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Howard Kolb
Central Coast Regional Water Quality Control Board
895 Aerovista Place, Suite 101
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Re: Eligibility Criteria and Monitoring and Reporting Plan

Dear Howard:

Here are some of my ideas regarding construction of the Eligibility Criteria decision matrix. I will send you comments regarding the Monitoring and Reporting Program in a separate letter.

Cumulative Effects Ratio

Sediment related cumulative watershed effects are the result of sediment produced through the interaction of management activities with hillslope processes and subsequently how in-stream processes react to the sediment delivered from the hillslopes.

Before the formula for the Cumulative Effects Ratio (CER) can be discussed the following fundamental questions should be addressed.

1. What is the time horizon that should be used to evaluate cumulative effects?
2. What is the proper scale of a watershed to use when evaluating cumulative effects?
3. What types of projects should be included?
4. Are there any continuing, significant, adverse impacts from past land-use activities that may add to the impacts of the proposed project?

Time Horizon

The Forest Practice Rules CCR 895.1 Definitions, Past Projects says,

> These generally include, but may not be limited to, projects completed within the last ten years.

So, the 10-year time horizon used in most THPs can be viewed as an absolute minimum to evaluate cumulative watershed effects. I e-mailed Leslie Reid to ask her for citations regarding the recovery of hillslopes from logging. A portion of her response is given below.

> There are several papers suggesting that soil compaction isn't fully recovered 30 to 40 years after tractor logging, and there's no challenge at all to finding still-bare mineral soil on 40-year-old tractor skid roads. Hydrologically, our Caspar Creek experiment suggested that we might expect to get

> close to a pre-logging peak flow regime again 12 years after logging, but the area was pre-commercially thinned after about 10 years, so all bets are off. Sediment loads at Caspar Creek still appear to be elevated 12 years after logging.

The Caspar Creek studies indicate that the increases in peak storm flow are responsible for some of the increases in sediment load after logging (Lewis, 2001). Therefore, a 10-year time horizon for the evaluation of cumulative effects appears too short.

The effect of large storms must also be considered. Cafferata and Spittler (1998) compared logging from the 1970's with that from the 1990's in the Caspar Creek watershed. Previous studies suggested that sediment loads returned to pre-harvest levels within a decade. However, these studies occurred prior to the large storms of early 1998 which caused numerous failures of the South Fork roads built in the 1960's. Cafferata and Spittler (1998) note that:

> Sediment loads appeared to have returned to pre-logging levels in the 6th or 7th winter after the completion of logging (Thomas 1990). However, on the basis of widespread failures noted along South Fork roads during winter 1998, this conclusion may have been premature.

The failure of the South Fork roads thirty years after their construction, indicate that roads, especially those built prior to the Forest Practice Rules, can be ongoing sources of sediment.

Studies of shallow landsliding show that root cohesion increases slope stability (Keim and Skaugset, 2003).

> Four sequential clearcuts and partial cuts with variable rotation lengths were simulated with or without leave areas and with or without under-storey vegetation in a subwatershed of Carnation Creek, Vancouver Island, British Columbia. The combined infinite slope and distributed hydrologic models used to calculate safety factor revealed that most of the simulated landslides were clustered within a 5 to 17 year period after initial harvesting in cases where sufficient time (*c.* 50 years) lapsed prior to the next harvesting cycle. Partial cutting produced fewer landslides and reduced landslide volume by 1·4- to 1·6-fold compared to clearcutting. Approximately the same total landslide volume was produced when 100 per cent of the site was initially clearcut compared to harvesting 20 per cent of the area in successive 10 year intervals; a similar finding was obtained for partial cutting.

Keim and Skaugset (2003) imply that a fifty year period is required for hillslope recovery. While a 50-year recovery period is in line with the 30-40 year period for recovery of compaction suggested studies mentioned by Reid, it is probably too long a time period to use in the calculation of the CER. In Keim and Skaugset (2003) study of simulated harvest on slope stability found that landslides clustered within a 5-17 year period after logging. Landslides are an important mechanism for delivering sediment to streams. The use of a 17-year time horizon for the CER would tend to include the previous harvest since the local reentry period is about 14 years. Therefore, the use of a 17 year time horizon for calculating the CER might be appropriate.

Watershed Size

What is the proper size of the watershed to use to calculate the CER? MacDonald (1991) notes that it is difficult to detect changes in water yield on moderate to large streams for example, streams larger than second or third order. Increases in sediment and turbidity are linked to increases in water discharge. Therefore, limiting the size of the analysis watershed to fourth order streams appears to be reasonable, where order is defined based on a 7.5' topographic map. Fourth order streams can, in some cases, have a substantial watershed area. Therefore, limiting the maximum watershed size to the range of 10 to 15 square miles may be appropriate.

The procedure for determining the analysis watershed is as follows. Locate the THP on a 7.5-minute topographic map. Draw the boundary of the watershed containing the THP and extend the watershed boundary downstream to either the confluence with a fourth order or until the total watershed is between 10 and 15 square miles. When the THP crosses a watershed divide (i.e. is in more than one watershed) a separate cumulative effects analysis watershed should be drawn for each watershed the THP is contained in.

The CER Formula

The original formula for CER was:

$$CER = ((AH+PA)/TA)$$

Where AH = acres of the CalWater Watershed harvested in the last 10-years, PA = the acres to be harvested and TA is the total acreage of the CalWater Watershed. The original formula does not account for projects undergoing review. Since the vast majority of THPs are eventually approved it is reasonable to include Plans undergoing review in the CER.

The revised CER formula would be:

$$CER = ((AH + AA + RA + FA + PA)/TA)$$

Where,

- AH = acres of the analysis watershed harvested in the last 15-years,
- AA = acres of the analysis watershed that have been approved but not harvested,
- RA = acres of the analysis watershed under active review,
- FA = acres of harvest in "reasonably foreseeable future projects" as per CEQA
- PA = the acres to be harvested by the THP under consideration,
- TA is the total acreage of the analysis watershed

The February Staff Report defines a CER<10% as low, 10%<CER<15% as medium and a CER>15% as high. The February Staff Report states that this scale was adapted from Klein, 2003.

> The North Fork studies focus on the effects of clearcut logging, largely in the absence of near-stream roads. The primary study was designed to test for the presence of synergistic cumulative impacts on suspended sediment load and storm flows. Nested watersheds were monitored before and after logging to determine whether the magnitude of hydrologic and sediment transport changes increased, decreased, or remained constant downstream. Results showed that the short-term effects on sediment load and runoff increased approximately in proportion to the area logged above each gauging station, thus suggesting that the effect is additive for the range of storms sampled. Long-term effects continue to be studied.
>
> Results also show an 89 percent increase in sediment load after logging of 50 percent of the watershed (Lewis, these proceedings). Peak flows greater than 4 L s^{-1} ha^{-1}, which on average occur less than

Staff's classification of the CER appears reasonable.

Projects to be Considered

All THPs, within the analysis watershed, that have been harvested or approved during the last 17 years should be considered. In addition, all THPs, within the analysis watershed, that are in the approval process should be included.

Other types of land use should also be considered, especially non-timber roads and other hard surfaces that could increase runoff. The total length of non-timber roads and the area of housing or other buildings could be calculated. This information could be generated by use of GIS software. The results could be combined with the timber harvest area to come up with the total area of the watershed affected by some type of development or harvest.

Table 1 gives metric thresholds for *Urbanization Potential* and *Future Development Potential* associated with four levels of habitat quality used in the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, Appendix E, Chapter 4, Integrated Watershed Assessment (see References for web link). A rating of Low/Poor indicates that the metric threshold is associated with poor habitat conditions, in other words, presents a high risk to water quality. The Urbanization Potential and Future Development Potential represent significant non-forestry threats to water quality.

Habitat impact thresholds for *Road Density, Streamside Road Density* and *Stream Crossing Density* are also given in Table 1. These three density parameters could be incorporated into the CER or into the Soil Disturbance Factor.

Beneficial Uses

All the Beneficial Uses of water that occur within the analysis watershed should be listed. The number, type and proximity of beneficial uses could be used as a weighting factor applied to CER.

Drainage Density Index

The Humboldt Watersheds Independent Scientific Review Panel (Review Panel) was charged with reviewing PALCO's Habitat Conservation Plan (HCP). The Review Panel notes that Class-III streams should receive the greatest level of protection to protect water quality (p29-30):

> The most critical example of this issue is in the design of stream buffers. In the Panel's judgment, the priority of buffers as outlined in the HCP is the reverse of what would be used if protecting water quality were the objective. The present HCP's guidelines for the use of riparian management zones (RMZs) that form buffers along streams, which were set before watershed analysis was carried out, gave greater protection to larger streams. On Class-I (fish bearing) streams, RMZs take the form of 100 foot no harvest inner bands and 100-170 foot restricted harvest outer bands. Class-II (non fish bearing, perennial) streams have a 30 ft no-harvest band and a 30-130 foot selective entry band, and Class-III (ephemeral) streams have a 10-100 ft zone where limited harvest is permitted outside a 10 ft no-harvest zone. While these measures provide some protection to water quality, the Panel finds that emphasis on Class-I waters over Class-II and III waters reduces their effectiveness for water quality. **This is because large amounts of sediment enter the river system via small tributaries in steep headwaters areas and hollows, which are likely to be Class-II or III waters and which make up a much greater length of the stream network than Class-I waters. Although these waters may be unimportant as fish habitat, they are very important as inputs to the river system.** (Emphasis added)

Class-II and Class-III streams are where the majority of sediment enters the stream channel network.

Class-I streams may be more sensitive to the direct input of sediment, but a greater volume of sediment enters the channel network through Class-III streams and the protection for Class-III streams is less than for Class-I's.

I recommend that the DDI be replaced by the Erosion Hazard Rating that is already calculated for every THP. If you choose to retain the DDI, please reconsider the weighting factors you assign.

The DDI is intended to measure the sensitivity of the site to water quality threats by noting the frequency of occurrence of drainage courses on the project site. As formulated the DDI does not account for the erodibility of the soil. Including the EHR will take the sensitivity of the soil into account.

Soil Disturbance Factor

Harvests on Steep Slopes

The use for a 65% slope break point for rating the disturbance of tractor operations deeply concerns me. A more logical division would be:

- slopes less than 15% are considered to have the lowest risk,
- slopes between 15% and 30% would be assigned a moderate level of risk
- slopes between 30% and 50% would be assigned a high level of risk
- slopes greater than 50% would be assigned a very high risk.

Use of heavy equipment to log slopes greater than 65% presents a very high risk to water quality. Tractor logging on slopes greater than 65% is an in-lieu practice that should be discouraged. If a THP proposes to use tractor or skidder operations on slopes greater than 65%, the THP should be subjected to a higher level of monitoring than otherwise would be the case.

Winter Operations

Any winter operations should be considered a significant risk to water quality. Refer to the North Coast Regional Water Quality Control Board's conditions for waivers.

The Forest Practice Rules for the Santa Cruz region define the winter as October 15 through April 15. Any operations that disturb the soil during the defined winter period should be given a higher level of risk for water quality.

Lately, CDF has been allowing summer type operations up until November 30 or the accumulation of 4 inches of rain, whichever comes first. A THP that utilize the looser winter operations conditions that CDF has been offering should be recognized as presenting a higher risk to water quality and should therefore be subjected to stricter monitoring requirements to earn a waiver.

The proposed weighting factor of 1.2 for winter operations is much to low. I suggest that a weighting factor of 2 be used when winter operations are proposed.

Roads

A distinction should be made between in-sloped and out-sloped roads. In-sloped roads tend to concentrate water which creates a higher potential for erosion than an out-sloped road. In addition, the inside ditch and associated culvert system delivers water and sediment directly to stream channels.

The weighting factors proposed for road and skid trail crossings are heavily weight towards the protection of Class-I streams whereas the weightings for Class-III streams are much lower. The proposed weighting is not the best choice to protect water quality. First, the Forest Practice Rules provide greater protection to Class-I streams than they do for Class-III streams. Second, Class-I streams tend to be larger and require the installation of a bridge or larger culverts and therefore are more carefully designed and implemented. Third, Class-I crossings tend to be permanent whereas Class-III crossings tend to be temporary. Fourth, Class III crossings are more numerous and tend to provide more sediment than Class I crossings.

I recognize the need to ensure that Class I crossings do not pose a risk to water quality. Therefore, I recommend that the score be based on the type of crossing and not the stream Class. Bridges would receive the lowest weighting, culverts an intermediate rating and rocked fords the highest rating. It is the type of crossing that produces the sediment not the stream class. The distinction between seasonal/temporary and permanent and between existing and proposed should be retained. The same system should be applied to both roads and skid trails.

The weightings for skid trails are consistently lower than for roads. I strongly disagree with assigning a lower rating to skid trails. Skid trails on steeper slopes tend to be blade to make them safer for skidder operation. On flatter slopes the soil surface is not disturbed as much by skid trails. I recommend that skid trails on slopes greater than 30% be given weighting that are higher than the weightings used for roads. It may be reasonable to use the proposed weighting for skid trails on slopes less than 30%.

Similarly, roads traversing slopes greater than 30% should receive a higher weighting than roads on slopes of less than 30%. In addition, roads and skid trails within 100 feet of a watercourse of any class should be weight heavier than more distant roads.

The weightings for "Number of In-lieu/Alt rule in WLPZ" are far too low. The weighting factor of 10 for the roads "Number of In-lieu/Alt rule in WLPZ" is equivalent to 2.5 feet of seasonal/temporary road. In-lieu practices in the WLPZ are usually proposed to benefit the production of timber instead of to protect water quality.

At the bottom of the Soil Disturbance Factor worksheet is a calculation of the total number of landings and crossings divided by the harvest area. However, this calculation does not appear to be used in any way. The ratio of the sum of the landings and crossings to the harvest area seems very similar to calculations of *Road Density, Streamside Road Density* and *Stream Crossing Density* shown in Table 1.

The thresholds of the three density parameters from Table 1 have already been determined and so are preferable to new measures of disturbance that have not been calibrated against real habitat degradation.

These three parameters are typically measured at the watershed scale. However, applying them to the THP scale is reasonable for THPs of 40 acres or more or groups of THPs that cumulatively exceed 40 acres in the watershed at one time.

The three density parameters could be incorporated into the Soil Disturbance Factor or used in the Cumulative Effects Ratio. Road density would be calculated as the length of roads, including skid trails and non-forestry roads, measured in miles within the THP divided by the area of the THP measured in square-miles. The Streamside Road Density is the density of roads within 100 feet of any watercourse within the THP. The Stream Crossing Density is the number of stream crossings (all watercourse classes) divided by the total length of all watercourses with in the THP.

As mentioned above, I will be sending comments on the Monitoring and Reporting Plan soon.

Sincerely,

Dennis Jackson
Hydrologist

References

Cafferata, Peter H. and Thomas E. Spittler, 1998 Logging Impacts of the 1970's vs. the 1990's in the Caspar Creek Watershed, USDA Forest Service Gen. Tech. Rep. PSW-GTR-168.

Humboldt Watersheds Independent Scientific Review Panel, *Phase II Report: Independent Scientific Review Panel on Sediment Impairment and Effects on Beneficial Uses of the Elk River and Stitz, Bear, Jordan and Freshwater Creeks*, prepared for the North Coast Regional Water Quality Control Board, August 12, 2003.

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Lewis, J.; Mori, S.R.; Keppeler, E.T.; Ziemer, R.R. 2001. Impacts of logging on storm peak flows, flow volumes and suspended sediment loads in Caspar Creek, California. In: Mark S. Wigmosta and Steven J. Burges (eds.) Land Use and Watersheds: Human Influence on Hydrology and Geomorphology in Urban and Forest Areas. Water Science and Application Volume , American Geophysical Union, Washington, D.C.; 85-125.

Keim, Richard F. *, Arne E. Skaugset, August 2003, Modeling effects of forest canopies on slope stability, Earth Surface Processes and Landforms, Volume 28, Issue 8 , Pages 853 – 868, Published Online: 7 Aug 2003, Copyright © 2003 John Wiley & Sons, Ltd

http://www3.interscience.wiley.com/cgi-bin/abstract/104525588/ABSTRACT

Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, Appendix E, Chapter 4 Integrated Watershed Assessment, December 2004.

http://www.lcfrb.gen.wa.us/December%20Final%20%20Plans/Approved%20Recovery%20Plan/Technical%20Appendix/Appendix%20E/TA%20E%20Ch.%204%20IWA%20Methods.pdf

MacDonald, L.H.; Smart, A.W.; Wissmar, R.C. 1991. Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska. EPA/910/9-91-001. U.S. Environmental Protection Agency, Water Division.

Reid, Leslie, 2/22/2005, e-mail response to question about hillslope recovery. (attached)

From: Leslie Reid [lreid@fs.fed.us]

Sent: Tuesday, February 22, 2005 2:12 PM
To: laughingdog@sbcglobal.net
Subject: Re: Hillslope Recovery

I wish such info existed! I've been using 15 years for calculations in Humboldt County simply because, through a quirk in someone else's study design, the landslide inventories I was using subdivided the slides into those on cuts older and younger than 15 years. I expect that "recovery" rate depends a lot on what kind of impact you're concerned about. There are several papers suggesting that soil compaction isn't fully recovered 30 to 40 years after tractor logging, and there's no challenge at all to finding still-bare mineral soil on 40-year-old tractor skid roads. From a wildlife point of view, recovery might mean reestablishment of a mature forest. Hydrologically, our Caspar Creek experiment suggested that we might expect to get close to a pre-logging peak-flow regime again 12 years after logging, but the area was pre-commercially thinned after about 10 years, so all bets are off. We'll know progressively more as the years tick by. In snow-melt areas in Washington State, I think they're assuming about 50 years for hydrologic recovery. Sediment loads at Caspar Creek still appear to be elevated 12 years after logging. We're also finding that hillslope swales that were probably gullied 100 years ago still haven't recovered--they're still gullies, suggesting that sediment yields might remain higher than "naturally occurring background levels" even in our control watersheds.

I guess if I were approaching the problem, I'd start from the point of view of the impacts of concern, and figure out what aspects of hillslope conditions would need to recover (and by how much) for those impacts to no longer be influenced. I'd then search the literature for info (unfortunately, it'll probably be sparse) for those particular attributes. Then I'd spend some time in the field looking at cuts of different ages to figure out if my area is behaving like the areas described in the literature. Or, to put it another way, the best estimate might come from local fieldwork, once you know which kinds of change you're most concerned with.

But you asked me for citations, not for an essay or a study plan. I don't know of any good overview of recovery rates, but most papers describing long-term watershed experiments in forestry address recovery rates for the particular aspects they're interested in. I'm not up to date on these, but I'd go about finding them by using Google's new search engine for technical papers. I'd also use this to search for info on particular attributes (e.g., I'd search on "soil compaction recovery forestry" [without the quotes]). In many cases, the search results will even show you the abstracts, so you can choose what's applicable. Be careful, though--that search engine is addictive.

Anyway, good luck with the project, and I'd be very interested in seeing what you come up with. --Leslie

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Dr Reid,

I am working with the Central Coast Regional Water Quality Control Board to develop a science based method for determining when to grant waivers for THPs. I have see reference to your use of 15-years as a reasonable time-horizon for the recovery of hillslopes. Can you send me documentation or references or web links for the 15-year recovery?
Thanks, Dennis

Table 4-4. Process trend factor characteristics, metric thresholds, and general metric rating thresholds

		Metric Thresholds/Rating Criteria				
Characteristic	**Metric**	**Low/Poor**	**Moderate Low/Fair**	**Moderate High/Good**	**High/Excellent**	**Data Source**
Wetlands	Acreage of palustrine or littoral lacustrine wetlands directly associated with habitat channel (within 200 feet of channel less than 4% gradient	<1 acres total in SWS	1-20 acres total in SWS	>20 to 100 acres total in SWS	>100 acres total in SWS	Derived from NWI and SSHIAP data sets (see Ch. 6 for description). Thresholds derived from relative rating for subwatersheds in the LCR
Subwatershed area with hydrologically mature vegetation	% of subwatershed area in vegetation class 1, 2 or 3	<25% class 1, 2, or 3	25 to 50% class 1, 2, or 3	>50 - 75% class 1, 2, or 3	>75% class 1, 2, or 3	Derived from Lunetta et. al (1997) data set provided by Lewis County GIS. Thresholds derived from Beamer et al. (2002)
Urbanization potential	% of SWS area with currently zoned but vacant lands	>15% zoned but vacant	>7.5 to 15% zoned but vacant	>4.5 to 7.5% zoned but vacant	0 to 4.5% zoned but vacant	Derived from Clark County zoning data and thresholds from Beamer et al. (2000). Thresholds derived from a relative rating of zoned LCR subwatersheds.
Future development potential	% of SWS area with potential to be impervious surface based on currently vacant lands zoned industrial, commercial, or residential	>10% effective impervious surface	>5 to 10% effective impervious surface	>3 to 5% effective impervious surface	0-3% effective impervious surface	Derived from available GIS zoning coverages. Threshold values from Beamer et al. (2000).
Road density	Road density in miles/mile^2 (m/m^2) of SWS area	Road density >6 m/m^2	Road density >3-6 m/m^2	Road density >2-3 m/m^2	Road density 0 to 2 (m/m^2)	WSDOT/USFS/DNR GIS data. Thresholds derived from Wade (2001).

Table 1. Metric thresholds associated with four levels of habitat quality. From Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, Appendix E, Chapter 4 Integrated Watershed Assessment

		Metric Thresholds/Rating Criteria				
Characteristic	**Metric**	**Low/Poor**	**Moderate Low/Fair**	**Moderate High/Good**	**High/Excellent**	**Data Source**
Streamside road density	Miles of streamside road per mile of stream	>0.71 miles of road/mile of stream	>0.37 to 0.71 miles of road/mile of stream	>0.04 to 0.37 miles of road/mile of stream	0 to 0.04 miles of road/mile of stream	WCC GIS coverage developed for LFA report. Thresholds derived from a relative rating of LCR subwatersheds.
Stream crossing density	Number of stream crossings per mile of stream	>3.9 stream crossings/mile	>2.7 to 3.9 stream crossings/mile	>1.4 to 2.7 stream crossings/mile	0 to 1.4 stream crossings/mile	Relative rating of stream crossing densities across the LCR. Thresholds derived from a relative rating of LCR subwatersheds.

Table 1 (Continued). Metric thresholds associated with four levels of habitat quality. From Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, Appendix E, Chapter 4 Integrated Watershed Assessment