State of California

The Resources Agency

Memorandum

To: Mr. Dave Driscoll, Region Chief
Northern Region
135 Ridgway Ave.
Santa Rosa, California 95401

Date: March 15, 2004

Telephone: (916) 653-9455

Attention: Ms. Leslie Markham, Resource Manager
Forest Practice, Coast Area Office

From: **Department of Forestry and Fire Protection**
Sacramento Headquarters

Subject: THP No. 1-03-173 SCR
Hydrologic Review

This memorandum reports the results of a field inspection of THP No. 1-03-173 SCR held on March 11, 2004. This was a focused Pre-Harvest Inspection (PHI) inspection that followed two previous PHIs and took place prior to the CDF Second Review of the THP. It is limited to comments regarding the Class II watercourse protection zone. Specifically, I was asked to help evaluate if the trees marked in the Class II WLPZ were in the channel zone as defined by the California Forest Practice Rules, and to determine if the mark in the Class II was appropriate based on watershed processes such as large wood recruitment and bank stability. Participants for the field inspection held on March 11, 2004 included:

Peter Twight	RPF, Redwood Empire
David Van Lennep	RPF, Redwood Empire
Bill Arkfeld	Central Coast Regional Water Quality Control Board
Kent Aue	Department of Fish and Game
Kris Vyverberg	Department of Fish and Game
Richard Fitzpatrick	Department of Fish and Game
Donna Bradford	County of Santa Cruz
John Schlosser	California Geological Survey
Angela Petersen	CDF, San Mateo-Santa Cruz Unit
Pete Cafferata	CDF, Sacramento Headquarters

Field Observations

The field team walked the entire stretch of the Pryce Fork of Ramsey Gulch adjacent to the THP boundary, a Class II watercourse, during the afternoon of March 11th. The total distance traversed was approximately 1800 feet, beginning at the northeast corner of the THP and ending at the western edge of the plan. Almost the entire area along this channel is planned to be cable yarded, due to side slope gradients of approximately 65 percent or more. Numerous older landslide features were noted on the landscape as we moved down the channel and observed the watercourse protection zone. For the vast majority of reach walked, the channel gradient was very steep (20% or greater). Boulders present in the channel were commonly 1 to 3 feet in diameter and the channel was found to be boulder/bedrock controlled (Figure 1). For one 100 to 150 foot stretch, the channel gradient was approximately 5 to 7 percent.

The channel is incised and well confined by the valley walls, and is a transport reach for sediment due to its steep gradient (Figure 2). For much of the channel, large pieces of wood were scarce. Some areas had small pieces present, sometimes forming organic debris steps, and one large madrone tree appears to have entered the channel in the past 2-5 years (Figure 3). The channel base level along this reach is controlled by boulder accumulations. Therefore, large wood is not needed here to prevent downcutting and overall channel lowering. Large wood will have little influence on channel form from this fluvial geomorphic perspective.

The field team concluded that it is very unlikely that the channel will have sufficient stream power to transport large pieces of wood down to the fish-bearing Class I watercourse below. Small branches and chunks of broken logs may be exported, but long segments of logs will remain in place. Debris torrents are a possible mechanism for wood transport down into much larger streams, but Mr. Schlosser commented that he did not think this channel was a likely candidate for debris torrents, since evidence of past torrenting was absent. Debris torrents are a primary large wood transport mechanism in small, steep low order tributaries, while floatation is the primary mechanism in larger channels (Lassettre and Kondolf 2003).

We had considerable discussion regarding what constitutes the channel zone in a confined situation, as defined by the Forest Practice Rules (FPRs). Clearly in tightly confined channels, floodplains are not present and secondary indicators, such as vegetation or other evidence of flood flows is needed to determine bankfull width and depth (WFPB 2001). The FPRs state the channel zone extends to the edge of the watercourse transition line (WTL). For confined channels, the WTL is defined as "*that line that is the outer boundary of a watercourse's 20-year return interval flood event floodplain. This outer boundary corresponds to an elevation equivalent to twice the maximum depth of the adjacent riffle at bankfull stage. The bankfull stage elevation shall be determined by field indicators and may be verified by drainage area/bankfull discharge relationships*" (14 § CCR 895).

In deliberations held 1-2 years ago, Board of Forestry and Fire Protection (BOF) determined that roots alone in a channel do not mean that that the tree itself is in the channel zone (note that these discussions were primarily regarding Class III watercourses and resulted in rule changes) (D. Hall, CDF, Acting Chief of Forest Practice, Sacramento, CA, per. communication). Clearly, however, other issues besides observing roots in the channel can necessitate leaving conifer trees very near the channel zone—including bank stability, large wood recruitment, shading, etc. If a lack of large wood is determined to be a significant issue, it is inappropriate to harvest trees that have a high potential to enter the channel. Similarly, if redwood clumps are contributing to bank stability, it will be appropriate to leave some of these trees standing, even though they are not in the channel zone. Thinning clumps of redwoods can accelerate growth on the remaining stems (Lindquist 2004), allowing larger trees to eventually be input into the channel—producing higher value, more structurally stable pieces of wood.

We encountered several trees that were immediately next to the incised channel that did qualify as channel zone trees and had not been marked (Figure 4). We found the FPR rule for confined channels related to the channel zone hard to apply in many instances, however, due to the inability to determine clearly where the bole of the tree ends and the roots and/or root ball begins. Based on discussions held during the previous PHIs for this THP, four trees/tree areas where marking had occurred were identified as questionable regarding the channel zone FPR interpretation. We reinvestigated these areas during this focused PHI.

<u>Observations at Specific Marked WLPZ Tree Sites</u>

At tree site 1, where we began our field observations, we estimated that the elevation of the water of a riffle area would be approximately 12 to 14 inches higher than the depth currently present, and two times this depth would be 24 to 26 inches above the existing water elevation. The marked redwood tree (approximately 30 inches at dbh) was found to be considerably higher than this on the hillslope. Therefore, we concluded that this tree was not in the channel zone. No sediment marks were observed on the tree from past flood events. Four floods of 20 year recurrence interval or higher have occurred in the Corralitos Creek drainage since 1982 (see Figures 5 and 6, and the following discussion section).[1]

At tree site 2, a large redwood stump cut about 100 years ago is adjacent to the channel, and a second-growth redwood tree approximately 30 inches in diameter that sprouted from the old-growth tree is set further back from the channel. Ms. Vyverberg of DFG expressed the opinion that this was really one structural unit and that an old debris slide area located on the hillslope above the tree provides further justification for retention of this tree. My opinion is that the live redwood is clearly out of the channel zone and is not required for bank stability since the old growth stump is structurally sound. It is also clear that numerous large redwoods are not marked in the old debris slide feature, so that a future failure would still input abundant large wood to the channel in the event of a reactivation of the slide area. Redwood root dieback of about 40% (<25 mm [~ 1 inch] roots only) is likely by about the end of the first decade following cutting, and will then begin to increase again (Ziemer and Lewis 1984) (see discussion on redwood root dieback in the following section).

At tree site 3, a 30 inch dbh (approx.) redwood tree is located near the stream channel where active streambank erosion/bank cutting is occurring through old debris slide deposits. It was the opinion of the agency personnel present that this tree has a high likelihood of falling into or across the channel in next five years, and should not be marked for removal. The location of this tree along with active bank erosion makes this

[1] Mud or sediment marks were not found on any of the redwood trees growing out of the incised channel along this reach. High water sediment marks on redwood trees in other locations are known to have lasted for at least four decades.

a good candidate for recruitment of future large wood (Figure 7). Mr. Twight agreed to unmark this tree.

At tree site 4, we observed an area where a large old landslide had deposited abundant sediment and large wood. A side channel exists at a somewhat higher elevation than the main channel which is currently flowing water, and is probably related to the landslide feature. The side channel had a slight amount of flow, but was covered with organic litter and did not have evidence of recent significant discharge. An elevated area exists between the two channels with large redwood trees that had been marked for harvest (Figure 8). Additionally, a 20 inch (approx.) redwood was marked near the head of the side channel that currently helps to anchor the debris jam blocking the side channel and stabilize the adjacent hillslope area above. Numerous suppressed small redwoods are part of this redwood clump as well. After a lengthy discussion, Mr. Twight agreed that the side channel area, as well as the elevated area between the main channel and the side channel, should all be considered to be in the channel zone. He agreed to unmark the three trees in the elevated "island area," the 20 inch dbh tree near the head of the side channel, and the very large (50 inch+) redwood in the center of the side channel.

Background Information and Discussion

Large Wood Recruitment

The Department of Fish and Game representatives present in the field stated that they were particularly concerned about future recruitment of large wood into the Class II channel, particularly for storage of coarse bedload sediment and increased overall biological productivity. Mr. Aue stated that large wood provides substrate for non-fish organisms and helps supply nutrients to the channel system (see Lassettre and Kondolf 2003 for additional discussion of large wood, nutrient dynamics, and stream ecology). They also expressed concern over appropriate late seral stage development in the Class II WLPZ.

Benda (2002, 2004) has reported on large wood in second-growth redwood watersheds for two North Coast basins. He has found very high spatial and temporal variability in large wood input. Benda (2002, 2004) states that if the goal is to recruit large wood to the channel, then it is critical to determine the dominant large wood input mechanism operating along fairly short reaches of stream channel. Input mechanism possibilities include windthrow/mortality, landslides, bank erosion, and anthropogenic (logging-related) causes. The source distance is highly controlled by recruitment process (Benda 2004). Where bank erosion is the dominant mechanism, it is likely that in second-growth redwood forests the majority of the trees will enter from the approximately the first 25 to 33 feet from the edge of the channel. Where landsliding is the key process, 90% of large wood will likely be produced from the first 200 feet (Benda 2003). In small colluvial channels draining steep hillslopes, processes associated with slope instability have been found to dominate large wood recruitment (May and Gresswell 2003).

Based on our rapid field reconnaissance, the dominant input mechanisms for large wood over the past 100-200 years in this part of the Pryce Fork channel have been landsliding and past old-growth logging activities. Bank erosion and mortality/windthrow appear to be much less important processes. While a comprehensive inventory of large wood in the channel was not undertaken, it was clear that greater than 50 percent of the pieces of wood of significant size currently in the channel are the result of past historic logging activities (Figure 9). It is my opinion that the selective mark required in Santa Cruz County THPs, as well as the conifers retained in the WLPZ, will supply abundant large wood when large landslide events occur in this drainage.

Flood Recurrence Intervals

Recurrence intervals for flood events can be determined relatively easily for USGS gaging stations through the use of PEAKFQ, a USGS produced computer software program available online that performs a flood-frequency analysis based on Bulletin 17B, which is the accepted methodology published by the Interagency Advisory Committee on Water Data. It is available from the USGS website at: http://water.usgs.gov/software/peakfq.html. The USGS gaging station for Corralitos Creek at Freedom was used to determine recurrence intervals for recent flood events in this drainage (see Figures 5 and 6).[2] Using the USGS PEAKFQ software program and its output for this station, I determined the following approximate return intervals: 1982 --70 yrs; 1986--55 yrs; 1997--20 yrs; and 2000--30 yrs.

Second Growth Redwood Root Dieback

Unfortunately, relatively little work has been completed on second-growth redwood root decay following harvest. Ziemer and Lewis (1984) completed a brief unpublished retrospective study of root dieback in coast redwood. Root biomass in several different ages of cutblocks and second-growth stands were plotted along with that found in old-growth forests. Live less than 25 mm (approx. 1 inch) redwood root biomass reached a minimum 11 years after logging. Thereafter, it gradually increased to pre-logging levels by age 65, except in the layer below a meter in depth. They reported that for redwood, root biomass dropped 42% in 11 years and thereafter began to increase again. Live root biomass declines, but does not drop to zero, after logging as coast redwood roots come into equilibrium with the drastically reduced above ground biomass. In forested areas, the influence of root reinforcement is limited to the depth of root penetration and the cohesive properties of the parent material (Cafferata and Spittler 2004).

Conclusions

With the agreement reached at the conclusion of the focused PHI between the RPF, Mr. Twight, and Forest Practice Inspector Petersen (i.e., unmarking 6 redwood trees), I conclude that adequate numbers of large redwoods will be retained for future recruitment of large wood into the channel. It is clear that the main input mechanisms

[2] There is no regulation above this gaging station site, but the Watsonville Water Works can divert up to 8.0 ft^3/s upstream from the station for municipal supply, domestic use, and irrigation. The station is located 2.3 miles north of Watsonville and has a drainage area of 27.8 mi^2.

for this very steep gradient, boulder-controlled channel have been landslide activity and historic old-growth logging activities. When future large debris slides are triggered by very wet soils in combination with very intense rainstorms (Cafferata and Spittler 1998), as well as possibly recent earthquake activity (T. Spittler, CGS, Santa Rosa, per. communication), it is clear that the selectively harvested slopes in both the Class II WLPZ and on the hillslopes above the WLPZ will have sufficient post-harvest stocking of large conifers to allow adequate large wood input to this steep gradient, boulder-controlled channel.

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Peter H. Cafferata
Forest Hydrologist
RPF No. 2184
CPESC No. 417

Figure 1. Representative stretch of the incised, confined boulder-controlled Class II watercourse channel.

Figure 2. Pre-Harvest Inspection team examining the Class II watercourse channel and WLPZ mark. Note boulders, small wood, and limited large wood in the channel.

Figure 3. Mr. Schlosser examining a recently deposited madrone tree in the Class II channel. This was the only recently deposited large tree observed within the 1800 foot reach.

Figure 4. Mr. Twight standing next to a redwood tree that was determined to be within the channel zone.

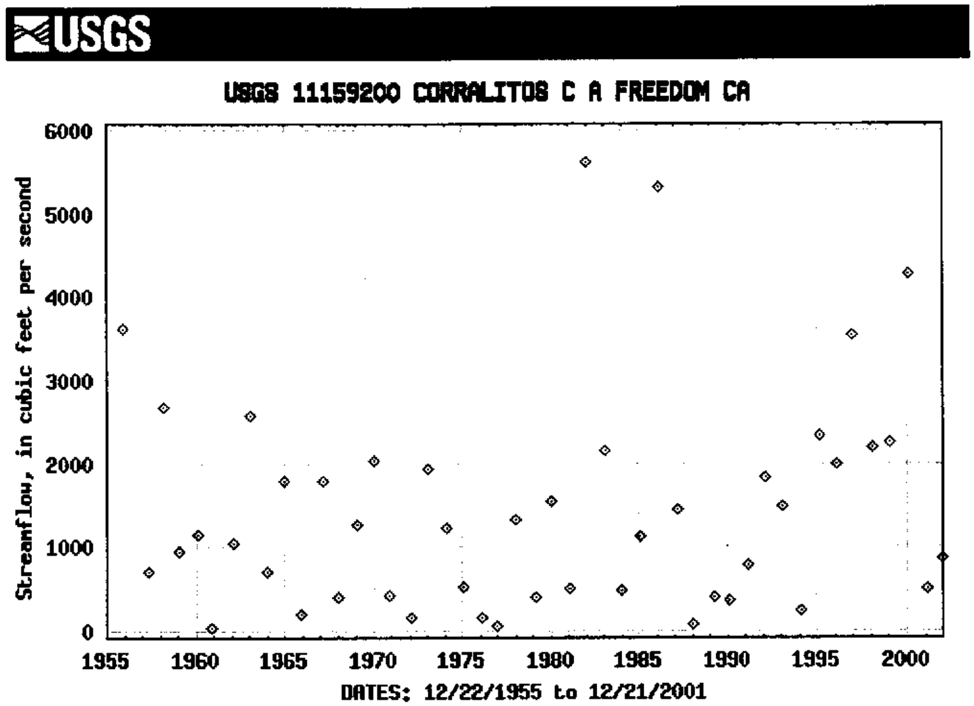

Figure 5. Annual peak discharges for the Corralitos Creek at Freedom USGS gaging station

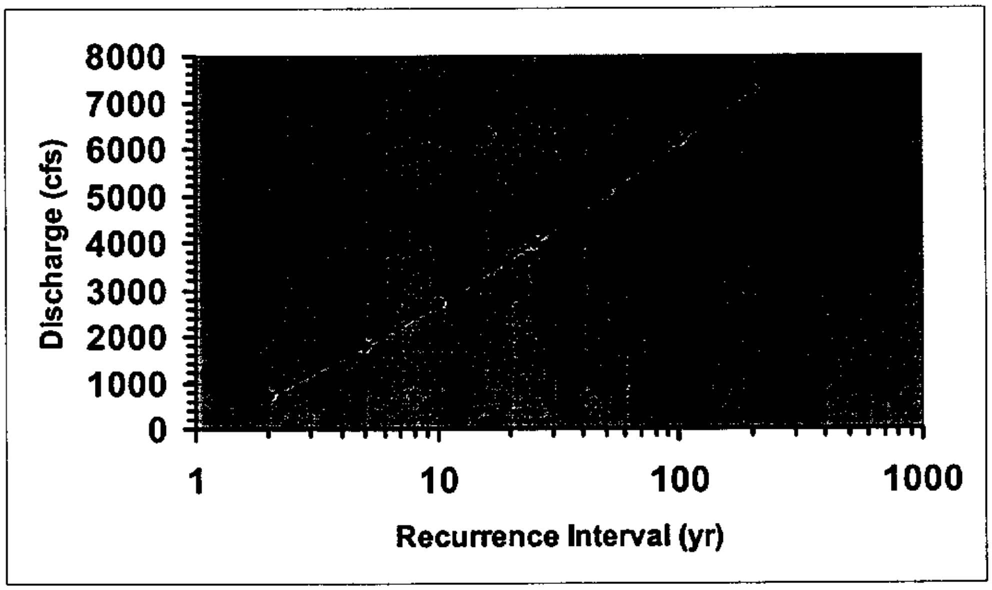

Figure 6. Plot of recurrence intervals and corresponding discharges for flood events of varying magnitudes, Corralitos Creek at Freedom (data determined using the USGS PeakFQ software program).

Figure 7. Mr. Schlosser and Mr. Aue examining the loose, porous debris slide material that is actively being eroded by the channel, with tree No. 3 at high risk for toppling situated on the deposit. The RPF agreed to unmark this large redwood and allow it to be a recruitment tree.

Figure 8. Large redwood trees, some of which had been marked, located in an elevated area between the main channel and a side channel. These trees were determined to be within the channel zone due to the existence of the expanded channel zone here. The marked trees within the expanded channel zone here were agreed to be left.

Figure 9. Debris jam area where abundant large wood was observed, located in the lower reach along the THP boundary. Large wood pieces appear to be mostly related to past old-growth logging activities. Some coarse bedload sediment is being retained by this debris jam feature.