet meadow area along the northeast portion adjacent to highway 36 (forms part of a large translational bench). This area has been flagged out. Eastern boundary formed by draw has been flagged.

9 Unit 9 (West) contains two small dormant landslides which have been flagged out. SMZ along unnamed creek has been flagged. Unit 9 (mid) has an unnamed creek; the SMZ has been flagged.

10 Two draws within unit. Two 75’ SMZ have been flagged.

11 Three ephemeral draws within unit. Westernmost flagged. No cut within SMZ.

12 Unnamed ephemeral draw within unit flagged to road 30N27

13 SMZ of unnamed ephemeral draw along the west of unit flagged along with tributary draw.

14 Western portion of unit between creek and plantation flagged SMZ along creek; some inner gorge mass wasting in evidence.

15 15 (west) recommend dropping portion between creek and plantation. Portion of unit between roads 30N14 and 30N27 delete portion from creek to watershed flagging; area nested. Delete the easternmost portion of unit.

16 Unchecked; deferred

17 Eastern 1/3 to ½ is active mass wasting. This area is flagged out to old temp road on north end. Area below this temp road is steep and also demonstrated potential instability. This area has also been flagged out to road 30N18B.

18 Northwest boundary along a gully has been flagged in white/blue stripped flagging.

19 Ephemeral draw along northeast. SMZ flagged.

20 Checked. No instability

21 No instability

22/23 SMZ of ephemeral draw and tributary flagged. SMZ of former flagged to temp road located in unit 23.

24 Checked. Okay

25 No instability

26 Eastern area near creek shows mass wasting. Recommend moving boundary to west congruent with watershed flagging. Creeks on west and middle still need to be flagged.

27 Unchecked

28 Active mass wasting from middle of unit to Hwy. 36; flagged out.

29 Deferred

30 Potential mass wasting from road 30N18 to watershed flagging. This area has been flagged out.

31 Deferred

32 Checked. Ephemeral draw needs to be flagged. Otherwise okay.

33 Checked. Okay.

34 Deferred.

35 Small area adjacent to road 29N55, approximately 2 acres, flagged out due to potential mass wasting. Three ephemeral draws with debris flow deposits located in the southeast portion of unit flagged out.

36 Unchecked

37 About 5 acres of potentially unstable mass wasting located in the southern portion of unit adjacent to and above road 30N28. This area has been flagged out.

38 Deferred

39 Deferred

40 SMZ along ephemeral draw in middle of unit and along western boundary has been flagged out.

41 Deferred

42 Deferred

43 Deferred

44 Deferred