Timber Products Company
THE TREMENDOUS RESOURCE

P. O. Box 766
Yreka, CA 96097
Phone (530) 842-2310
Fax (530) 842-3825

5/1/2006

6/7/06 Bd Mtg: Scott River-
Item__Deadline 5/10/06

State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Subject: Comment Letter – Sediment and Temperature TMDL in the Scott River Watershed.

Dear Members of the Board;

The State Water Resources Control Board has requested comments regarding the proposed Scott River TMDL. I was a member of the Techinical Advisory Group (TAG) for the Scott River TMDL and provided many written and orals comments during that process. I also provided both written (see attached) and oral (see attached) comments on the proposed Scott River TMDL.

My comments have been based on the scientific information I have collected or my Company has collected in the watershed. My comments have also been based on experienced gained as a member of the French Creek Watershed Advisory Group which is recognized by scientific professionals as a regional example of cooperative watershed restoration and a winner of a national watershed award.

As I previously described in the written comments on the Scott River TMDL, Timber Products Company goal for being involved in the Technical Advisory Group (TAG) was to help make the Scott River TMDL a credible and useful scientific document to guide maintenance and restoration of water quality. We realize that there are time and budget constraints for preparing the TMDL. However, these constraints should not jeopardize the quality or scientific accuracy of the analysis. The Scott River TMDL has so many scientific oversights that future Scott River watershed management plans are likely be **misguided by the TMDL. The TMDL represents a significant change and departure from the currently successfully watershed restoration on going in the Scott River watershed.** It is our belief that the current proposed TMDL will not facilitate and likely discourage on going voluntary and proactive restoration efforts, that are science based, and the NCRWQCB has recognized as important in restoration of water quality in the Scott River watershed.

I encourage you to review my 42 individual scientific recommendations I made as part of my comments on the Scott River TMDL. Hopefully, these comments are helpful and do not hesitate to call if you have any questions.

Sincerely

Stuart Farber
Wildlife & Fisheries
stuf@sor.timberproducts.com

Timber Products Company
THE TREMENDOUS RESOURCE

P. O. Box 766
Yreka, CA 96097
Phone (530) 842-2310
Fax (530) 842-3825

12/7/05

Scott River TMDL Public Hearing Comments

Dear Members of the Board:

In addition of my written public comments submitted on October 21, 2005, please consider my oral comments as part of the Scott River TMDL hearing. Timber Products Company has been part of the successful French Creek WAG and has conducted voluntary intensive road inventories throughout the watershed. The TMDL has recognized these positive steps towards watershed maintenance or restoration. We are pleased that TMDL recognizes these accomplishments.

We participated in both the South Fork Road Pilot Study and the TMDL Technical Advisory Committee (TAG). We submitted 20 pages of comments including 42 individual recommendations. Our major concerns with the TMDL and Implementation Plan still remain.

1. The TMDL and Implementation Plan will not guide maintenance and restoration of watershed.

2. Road sediment erosion rates used inappropriate calculation methods and then inappropriate extrapolation methods throughout the highly diverse Scott River watershed.

3. The TMDL and Implementation Plan require landowners to identify and fix every teaspoon of sediment. The successful French Creek WAG did not identify and fix every teaspoon of sediment.

4. Erosion from Effects of Multiple Interacting Human Activities are below erosion in natural stream channels (Table 3.15). Granitic stream channels are 37% less and Metamorphic stream channels are 57% less. We recommend changes to Sediment Load Allocation Table 3.23.

5. Up to 30% of large woody debris found in stream channels, important for sediment trapping and fish habitat formation, is recruited from in channel erosion and bank erosion.

Based on all these major concerns, the TMDL and Implementation Plan will make successful maintenance or restoration watershed more difficult. **To attempt to remedy some of these concerns, I encourage the Board to direct your staff to work with the TMDL TAG over a minimum of 3 meetings, but no longer than 3 months, to attempt to resolve my concerns, many other TAG concerns and the many concerns described your own peer review documents.**

Thank you for considering my comments.

Sincerely,

Stuart Farber
Wildlife & Fisheries
Timber Products Company
stuf@sor.timberproducts.com

Timber Products Company
THE TREMENDOUS RESOURCE

P. O. Box 766
Yreka, CA 96097
Phone (530) 842-2310
Fax (530) 842-3825

10/21/05

North Coast Regional Water Quality Control Board
5550 Skylane Blvd., Suite A
Santa Rosa, CA 95403
Attention: Mr. Ben Zabinsky

Dear Members of the Board;

The NCRWQCB has requested comments regarding the proposed **Scott River TMDL** dated September 19, 2005. I have reviewed the currently proposed Scott River TMDL and have the following comments and 41 recommendations to improve the TMDL. Many of my comments are similar to comments given to the NCRWQCB staff on August 12, 2005 as a Technical Advisory Group (TAG) member. I have summarized my comments below and if necessary can provide more detailed comments and copies of literature citations regarding these issues.

Comments Regarding Scott River TMDL Structure and Goals

TMDL will not Guide Maintenance and Restoration of Water Quality. (TMDL Page 1-4) Timber Products Company goal for being involved in the South Fork Pilot Study and the technical advisory group (TAG) was to help make the Scott River TMDL a credible and useful scientific document to guide maintenance and restoration of water quality. We realize that there are time and budget constraints for preparing the TMDL. However, these constraints should not jeopardize the quality or scientific accuracy of the analysis. The Scott River TMDL has so many scientific oversights that future Scott River watershed management plans are likely be misguided by the TMDL. The TMDL represents a significant change and departure from the currently successfully watershed restoration on going in the Scott River watershed. It is our belief that the current proposed TMDL will not facilitate and likely discourage on going voluntary and proactive restoration efforts, that are science based, and the NCRWQCB has recognized as important in restoration of water quality in the Scott River watershed.

Recommendation #1: The NCRWQCB staff should directly respond to comments provided by the Scott River Technical Advisory Group (TAG) and work with the TAG members so that the Scott River TMDL will continue the currently successful watershed restoration on going in the Scott River watershed.

Basin Plan Amendment and Implementation Plan will greatly reduce the restoration of the Scott River watershed (TMDL Page 5-2): During a recent TAG meeting the NCRWQCB agreed with TAG members that ongoing volunteer and proactive restoration efforts are key to achieving water quality objectives. "Staff recognize that the proactive efforts of these stakeholders have improved water quality conditions and that continued water quality improvements will occur much faster and easier if stakeholders continue their efforts and help implement the Scott River TMDL Action Plan"(TMDL Page

5-1). However, many requirements of the draft implementation plan do not encourage or build upon on-going and proactive restoration as claimed by the NCRWQCB (TMDL Page 5-3). As an example, volunteer and proactive efforts have inventoried erosions and aquatic habitat sites and prioritized the fixing of erosion sites improvement of aquatic habitat sites During our recent TAG meeting, TAG members described to NCRWQCB staff the prioritization of erosion and aquatic habitat sites is key to restoring a watershed. Prioritization focuses limited resources including staff, time and funding to sites that improve water quality the quickest.

Unfortunately, NCRWQCB stated that the TMDL needed to fix "even a teaspoon of sediment" throughout the watershed. Contrary to successful on going efforts, this NCRWQCB policy does not recognize that the on going successful volunteer and proactive efforts that do not try to fix every "teaspoon of sediment". The stakeholders in the Scott River watershed firmly believe this is one reason why volunteer and proactive efforts have been successful.

As an example, the NCRWQCB states in the TMDL that the load allocation for road gullying should be 1 tons/sqmi/year or 0.67 cuyds/sqmi/year. Yet in the TMDL Erosion Control Plan guidance the NCRWQCB states "... sediment waste discharge sites that discharge or threaten to discharge less than 1 cuyds/year should not be included in an inventory. Such discharges are often too small to be a significant threat to water quality and should not be the primary focus of sediment waste discharge control efforts" (TMDL Appendix D Page D-2). Since the TMDL load allocation clearly requires 0.67 cuyds/sqmi/year, the TMDL load allocation is requiring that sites "too small to be significant" to be fixed. In other words, the TMDL is requiring in fact that "even a teaspoon of sediment" is remedied throughout the watershed.

As another example, Table 3.17 of the TMDL correctly states that erosion rates are different for each unique geology type. Current on going voluntary and proactive restoration efforts in the Scott River watershed have been based on this scientific understanding of the watershed. However the Implementation Plan of the TMDL requires that sediment be reduced uniformly across the watershed (TMDL Table 3-23). This approach by the NCRWQCB does not prioritize by erosion rates and would represent a significant reduction in effectiveness of restoration efforts in the Scott River watershed.

Recommendation #2: If the NCRWQCB wants to continue the successful on going efforts in the watershed, the NCRWQCB needs to describe in the TMDL (TMDL Page 5-2) how restoration and compliance with the TMDL should be prioritized and that on going and proactive programs should focus on larger (> 5 cuyd) biologically significant sites. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #3: The NCRWQCB should correct or explain the apparent conflict between a road gullying load allocation and other load allocations that requires 0.67 cuyds/sqmi/year and Erosion Control Plans that consider this very small amount of sediment "too small to be significant"?

Recommendation #4: The NCRWQCB should explain why the Implementation Plan of the TMDL which requires that sediment be reduced uniformly across the watershed and does not prioritize by erosion rates and explain how this will be more effective than on going proactive restoration efforts in the Scott River watershed?

Technical Advisory Group (TAG) deserves written response to concerns (TMDL Page 5-2): The Technical Advisory Group (TAG) is made up of stakeholders who are responsible for the on going volunteer and proactive restoration in the Scott River watershed. The stakeholders have identified issues, developed programs and implemented projects to improve water quality in the Scott River watershed. The TAG members possess a wealth of scientific expertise, professional knowledge and in the field experience that have created the many success stories the NCRWQCB has highlighted in the Scott River TMDL.

Recommendation #5: Considering the background and success of the TAG members, the specific comments given to the NCRWQCB from the TAG regarding the Scott River TMDL deserve a specific written response before the issuance of the Scott River TMDL to the public. The recommendations of the TAG members were not addressed in writing before the issuance of the Scott River TMDL. During the public review of the TMDL, the NCRWQCB should provide a written response to TAG members regarding their specific comments and concerns.

Comments Regarding Water Temperature

TMDL Temperature Metrics could be harmful to coho salmon (TMDL Page 2-26): The TMDL references Sullivan *et al.*, 2000 to describe stream water temperatures that support salmonids. In this study direct measurement of coho salmon versus water temperatures found a range of 14.3C to 18.0C that support optimal food consumption and growth conditions. As stated by the researchers the approximate peak of consumption and growth for coho was 17.0C. Temperatures both colder and warmer than 17.0C represented reductions in both consumption and growth. Therefore, water temperature criteria described in Table 2.9 of the TMDL and in the risk assessment of Sullivan *et al*, 2000 represent temperatures that would reduce the growth of coho salmon, not increase.

Recommendation #6: Water temperatures within the range of 14.3C to 18.0C MWAT support healthy coho salmon and the Scott River TMDL should reflect this understanding. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Natural Receiving Water Temperatures (TMDL Page 5-13): The TMDL presumes that to "... maintain natural receiving water temperatures, natural shade conditions provided by vegetation must also be maintained"(TMDL Page 5-13). However, numerous other physical conditions may cause stream water temperature to increase above natural receiving water temperatures. These physical conditions include extreme air temperatures, distance to watershed divide, channel width, elevation and aspect (Sullivan *et al.* 1990). Accordingly, loss of streamside shade may not necessarily increase stream water temperatures due to other physical conditions that may be controlling water temperatures. Therefore, it is important to know what "natural receiving water temperatures" are so that these temperatures can be maintained where temperatures currently meet objectives. To improve the TMDL:

Recommendation #7: The TMDL needs to describe the specific numeric data that describes natural receiving water temperatures in the Scott River watershed. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #8: Describe the range of natural water temperatures in the Scott River watershed that would be similar to natural receiving water temperatures and also meet water quality objectives. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Stream Heating Processes (TMDL Page 4-3): The NCRWQCB correctly states that "..five factors human activities in the Scott River watershed may have affected, or have a potential to affect stream temperatures". However, these five factors may or may not affect water temperatures due to other natural physical factors that influence stream water temperatures. These natural physical factors include natural vegetation growth, extreme summer air temperatures, distance to watershed divide, channel width, elevation and stream aspect (Sullivan *et al.*, 1990).

Recommendation #9: The NCRWQCB needs to state in the TMDL where there is physical empirical evidence that streams temperatures have increased in the forested sub-watersheds of the Scott River. There is no cause-and-effect scientific evidence in the TMDL where stream shade, stream flow, groundwater flow, channel geometry or microclimate have contributed to increased or decreased stream temperatures.

This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments. In my August 12, 2005 comments and below in this letter I present cause-and-effect scientific evidence where removal of some stream shade does not affect stream temperatures as proposed in the TMDL.

Shade simulation needs verification with historical photography(TMDL Page 4-15): One of the potential factors that influence water temperatures is shade. NCRWQCB has recognized in the TMDL that natural vegetation patterns or potential vegetation can vary widely in the Scott River watershed. One source of information to determine or verify natural vegetation patterns is through the examination of historic aerial photography. Historic aerial photography is publicly available back to 1944. NCRWQCB staff indicated they had not reviewed historic photography during the development of the stream temperature model. NCRWQCB staff indicated they reviewed some historical photography following development of the model at the request of TAG member comments. To improve the TMDL:

Recommendation #10: TAG member's encouraged NCRWQCB staff to review historic photography, especially 1944 photography, to verify natural vegetation predictions made with the stream temperature model. NCRWQCB staff indicated they would review historical photography. Review of aerial photography should include not only 1944 photography, but sequences of photography so the TMDL reflects the naturally dynamic change in stream shade between 1944 and the present. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #11: TAG members shared with the NCRWQCB staff that review of historical photography has indicated that natural vegetation patterns and streamside canopy was far less in historic photos (1944) than currently exists along many of the stream channels in the Scott River watershed. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #12: NCRWQCB should review this historical photography and state in the TMDL why historical photography of natural vegetation would be different than vegetation predicted by the stream temperature model? This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Shade simulation an idealistic approach, but not a realistic approach (TMDL Page 4-15): The stream temperature model of the TMDL assumes an idealistic view of the Scott River watershed. It assumes that trees and vegetation grow with only an assumed "10% modification" to account for drought, fire, disease and insect infestation. This model does not account for frequent natural floods that occur on 2, 5, 10, 25 and 50 year cycles. These natural floods remove vegetation from stream channels, channel banks and flood plains. In the Scott River watershed, these natural floods have recently occurred in the 2000 (5 year event), 1997 (25 to 50 year event) and in 1964 (100 year event). They have and will continue into the future to dramatically alter the natural vegetation pattern along stream channels, channel banks and flood plains. Based on these known natural events, the TMDL goals for vegetative shade and its potential to influence stream temperatures is not realistic. To improve the TMDL:

Recommendation #13: During the recent TAG meeting, numerous TAG members asked the NCWQCB staff to modify text in the TMDL to indicate the model is an idealistic view. Goals for stream channel and stream shade should reflect natural episodic effects of flood events. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

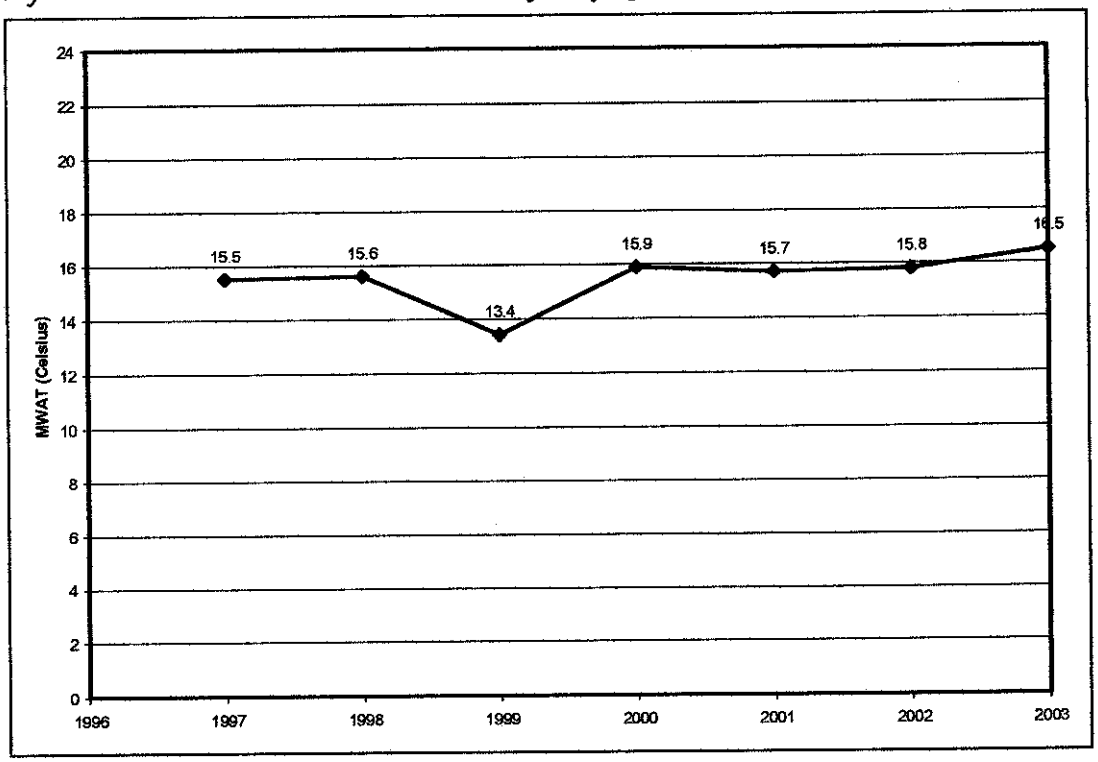
Recommendation #14: Because effects of natural floods events was not considered in development of the TMDL, TAG members asked text be changed to state that this model does not portray realistic measure of potential conditions in the Scott River watershed. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Validation of Stream Temperature Predictions from Models (TMDL Page 4-35): The TMDL has made a general association between vegetative shade and stream water temperatures. The TMDL states "...the analysis of factors affecting the temperature of the Scott River and its tributaries indicate that human activities have resulted in significant increases in temperature in many areas of the watershed". "Removal of vegetation could cause temperature increases in the future" (TMDL Page 4-35).
This general association is in apparent conflict with the only water temperature study of the Scott River watershed (Quigley *et al*, 2000). The TMDL predicts "significant increases" in stream temperatures from timber harvest of shade canopy. Since on going timber harvest has occurred throughout the Scott River watershed during the study period of 1997 to 2000, based on model predictions, significant increases in annual stream water temperatures should have been observed. However, no increase in annual water temperatures were observed during the study period of 1997 to 2000 (Quigley *et al,* 2000).

To determine with more certainty if a general hypothetical association is true or are merely an artifact of other physical processes in the watershed, a series of cause-and-effect studies are usually conducted. Unfortunately, very few cause-and-effect studies have examined if reduction in shade canopy actually increases stream water temperatures. One such stream water temperature cause-and-effect study found that when "patchcut" clearcut harvests of 25 ha (61.8 acres) retained small narrow corridors for riparian shade, no increases in stream water temperatures were observed (Alsea Watershed Study, Oregon, 1973).

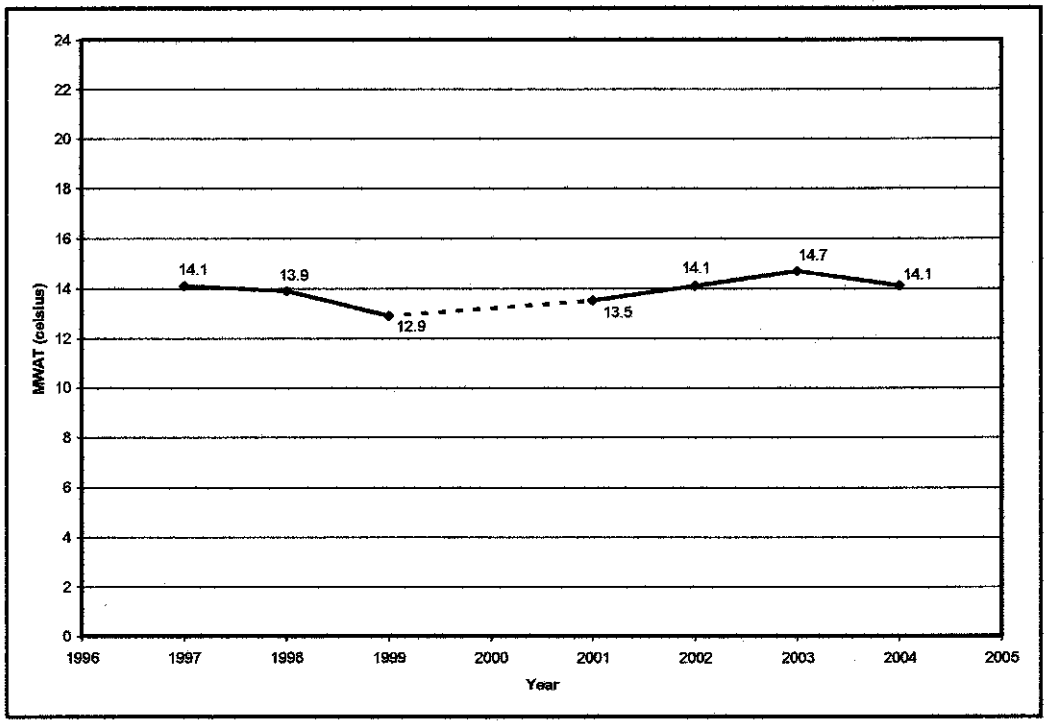
In the Scott River watershed in 2004, to better understand cause-and-effect relationships between riparian zone shade and stream water temperatures, seven years of stream temperature monitoring in French Creek was compared to the amount of riparian zone harvest during the same period (French Creek THP 2-04-128). The Upper North Fork of French Creek water temperatures (MWAT) remained unchanged between 1997 and 2004 during the harvest of 2,800 feet of Class I riparian habitat (see chart). The middle reach of French Creek MWAT stream temperatures remained unchanged during the harvest of 11,300 feet of Class I riparian habitat and 4,000 feet of Class II riparian habitat. The conclusions of the study found that stream temperatures in French Creek do not appear to have increased or decreased following timber harvest that retained either 70% canopy closure (Class I) or 50% canopy closure (Class II) (French Creek THP 2-04-128).

Example from French Creek THP 2-04-128: 2,800 feet of riparian zone harvested in 2000.



Another example of cause-and-effect monitoring in the Scott River watershed has been the timber harvesting within the Etna Creek watershed. For seven years of stream temperature monitoring in Etna Creek has been compared to the amount of riparian zone harvest during the same period (Etna Creek THP 2-05-138). Timber harvest in 1997 above the Upper Etna Creek station included 300' of Class II riparian zone that maintained 50% canopy closure. Timber harvest in 2002 above the Upper Etna Creek station included 11,660 feet of Class II riparian zone that maintained 50% canopy closure. Timber harvest in 2002 above the Upper Etna Creek station included 4,600 feet of Class I riparian zone that maintained 75% canopy closure. The Upper Etna Creek water temperatures (MWAT) have remained unchanged between 1997 and 2004 (see chart). Extensive timber harvest has also occurred above the Lower Etna Creek station and MWAT stream temperatures remained unchanged following the harvest. The conclusions of the study found that stream temperatures in Etna Creek do not appear to have increased or decreased following timber harvest that retained either 75% canopy closure (Class I) or 50% canopy closure (Class II) (Etna Creek THP 2-05-138).

(Example from Etna Creek THP 2-05-138: 4,600 feet of Class I riparian zone harvest in 2002
11,600 feet of Class II riparian zone harvest in 2002.)



Based on the results of regional studies (Alsea Watershed Study), the original Scott River Water Temperature report (Quigley *et al*, 2000) and results of modification of stream shade in French Creek we have found no cause-and-effect relationship between reduction of shade canopy and elevated stream water temperatures in forested watersheds. Based on these results, to improve the TMDL:

Recommendation #15: The NCRWQCB should review results of these studies and possibly other cause-and-effect studies to evaluate the apparent erroneous projections from stream temperature models proposed in the TMDL. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #16: The TMDL also claims that the current California Forest Practice Rules do not ensure that water quality objective (temperature) set in the Basin Plan will be met (TMDL Page 4-35), this statement should be revised to reflect the results of cause-and-effects studies. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #17: The NCRWQCB should describe in the TMDL where and when stream temperatures have increased above natural receiving waters? Currently there is no empirical evidence in the TMDL that shows historical or recent increases in water temperatures above natural receiving water temperatures? This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Vegetation Should Not be Removed (TMDL Page 5-13): The TMDL presumes that to "... maintain natural receiving water temperatures, natural shade conditions provided by vegetation must also be maintained"(TMDL Page 5-13) and that "...human activities have resulted in significant increases in temperatures in many areas of the watershed".(TMDL Page 4-35). The NCRWQCB staff has indicated these statements mean that removal of any streamside vegetation that may contribute shade shall not be allowed under the TMDL? Are these statements confined to the channel zone, riparian habitat or some upslope forested habitats? These statements are in conflict with scientific regional studies (Alsea Watershed Study), the original Scott River Water Temperature report (Quigley *et al*, 2000) and results of modification of stream shade in French Creek and Etna Creek where we have found no cause-and-effect relationship between reduction of shade canopy and elevated stream water temperatures in forested watersheds.

Recommendation #18: If NCRWQCB staff statement that "any streamside vegetation that may contribute shade shall not be allowed" is accurate, the NCRWQCB needs to explain why this statement conflicts with results of cause-and-effect studies that have found no increase in water temperatures following timber harvest in a forested watershed. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #19: The TMDL also needs explain or correct why requirements in the TMDL (Implementation Plan Page 14) conflict with results of cause-and-effect studies that have found no increase in water temperatures following timber harvest in a forested watershed. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Stream Temperature and Vegetation (Basin Plan Amendment Page 14): The Basin Plan Amendment states that TMDL encourages landowners to preserve and restore streamside vegetation. The amendment also states that NCRWQCB will take appropriate permitting and enforcement actions to address removal shade vegetation with the Scott River watershed. Numerous other physical conditions may cause decreases or increases stream water temperatures. These physical conditions may include extreme air temperatures, distance to watershed divide, channel width, elevation and aspect. Accordingly, loss of streamside shade may not necessarily increase stream water temperatures due to physical conditions that may be controlling water temperatures (Sullivan *et al*, 1990).

Recommendation #20: The TMDL should reflect these well known scientific understandings of heating and cooling of stream water temperatures from well cited papers like Brown (1969), Brown (1971), Caldwell et al, 1991 and Sullivan et al, 1990. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Stream Temperature: (Basin Plan Amendment Page 6): During a recent TAG meeting NCRWQCB staff indicated the Section B text describes potential effective shade conditions. The text describes shade value for individual "stream lengths". Limited accuracy in the LANDSAT vegetation descriptions and limited accuracy of the stream model predictions make predictions at the stream length scale in

appropriate. During a recent TAG meeting NCWQCB staff agreed that the model predictions were not appropriate at the reach scale.

Recommendation #21: The NCRWQCB should modify the text in this section to improve clarity and state that the stream temperature model should not be used for reach or smaller scale assessments. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Comments Regarding Sediment

Effects of Multiple Interacting Human Activities (TMDL Page 3-24): The TMDL describes that "...the present state of knowledge it is not possible to determine with certainty for each sediment delivery feature the proportion of natural and human-activity-induced contribution. Yet without following any scientific methods or any field validated empirical scientific information the TMDL determines with certainty estimated anthropogenic contribution of sediment in each sub-basin?

Recommendation #22: The NCRWQCB needs to clarify in the TMDL how without any additional scientific information estimates of anthropogenic contribution were determined. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

We suggest to the NCRWQCB that to better determine the anthropogenic contribution of sediment into the Scott River watershed the NCRWQCB could compare simple sediment erosion rates in undisturbed sub-basins versus manmade disturbed sub-basins. This simple comparison would provide empirical scientific information that would validate or in validate the hypothesis that "...cumulative watershed effects from more than a century of resource exploitation have created a number of sediment-generating processes..."(South Fork Pilot Study Page 11) or the hypothesis that "...it is clear that both human activities and natural processes affect sediment contribution..."(TMDL Page 3-25). To my knowledge, the TMDL does not have this comparison as part of the assessment.

Recommendation #23: The NCRWQCB should complete a comparison of erosion rates in undisturbed sub-basins versus manmade disturbed sub-basins. Results should be stated in the TMDL and Load Allocations be based on these results. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Effects of Multiple Interacting Human Activities EMIHA(TMDL Table 3-15): As we have suggested, the Company compared erosion rates from areas with only natural disturbance versus areas with manmade disturbance. We used the TMDL Table 3-15 as our data set. In Table 3-15 the total contribution of sediment either from human related activity (manmade) or with no human related activity (natural) is described. Of course, no places in the Scott River watershed have only manmade disturbance. Natural disturbance and soil erosion occur in every sub-basin of the Scott River watershed. So soil erosion amounts associated with "manmade" are actually the combination of natural erosion and human caused erosion. We completed this analysis to determine if the hypothesis(s) proposed by the TMDL are true. If true, the empirical field estimates in Table 3-15 should show dramatically larger amounts of erosion in disturbed reaches than undisturbed reaches.

So the mean (total contribution in tons/number of reaches) amount of sediment for undisturbed (natural) and disturbed (natural and human related) for each unique geologic type was calculated. The mean for all geologic types was also calculated. The results indicate that for all geologic types the amount of sediment found along undisturbed natural reaches was 1,187 tons and 1,273 tons along disturbed reaches or a 7% increase along disturbed reaches. In geologic types typically found along forested stream reaches, in granitic based stream reaches mean sediment amounts were 37% less along disturbed reaches than found along natural reaches. In sedimentary/metamorphic reaches mean sediment amounts were 57% less along disturbed reaches than found along natural reaches. This simple review of the NCRWQCB own data indicates that the hypothesis proposed in the both the South Fork Pilot Study and TMDL are not supported by empirical scientific measurements in the Scott River watershed.

Comparison of mean estimated sediment amounts from Natural vs. Human Related Activity (Recalculation based on estimates described in TMDL Table 3.15)

Geology Type	Natural Number of Reaches	Natural Mean Sediment Amount (tons/reach)	Human Related Number of Reaches	Human Related Mean Sediment Amount (tons/reach)
Quaternary	3	37 tons	7	722 tons
Granitic	9	1,917	9	1,202
Mafic/Ultramafic	3	279	14	912
Sedimentary/Metamorphic	5	1,108	4	481
Mean for All Types *1,273/1,187 = 7% mean increase over Natural	20	1,187	24	1,273

Recommendation #24: Unless additional field data is available and presented in the TMDL, sediment sources that cannot be linked to a specific cause-and-effect should not be attributed to land use based only on the fact that land use has occurred above the site. Specifically, unless NCRWQCB staff can demonstrate cause-and-effect relationships of anthropogenic erosion upslope to erosion measured in stream, references to "EMIHA" Load Allocations for Sediment should be associated with natural erosion in Table 3.23.

Effects of Multiple Interacting Human Activities EMIHA (TMDL Page 3-24): The results of our simple comparison of natural undisturbed versus disturbed erosion rates are in apparent conflict with estimates made by the NCRWQCB. The NCRWQCB states that "...lacking that certainty, the NCRWQCB staff used the best available information to estimate the anthropogenic portion of sediment contribution by sediment delivery features that were not clearly associated with a particular anthropogenic feature"(TMDL Page 3-24). To improve the TMDL:

Recommendation #25: The method of assigning estimates of sediment contribution needs to be better described in the TMDL. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #26: The TMDL needs to describe how were the estimates made? Were field measurements taken upslope and were the amounts of erosion recorded? If so, these data sets should be tabulated in the TMDL.

Recommendation #27: Were anthropogenic features (roads, harvests, homes) in the watershed field Measured and reviewed as part of EMIHA measurements? In the field, was sediment observed being delivered from these anthropogenic features? Was the amount of erosion recorded? All of these scientific measurements would be helpful in evaluating the scientific basis for the TMDL.

Recommendation #28: The NCRWQCB needs to develop statistical confidence intervals for the near stream erosion estimates to determine significance of differences between undisturbed and disturbed reach segment data.

All these recommendations were also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments. If the NCRWQCB addresses these questions, further refinement of this information might provide insights into differences between projections of sediment made from empirical field data and estimates by NCRWQCB staff.

Effects of Multiple Interacting Human Activities (TMDL Page 3-24) and Scott River Sediment Load Allocation (Table 2)(TMDL Implementation Plan Page 9) may cause significant environmental impact on water quality and fish habitats (TMDL Page E-1 to E-16):

The NCWQCB has proposed that sediment generated from the "Effects of Multiple Interacting Human Activities" (EMIHA) should be reduced in the Scott River basin. However, simple comparison of sediment erosion amounts between natural stream reaches and disturbed stream reaches found 37% less along disturbed reaches than found along natural reaches and in sedimentary/metamorphic reaches mean sediment amounts were 57% less along disturbed reaches than found along natural reaches. However, even though the NCRWQCB own data indicates that the TMDL is not supported by empirical scientific measurements in the Scott River watershed, the TMDL requires landowners to reduce sediment erosion from features associated with EMIHA. Stream bank erosion was one of the stream channel features that NCRWQCB staff identified as excessive along disturbed reaches and needed to be reduced.

Large woody debris in stream channels can be a significant features in maintaining water quality and forming fish habitats (Spence *et al*, 1996; McDade *et al*, 1990). Studies of stream channels and origins large woody debris conducted in northern California and in the Pacific Northwest have identified large woody debris recruitment processes (Benda *et al*, 2003). Stream large woody debris can be recruited into the stream from tree mortality, fire, disease, blowdown, stream bank erosion, landslides and debris torrents. Stream channel research has found that stream bank erosion can be a significant natural factor in recruitment of large woody debris into the stream in the redwood region (35-81% of wood)(Martin and Benda 2001; Benda *et al.*, 2003; Benda 2004). Based on results of Company stream habitat surveys and resulting stream woody debris budgets 34% of large woody debris in French Creek was sourced to stream bank erosion and an additional 47% in jam wood resulting from massive 1964 flood debris torrents associated with large scale bank erosion. Requirements for reduced stream bank erosion proposed in the TMDL (Table 3.23) will likely cause reduction in the recruitment of stream woody debris. The reduction in stream bank erosion below natural levels would likely reduce stream woody debris levels below natural

levels. Accordingly, reduction of stream woody debris below natural levels would likely cause a potential significant environmental impact to water quality and fish habitats.

Recommendation #29: The NCRWQCB should remove Load Allocations currently associated with human EMIHA erosion and place these Load Allocations under natural disturbances. The NCRWQCB has not presented any empirical field measured data that suggests that erosion found along "disturbed" channels are result of human activities. Rather the erosion rates found along "disturbed" channels is less than natural channels. Accordingly, load allocations from EMIHA should be associated with natural conditions in the TMDL Table 3.23.

S. F. Scott River Watershed: Pilot Study for the TMDL for Sediment (TMDL Page 3-8): Timber Products Company reviewed the draft South Fork Pilot Study (February 4, 2005). We gave written and oral comments on February 10, 2005 that needed to be addressed and still need to be addressed in the TAG draft TMDL. The South Fork Pilot Study is the only place in the watershed where on the ground road erosion was quantified. The measurement methods, results and extrapolations from this study need to be clearly known in the TMDL.

Recommendation #30: Please review comments submitted regarding the South Fork Pilot Study and respond to our specific questions. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Recommendation #31: The South Fork Pilot Study should be part of the TMDL. The pilot study should be placed as an appendix item in the TMDL. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Sediment Source Analysis should represent the diversity of geology in watershed (TMDL Page 3-2): We continue to believe that using one sub-basin (South Fork Pilot Study) to generalize road erosion rates in the entire Scott River watershed is inappropriate. The unique land use history and natural disturbance history of each sub watershed in the Scott River watershed, as the NCRWQCB describes, is important for developing a useful TMDL. Using detailed information from each sub-basin would be both instructive and fair to landowners who have been maintaining good water quality or working to restore water quality where it has been degraded. The South Fork Pilot Study was intended to test the methods for a sub watershed scale analysis. The entire Scott River watershed may or may not reflect the land use history and other factors in the South Fork Pilot Study. To improve the TMDL:

Recommendation #32: The correct use of the South Fork Pilot Study data should be to compare to other sub-basins in the Scott River watershed and to develop a scientific based and useful TMDL that will guide restoration in all the sub-basins of the watershed. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Stratified Random Sampling not appropriate for a non-normally distributed population (TMDL Page 3-8): During the early development of the South Fork Pilot Study the Company explained to NCWQCB staff that detailed road inventories had found that sediment erosion from road segments was not normally distributed throughout a sub-basin (South Fork Scott River; Mill Creek Road Inventory 2003; Etna Creek Road Inventory 2003). In addition, the design of the South Fork Pilot Study and

subsequent TMDL would be based on erroneous assumptions and not scientifically supported. To use a simple random sample or stratified random sample the sample population is assumed to be normally distributed. Unfortunately, road erosion is rarely normally distributed. In fact, the NCRWQCB South Fork Pilot Study states that "...in other words, 19% of the features produced 86% of the sediment" (Page 6 of the South Fork Pilot Study). The NCRWQCB own report states that the road erosion features are not normally distributed and therefore violate the first statistical assumption to properly extrapolate data from one sub-basin to another.

Recommendation #33: Based on the NCRWQCB own statements in the South Fork Pilot Study, the extrapolation of road erosion rates from the pilot study to the entire Scott River watershed is not statistically or scientifically supported and appropriate changes to the TMDL should be made. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

South Fork Road Related Sediment delivery needs to be corrected (TMDL Page 3-8): The use of a 14 year period for determining sediment rates is not the accurate way to look at this data. The use of a sample of data from the Resource Management road surveys necessitates determining what length of time that sample represents. The sediment measured by Resource Management from roads is the total amount of sediment that can be seen from the existing road. The period of time that is represented includes years without large storms, drought years, wet years and stressing storm events. The sample of sites visited by NCRWQCB staff had sites with estimated ages up to 30 years. This would indicate that the sample represents at least 30 years of erosion sites. The method used in the South Fork Pilot Study report tries to pick a storm frequency as representing the life of the erosion sites.

Recommendation #34: There is little correlation presented in the South Fork Pilot Study between storm frequency and erosion sites. The time period used to accurately date erosion sites should be from review of aerial photography and not from assuming some arbitrary storm frequency period. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

South Fork Road Related Sediment delivery does not need to be expanded (TMDL Page 3-8): Our understanding of the South Fork Pilot Study is that direct measurements of sediment from point sources was completed for 100% of the inventoried roads. However, the pilot study seems to extrapolate data to sediment per mile of road. The road surveys measured 100% of the visible sediment.

Recommendation #35: With 100% sampling there should not be a need to expand the data. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

In the South Fork Pilot Study the number of stream crossings was doubled from the number that was on the GIS layer. We talked to Mr. Don Coates about this and he said that the Forest Service roads were not inventoried and therefore the data from RM had to be extrapolated. Our memory was that there was data on all the crossings. The reason we chose the South Fork Pilot Study was the near 100% road inventory.

Recommendation #36: The NCRWQCB needs to review and explain in the TAG draft TMDL why the number of crossings was doubled and how this number was extrapolated. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Comments Feature 92 – A Special Case

The NCRWQCB staff conducted a field investigation to determine whether "Feature 92" was a natural or anthropogenic feature. The NCRWQCB staff concluded that "...Feature 92 of the air-photo inventory, as discussed in the South Fork Pilot Study, is not a landslide. It is a segment that has had extreme erosion". (TMDL Page 3-28).

Using historical aerial photography I investigated Feature 92. I used aerial photography from 1944, 1980 and 2000. Feature 92 is a stream channel that is tributary to Boulder Creek and is approximately 5,300 feet long from headwaters to confluence (see enclosed map).

1944: In 1944 the lower 3,000 feet of Feature 92 (Point B to confluence) had a deep incised channel that was densely vegetated. Natural erosion from steeper slopes above is evident in 1944. No evidence of either hydraulic mining, placer mining, timber harvest or any human disturbance is evident.

1980: In 1980 the entire length of Feature 92 (Point A to confluence) had a deep incised channel that was only sparsely vegetated. Stream channel and portions of the flood plain outside of the channel are visible in the 1980 photography. A landslide track initiating at Point A and depositing at Point C is visible in the 1980 photography. The deposition zone begins at the confluence with Boulder Creek and ends approximately 500 feet downstream of the confluence at Point C. Aerial photography indicates that a large landslide event and resulting debris torrent occurred between 1944 and 1980. Numerous similar landslides events occurred in the Scott River watershed during the 1964 flood (Examples: Etna Creek, French Creek).

2000: In 2000 the entire length of Feature 92 (Point A to confluence) had a deep incised channel that was only sparsely vegetated. The stream channel and portions of the flood plain outside of the channel are visible and larger than indicated in the 1980 photography. A new landslide track initiating at Point D is visible in the 2000 photography. This new landslide track is likely attributed to the 1997 flooding as numerous similar landslides events occurred at nearby Scott Mountain during the 1997 flood.

Field Verification: During the fall of 2005 I field investigated Feature 92. The headwaters of Feature 92 is a boulder slope located on steep slopes exceeding 70%. The headwaters are located on a concave topography and over steepened slope position indicative of headwall swales that are known to be landslide initiation points. At the base of the boulder slope (Point A) a relatively small slide occurred in the historic past and began a debris torrent. The scoured channel formed below Point A is approximately 4 feet in depth and 20 feet in width. For approximately 200 feet below Point A, the scoured channel has revegetated with red fir and white fir seedlings, grasses and mountain mahogany. The slope position and rate of revegetation indicates that the landslide visible in the 1980 photography is likely from the 1964 flood.

Approximately 200 feet below Point A, located on a concave topography and over steepened slope position a second small slide occurred which began a second debris torrent (Point D). The channel re-scoured below Point D and is approximately 15 feet in depth and 40 feet in width. The re-scoured

channel has not revegetated and only sparse grass is found within the scoured channel. The slope position, rate of revegetation and confirmation from the 2000 photography indicates that the landslide visible in the 2000 photography is likely from the 1997 flood.

During my field review of Feature 92 no evidence of hydraulic mining, placer mining or timber harvest were found at Point A, Point D or between Point A and Point B. Neither the small slide at Point A or Point D was a result of any human disturbance. In addition, no timber harvest has occurred above Point A or Point B. Consequently I found no evidence in the field that either landslide debris torrents that likely occurred in 1964 or 1997 were related to any human disturbance.

Similar to observations found by the NCRWQCB staff, lower reaches of Feature 92 are steep-sided and bare of any vegetation. However, review of historic aerial photography and field review of the upper reaches of Feature 92 confirmed that Feature 92 is a natural landslide channel. In addition, Feature 92 is a channel that has likely had at least two landslide debris torrents, one in 1964 and one in 1997.

Recommendation #37: The NCRWQCB staff should investigate in the field, Feature 92 headwalls, the entire landslide run out area and confluence with Boulder Creek to determine whether this feature is a natural or anthropogenic feature. If field work by NCRWQCB confirms my findings, the TMDL should reflect that this feature as a natural landslide and Load Allocations in Table 3.23 should reflect this change.

Comments Regarding Implementation Plan

Implementation Plan: Removal of shade vegetation will not cause increases in stream water temperatures (TMDL Implementation Plan Page 14).

The proposed TMDL presents no field collected water temperature information that demonstrates that removal of streamside shade in forested watershed will increase stream water temperatures. Based on all the water temperature information collected in the field indicates that stream temperatures in forested watersheds have not increased over the previous 10 years.

During the previous 10 years thousands of acres of forested riparian zone habitat and streamside shade have been removed as part of permitted timber harvest plans. The proposed TMDL requires that all streamside shade shall be retained, (TMDL Page 4-35, Page 5-13, Implementation Plan Page 14) and NCRWQCB staff have confirmed this understanding. This is in apparent conflict since the proposed TMDL does not present any field collected water temperature data that indicates future removal of shade would be increase stream temperatures.

Recommendation #38: The NCWQCB staff should either present field collected water temperature that indicate increasing temperatures following timber harvest plans or remove requirements for Temperature & Vegetation on page 14 from the Implementation Plan. This recommendation was also given to the NCRWQCB on August 12, 2005 as part of my Technical Advisory Group (TAG) member comments.

Implementation Plan: Scott River Sediment Load Allocation(Table 2) not based on scientific methods and will misguide restoration efforts in the Scott River watershed (TMDL Implementation Plan Page 9)

Based on my previous comments the Load Allocation assigned to sources from "Effects of Multiple Interacting Human Activities" (EMIHA) is not supported by any scientific data currently present in the TMDL. Rather, the TMDL needs to reflect scientifically supported Load Allocations that place erosion currently identified as EMIHA into erosion identified as natural erosion. This change in the TMDL current loadings would require Large Features EMIHA (53 tons/sqmi/yr) and Small Feature EMIHA (149 tons/sqmi/yr) to be placed under natural erosion. This total estimate of 202 tons/sqmi/yr would bring the current load estimate to 637 tons/sqmi/yr (see table below). This change should also be reflected in the TMDL Load Allocations, which would require Large Features EMIHA (16 tons/sqmi/yr) and Small Feature EMIHA (50 tons/sqmi/yr) to be placed under natural erosion (see table below) In summary, the more scientifically supported current loading estimate should be as follows:

(Modified Table 3.23 Load Allocation of Sediment that is more supported by scientific results of watershed conditions)

Sources	Current Loading Estimate (tons/sqmi/yr)	Load Allocation (tons/sqmi/yr)	Reduction Needed (%)
Natural	435	435	0%
EMIHA*	202	202	0%
Total Natural	637	637	0%
Road Related	17	10	42%
Landslides	23	12	48%
Streamside Delivery	56	22	61%
Total Anthropogenic Percentage Above Natural	96 (15%)	44 (7%)	54%
TMDL (tons/sqmi/yr)		**681**	

*NCWQCB data in TMDL suggest EHIHA erosion rates are within natural levels.

Recommendation #39: The Load Allocation for sediment should guide future restoration efforts in the watershed. Basing Load Allocations on inaccurate and unsupported scientific methods will misguide restoration efforts in the watershed by focusing limited time and resources to hypothetical erosion sources including EMIHA. Please modify the Load Allocation of Sediment (Table 3.23), as suggested in my comments, so that sediment load allocations reflect scientifically supported results of your own stream channel erosion data.

Implementation Plan: Based on TMDL Load Allocations the Erosion Control Plans are unnecessary (TMDL Page D-1 to D-10):

Within the inventory guidance portion of the Erosion Control Plan the proposed TMDL states that "...sediment waste discharge sites that discharge or threaten to discharge less than 1 cuyd/yr or 10 cuyd/10 years usually should not be included in an inventory. Such discharges are often too small to be a significant threat to water quality"(TMDL Page D-2). However, the TMDL Load Allocations require that road crossing failures, road related gullying and road cut and fill failures be reduced to 0.67 cuyd/sq mile of watershed for each road related feature? To improve the TMDL:

Recommendation #40: The TMDL Load Allocations need to explain or correct why existing road crossing failures (2 cuyd/sq mile), road related gullying (0.67 cuyd/sq mile) and road cut and fill failures (2.7 cuyd/sq mile) that are apparently at such low quantities that are too small to be a significant threat to water quality, need to be inventoried in an Erosion Control Plan?

Recommendation #41: If the existing conditions (0.67 cuyd/sq mile) are too small to be a significant threat to water quality, as stated in the Load Allocation plan (Table 3.23), why would Erosion Control Plansbe required when the current existing condition does not pose a significant threat to water quality?

Comments Regarding CEQA Environmental Checklist

TMDL will likely cause Potential Significant Environmental Impact on water quality and fish habitats(TMDL Page E-1 to E-16):

Based on results of Company stream habitat surveys and other stream channel research (Martin and Benda 2001; Benda *et al.* 2003; Benda 2004) and resulting stream woody debris budgets, the proposed TMDL will likely cause reduction in the recruitment of stream woody debris. Results of field studies in the Scott River watershed indicate that a large percent (40% or more) of stream woody debris is recruited to the stream by stream bank erosion. This finding is very similar to other researchers who have studied stream channels in interior California (Benda *et al.* 2003; Benda, 2004). The proposed TMDL requires reduction in erosion including stream bank erosion (EMIHA) below natural levels which would likely reduce stream woody debris levels below natural levels. Stream large woody debris is an important element in the stream channel that either traps sediment or can form specific fish habitats. Reduction of stream woody debris below natural levels would likely cause a potential significant environmental impact.

Recommendation #42: The TMDL should reflect that reduction of stream woody debris below natural levels would likely cause a potential significant environmental impact. I recommend changing the CEQA checklist, as I have described below, to reflect this understanding

Environmental Factor	Potentially Significant Impact	Justisfication
Biological Resources (a)	X	Proposed TMDL would likely cause a substantial adverse effect on stream habitat used by native trout or anadromous fish. Stream wood debris can form complex fish habitats and trap sediment. As required in the TMDL Load Allocation (EMIHA), reduction of stream woody debris below natural levels could impede use of native trout or anadromous fish habitat.
Biological Resources (d)	X	As required in the TMDL Load Allocation (EMIHA), proposed TMDL could impede use of native trout or anadromous fish habitat by requiring stream woody debris levels to be reduced below natural levels. Stream wood debris can form complex fish habitats. Reduction of stream woody debris below natural levels could impede use of native trout or anadromous fish habitat.
Hydrology (c)	X	As required in the TMDL Load Allocation (EMIHA), the proposed TMDL could substantially alter natural drainage or erosion patterns by requiring stream woody debris levels to be reduced below natural levels. Stream wood debris can trap sediment in stream channels. Reduction of stream woody debris below natural levels could substantially alter natural drainage and increase erosion transport rates.
Hydrology (f)	X	As required in the TMDL Load Allocation (EMIHA), the proposed TMDL could substantially degrade water quality by requiring stream woody debris levels to be reduced below natural levels. Stream wood debris can trap sediment in stream channels. Reduction of stream woody debris below natural levels could substantially degrade water quality.
Land Use and Planning (b)	X	As required in the TMDL Load Allocation (EMIHA), the proposed TMDL would misguide cooperators and conflict with on-going voluntary and regulated sediment erosion control efforts.
Transportation (e)	X	Based on proposed TMDL Load Allocations for roads, attainment of < 1 cuyd/sq mile would require removal of a significant amount of forestland roads in the watershed. This removal would result in inadequate emergency access to

		prevent or extinguish catastrophic wildfire that could potentially impact forestland, rangeland, homes, towns and citizens.
Mandatory Findings of Significance (a)	X	Proposed TMDL will likely degrade habitats for fish below natural levels.
Mandatory Findings of Significance (c)	X	Proposed TMDL will likely cause substantial adverse effects on human beings by removing significant amount of forestland roads which would result in inadequate emergency access to prevent or extinguish catastrophic wildfires.

Hopefully, these comments are helpful and do not hesitate to call if you have any questions.

Sincerely,

Stuart Farber
Wildlife & Fisheries
stuf@sor.timberproducts.com

References

Alsea Watershed Study 1971 Alsea Watershed Study to Determine the Effects of Logging on Aquatic Resources. Oregon State University.

Benda, L. and D. Miller, J. Sias, D. Martin, R. Bilby, C. Veldhuisen, T. Dunne 2003. Wood Recruitment Processes and Wood Budgeting. In The Ecology and Management of Wood in World Rivers. American Fisheries Society 37:49-73, 2003.

Benda, L. 2004 Wood Recruitment to Streams on the Mendocino Coast, California. Prepared for Campbell Timberland Management, Fort Bragg CA 95437 March 10, 2004 17 pp.

Brown G. 1969 Predicting temperatures of small streams. Water Resources Research 5(1):68-75.

Brown G and G. Swank, J. Rothacher. 1971. Water temperature in the Steamboat drainage. USFS, PNW-119. Portland, Oregon.

Caldwell, J. and K. Doughty, K. Sullivan. 1991 Evaluation of downstream temperature effects of type

4/5 waters. TFW-WQ5-91-004. TFW CMER Water Quality Steering Committee. Washington State Department of Natural Resources., Olympia, Washington

Martin, D. and L. Benda 2001 Patterns in Instream Wood Recruitment and Transport at the Watershed Scale. Transactions of the American Fisheries Society 13: 940-958. 2001

McDade, M. and F. Swanson, W. McKee, J. Franklin 1990 Sources distances for coarse woody debris entering small streams in western Oregon and Washington. Canadian Journal of Forest Sciences 20:326-330.

Quigley D. and S. Farber, K. Conner, J. Power, L.Bundy 2000 Water temperatures in the Scott River Watershed in Northern California. Prepared for the US Fish and Wildlife Service grant. Sept. 20, 2001.

Spence B. and G. Lomnicky, R. Hughes, R. Novitzki 1996 An Ecosystem Approach to Salmonid Conservation. Management Technology December 1996.

Sullivan K. and K. Doughty, J. Caldwell, P. Knudsen 1990 Evaluation of predictions models and characterization of stream temperature regimes in Washington. TFW-WQ3-90-006. TFW CMER Water Quality Steering Committee. Washington State Department of Natural Resources., Olympia, Washington

Sullivan K. and D. Martin, R. Cardwell, J. Toll, S. Duke 2000. An Analysis of the Effects of Temperature on Salmonids of the Pacific Northwest with Implications for Selecting Temperature Criteria. Sustainable Ecosystems Institute, Portland, Oregon.