

**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**

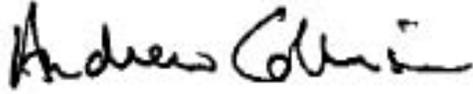
Authored by the Humboldt Watersheds
Independent Scientific Review Panel

Convened and Facilitated by CONCUR, Inc.
Under the Auspices of the North Coast Regional Water Quality Control Board



Report Prepared August 12, 2003

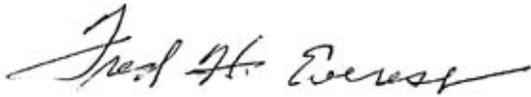
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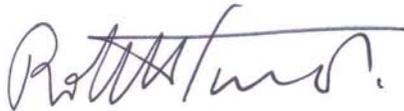
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LIST OF ACRONYMS

ACP - Aquatic Species Conservation Plan
BMP - Best Management Practice
CDF - California Department of Forestry and Fire Protection
CDFG - California Department of Fish and Game
CDMG - California Division of Mines and Geology
CGS - California Geologic Survey
CWE - Cumulative Watershed Effect
ESU - Evolutionarily Significant Unit
FPA - Forest Practice Act
GIS - Geographic Information System
HCP - Habitat Conservation Plan
IMST - Independent Multidisciplinary Science Team
MSP - Maximum Sustained Yield
MWAC - Mass Wasting Area of Concern
NCRWQCB - North Coast Regional Water Quality Control Board
NMFS - National Marine Fisheries Service
NTU - Nephelometric Turbidity Unit
PALCO - Pacific Lumber Company
PDO - Pacific Decadal Oscillation
RMZ - Riparian Management Zone
ROR - Rate of Recovery
RPF - Registered Professional Forester
SYP - Sustained Yield Plan
THP - Timber Harvest Plan
TMDL - Total Maximum Daily Load
TOR - Terms of Reference
USFWS - United States Fish and Wildlife Service
WEPP - Water Erosion Prediction Project

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I. EXECUTIVE SUMMARY

A. Overview of Independent Scientific Review Panel

The North Coast Regional Water Quality Control Board (Regional Water Board) convened an Independent Scientific Review Panel (Panel) in August 2002. The objective was to strengthen the science basis for its decision-making for protecting and restoring the sediment-impaired beneficial uses of waters in the Elk River and Freshwater, Bear, Jordan, and Stitz Creek watersheds in Humboldt County, California. The Panel was convened in response to a five-part motion that the Regional Water Board approved on June 27th, 2002.

In the first phase of its work, the Panel produced a report entitled, “Final Report on Sediment Impairment and Effects on Beneficial Uses of the Elk River and Stitz, Bear, Jordan and Freshwater Creeks” on December 27, 2002, and presented its findings at the January 23, 2003 Regional Water Board meeting. On January 24, 2003, the Regional Water Board passed five motions relative to the Panel’s findings and directed the Panel to respond to a new set of questions as part of a Phase II. The Regional Water Board specifically requested that the Panel review and comment on the levels of protection in the HCP/SYP and the effectiveness of existing mitigation measures. The Regional Water Board anticipates that the Panel’s Phase II findings will be used to inform the scientific basis for the development of TMDLs in all five watersheds.

Specifically, the Panel was asked in Phase II of its work to address four issues:

- Issue A: Examine the cause and effect relationship linking protective measures undertaken through the HCP/SYP/THP process and the actions needed to ensure protection of water quality, including a clear discussion of the logic of the relationship.
- Issue B: Evaluate whether a specific rate of recovery of the beneficial uses of water, as identified in the Basin Plan, can be determined. A determination, along with a timeframe for recovery, will be needed to allow appropriate load allocations in the TMDL development process.
- Issue C: Evaluate the water quality protection measures provided by the HCP/SYP (including the intended performance under full versus current level of implementation) in the context of water quality standards specified in the Basin Plan. The Panel was also asked to comment, from a science perspective, on the way in which the HCP/SYP and the corresponding watershed analysis and adaptive management process does or does not address the Basin Plan standards over different time intervals.
- Issue D: Evaluate the degree to which the recommendations presented in the Dunne Report No. 46 are appropriate for the five watersheds, and determine how these recommendations might be implemented over short-, intermediate- and long-term time frames.

The Panel responded by soliciting and reviewing documents relevant to the questions and hearing presentations made by various stakeholders, including Pacific Lumber Company (PALCO), the HCP signatory agencies, California Geologic Survey (CGS), residents and several watershed scientists at a technical workshop held in Eureka on May 5, 2003. This report presents the Panel's findings for each of the issues posed. For each question, we first state the Panel's summary findings. Next we present more detailed analysis and findings. Finally, we present pertinent policy considerations for the Regional Water Board.

B. Panel Findings

The Independent Scientific Review Panel was convened to assist the North Coast Regional Water Quality Control Board in making science-based decisions on issues related to impairment of water quality, and flooding, in Freshwater, Bear, Jordan, Stitz and Elk watersheds due primarily to excess sediment loads. Part of the Regional Water Board's mission is protection of water quality in these watersheds. Consequently, the Board is pursuing ways to limit sediment production from the watersheds, which are largely owned by PALCO and used for timber production.

It is well documented in the scientific literature that timber harvesting generally results in increased sediment production and lower water quality. The increase in sediment production is from mass wasting triggered from harvesting unstable hillslopes, erosion of exposed surfaces and erosion of roads where sediment is mobilized due to traffic and road drainage. PALCO asserts that through a combination of Best Management Practices such as road upgrades, and the provisions of the HCP/SYP/THP process, their harvest activities will not result in detrimental water quality impacts, and instead will improve water quality over that which would be found were they to cease harvest and mitigation activities in the watersheds. In the absence of monitoring data showing these mitigation measures to be effective, this assertion should be regarded as an untested and highly controversial hypothesis at this stage. In the light of numerous existing studies showing detrimental water quality impacts from high rates of timber harvest, the burden of proof would appear to be on those arguing that timber harvest is not damaging water quality.

The broad question posed to the Panel in Phase II is: will the prescriptions and protections that are part of the HCP/SYP/THP processes limit sediment production sufficiently to allow recovery of the beneficial uses of water in these watersheds? The Panel has concluded that these planning processes are unlikely, at the current rate of logging, to limit sediment production sufficient to allow timely recovery of the beneficial uses of water. For example, in Freshwater, the harvest and road construction rates over the last five years have been extremely high and have impacted a significant portion of that watershed. These activities and impacts are documented in the Freshwater Watershed Analysis, a centerpiece of the HCP/SYP planning process. The Panel concludes that the approval of plans generating this documented level of impact constitutes a strong indication that this planning process will not result in recovery of this watershed. The Panel points out that the other four watersheds have also received extensive disturbance from logging. The Panel is unaware of any studies documenting that the current intensive timber harvest in the five watersheds can be accomplished without extensive sediment inputs to streams.

Next, we turn to the specific issues we were asked to address.

1. Summary of Findings for Question A

With regard to Issue A, the Panel has concluded that the HCP/SYP/THP process does not and cannot ensure attainment of water quality objectives for four principal reasons. First, water quality is incidental to the stated purposes of the plans (i.e. habitat conservation and sustained timber yield and harvest). Second, the plans have multiple objectives that are intrinsically contradictory and cannot be maximized simultaneously. Third, although the plans, and in particular the HCP, incorporate measures that may help to improve water quality over time, they are statements of intent and not guarantees of attainment. The plans are based on a large set of assumptions about the effectiveness of planned actions. These assumptions have not yet been tested or adjusted on the basis of effectiveness monitoring. Critical features such as phasing, tracking, triggering mechanisms, and adjustments based upon measured success all are lacking. Finally, the processes and procedures are poorly defined, and lack specific and enforceable water quality standards as well as impartial scientific review.

2. Summary of Findings for Question B

With regard to Issue B, the Panel has concluded that currently available information is insufficient to determine rates of recovery in the five watersheds. The two main reasons why it is currently difficult to determine a rate of recovery are (1) disturbances in the watersheds are continuing at a high rate even when proposed (and in some cases partially implemented) protective measures are being considered, and (2) the necessary effectiveness and trend monitoring data required to make an informed estimate of recovery rate in these watersheds does not yet exist. Therefore, it is impossible to determine at this point in time whether protective measures described in the HCP and other plans will work as intended. More problematic is the fact that, even though PALCO is beginning to collect some effectiveness monitoring data, a rigorous monitoring program capable of providing the necessary information will take years or decades to fully implement. A complicating factor is that neither “recovery” nor “background” is adequately defined. Although scientific information can be used to help define recovery and background, the adoption of the specific measures that will be used to gauge recovery and definition of background rates is ultimately a policy decision. Recognizing the current limitations, the Panel notes that it is nonetheless feasible to develop a strategy to (1) determine a realistic rate of recovery and (2) stabilize watershed conditions.

3. Summary of Findings for Question C

With regard to Issue C, it is the Panel’s conclusion that the HCP/SYP/THP structure and the corresponding Watershed Analysis process cannot be relied upon to meet water quality objectives. Some of the reasons for this conclusion are discussed in the Panel’s assessment of Issue A. In particular, the most critical shortcoming is the practice of continuing approval of timber harvest plans without watershed analyses being adopted and implemented. The Panel has concluded, however, that the HCP process *might* have been relied upon to ensure water quality had it not fallen short in eight areas as elaborated upon in the main body of this report. Similarly, the Panel concludes that, although there is not a clear linkage between SYP provisions and water quality, Regional Board staff might consider several different strategies to make the plan workable, including the preparation of interim cumulative effects assessments.

The Panel also evaluated the applicability of the two sediment budget models discussed in its Phase I report. Both approaches have advantages and disadvantages. The primary limiting factor is a lack of field-based factual information. This limitation particularly constrains more complicated models (for example, the WEPP erosion and sedimentation model). The Panel therefore reiterates its earlier conclusion that an empirical sediment budget model of the type originally described by Dr. Reid, with calibrations and adjustments to account for geologic and geomorphic differences among watersheds, is most consistent with the quality and quantity of data that are currently available or likely to become available in the short term.

4. Summary of Findings for Question D

With regard to Issue D, the Panel concludes that recommendations made in the Dunne report would increase the probability of attaining water quality goals in the long term. These include the long-term development of stochastic process-based models to supercede empirical models (which are now more appropriate given our current state of knowledge) and the necessity of independent third party review of model assumptions and results. The Panel concurs with the Dunne Committee that there is no science-based justification for assuming that sedimentation and water quality impacts can be mitigated to zero levels or even produce positive benefits.

C. Conclusion

In sum, the Panel concludes that the HCP/THP/SYP processes have significant limitations in terms of their architecture, execution, standards and feedback mechanisms, which prevent them from ensuring attainment of water quality standards. While minor improvements could be made (that are explained within the report), the Panel finds no science basis to expect that implementing minor improvements within the existing system will ultimately lead to significant improvements in water quality.

II. INTRODUCTION

PROJECT HISTORY

A. Background of the Panel – Phase I

The North Coast Regional Water Quality Control Board (Regional Water Board) convened an Independent Scientific Review Panel (Panel) in August 2002. The objective was to strengthen the science basis for its decision-making for protecting and restoring the sediment-impaired beneficial uses of waters in the Elk River and Freshwater, Bear, Jordan, and Stitz Creek watersheds in Humboldt County, California. The Panel was convened in response to a five-part motion that the Regional Water Board approved on June 27th, 2002.

In Phase I, the Panel was asked to identify and evaluate a set of actions that could be initiated in the short term to protect beneficial uses and reduce flooding in all five watersheds. In addition, the Panel was asked to evaluate the technical strengths and weakness of several approaches to calculating rates of timber harvest that would not impede recovery from excess sediment loads and would not cause or contribute to exceedence of water quality objectives. In response to these directives, the Panel produced a report entitled, “Final Report on Sediment Impairment and Effects on Beneficial Uses of the Elk River and Stitz, Bear, Jordan and Freshwater Creeks” on December 27, 2002, and presented its findings at the January 23, 2003 Regional Water Board meeting.

B. Background of the Panel – Phase II

On January 24, 2003, the Regional Water Board passed five motions relative to the Panel’s findings and directed the Panel to respond to a new set of questions as part of a Phase II. In response to feedback from various stakeholders and resource agencies, the Board emphasized that a review of the HCP/SYP/THP processes and appropriate existing documents should be included as part of Phase II. The Regional Water Board specifically requested that the Panel review and comment on the levels of protection in the HCP/SYP/THP processes and the effectiveness of existing mitigation measures, especially the extent to which the existing HCP/SYP/THP processes address rate of recovery of beneficial uses in the sediment impaired watersheds. The Regional Water Board anticipates that the Panel’s Phase II findings will be used to inform the scientific basis for the development of TMDLs in all five watersheds.

C. May 5th Technical Workshop

There was also a strong recommendation from both the Panel members and various stakeholders to conduct a technical workshop with HCP/SYP/THP signatory agency staff, PALCO staff, Regional Water Board staff, as well as individual watershed scientists at the Panel’s request. The Panel did conduct such a technical workshop in Eureka, CA on May 5th, 2003. The purpose of the meeting was to establish a productive forum for exchange of information focused on:

- (1) the work underway in the five watersheds
- (2) the scientific basis for how the processes have evolved (e.g. watershed analysis, management prescriptions, THPs, and adaptive management changes)
- (3) the extent to which they have worked together to protect, ameliorate, or restore the beneficial uses of the watershed

In preparation for the meeting, all participants were asked to provide a list of documents for the Panel to review, which specifically address the three objectives of the meeting. The Panel requested that, to the extent possible, the documents be submitted in advance. The documents submitted contained information about recent revisions to the prescriptions, the efficacy of the prescriptions implemented to date, monitoring results, plans to further develop this information, and descriptions of how monitoring results and/or other analyses are incorporated into decision-making processes. The documents were all submitted to both CONCUR and Regional Water Board staff. The Panel requested a few clarifications from various stakeholders following the meeting. Each of these was relayed via the CONCUR team. In carrying out this review, the Panel also referred to documents provided in the Phase I Terms of Reference, as well as other relevant scientific articles and publications.

D. The Phase II Assignment

As per the Phase II Terms of Reference, the Panel was charged with: (1) reviewing the specifics of the HCP¹/SYP/THP management measures and their scientific basis for achieving water quality standards contained in the Basin Plan, including timeframe for achievement; and (2) assessing how the Dunne Report No. 46 can be implemented in the five watersheds.

Specifically, the Regional Water Board asked the Panel to:

- Examine the cause and effect relationship linking protective measures undertaken through the HCP/SYP/THP process and the actions needed to ensure protection of water quality, including a clear discussion of the logic of the relationship.
- Evaluate whether a specific rate of recovery of the beneficial uses of water, as identified in the Basin Plan, can be determined, as this determination will be needed along with the timeframe for recovery, to allow appropriate load allocations through the TMDL process.
- Evaluate the water quality protection measures provided by the HCP/SYP/THP (including the intended performance under full versus the current level of implementation) in the context of the water quality standards specified in the Basin Plan. Comment, from a scientific perspective, on the way in which the HCP/SYP/THP and the corresponding watershed analysis/adaptive management process does or does not address the Basin Plan standards over selected periods of time.

¹ HCP review should include related documents, including the streamlined watershed analysis methods, the post watershed analysis and any prescriptions that may have changed as a result of decisions arising from the adaptive management process.

- Evaluate the degree to which the recommendations presented in the Dunne Report No. 46 are appropriate for the five watersheds, and determine how these recommendations might be implemented over short-, intermediate- and long-term time frames.

The report that follows is organized around the four specific questions listed above.

III. PANEL FINDINGS

QUESTION A

Examine the cause and effect relationship linking protective measures undertaken through the HCP/SYP/THP processes and the actions needed to ensure protection of water quality, including a clear discussion of the logic of the relationship.

A. Summary Findings

Water quality protection is mentioned in the three plans (HCP, SYP and THP) under which PALCO is currently operating. The implication of these plans is that water quality will be maintained if these plans are properly implemented. The major water quality and related aquatic concerns in the five subject watersheds include excessive sedimentation and increased flooding of the lower stream reaches, burial of spawning gravels in fine sediment, and high turbidity levels that impair survival, growth, and development of juvenile salmonids. In addition to these flooding and wildlife concerns, Regional Water Board staff must consider other beneficial uses, such as the quality of drinking water and recreational opportunities, which are currently excluded from consideration in the three plans.

With regard to the Water Board's responsibilities to ensure the attainment of water quality standards and the recovery of impaired watersheds, the logic of the existing HCP/SYP/THP processes appear to be based on two working assumptions. The first is a general assumption that good wildlife habitat implies acceptable water quality. The second is a pervasive assumption that implementation of the three plans will lead to desired water quality results even though none of them directly address water quality and the effectiveness of mitigation measures is at this point largely untested.

The Panel has found that despite the intentions of the HCP/SYP/THP processes to maintain water quality, they cannot guarantee protection of water quality for four compelling reasons:

- Water quality is incidental to the stated purpose of the plans (habitat conservation and sustained timber yield) and is not enforceable.
- The plans have multiple goals and stipulations, which are intrinsically contradictory and cannot be maximized simultaneously.
- The plans are based upon untested assumptions about the effectiveness of planned actions.
- The processes and procedures are poorly defined, subjective and lack impartial review.

These issues are further elaborated on below.

B. Overview of the HCP/SYP/THP Planning Process

As summarized in the Panel's Terms of Reference, the HCP, signed March of 1999 is neither a stand-alone nor a static management document. The HCP Aquatic Species Conservation Plan

(Section 6.3) includes interim measures that are to be revised through the Watershed Analysis and Adaptive Management processes specified in the HCP. The Watershed Analysis process (Section 6.3.1) is to be conducted in each of the watershed assessment areas within the first five years of HCP implementation. Following each watershed analysis, watershed-specific prescriptions (Section 6.3.2.2) are to be developed to replace the interim prescriptions of the original HCP. Additionally, prescriptions are subject to revision through the Adaptive Management process (Section 6.3.6) after which the adapted prescriptions become part of the HCP. This process is currently underway and some of the prescriptions have already been revised.

The HCP specifies that effectiveness monitoring (Section 6.3.5.2) of specific prescriptions be measured through both instream and hillslope monitoring. Effectiveness monitoring would be conducted to determine if the specific prescriptions, as applied to the hillslopes, result in the intended and necessary protection of aquatic values. The effectiveness monitoring can lead to modification in prescriptions through adaptive management. Trend monitoring (Section 6.3.5.3) is intended to determine if the watersheds are achieving the target instream conditions. All THPs developed for lands covered by the HCP/SYP must follow the applicable HCP/SYP prescriptions. As currently implemented, monitoring is the responsibility of the regulated party (PALCO) rather than the regulators. Monitoring results can therefore be withheld, delayed, or otherwise made unavailable to interested parties. While there is a legitimate need to take time for verification and quality assurance, there is an equally compelling need for the results to be made public in a timely manner. The Panel also finds that the guiding strategy is to monitor the effectiveness of mitigation measures after they are implemented on a broad scale rather than to institute and carefully monitor pilot projects on a small scale before they are adopted for regular use.

C. Logical Weaknesses of the HCP/SYP/THP Processes

1. Attainment of Water Quality Standards Incidental to HCP/SYP/THP Goals and Not Enforceable

The first logical weakness regarding cause and effect relationships between measures described in the HCP/SYP/THP and the protection of water quality is that the plans have goals that are only incidentally related to the attainment of water quality standards. The objective of the HCP is, as its name implies, the conservation of habitat:²

“The goal of the Aquatic Species Conservation Plan is to maintain or achieve, over time, a properly functioning aquatic habitat condition.”

The final HCP lists water temperature, canopy cover, sediment, instream large wood, large wood recruitment, pool frequency, and pool quality as key variables in the Aquatic Species Conservation Plan (ACP).³ The draft HCP, to which readers are referred by the final HCP, further describes the use of bulk sediment samples and pebble counts to characterize the aquatic

² HCP, p.P-36

³ HCP, p. P-36

habitat condition as part of the trend monitoring program.⁴ Monitoring of sediment production from slopes and roads is included as part of the effectiveness monitoring program described in the draft HCP, but no specifics are given. Turbidity monitoring, as described in the draft HCP, will be limited to one or two pilot turbidity monitoring stations as part of the trend monitoring program. The draft HCP further states “Results from this pilot program will be used to determine whether to continue or expand this program.”⁵ The draft HCP does not state what criteria will be used to evaluate the success of the pilot turbidity monitoring program or who will decide whether to continue the program.

Although the existence of properly functioning aquatic habitat in general implies good water quality, the Panel notes that the HCP does not list the attainment of specific water quality standards among its requirements.⁶ Moreover, the HCP states that “...specific habitat standards are not enforceable under the Plan.”⁷ If the HCP contributes to the attainment of water quality standards acceptable to the Regional Board, the attainment will be incidental to its primary purpose, as it is in no way required or guaranteed by the HCP. The same holds true for the SYP and THP processes. Indeed, the ACP section of the HCP explicitly acknowledges this lack of enforceability (*italics added*):

“Not all variables will be attainable over the life of the Plan, regardless of PALCO’s effort. Specifically, this includes the recruitment of large wood onto the forest floor and into the watercourses. For this reason, and because habitat conditions are not static, *the specific habitat variables are not enforceable standards under the Plan.*”⁸

This statement acknowledges the likelihood that some goals will not be met due to natural variability and uncertainty and may thus be challenging to enforce fairly. The partially unattainable and wholly unenforceable goal of properly functioning aquatic habitat (as characterized by variables listed in the HCP) without reference to other enforceable water quality standards of concern to the Regional Board (most notably turbidity) cannot guarantee the attainment of the Regional Board’s water quality standards. The policy choice thus presented to the Regional Board is whether to rely on the possibility that the combined HCP/SYP/THP processes can incidentally lead to the attainment of water quality standards or to take more proactive steps to ensure compliance.

2. HCP/SYP/THP Processes Have Goals that Cannot be Maximized Simultaneously

a. SYP: Timber Production Weighted Over Environmental Protection

In addressing the concept of SYPs, the California Forest Practice Rules state (*italics added*):

“This Article carries out the Legislature’s direction that the Board adopt regulations to assure the continuous growing and harvesting of commercial forest

⁴ Draft HCP, Volume 4, Part D, Section 1, p. 103-104

⁵ Draft HCP, Volume 4, Part D, Section 1, p. 104

⁶ HCP, p. P-36

⁷ HCP, p.P-36

⁸ HCP, p.P-36

tree species and to protect the soil, air, fish and wildlife, and water resources in accordance with the policies of the Forest Practice Act (FPA). Those policies include creating and maintaining a system of timberland regulations and use which *ensures that timberland productivity is maintained, enhanced and restored where feasible and the goal of maximum sustained production (MSP) of high-quality timber products is achieved while giving consideration to environmental and economic values.*⁹

Whereas environmental and economic issues are given consideration under the SYP concept, primacy is accorded to the maximization of timber production. Timber production is to be *ensured* whereas environmental and economic values are to be *considered* (and, by the definition of consideration, may be set aside or de-emphasized). Environmental protection is therefore a secondary consideration of the SYP process. This is not to say that the SYP process does not address environmental concerns such as water quality, but rather that environmental concerns are secondary to the maximization of timber production.

Given this balancing of values, the Panel would expect that factual information on such environmental values as water quality would be infused at each key step in the decision process. For this reason, in reviewing the documents, the Panel paid particular attention to the extent and nature of water-quality related information present at such key points in the process. The Panel found that the complex linear programming model through which the SYP is derived, while designed to optimize the tradeoffs between environmental protections and timber yield, is based on several untested assumptions about how different silvicultural approaches affect harvest rate, wildlife and watershed values.

Furthermore, these processes are based on numerous models, which rely on calibrations and assumptions that must be changed, refined or confirmed by a series of watershed analyses. Many of these calibrations and assumptions have important implications for water quality and yet there is no mention in the SYP process of any specific feedback loop between water quality and the impacts of timber harvest activities. In addition, only one watershed analysis has been approved, and it has not yet been fully implemented, which means the feedback loop to validate the assumptions for these models remains unclosed, as described later in this report.

b. THP: Environmental and Economic Objectives Conflict

The THP process also appears to contain conflicting objectives and subjectivity as outlined below. The Forest Practice Rules¹⁰ state (*italics added*):

“The goal of forest management on a specific ownership shall be the production or maintenance of forests which are healthy and naturally diverse, with a mixture of trees and under-story plants, in which *trees are grown primarily for the production of high-quality timber products* and which meet the following objectives:

⁹ CDF, 2003, p.175

¹⁰ CDF, 2003, p.21

- (A) Achieve a balance between growth and harvest over time consistent with the harvesting methods within the rules of the Board.
- (B) Maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed.
- (C) Retain or recruit late and diverse seral state habitat components for wildlife concentrated in the watercourse and lake zones and as appropriate to provide for functional connectivity between habitats.
- (D) Maintain growing stock, genetic diversity, and soil productivity.”

The Forest Practice Rules further state that (*italics added*):

“In evaluating a plan, the review team shall review any discussion of feasible alternatives or additional mitigation to the proposed timber operations as prescribed in 14 CCR 898. Plan reviewers *must* consider the economic as well as the environmental benefits of feasible alternatives. The review team shall serve in an *advisory capacity* to the Director in making recommendations on plans.”¹¹

Environmental concerns are given consideration by THP reviewers, but they can be offset by economic factors. Because the THP review team serves only in an advisory capacity, it is also possible for concerns about environmental and economic issues to be set aside or modified by the Director.

3. Processes are Statements of Intent, Based on Untested Assumptions about Effectiveness

The next logical weakness identified by the Panel relates to the fallible nature of plans, which in this case are proposed courses of action or intended procedures. Although they may be based on good intentions and the best available information, plans (whether they are HCPs/SYPs/THPs prepared by PALCO or basin plans or TMDLs proposed by Regional Water Board staff) are not guarantees that a specific result will be achieved. They are merely expressions of intent until their effectiveness is borne out by monitoring programs to ensure that the results conform to predictions.

a. Monitoring Inadequate and Late

To be efficient tools for environmental management and protection, including the attainment of water quality standards, the plans such as the HCP/SYP/THP must be:

- continually and critically evaluated by monitoring
- checked by independent scientific third party review of procedures and data
- backed by a willingness to change the plan if data suggest it is not working.

The Panel understands that the HCP prescribes effectiveness and trend monitoring, and that PALCO is currently establishing a monitoring program. However, the Panel notes that more than four years after the signing of the HCP, very few monitoring data are available to assess the

¹¹ CDF, 2003, p.138

effectiveness of sediment savings measures implemented by PALCO. At this point it is impossible to determine the effectiveness of any sediment reduction measures that PALCO has implemented since the signing of the HCP. Moreover, it is the Panel's conclusion that it will take at least 5 to 10 years of data collection before there are enough data to do so. With the current rate of logging, this could make engaging in monitoring activities a moot point.

Both the THP and SYP also contain monitoring components. However, the data resulting from these have been very limited to date, thus making it impossible to determine whether THP prescriptions were successful. Thus, THPs are continuing to be approved on the basis of projected sediment savings even though the estimates of implementation impacts may be incorrect. Without effectiveness monitoring and periodic assessment, there is no way to know whether mitigation strategies are effective (see Question A, section B.2.b. below).

b. Sediment Budget Models and Estimates Unverified

Because plans are statements of intent rather than guarantees, monitoring data are essential in order to evaluate the validity of any environmental management plan. The results of calculations and computer models— even if they are obtained using the best available information—are simply predictions that need to be verified with field-based observations. The Panel has not been provided any documents that suggest PALCO or its consultants routinely verify the results of erosion and sedimentation model predictions with detailed field measurements. Some gross comparisons between predicted and observed sediment yields have been made, but these do not constitute the kind of long-term monitoring necessary to verify predictions of sediment savings as a result of mitigation activities. For example, PALCO's consultants have compared some observed and inferred sediment transport information to the results predicted by computer models (O'Connor, 2002). Although this is an important first step, this kind of preliminary comparison is not sufficient to predict the impact of future land management choices or the effectiveness of mitigation schemes.

PALCO maintains that its activities will result in zero net sediment discharge under the HCP (Barrett, 2003). This estimate is based on:

- simulations using the Water Erosion Prediction Project (WEPP) computer program to predict the amount of sediment that will be generated by activities such as stormproofing roads
- subjective field-based estimates of the amount of sediment saved by mitigation activities such as the removal of Humboldt crossings.

The Panel points out four significant sources of uncertainty in PALCO's sediment budgeting procedure. First, the results of a computer model, no matter how sophisticated or skillfully obtained, represent but one possible approximation of the solution to a highly idealized set of equations. They may or may not be an accurate prediction of the amount of sediment generated, and different scientists making different assumptions may well obtain substantially different results. It is impossible to assess the reliability of computer simulations of geologic and hydrologic processes without monitoring.

Second, as shown in studies by the National Park Service, field-based estimates of sediment savings can be highly subjective and vary substantially from person to person. As described in Wartella (1995), estimates of the volume of potentially erodible sediment made by different professionals can differ by as much as $\pm 100\%$. Estimates based on the assumption that all potentially erodible sediment will reach streams add another degree of uncertainty because they are likely to overestimate the amount of sediment saved.

Third, comparing elements of a sediment budget that are estimated using different methods introduces additional uncertainty. It is very hard to tell if differences between two modeled sediment sources really reflect differences in sediment production and delivery, or differences in modeling approach (e.g. between an empirical model and a field observation, both containing different sources of bias).

Fourth, the Panel notes that building, stormproofing, using and decommissioning roads, even when done to best environmental standards, still produce various levels of sediment. For example, removing Humboldt crossings or decommissioning roads will produce a short-term increase in sedimentation. Forest roads produce more sediment under high levels of use than under low to moderate use. The net result of mitigation activities may be to save some sediment over twenty years' time, but in the short term they are producers of sediment. Also, gross predictions of sediment savings from road decommissioning or removal of Humboldt crossings may or may not be realistic, but they are all counted as mitigation against heavy use of improved roads. The Panel notes that mitigation activities eventually face diminishing returns.

4. Processes and Procedures Poorly Defined, Subjective, and Lack Impartial Review

a. Conditions Required to Refine Interim Prescriptions Vaguely Defined

Another potential shortcoming of plans, especially the HCP, is a reliance on undefined or poorly defined procedures and processes that can result in the easing of restrictions of interim prescriptions. The HCP states, for example, that Mass Wasting Areas of Concern (MWACs) cannot be logged under interim prescriptions. After watershed analyses have been completed, however, roads can be built across or timber harvested from MWACs¹² and the conditions that must be met in order to do so are defined only in vague terms. The HCP states that the restriction on harvest in MWACs “may be modified as a result of watershed analysis,” that roads can be constructed across MWACs if a site-specific “geologic analysis of the risk of hillslope failure by the proposed new construction and reconstruction” is acceptable and that before or after watershed analyses the MWACs can be “further defined on the ground (ground-truthed) with respect to area boundaries (size) as part of individual THPs.”

b. Geologic Assessments Subjective and Lack Impartial Review

The redefinition of MWACs, according to the HCP, “... shall be conducted by the California Division of Mines and Geology (CDMG) or a qualified geologist, including but not limited to, certified engineering geologists licensed by the state of California.” Even under the best conditions, geologic mapping of the kind used to delineate MWACs and verify the existence of

¹² HCP, p.P-47 and P-48

landslides in the field is a subjective procedure prone to considerable error. Peer reviewed studies have shown that experienced geologists can produce strikingly different maps of landslide hazards in the same area, with spatial mismatch rates as high as 80% when maps made by three different groups of geologists are compared (Ardizzone et al., 2002; Wills and McCrink, 2002). A compounding factor is that there is no formal process for impartial third party review of these subjective maps. More uncertainty is introduced when geologists use simple field inspections in an attempt to predict the effect of timber harvesting on slopes that have not yet failed. Pyles et al (1998) found that predicting where landslides will occur is not well understood.

A rigorous evaluation of pre- and post-harvest slope stability for various land management, climatic, seismic scenarios— which would require undisturbed soil sample collection, laboratory testing, and quantitative slope stability analysis— can be prohibitively expensive and have its own significant environmental impacts (*e.g.*, access roads for drilling rigs). Based upon the Panel's document review, field trip, and workshop, it cannot offer assurance that pre-harvest field inspections, even when conducted by licensed geologists will be sufficient to address the direct and cumulative effects on water quality.

D. Policy Considerations

It is not the role of the Panel to decide how much weight society in general or the Regional Board in particular should give to the competing demands of maximized timber production, environmental concerns and economic impacts. Such a decision is clearly beyond the scope of a scientific review. The Panel does emphasize, however, that it is generally impossible to maximize three competing variables. The best that can generally be done is to optimize the variables subject to policy-driven tradeoffs and constraints.

As the Panel wrote in its Phase I report, there are two fundamentally different policy options available to the Regional Board. One option is to assume that the procedures and methods in the HCP/SYP/THP triumvirate will work as planned and make regulations that allow logging to continue at current or increased rates.

Another option is to assume that the procedures and methods may not work as planned, and to make regulatory decisions consistent with permitting logging to continue at reduced rates while the effectiveness of the HCP/SYP/THP measures is evaluated by a scientifically-valid monitoring program. Such a program would need to be thoughtfully designed, correctly implemented, adequately funded, and include impartial third-party scientific review along with well-executed feedback loops. The feedback loops, in particular, should be designed so that monitoring results could be used to adjust the initially conservative logging rates if the protective measures were shown to be effective.

The Panel also emphasizes that neither its nor any other analysis can predict with certainty what combination of measures and logging rate restrictions will *ensure* the protection of water quality and recovery of impaired watersheds. The best that can be done is to postulate a plan based on the best available information, continually test the plan using a combination of compliance, effectiveness, and trend monitoring, and revise the plan in a timely and appropriate manner based on monitoring results.

QUESTION B

Evaluate whether a specific rate of recovery of the beneficial uses of water, as identified in the Basin Plan, can be determined, as this determination will be needed along with the timeframe for recovery, to allow appropriate load allocations through the TMDL process.

A. Summary Findings

The Panel concludes that given current information, accurate and specific rates of recovery (ROR) of the beneficial uses of water cannot be calculated for Bear, Jordan, Stitz, Elk, and Freshwater watersheds. There are two primary reasons why ROR cannot be determined at the present time. First, human disturbances in the watersheds from roads and logging continue at a high rate despite attempts by PALCO to apply protective and mitigative measures to counter the disturbances. Second, effectiveness monitoring data on the outcome of protection and mitigation is generally lacking. Consequently, it is currently unknown whether continued disturbances outweigh protection and mitigation, or vice versa. A statistically-sound effectiveness monitoring program that provides the information necessary to calculate ROR of the beneficial uses of water, or their further degradation, will take years to decades to accomplish.

The water quality control plan for the North Coast Region of California defines the beneficial uses of water as:

“Beneficial uses” of the waters of the state that may be protected against water quality degradation include, but are not necessarily limited to, domestic, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.

The most sensitive beneficial uses from the standpoint of water quality management are municipal, domestic, and industrial supply, recreation, and uses associated with maintenance of resident and anadromous fisheries (California Regional Water Quality Control Board, 1993).

How are these beneficial uses of water addressed by PALCO’s HCP, SYP, and THPs? As a group, the plans focus on timber yield, maintenance of stand conditions for specific wildlife species, and maintenance of water quality and habitat parameters to benefit aquatic species, especially anadromous salmonids. Features of the plans that benefit aquatic species may also benefit municipal, domestic, industrial water supply, and recreation, although these are not primary considerations of the plans. The HCP focuses on maintaining desirable aquatic habitat conditions by controlling the key variables of water temperature, canopy cover, sediment, instream large wood, large wood recruitment, pool frequency, and pool quality. Desirable characteristics of water temperature and sediment for aquatic species also benefit water supply for municipal, domestic, and industrial use, and recreation.

The plans do not emphasize maintenance of the natural flow regimes that are needed to maintain these beneficial uses. PALCO’s effectiveness monitoring plan has also not been finalized so the locations and scales at which data will be collected are in many cases yet to be determined. The exact details of what, where, when, and how PALCO will monitor will be determined by

questions and hypotheses posed by PALCO and the wildlife agencies (USFWS and CDF, 1999). Monitoring would be only the first step in a multi-year process that would include a feedback loop to restrict management activities. This is cause for concern about the timely correction of depleted watershed values.

B. Determining Rate of Recovery of Waterways in Basin Plan

1. Factors Considered in Determining Rate of Recovery

Determining the rate of recovery (ROR) in a disturbed watershed is in a word, complex. This task cannot be achieved through planning or simple modeling exercises. Quantitative data is needed to determine whether recovery is occurring, and if it is occurring, the rate of recovery. The complexity in determining ROR is related to:

- *Defining “recovery”* in quantitative terms and collecting the necessary trend monitoring data to evaluate whether characteristics of the watershed are moving toward or away from the defined goal.
- *Defining “background” levels* of environmental characteristics of concern, e.g., beneficial uses of water.
- *The frequency and distribution of natural and human disturbances* in a watershed (ROR is strongly affected by whether combined disturbances are declining, constant, or increasing).
- *The infrequent occurrence of large storm events* that test the effectiveness of measures applied to protect water quality, fish and wildlife habitats, and ecosystem functions.
- *Inclusion of anadromous fish habitat as a beneficial use of water* (includes the recovery of ESA-listed anadromous salmonid stocks and requires consideration of both freshwater and marine habitat conditions).

The above factors complicate any study of rate of recovery in a watershed influenced by human and natural disturbances. Below is the Panel’s assessment of how these factors impact the situation in the five Humboldt watersheds in question.

2. The Role of Disturbances in Determining Rate of Recovery

The natural and human disturbance regimes imposed on the Bear, Jordan, Stitz, Freshwater, and Elk watersheds are a key factor in assessing ROR. These watersheds are currently listed as sediment impaired water bodies under Sec. 303d of the Clean Water Act. The trajectory toward or away from recovery in these watersheds is a function of the cumulative spatial and temporal distribution of natural events and human activities within their boundaries. Without a clear quantitative definition of what constitutes recovery, coupled with a clear definition of what constitutes background conditions against which to measure recovery, and adequate quantitative effectiveness monitoring data, it is not possible to determine if these disturbed watersheds are moving toward a more impaired condition, or moving toward recovery.

a. Pulse vs. Press Disturbances

Watersheds throughout the west, including northern California, are subject to disturbances from natural events such as wind, fire, and flooding, and human activities such as logging, roads, and agriculture. The type and timing of disturbances largely determines their effects on ecosystem resilience, ecological processes, beneficial uses of water, and indigenous biota. Ecosystem disturbances can be classified as either “pulse” or “press” disturbances based on their temporal and spatial frequency. Yount and Niemi (1990) refer to disturbance regimes that maintain the resiliency of ecosystems as pulse disturbances. Pulse disturbances occur infrequently, and there is typically sufficient time between disturbances to enable ecosystems to recover to pre-disturbance conditions. Pulse disturbances allow ecosystems to remain within their natural historic range of states and conditions.

Press disturbances, on the other hand, are characterized by frequent or continuous events (like industrial forestry, intensive agriculture, or urbanization) interspersed with insufficient recovery time to allow ecosystems to return to pre-disturbance conditions. Press disturbances reduce the resiliency of ecosystems, and may ultimately impose new regimes of variability that are outside the natural historic range of variability of a watershed or ecoregion. Natural and human disturbances can fall into either the pulse or press category, although natural disturbances are most often associated with the former and human disturbances with the latter.

Natural and human disturbances in watersheds may accumulate for years or decades before a large storm event (e.g., recurrence interval of 25-50 years) reveals their true effects on the landscape. Also, protective measures to mitigate the effects of human disturbances, like “storm proofing” roads, or measures to reduce mass wasting events, may appear to meet all expectations until tested by a major storm. A large storm event may reveal that the measures were ineffective, or less effective than planners and modelers expected (Benda et al. 1997). The downside of stochastic storm events is that it can take years to assess the real effects (positive or negative) of new plans (e.g., HCP and ACP) and forest practice rules.

3. The Effect of Disturbances on Recovery of Beneficial Uses of Water

a. Recovery Uncertain Under Present Disturbance Regime

How do these concepts relate to the recovery of beneficial uses of water in Bear, Jordan, Stitz, Freshwater, and Elk watersheds? As long as logging and road effects occur at the present rate in these watersheds, it is unclear with the present information whether the HCP or any other plans will lead to recovery. Press disturbances in the five watersheds resulting from industrial forestry might preclude initiation of recovery and push the watersheds toward a new ecological state. Based on its professional experience and its review of studies of analogous sites (presented below), the Panel concluded that it is possible that these watersheds are presently outside of the range of their historical ecological conditions and may remain there if the present rate of disturbance continues.

The Panel calls attention to a study of the historical characteristics of forests in western Oregon (Wimberly et al. 2000). This study reported that late-successional forests (ages 80 to 200 years)

in the Coast Range historically occupied between about 49% to 91% of the landscape at the provincial scale. Following decades of intensive timber harvest, the remaining late successional forests in the Coast Range currently total about 11% - well outside the historic range. The authors concluded that with the current emphasis on industrial forestry on private lands in this region (referred to as a province), historic conditions are unlikely to be restored. Therefore, current negative effects on flora, fauna (including ESA-listed salmon stocks), and beneficial uses of water are likely to persist. A similar study is not available for northern California, but the extent of logging-related disturbances between the two geographic areas is similar.

The Panel considered another set of studies based on the Oregon Forest Practice Rules. These rules, adopted in 1999, provide comprehensive protection for aquatic and riparian habitats at least on a par with the California Forest Practices Act and the HCP. In an independent assessment of the new rules, Oregon's governor commissioned an Independent Multidisciplinary Science Team (IMST) to assess the new rule set's effectiveness for protecting salmonid habitats (a beneficial use of water in both Oregon and California). The IMST consisted of foresters, range scientists, fisheries biologists, and oceanographers. While no conclusive monitoring has yet been done, the IMST concluded that the 1999 rules for riparian protection, large wood management, and sedimentation control are unlikely to contribute to the recovery of habitat of depressed stocks of anadromous salmonids (IMST 1999). The Oregon IMST found that that the rules were dominated by site- and action-specific strategies. Actions accomplished at these scales were deemed insufficient for the recovery of critical habitats for wild anadromous salmonids due to the lack of watershed-scale focus.

b. Recovery of Stream Flow Studies Not Applicable

Other studies that the Panel has reviewed have attempted to document rate of recovery of some watershed functions disturbed by logging. However, these studies are not directly applicable to an estimation of the recovery rate in the five Humboldt watersheds because they relate to a one-time 'pulse' disturbance rather than continuous 'press' disturbance. At Caspar Creek in the California redwoods region, a one-time disturbance was imposed in the watershed, and then recovery of stream flow was tracked over time. Recovery of flow regimes took about 13 years after the disturbance in the watershed ceased (Keppler and Ziemer 1990; Ziemer et al. 1996). Other studies have examined rates of recovery for specific watershed parameters in other geographic areas. In North Carolina, Swank and Helvey (1970), estimated that runoff rates recovered about 35 years after clearcut logging ceased. Also, Ziemer (1964) documented that recovery of runoff regimes required 16 years after logging in the Sierra Nevada Mountains of California.

c. Assessment of Biological Recovery Unclear

Although recovery of flow regimes has been documented in some studies, assessment of biological recovery, especially of fish habitat, biogeochemical cycles, aquatic macroinvertebrate communities, and fish assemblages, is less well known. There is not even concurrence in the professional literature on how to measure recovery of biological characteristics following disturbances due to timber harvest. Biological characteristics such as salmonid habitat quality and salmonid production are among the most important beneficial uses of water that the

NCRWQCB can affect indirectly through TMDLs and other regulations. Crafting TMDLs that address suspended sediment and water temperature would help to protect these important water quality issues, but still fail to protect the structural components of fish habitat.

Methods for measuring biological and ecological recovery range from qualitative (e.g., species persistence) to quantitative (e.g., return to pre-disturbance population densities) (Poff and Ward, 1990). Factors that affect biological recovery can include changes in aquatic habitats, changes in stream productivity, residual toxicity, time of impact, and presence or distance of refugia. Disturbances that resulted in physical habitat alterations were usually associated with long recovery times (Niemi et al. 1990). For example, recovery time for macroinvertebrate populations disturbed by timber harvest (review of 16 studies) took >5 years for biomass, >5 years for density, and <5 years for species richness. Recovery of structural components of fish habitat may take much longer, from decades to a century or more (Bryant 1980, Beechie et al. 1994). Karr et al. (1986) developed an index to biological integrity that may hold some potential for estimating recovery of overall stream condition. In the Humboldt watersheds, logging disturbances continue at a high rate annually so none of the studies cited above, which tracked recovery after a one-time disturbance, are applicable for calculating ROR.

An added source of uncertainty is the natural variability in biological indicators (such as fish population) that exceeds variability in physical indicators (such as particle size distribution). Clayton (2002) showed that in order to distinguish a statistically meaningful change in signal through the noise of natural variability required a monitoring period on the order of twenty to fifty years for biological indicators, compared to five to ten years for physical indicators. In the five watersheds the duration of monitoring data falls far short of that which would be required for a statistically significant identification of recovery.

4. Anadromous Fish as Factor in Recovery

Including anadromous fish as a beneficial use of water in the five watersheds increases both the urgency and the complexity of determining ROR. Water quality is just one component of fresh water fish habitat. The physical structure of habitat, including the frequency and quality of habitat components such as pools, and habitat structure such as large woody debris, is equally important. And, because anadromous fish utilize freshwater and marine habitats, both environments must be considered in stock recovery.

a. Influence of Pacific Decadal Oscillation (PDO)

Recovery of listed salmonids (chinook, coho, and steelhead) in the evolutionarily significant units (ESU) of the northern California coast (Federal Register 1997, 1999, 2000) is dependent on recovery of freshwater habitats in the ESUs and is strongly influenced by a phenomenon known as the Pacific Decadal Oscillation (PDO), which controls the productivity of the North Pacific Ocean for anadromous salmonids (Mantua et al. 1997, Hare 1998). The PDO is an inter-decadal event with warm and cool regimes that affect temperature, precipitation, run-off patterns, and riparian and aquatic ecosystems in western North America and the productivity of anadromous salmonid rearing areas in the North Pacific Ocean.

The PDO alternatively favors salmonid production in the northern and southern sectors of the North Pacific Ocean (Hare et al. 1999). During 1925-1946 and 1977 to at least 1995, the PDO favored salmonid production in the Gulf of Alaska, increased storm activity and precipitation in Alaska, and produced calmer, warmer, and drier weather in the Pacific Northwest and California. In contrast, in the Pacific Northwest and California, anadromous salmonid production was highest during 1890-1924 and 1947-1976. Another shift in the PDO in 1995 initiated increases in ocean productivity off California, the area where northern California anadromous stocks rear. If current patterns prevail, with shifts in the PDO occurring every 20 to 30 years (Hare et al., 1999), the next negative shift in the PDO for California is likely to occur in the 2015 to 2020 timeframe. The next shift may be critical for ESA-listed stocks in Bear, Jordan, Stitz, Freshwater, and Elk watersheds. If fresh water habitats in the watersheds have not recovered by that time, the fish will simultaneously face both degraded freshwater habitats and an unproductive ocean. The result could shift the stocks to endangered status or result in extinctions.

5. Information Needed to Determine ROR

Information needed to determine ROR is dependent on both policy decisions and a science-based monitoring program. Some key information needs are:

- *A definition of recovery.* The Panel notes that what constitutes recovery is a policy decision. For example, does recovery mean a return to watershed conditions prevalent prior to human disturbances in the watersheds, or maintenance of conditions at some other documented point in time? Is some other definition of recovery appropriate?
- *A definition of “background” characteristics for environmental parameters to be monitored.* Although definition of recovery and background are different, they are closely related. Several water quality parameters listed in the Basin Plan (e.g., suspended sediment) are measured as deviations from background levels. It is therefore essential that background be defined.
- *A monitoring program that tracks a suite of water quality and fish habitat parameters.* The North Coast Region Water Quality Control Plan, the HCP, and the ACP list a suite of critically important variables that cover water quality, fish habitat concerns, and special mitigation measures like storm proofing roads and mass wasting control. A valid monitoring program should therefore contain most or all of these variables.
- *A scale at which environmental variables are monitored.* Monitoring can occur at the site, reach, sub-watershed, and watershed scales. The most meaningful measurements are often made at the larger scales in the downstream areas of watersheds because downstream waters integrate the effects of upstream disturbances, and are historically the most productive parts of watersheds for salmonid production (Peterson and Reid 1984; Li et al. 1987; Brown and Hartman 1988). However, the HCP indicates that scales used in the monitoring effort are not yet agreed upon. Currently, the focus of PALCO’s monitoring is on company lands, which precludes monitoring of important downstream waters in the larger watersheds like Elk and Freshwater. A mix of monitoring scales should be used. Monitoring at small scale that isolates sediment production from individual THP and non-harvested areas would be useful in testing the effectiveness of mitigations and preventative measures that are part of the THP. Monitoring at large scale is also necessary to quantify the aggregate watershed response.

6. Time Required to Test Plans for Recovery

For the sake of discussion, let us assume that all of the necessary components of a monitoring plan are in place. This would include definitions of recovery and background, parameters to be measured at the most advantageous scales, statistical programs to analyze results, the location and areal extent of future human disturbances in the watersheds, and adequate funding to maintain the program for the necessary period of time. If all these conditions were met, how long might it take to demonstrate the effectiveness of the HCP? The answer cannot be quantified exactly at present, and at least several years of application of the HCP will be needed, followed by the time needed for a major storm event to test the protection and mitigation offered by the HCP. The answer, then, may be in the range of 10 to 20 years, or longer. Results may come too late to provide feedback to adaptive management efforts in these watersheds, but results could prove useful to future programs in other watersheds. Few companies or even agencies have the funding and long-term planning abilities to execute a program of this duration. Consequently, few long-term monitoring programs of this type have ever succeeded.

7. Steps in Estimating Rate of Recovery

Recovery of a sediment-impaired stream depends upon (1) control of sediment production from hillslopes; and (2) instream sediment transport to flush the excess sediment from the system and restore the stream to a more natural state. Approaches to the calculation of the rate of recovery for a specific watershed may include empirical estimates based upon paired watershed measurements and the use of numerical models.

Can ROR be estimated empirically?

Paired watershed studies that compare disturbed and undisturbed watersheds are a direct approach to determining ROR. Paired watersheds can trade space for time and help to quickly establish the level of impairment in the disturbed watershed. Also, the undisturbed watershed can provide information on background levels for environmental parameters, and a definition of recovery. However, even if such paired watersheds could be found on the northern California coast, which is doubtful, demonstrating the trajectory of the disturbed watershed toward or away from recovery could take years if logging-related disturbances continue at a relatively constant rate.

Can the O'Connor or Reid sediment models be used to calculate ROR for the five impaired watersheds?

In the Panel's Phase I report, we considered the models put forth principally by Reid and O'Connor. Now, we consider whether either model can predict ROR with the present level of information from the watersheds. The O'Connor model contains a large number of sediment source variables that are driven by a scarcity of empirical data. It is, therefore, difficult to assess the degree of reliability or uncertainty associated with each sediment source estimate. Consequently, it is difficult to infer, in the absence of supporting data, that this model could be used at the present time to calculate a meaningful ROR.

The Reid sediment model provides an estimate of sediment production from harvested and non-harvested hillslopes with production rate factors based upon observations. A fixed period L (Reid used 15 years) is used to separate recently harvested from non-harvested or recovered hillslopes. The Reid model could be used to assess the hillslope sediment production as a function of the fraction of hillslope that is harvested. As such it could be used with a designated hillslope sediment production threshold to determine the allowable harvest rate. The designated hillslope sediment production rate could be chosen with recovery of the stream as a goal, but the model would only quantify the recovery in terms of hillslope sediment production and would not predict the trajectory of recovery of streams in the system where excess sediment needs to be flushed out.

C. Application of Rate Of Recovery to the TMDL Process

1. Turbidity Exceedence Curves

In its Phase I report, the Panel discussed the concept of using deviations from sediment rating curves as a method of measuring exceedence of acceptable turbidity limits. In the work Klein and Trush presented at the May 5, 2003 Technical Workshop, an approach was presented that the Panel finds promising as a method for relating harvest rate to beneficial uses of water. This approach could be used to form a scientifically rigorous method of developing a TMDL for the five Humboldt County watersheds.

Klein (2003) analyzed data for eight watersheds, including Freshwater Creek, to develop “turbidity exceedence curves.” These are graphs of turbidity (in nephelometric turbidity units [NTU], a turbidity standard that measures the scattering of light through water caused by materials in suspension or solution) versus percent of time turbidity threshold values are equaled or exceeded. Turbidity exceedence curves are analogous to flow duration curves, a common tool in hydrology. From these curves, which could be developed for all five Humboldt County watersheds, one can read the percent of the time that a given NTU value is equaled or exceeded.

As part of his analysis, Klein developed separate turbidity exceedence curves for “normal” water years, “dry” water years, and “very dry” water years. This is an important step in developing TMDLs because it recognizes that salmonids experience stress from turbidity of different duration in years with contrasting runoff. Moreover, Klein presents data in the form of two graphs (with supporting statistics in Appendix C of his report), the first of which (Figure 12) relates annual harvest rate to the turbidity (in NTU) that is exceeded 10% of the time ($r^2 = 0.598$). A second graph (Figure 13) relates road density to the turbidity (in NTU) that is exceeded 10% of the time ($r^2 = 0.617$). A multiple regression with the two variables explained 75.2% of the variance in turbidity exceedence levels, significant at the $p = 0.05$ level (see Figures 1 and 2 below).

A strength of this method is that rather than using arbitrary thresholds such as 20% above background, this approach may be used to directly relate a physical property (turbidity) to a beneficial use (fish abundance).

Figure 1. Annual harvest rate since 1988 and 10% turbidity exceedences for WY2002¹³

Figure 12. Annual harvest rate since 1988 and 10% turbidity exceedences for WY2002 (site codes identify data points)

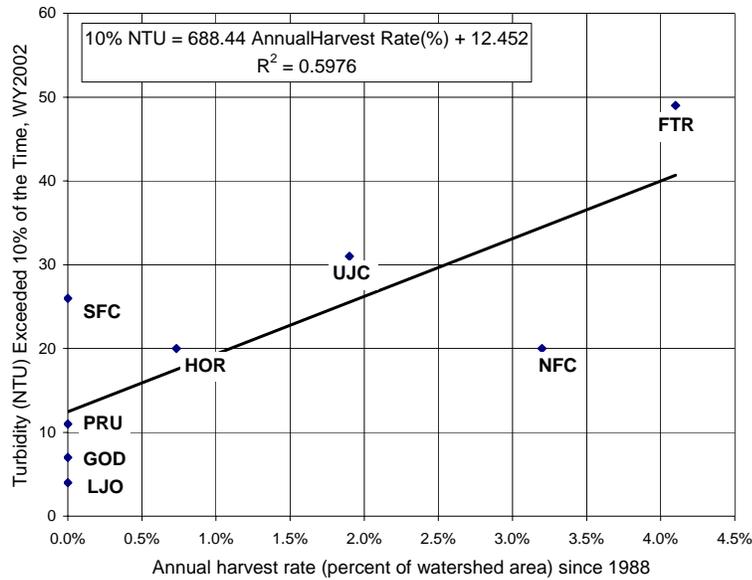
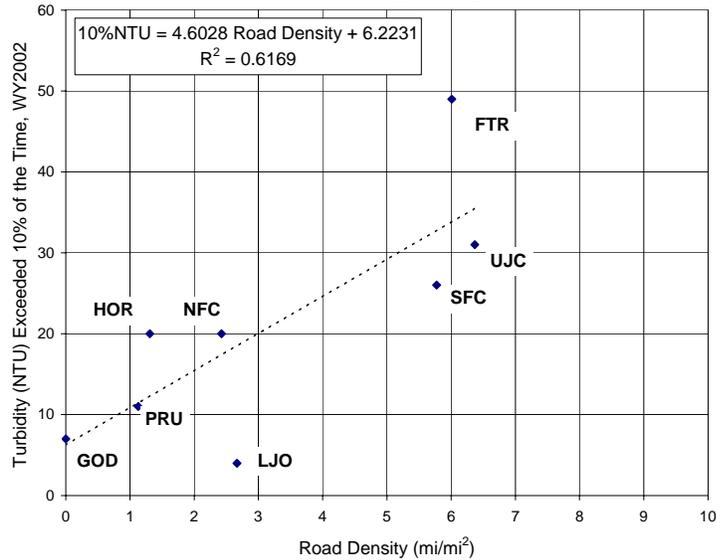


Figure 2. Road densities and turbidity exceedences for WY2002¹⁴

Figure 13. Road densities and turbidity exceedences for WY2002 (site codes identify data points)



¹³ Klein, 2003, p.20

¹⁴ Klein, 2003, p.20

2. Chronic Turbidity Thresholds

Trush (2003) has identified “chronic turbidity thresholds” for anadromous salmonid populations for each of the following flow conditions:

- mean daily average streamflow (23%-24%): NTU < 10
- winter base streamflow (10%): NTU < 25
- receding winter peak streamflow (5%): NTU < 70
- winter peak streamflow (2.5%): NTU < 100.

Identifying chronic turbidity thresholds for different portions of the annual hydrograph is an important step in developing TMDLs because it recognizes that the vulnerability of salmonids varies seasonally with position of the annual hydrograph. For example, the survival of salmonid embryos in gravel beds can be reduced by fine sediments entering streams during the critical species-specific incubation period (Everest et al. 1987). Also, chronically turbid water during the prime summer rearing period can reduce the density and growth of juvenile salmonids (Sigler et al. 1984), and cause a physiological stress response if turbidity occurs during periods when waters are normally clear (Redding et al. 1987).

In the case of Freshwater Creek, the turbidity thresholds have been exceeded at the frequency given in Table 1.

Table 1. Percent of time that turbidity exceeded the chronic turbidity threshold for Freshwater Creek at the Salmon Forever/Watershed Watch site (Calwater No(s) 1100.000101 and 1100.000103)¹⁵

Turbidity Threshold Values	Normal Water Year Oct 1999-May 2000 (243 days)	Dry Water Year Oct 2001-May 2002 (243 days)	Very Dry Water Year Oct 2000-May 2001 (243 days)
10 NTU	65%	58%	60%
25 NTU	25%	22%	15%
70 NTU	5%	6%	2%
100 NTU	2.5%	4%	0.7%

The values in the table represent the percent of time that chronic turbidity thresholds were exceeded for the years indicated. Note that in the very dry year, chronic turbidity thresholds were exceeded at a lower frequency than during the normal water year. Also in very dry years, water temperature may be a limiting factor; temperature exceedence curves and chronic temperature thresholds could be developed in a similar fashion and incorporated into a TMDL.

3. Applicability to the TMDL Process

The use of turbidity thresholds is consistent with the NCRWQCB mandate to develop TMDLs for water quality, and recognizes that turbidity (and perhaps temperature) are key water quality

¹⁵ Klein, 2003, interpolated from Figures 9-11, p.18-19

characteristics that affect salmonid production, one of the beneficial uses to be protected. This approach links rate of harvest and/or road density to turbidity exceedence levels, and that is related to chronic turbidity thresholds for anadromous salmonids. For example, Klein (2003) shows in his Figure 12 that the annual harvest rate cannot exceed 1.7% in a dry year (like WY 2002) if a turbidity of 25 NTU (chronic level during winter baseflow) is not to be exceeded more than 10% of the time. A 4.2% rate of cut (average annual harvest rate for Freshwater Creek since 1988) would produce turbidity levels of 49 NTU that would be exceeded 10% of the time... a level that would be damaging to salmonids. Likewise, Klein's data show that the road density should not exceed 4.2 mi/mi² if the turbidity level is to remain below the 25 NTU chronic threshold at least 90% of the time, protecting salmonids. Current road density in Freshwater Creek watershed is approximately 6.0 mi/mi² as reported by Klein (2003).

The TMDL process is a better tool for controlling chronic pollution such as suspended sediment/turbidity (e.g., NTU load) and water temperature, than for dealing with episodic events like mass wasting resulting from major storm events. The TMDL process is ill-equipped to deal with large wedges of deposited sediment that enter channels through mass wasting or floods, and move downstream during large, infrequent flow events. Such sediment wedges may take decades to move through a watershed (Everest et al. 1987, Reeves et al. 1993). Deposited sediment elevates channel beds, aggravates flooding, and buries channel pools that would otherwise serve as rearing habitat and resting sites for migrating salmonids.

The Panel notes the pervasive and ongoing dispute among stakeholders regarding the magnitude and causes of increased flood frequency. In our view, a monitoring program that measures both water quality parameters and channel cross-sections at key locations throughout the channel network is more likely to inform management decisions that support recovery of beneficial uses of water than a program that focuses on water quality parameters alone.

D. Policy Considerations

Determining the rate of recovery of disturbed watersheds is complex and would require a sustained team effort between scientists and policy makers in order to succeed. In the case of determining the rate of recovery for watersheds in the North Coast Region that have been disturbed by human activities, policy makers would need to establish the following program elements:

- A definition of what constitutes "recovery" of disturbed watersheds.
- A definition of what constitutes "background" levels of various environmental characteristics.
- Environmental characteristics to be monitored (e.g., water quality criteria, anadromous fish habitat, indicator species), based on budgets, manpower, inter-agency cooperation, etc.
- The type of monitoring to be conducted (e.g., before and after disturbance, paired watershed studies).
- The scale at which monitoring is applied (e.g., site, reach, sub-watershed, watershed) again based on budgets, manpower, interagency cooperation, etc.
- The time that will be allotted to acquire data to use in calculation of ROR.

- The extent of reliance on plans, laws, and regulations such as the HCP/SYP/THP, the State Forest Practices Act, the Endangered Species Act, and TMDLs to initiate and maintain recovery.

With regard to developing TMDLs in particular, many of the same issues affecting rate of recovery need to be considered. These include the need to define and calculate 'recovery' and 'background' levels of physical parameters such as temperature and turbidity. TMDLs need to be defined in a way that addresses complex water use objectives. Some examples are given below:

- Ensuring water quality for salmonid habitat requires the development of maximum tolerable thresholds and exceedence probabilities as outlined by Trush and Klein.
- Preventing flooding due to channel bed aggradation requires definitions of acceptable sediment loading based on the rivers' ability to transport the material away (i.e. sediment loadings as a function of sediment transport capacity). This was discussed at length in the Panel's Phase I report.¹⁶

¹⁶ Humboldt Watersheds Independent Scientific Review Panel, 2002

QUESTION C

Evaluate the water quality protection measures provided by the HCP/SYP (including the intended performance under full versus the current level of implementation) in the context of the water quality standards specified in the Basin Plan. Comment, from a science perspective, on the way in which the HCP/SYP and the corresponding watershed analysis process and adaptive management changes does or does not address the Basin Plan standards over selected periods of time.

This question raises two issues: first, the effectiveness of the HCP/SYP/THP water quality measures, and second, adaptive management through the watershed analysis process as prescribed by the HCP/SYP. We address these questions separately, with Part One below addressing the effectiveness of water quality protection measures and Part Two reviewing the watershed analysis process as exemplified by the Freshwater Watershed Analysis, as this is the only Watershed Analysis that has been completed. In Part Three, we include further commentary on the sediment budget models that were reviewed in our Phase I report, which focused on the use of these models to estimate allowable harvest rate in addressing basin plan water quality objectives. This is in response to the uncertainty regarding these models that arose during the January 23, 2003 Regional Water Board meeting.

PART ONE: Effectiveness of the HCP/SYP/THP Water Quality Protection Measures

A. Summary Findings

Even if fully implemented as envisaged, it is the Panel's judgement that the HCP/SYP/THP structure cannot be relied upon to meet water quality objectives due to eight critical shortcomings . These shortcomings are outlined below. Further, because the HCP/SYP/THP process has not been implemented in a manner consistent with its design, there are serious negative implications for water quality, flooding, and Cumulative Watershed Effects (CWE). The most critical failing stems from the practice of continuing to approve harvest plans without the requisite watershed analyses.

1. Limitations of the HCP

It is also the Panel's judgement that the HCP process might have created a structure that could be deemed adequate from a water-quality perspective. However, there are at least eight significant shortcomings.

a. Lack of Maps Showing Mass Wasting Risks

Maps showing the extent and severity of the risks of mass wasting did not advise the initial development of the HCP. If such maps and analyses had been available (they still are not fully available), they would have enabled the regulatory agencies to identify the risks of accelerated sedimentation to all stakeholders interested in PALCO's land management activities. Such maps

could also have provided the regulatory agencies with the information necessary to assess the extent of potential harvest activities on areas with mass wasting concern with implications for water quality protection. Regulatory agencies who based plan approval on the assumption that water quality attainment would follow from plan prescriptions would have been able to see the extent of area over which this uncertain assumption was being relied upon to protect water quality. This would have aided them in factoring the extent of the risk and uncertainty into their policies and plan approvals.

b. Optimistic Assumptions of Harvestable Area

At the May 5th Technical Workshop, PALCO senior staff commented that its business model assumes that all areas of its properties are available for harvest. In regard to buffers and high-risk areas, it assumes a timber volume based on that available from thinning. These assumptions have logically led to a business plan with high expectations that now must be reduced in the face of scientific evidence. Mapping of areas with high risk of mass wasting could have created a more realistic base of expectations and given greater consideration to water quality concerns early in the decision process. While the geologically dynamic nature of the North Coast region appears to be widely accepted (tectonic uplift, high rainfall rates, mass wasting) these factors do not appear to have been fully considered in PALCO's business plan or in the HCP development process.

c. Increased Subjectivity in Identifying MWACs

With regard to the task of mapping of areas with high risk of mass wasting, PALCO also commented at the May 5th Technical Workshop that while geologic mapping will be continued, the company will not be preparing maps interpreting risk of mass wasting (as was done for the Freshwater watershed). Instead, a field checklist will be used. This necessarily increases the burden on field teams to make last-minute adjustments to harvest plans. Given the difficulties of making rapid judgments in forested terrain, without the benefit of subsurface investigation, it would likely be very difficult for field teams to compile scientific evidence sufficient to make more than minor adjustments to the company's plans for road locations, landings and harvest areas.

d. Conservation Measures Inappropriate to Water Quality

In lieu of using spatially specific maps showing areas with high risk of mass wasting (such as the hazard maps produced by CGS or the MWAC maps produced by PALCO), "Stringent Conservation Measures" were adopted. These measures are only stringent, though, in comparison to the general FPA rules. In the Panel's assessment, these measures are not overly stringent given this area's propensity for erosion and mass wasting. Furthermore, since the conservation measures target silviculture and fisheries issues only, they fail to adequately address the full range of beneficial uses.

The most critical example of this issue is in the design of stream buffers. In the Panel's judgement, 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

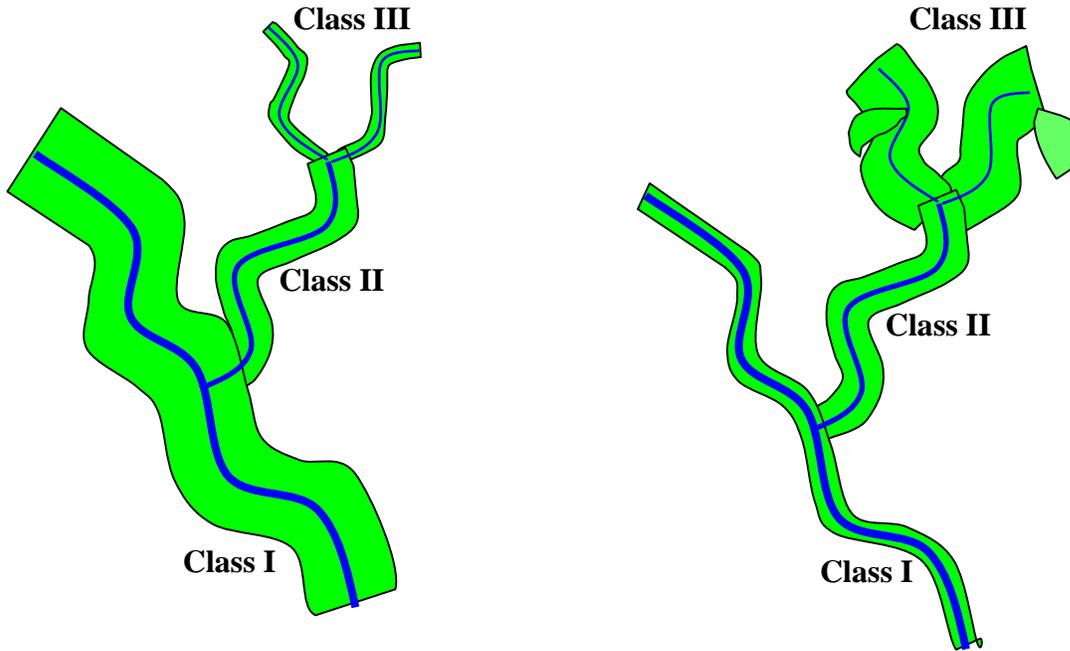
management zones (RMZs) that form buffers along streams, which were set before watershed analysis was carried out, gave greater protection to larger streams. On Class I (fish bearing) streams, RMZs take the form of 100 foot no harvest inner bands and 100-170 foot restricted harvest outer bands. Class 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.

While it is logical that a plan devised to protect riparian habitat adjacent to fish-bearing streams would place more emphasis on Class I streams, a plan designed to protect water quality in non-fish bearing headwaters would place more emphasis on Class II and III streams (with the focus on protecting these streams from sediment and heating effects) than is presently the case under the HCP. PALCO is currently monitoring the effectiveness of RMZs¹⁷ and this research may shed light on the effectiveness of RMZs on water quality protection. However, the study design contains several elements that limit its usefulness as a means of assessing the effectiveness of RMZs. For example, the sampling protocol asks users to ignore erosion entering the stream from windthrown trees and from mass wasting features within RMZs. However, analysis by Reid and Hilton (1998) has shown that treefall rates (and therefore erosion rates) are higher in RMZs due to the lack of shelter from surrounding harvest areas, suggesting that such erosion should be attributed to harvesting. Likewise, mass wasting in RMZs may well be due in part to elevated pore-water pressures resulting from loss of canopy interception and evapotranspiration upslope on harvested areas.

The Panel finds that stream buffer designs that address all of the beneficial uses of water at the watershed scale could be improved by retaining the existing RMZs along Class I streams, and increasing the width of RMZs along Class II and Class III streams (see Figure 3 below). The upstream extension of robust RMZs would provide enhanced protection against accelerated sedimentation and fish habitat degradation in downstream waters of Class II and Class III streams, as well as better protection against elevated water temperatures in Class II streams. Furthermore, the Panel finds that risk of sedimentation could also be reduced if wetlands and areas with high risk of mass wasting in the watersheds were restricted from timber harvest and provided with modest no-harvest buffer zones.

¹⁷ As outlined in the SCOPAC Science Team Technical Report TR-2001-401

Figure 3. Schematic comparison of stream buffers for habitat versus water quality protection¹⁸



Habitat Conservation Plan

The most valuable fish habitat is in Class I waters, therefore the largest buffer is on Class I waters and the smallest buffer is on Class III waters. The emphasis is on habitat conservation.

Water Quality Plan

Most sediment enters from headwaters, therefore the largest buffer should be on Class III waters, and the smallest buffer on Class I waters. The emphasis is on water quality protection.

HCP Guidelines¹⁹

Class I Water Body	permanent, fish bearing	100 ft No Harvest Band, 100-170 ft Outer Band (some harvest allowed)
Class II Water Body	permanent, non fish bearing	30 ft No Harvest Band, 30-130 ft Selective Entry Band (some harvest allowed)
Class III Water Body	intermittent, non fish bearing	10 ft No Harvest Band, 10-30 ft Limited Harvest Band, 30-100 ft Sediment Filtration Band (some harvest allowed with restrictions dependent on slope)

Note: The 10 ft No-Harvest Band is likely to be of no value for water quality purposes. CDFG and the California State Water Resources Control Board recommended 100 feet as the minimum buffer for the Pajaro River, for example.

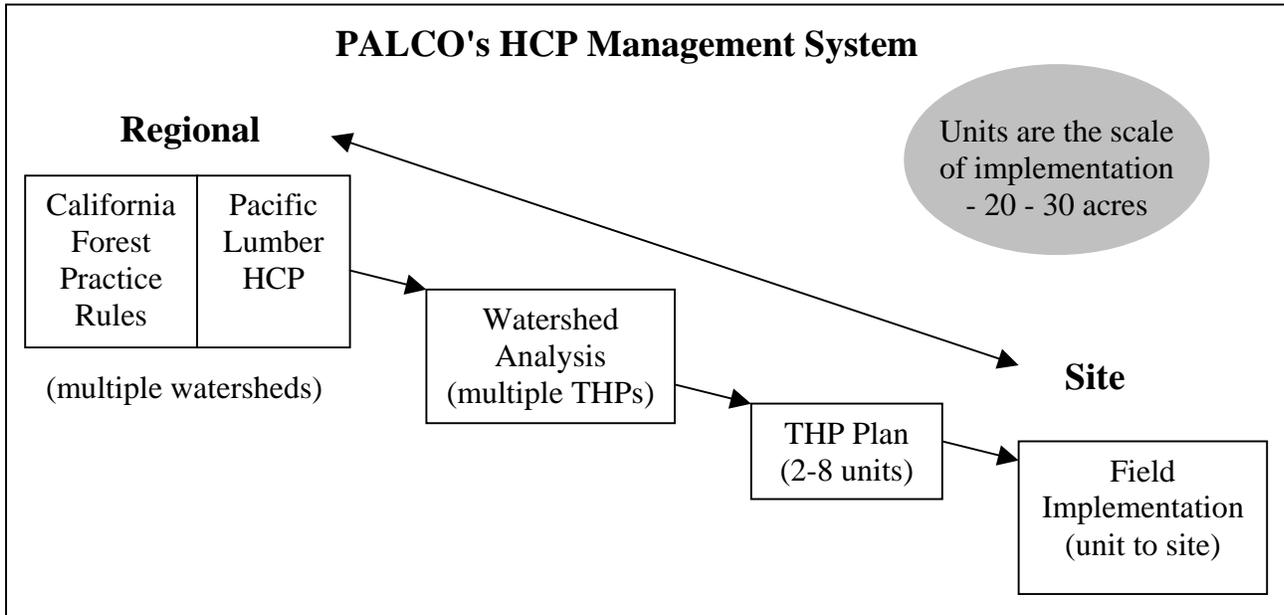
¹⁸ Collison, 2003

¹⁹ USFWS and CDF, 1999, p.50-56

e. Incomplete Watershed Analyses

The architecture of the HCP/SYP/THP process is explained in the following slide from PALCO's presentation at the May 5th Technical Workshop. Note that the HCP depends upon watershed analyses and that THPs are shown as flowing from them.

Figure 4. PALCO's HCP management system²⁰



While watershed analyses might have provided necessary elaboration of the HCP to ensure protection of water quality, in fact, only the Freshwater Watershed Analysis has been approved and prescriptions based upon it negotiated and agreed. Moreover, these prescriptions have not yet fully implemented on the ground. Other analyses are characterized as "nearly complete," but given the pace of Freshwater, it would be reasonable to expect that they may take some time for review and acceptance.

The Freshwater Watershed Analysis identifies significant management related sediment production, dominated by roads and landslides. The Watershed Analysis also documents significant rates of road construction and timber harvest in the last 5 years analyzed, resulting in significant sediment production that has a cumulative watershed effect. The prescriptions developed from this watershed analysis describe THP specific best management practices intended to limit sediment production. However, the prescriptions do not address the cumulative impact of the high harvest rate. This is a failure of the feedback from watershed analysis to Timber Harvest Planning and a represents a flaw in the management system. Additionally, the unproven effectiveness of the prescriptions derived from the Freshwater Watershed Analysis raises concerns as to how much water quality will improve from this large watershed analysis exercise. We comment at greater length on the Freshwater Watershed Analysis and the prescriptions derived from it in Part Two of this section below.

²⁰ PALCO, 2003

f. Mitigations Expected to be Relaxed

In regard to watershed analyses, the operative assumption is that the interim measures now in place are considered stringent. Moreover, there is an assumption by PALCO and the implementing agencies that watershed analysis will lead to relief from the stringency of the measures. This assumption runs counter to the experience of Washington State (where Watershed Analysis was initially developed) where forest practice prescriptions often became more restrictive following detailed watershed analyses. The Panel notes that scientifically sound adaptive management implies evenhanded review with the possibility that conservation measures could be either strengthened or relaxed.

Examples of the relaxation of prescriptions following watershed analysis include:

- Before watershed analysis, the HCP states that Class I streams have a 100 foot no-harvest band on each side. In PALCO's "Final Prescriptions based on Watershed Analysis for Freshwater Creek," the no-harvest band was reduced to 50 feet on each side of Class I streams.²¹
- Before watershed analysis, the HCP states that Class III streams have a 10 foot no-harvest band on each side. In PALCO's "Final Prescriptions based on Watershed Analysis for Freshwater Creek," there is no unconditional no-harvest band around Class III streams.²²

In the Panel's review of the Watershed Analysis, we did not find a credible scientific basis in support of these and other relaxations in the "Final Prescriptions based on Watershed Analysis for Freshwater Creek."

g. Lack of Independent Scientific Review

The argument that BMPs are sufficiently effective in reducing erosion and that renewed harvest with BMPs will result in a net *reduction* in sediment yield is central to PALCO's timber harvest planning and CDF's consequent approval. However, in the Panel's view, this argument is at best controversial and is certainly an untested theory not yet backed by sound, peer reviewed empirical data. Given its centrality to the THP, the Panel is concerned to note the following points:

- Intensive monitoring did not start until four years after the initial THPs were approved, and there is no transparent evidence of BMP effectiveness.
- PALCO staff, rather than regulatory agencies, appear to be taking the lead in devising and executing the experimental designs used in the monitoring program.

In the Panel's judgement, it is not sound scientific practice to have the discharger responsible for the monitoring protocol and analysis. In particular, the Panel is concerned that the manner in

²¹ PALCO, 2002, p.1

²² PALCO, 2002, p.8

which the experiments are constructed (e.g. sampling locations, frequencies, methods) can pre-determine or influence the outcome.

h. Inadequate HCP Process Design

Since mapping of areas with high risk of mass wasting has been insufficient, the HCP strategy has consisted of 1) the "Stringent Conservation Measures" in the Panel's assessment above and 2) dependence on follow-up inventory, mapping, and analysis to be performed at the Watershed Analysis stage. However, as John Clancy of the National Marine Fisheries Service put it during his presentation on the HCP at the May 5th Technical Workshop, "We went into a dark room. Now we're monitoring to learn what the room looks like." This statement on the tentative nature of the HCP's expectations and boundary conditions clearly underscores the need for monitoring and watershed analyses as depicted in the PALCO diagram. Without monitoring and watershed analyses, and without independent third party review of these processes, the Panel finds no scientific justification that these processes reliably protect water quality.

2. Limitations of the THP Process

The THP process does address certain aspects of water quality as well as other issues. It also provides for review by water-quality experts. However, the Panel notes that there are obstacles to bringing impartial science-based information and expertise to bear in this situation:

- As mentioned above in sections A.1.a through A.1.h, harvest plans start from an optimistic projection of the harvest area available, and from the standpoint of water quality protection, employ untested silvicultural techniques. The plans then require that proposed reductions or changes bear the burden of proof.
- The time available for review of plans (and assembling such proof) is severely constrained.
- The number of plans (roughly one hundred or more per year) dictates that time for field review is limited.
- There is neither time nor resources for sub-surface examination of mass wasting hazards.
- Estimation of risk must be made in adverse, forested terrain, so accurate evaluation would require much more time than can presently be allotted. Also, during the May 5th Technical Workshop, field experts indicated that they were under pressure to permit harvest within risk zones unless strong evidence to the contrary could be presented.

3. Limitations of the SYP

The SYP process, as currently structured, cannot be relied upon to provide a science-based assurance that water quality will be protected. The SYP purports to keep harvest levels within a range that is consistent with public values, such as water quality. However, the Panel notes that there is not sufficient mapping or GIS analysis of mass wasting hazard and water-quality related constraints (such as water-quality related stream buffers) to permit science-based review of the assumptions made by PALCO and approved by CDF and CDFG.

Furthermore, there is no enforceable requirement to distribute disturbances over the five watersheds addressed in this report for which there are estimates of allowable cut. The SYP is silent as to the scheduling and regulation of cut in any particular watershed. The rate of cut described in the SYP that was approved by the CDF varies from decade to decade. During the first two decades, the harvest rate in terms of Disturbance Index (DI) values is high in three watersheds (DI of 10-13.5), while harvest rates are low in the other watersheds (DI of 1-4). If the SYP were to be used for water quality protection, it would need to be restructured to adequately address water quality concerns, and to provide for transparent review of the conclusions.

B. Policy Considerations

If the HCP/SYP/THP processes are to be used as a valid tool in water quality protection, the Regional Board staff might consider several strategies to make the process workable:

- Staff could recommend that SYPs (and/or THPs) include certain minimum information sufficient to permit technical and science-based evaluation. This would include items such as mapping of water-quality related stream buffers (not the HCP widths) and peer-reviewed mass-wasting risk assessments.
- The SYP could also be more specific, relating the calculations in the SYP to a watershed-by-watershed level. Each watershed could have not-to-exceed levels of disturbance. Information considered should include not only recent harvest activity, but also current plans and a realistic estimate of harvest for the next five years. This would permit an adequate level of assurance that cumulative impacts will not be exceeded; the level of activity covered by the SYP would then meet water quality protection standards.
- If these recommendations are adopted by CDF, then the Regional Board could use the SYP in its waiver policies relative to THPs.
- Until such recommendations are adopted and implemented, Regional Board staff might logically conduct its own cumulative-effects analyses, using the best information available. For example, if the mapping of roads, settings, and harvest methods used to calculate the SYP are available, these could be used as a surrogate for actual plans. Even though there is not a one-to-one relationship to actual THP activity, this information is very likely the best means of estimating cumulative effects. If these source materials are not provided, an independent evaluation could be made of likely rates of disturbance, based upon past and current practices and levels of activity.
- If Regional Board staff do not receive the necessary empirical data from PALCO and CDF, they will need to make the best assessment possible with information that can be reasonably attained.²³ Under these conditions, considerable professional judgement would be required; this suggests that staff determinations might best be evaluated (and revised if necessary) by independent peer-review.
- The approach above, which involves parallel assessment by the Regional Board, is of course duplicative and inefficient in the long run. However, in the short term, the Panel sees this as an alternative to continued reliance on eleventh-hour, piecemeal review of

²³ Note that EPA guidance documents state that lack of information in and of itself is not a reason for failure to regulate.

individual THPs in which a lack of staff and information makes it difficult to conclude science-based determinations of water quality impacts.

Other policy considerations for improving monitoring protocols and analysis include:

- Organize monitoring as the responsibility of an impartial audit organization supported and supervised by regulatory agencies such as CGS and the Regional Board.
- Initiate monitoring in advance of harvest activities in these five watersheds. It is essential that baseline data be collected in advance of future harvest activities so that important questions will not remain unanswered in five years' time.
- Require documentation of benefits before THPs are approved in cases where THPs are issued on the basis that mitigation will exceed sediment generation.

PART TWO: Review of Freshwater Watershed Analysis

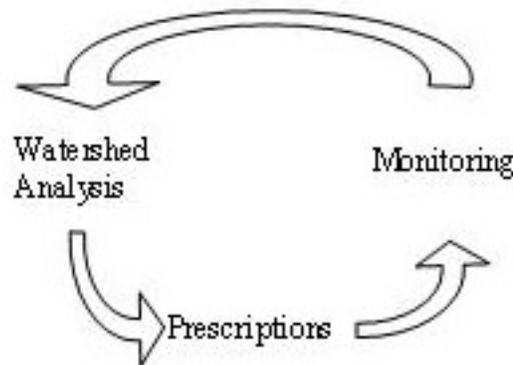
A. Summary Findings

Given the importance of Watershed Analysis in the SYP/HCP/THP process, the Panel conducted a review of the Freshwater Watershed Analysis and its outcome in terms of revised prescriptions. We focused on the connection between the information developed in the Watershed Analysis and the agreed-upon prescriptions (PALCO 2002). We did not focus in depth on the science in the Watershed Analysis as this was not in our mandate under the TOR, and also because this has been commented on by others.²⁴

Overall, the Panel finds that the Watershed Analysis did a reasonable job of quantifying the physical processes, modeling them and quantifying the level of uncertainty. The Watershed Analysis showed that timber harvest and associated management activities, primarily road construction, contribute significantly to increases in sediment production. The Analysis also showed that current timber harvest and road construction rates (and thus, without improved practices, sediment production rates) are significant. The Analysis indicated that road sediment production and sediment production due to mass wasting should be targeted in efforts to limit sediment production due to harvest activities.

The Panel finds, however, that the Watershed Analysis provides no quantitative measurement-based assessment of prescriptions to limit sediment production from those processes identified as being responsible for increased sediment inputs. Lacking such linkage to assurances, the Watershed Analysis does not provide a credible basis for confidence that the agreed-upon prescriptions in THPs (the ultimate outcome of the watershed analysis process) will indeed fulfill their expected effect of limiting sediment production leading to recovery of the watersheds. This is a failure to close the feedback loop from watershed analysis to prescriptions and represents a fundamental flaw in the process.

Figure 5. Feedback loop²⁵



²⁴ e.g. Reid and Lisle, 2001 Watershed Analysis Peer Review Panel, 2002

²⁵ Tarboton, 2003

The Panel also notes that the effectiveness of land management prescriptions and practices was not evaluated during Watershed Analysis. Thus, the Panel finds that the Watershed Analysis fails to provide a quantitative basis that supports the reliability of these prescriptions.

B. Context for Watershed Analysis

The HCP provides the context for watershed analysis.²⁶ Watershed analysis is part of the ACP, the goal of which is to maintain or achieve over time a properly functioning aquatic habitat condition. Watershed analysis is required for all covered lands in the HCP. A schedule was to be established to result in completion of the initial watershed analysis within five years of the issuance of the initial take permit. The procedure followed is a modified version of the Washington Forest Practices Board standard methodology.

The ACP states that "specific habitat variables are not enforceable standards under the plan," but that "the conservation goal is the cornerstone of the entire Aquatic Species Conservation Plan." This seems to be an example of a plan wherein the plan represents good intentions without any guarantees that it will work.

The HCP states, "A federal permit violation has not occurred if an activity that results in an unavoidable input of sediment to waters occurs, even though all wet weather and construction/reconstruction requirements were properly followed, in addition to all required erosion control measures being properly installed."²⁷ This effectively shifts the obligation for reliability from the responsible party and places it on the requirements or prescriptions. The prescriptions are therefore crucial, because they are the principal means by which management activities are controlled so as to be protective of water quality. The HCP also states that "hillslope management prescriptions may be modified as a result of watershed analysis."²⁸ From this we infer that watershed analysis is intended to be a feedback mechanism protective of water quality that provides the specific case-by-case analysis whereby these requirements may be modified following analysis. However, as noted earlier, there is not a functional feedback loop in the prescription process.

C. Commentary on Watershed Analysis Findings

The Panel found that the Watershed Analysis for Freshwater Creek provided a comprehensive estimate of the sediment budget from Freshwater Creek, focusing on the period 1988-1997. This sediment budget indicated that 56% of the sediment inputs to streams were from management sources, 37% were from natural background sources and 7% were due to legacy situations.²⁹ The Surface Erosion Assessment of the Watershed Analysis indicates that around 7,000 acres were harvested in this period. The watershed area is 31 mi² (20,000 acres), so this impact could be inferred to be $7,000/20,000 = 35\%$ of the watershed.

²⁶ HCP p. 37

²⁷ HCP p. 44

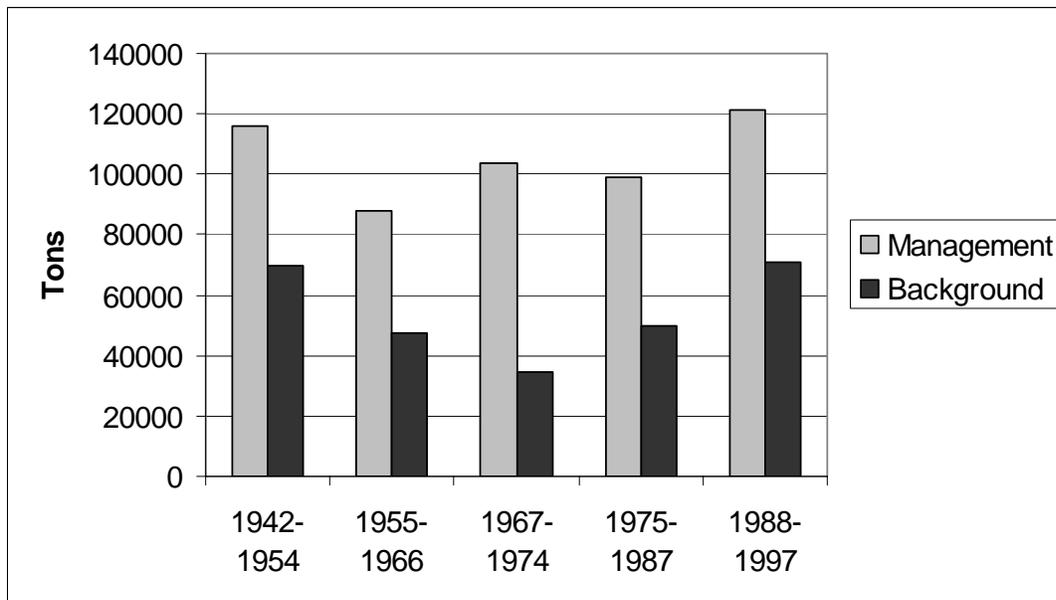
²⁸ HCP section 6.3.3.7, p. 47

²⁹ Watershed Professionals Network, 2001, Surface Erosion Assessment, p. 5

The Panel notes that the analysis implies about a four-fold ($0.56/(0.37 \times 0.35)=4.3$) increase in sediment production from impacted areas relative to background. There is considerable uncertainty associated with some of the estimates, and some dispute over reliability of the estimates (Reid and Lisle, 2001). There is also uncertainty in the above calculation due to changes in the impacted area over the 10-year period and the question of whether a different period should have been used. However, even if one accepts the Watershed Analysis estimates, the sediment production increases are significant.

The Watershed Analysis shows that the largest source of management-related sediment load was from roads (88% of management related inputs of which 59% is from surface erosion and 29% is from road related landslides). Shallow landslides in harvest units accounted for another 9% of the management-related input, with the balance due to surface erosion from harvest units and other effects. Figures 18 and 20 from the Cumulative Effects Assessment of the Watershed Analysis illustrate the impact of management on the overall sediment budget (see Figures 6 and 7 below).

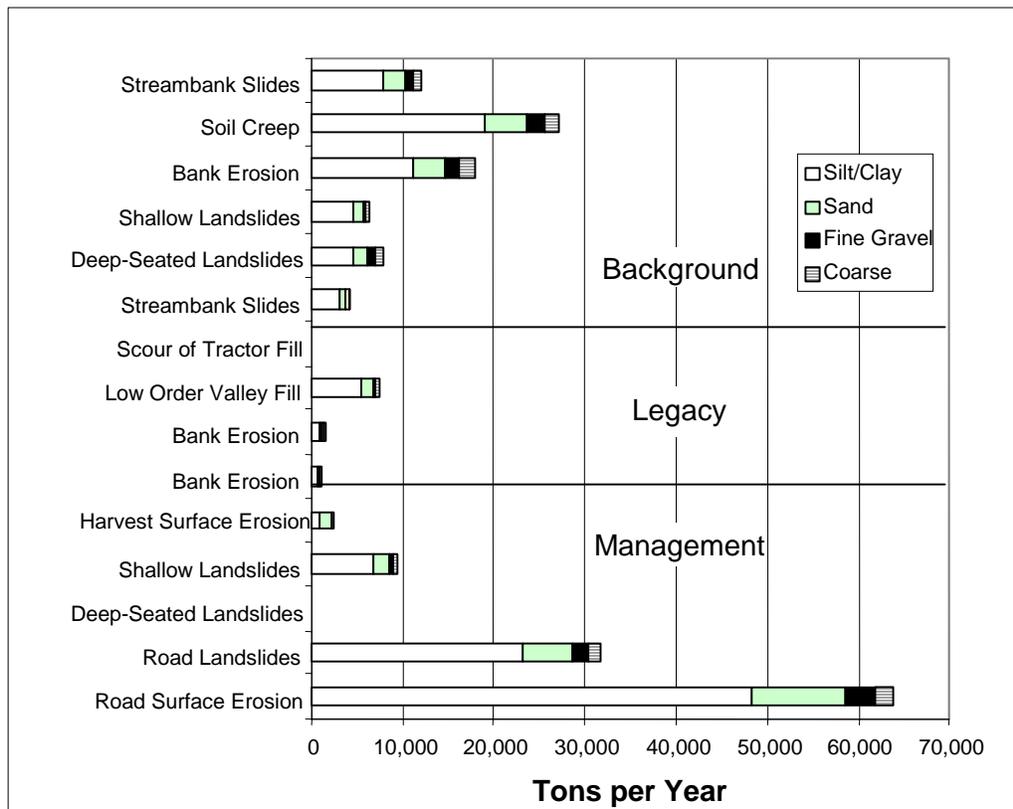
Figure 6. Figure 18: Background and management-related sediment inputs over time³⁰



Note: Management for the period of 1988-1997 includes that portion attributed to legacy inputs in discussions regarding the recent period.

³⁰ Watershed Professionals Network, 2001, Cumulative Effects Assessment, p. 40

Figure 7. Figure 20: 1988 to 1997 Total sediment inputs by source³¹



In examining these figures it is important to recognize that sediment inputs are averaged over the entire watershed, which comprises impacted (35% harvested in 10 years) and non-impacted area, so the intensity of sediment production from impacted areas is even larger than might be suggested by these figures. The Watershed Analysis identifies the processes responsible (roads and landslides) and mentions the road storm proofing program and thinning versus clear cutting on steeper slopes, but does not provide documentation of the effectiveness of these measures or the effectiveness of other lower impact measures.

a. Harvest Rates

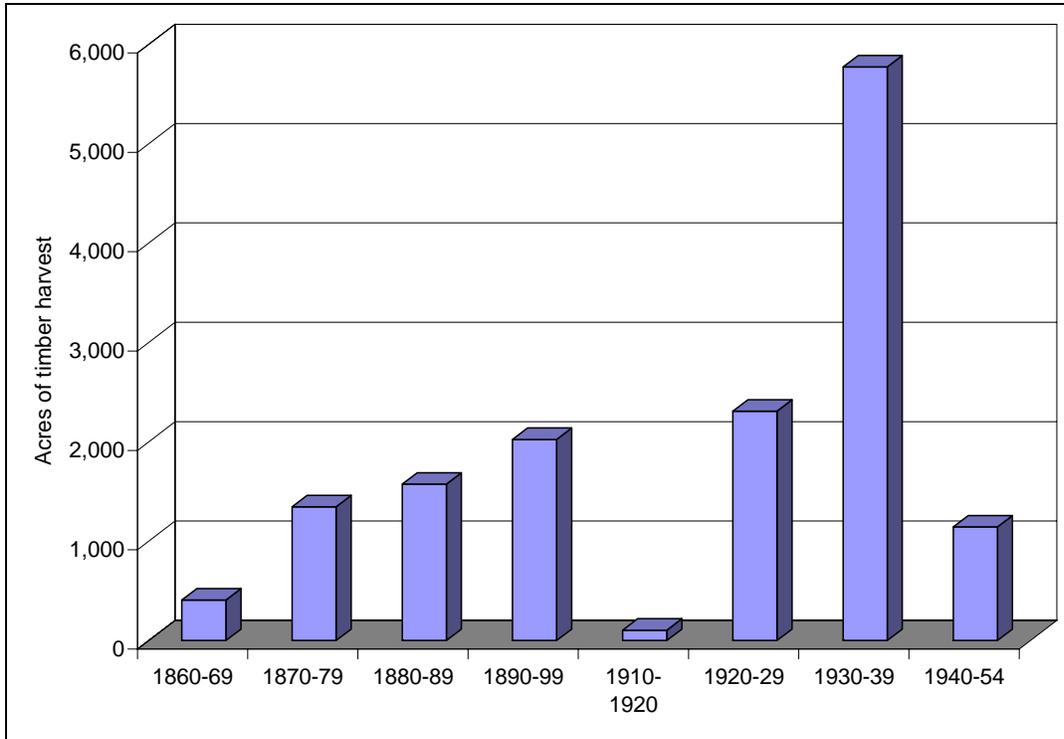
Figure 3-3 and Figure 3-4 from the Watershed Analysis Surface Erosion Assessment document the acres harvested over the history of harvest in Freshwater Creek (see Figures 8 and 9 below). The Panel calls attention to the scales. In the 10-year period (1988-1997) comprising the last two bars on Figure 3-4, the total is over 7,000 acres. This is the highest rate of harvest in the history of this watershed.

This fact is not immediately apparent in the presentation of these figures, which are reproduced here exactly as they are depicted in the Watershed Analysis. In Figure 3-3, 10-year intervals are used to show acres harvested over time, but in Figure 3-4, the 10-year period from 1988 to 1997

³¹ Watershed Professionals Network, 2001, Cumulative Effects Assessment, p.42

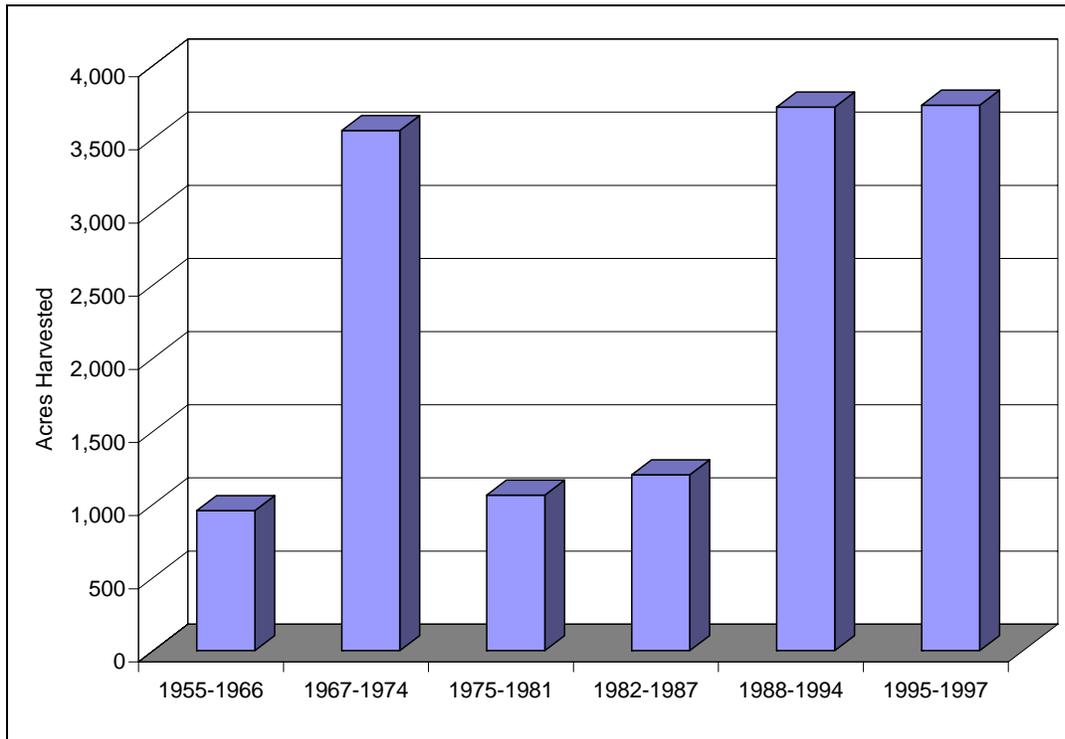
is reported using two bars, with 3,500 acres harvested shown in each block. Together the total number of acres harvested in 1988-1997 is 7,000, higher than any previous 10-year period. The two intervals used to report this last 10-year period are comprised of a 7-year and a 3-year interval, both of which show a harvest area of 3,500 acres, so the harvest rate for the last 3-year interval reported is more than 1,100 acres per year. This is more than double any previous harvest rate presented in these two graphs.

Figure 8. Figure 3-3: Acres harvested during first-cycle timber harvest, 1860-1954³²



³² Watershed Professionals Network, 2001, Surface Erosion Assessment, p.28

Figure 9. Figure 3-4: Acres harvested during second-cycle timber harvest, 1955-1997³³

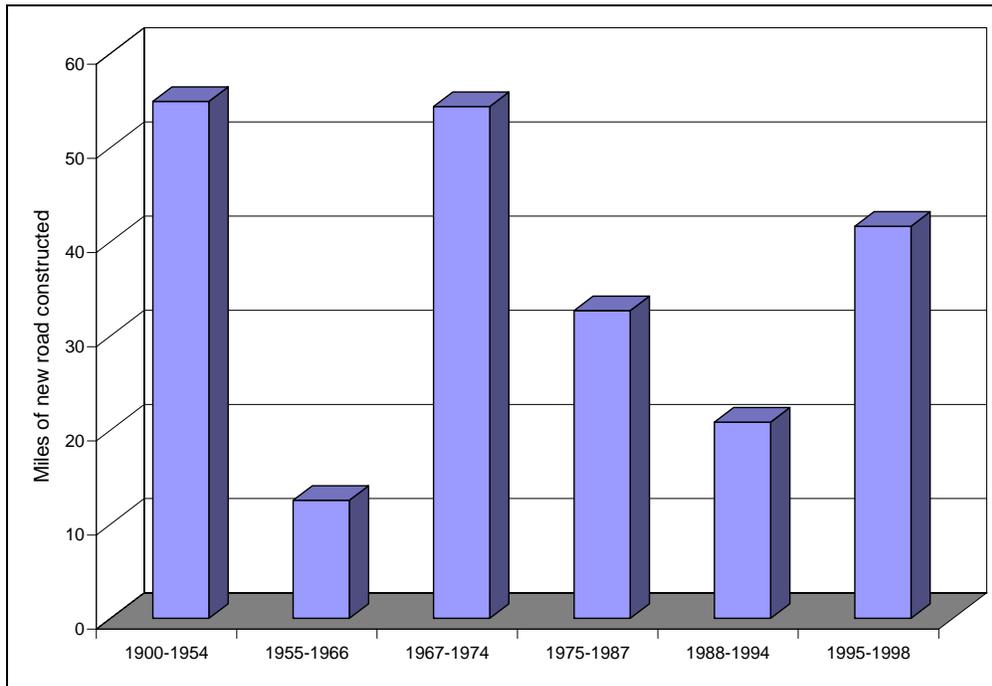


b. Roads

Roads are responsible for the largest component (88%) of management sediment production. Figure 4-1 from the Surface Erosion Assessment (see Figure 10 below), reports new road construction. The Panel calls attention to the years that apply to each bar. The rightmost bar indicates that 40 miles of new road were constructed in the last four years of the analysis (1995-1998) for a rate of 10 miles/year. The highest average rate in all periods prior to this was 52 miles in the 8-year period 1967-1974, for a lower rate of 6.5 miles/year. Concurrently with harvesting this watershed is also undergoing significant road construction rates. Given the way in which the data was graphed, this high rate of road construction for the latest period may not be immediately apparent.

³³ Watershed Professionals Network, 2001, Surface Erosion Assessment, p.29

Figure 10. Figure 4-1: Miles of new road construction by aerial photo period³⁴



Estimates of road sediment production were developed as part of the Watershed Analysis using WEPP and SEDMODL (a spatially explicit model used to identify road locations that deliver sediment). In considering the confidence in these estimates, the authors of the Watershed Analysis report that WEPP uncertainty is $\pm 50\%$. Figure 4-2 of the Watershed Analysis indicates that WEPP and SEDMODL differ by a factor of 2 for the road segments predicted to have the largest sediment production and by even larger factors where the sediment production is less. Reid and Lisle (2001) also noted problems with the model calculations of road erosion. Taken together this uncertainty raises concerns about the accuracy of the largest component of the sediment budget calculated by the Watershed Analysis. This uncertainty overwhelms much of the uncertainty associated with other sediment budget components.

The Panel notes that uncertainty in the respective models' estimates of road sediment production may be moot; however, because the effectiveness of strategies to reduce road erosion is not quantified and the prescriptions developed do not limit road construction.

The Watershed Analysis lists strategies to reduce road erosion.³⁵ These are:

- Surfacing. It suggests that even poor quality gravel on lengths that deliver sediment to a stream would reduce sediment delivery *cost effectively*, and seems more concerned with the cost than the effectiveness of the approach.
- Reducing length delivering by adding drainage structures

³⁴ Watershed Professionals Network, 2001, Surface Erosion Assessment, p. 55.

³⁵ Watershed Professionals Network, 2001, Surface Erosion Assessment p.68

- Reducing traffic and limiting road use during wet weather
- Reducing tire pressure
- Using sediment traps
- Decommissioning unnecessary roads
- Minimizing the construction of new roads. (Data from the most recent 4-year period (1995-1998) which indicates the highest road construction rate ever shows that this strategy has not recently been employed).

Specific estimates of the reductions due to these measures are not presented so the cumulative benefit of their implementation is unknown. Also, some of these measures are not new and are in fact part of current practice that is resulting in significant sediment production from roads.

In the Panel's view, there appears to be an important logical disconnect between the finding in the Watershed Analysis that roads are responsible for 88% of management sediment production and the prescriptions for this problem. While the prescriptions do have specific restrictions that in turn require geologic analysis of roads and mitigation of roads through riparian management zones, they do not limit road construction rate in a cumulative sense. Taken as a whole, the Watershed Analysis does not show how the amount of road in the watershed can be supported without consequent road-related sediment production. Stormproofing and road upgrading are suggested in the prescriptions to overcome this problem; however, no data have been presented that demonstrates the effectiveness of these programs.

c. Mass Wasting

The Panel notes that the Mass Wasting Assessment of the Watershed Analysis shows a strong relationship between landslide densities along roads and in harvested areas and morphological landform type, slope and geologic units. Higher landslide rates were found on recent clear cuts compared to second growth thinned and unthinned stands on steeply sloping areas. This finding has been carried forward into the prescriptions for retention of 50% canopy within inner gorges and headwall swales. However, the reliability of this inference is limited due to a small sample size (2 and 3 landslides used to estimate density). Table 2 below abstracts information from the Mass Wasting Assessment's Table 7-2 pertaining to headwalls and incised steep landforms.

Table 2. Excerpted from Table 7-2: Landslides per acre for the 1988-97 aerial photograph period using the landforms as recorded at the landslide initiation point from aerial photograph interpretation³⁶

Forest cover from the PALCO GIS	Generalized landform-slope categories from landform database	Total acres	Inferred forest cover from landslide database	Inferred landform from landslide database ¹	Number of landslides	Landslides per acre
Recent clearcuts			Clearcut 1-15 years			
	H	11		Headwall	12.0	1.080
	Is	264		Incised steep	5.0	0.019
Second growth thinned			Second-growth thinned			
	H	27		headwall	2.0	0.074
	Is	359		Incised steep	0.0	0.000
Second growth unthinned			Second-growth unthinned			
	H	9		headwall	2.0	0.222
	Is	136		Incised steep	3.0	0.022

Beyond these prescriptions for limiting harvest to thinning, nothing from the Mass Wasting analysis is carried forward into the prescriptions that were developed. Prescriptions do not differ by geology, despite the analysis having identified a relationship with geologic unit. The Mass Wasting analysis did not contain recommendations regarding prescriptions to limit landsliding or mass wasting sediment production. The team of credible scientists assembled to do the Mass Wasting analysis did not address what could be done to reduce sediment production due to mass wasting from harvested areas. This represents a weak link between the analysis presented and the prescriptions derived from the analysis. We therefore conclude that this makes the Watershed Analysis deficient in its purpose as part of the HCP process.

D. Final Prescriptions based on Freshwater Watershed Analysis

In three letters dated between August 15 and August 20, 2002³⁷, the US Fish and Wildlife Service, National Marine Fisheries Service and California Department of Fish and Game transmitted to PALCO unanimous agreement to prescriptions derived from the Freshwater Watershed Analysis. The cover letters indicated that these prescriptions were the result of a successful watershed analysis process involving input from the public, advisory agencies (including the NCRWQCB) and the Watershed Analysis Peer Review Panel established pursuant to the HCP. The three letters approved the preparation of THPs using the new prescriptions contingent upon the completion of two additional tasks: (1) Agreement on the methodology for calculating the "Disturbance Index (DI)", and (2) Development of monitoring procedures which require written approval and must be in place and operational prior to any timber operations. The Panel received no documentation to show whether these tasks were carried out.

³⁶ Watershed Professionals Network, 2001, Mass Wasting Assessment, p. 51

³⁷ Blum, 2002; Halstead, 2002; Koch, 2002.

In the Panel's view, the final prescriptions agreed to and transmitted to PALCO by the three agencies serve mainly to modify the language of the HCP. They are general watershed wide prescriptions with any case-by-case analysis left to the judgment of a licensed professional. We do not summarize these prescriptions here; rather, we comment on a few points related to sediment production and the linkages to watershed analysis.

a. Riparian Management Zone (RMZ)

The final prescriptions based upon the Watershed Analysis change the prescriptions for riparian management zones to allow the delineation of an inner band where timber harvest may not occur and an outer band where thinning occurs. Road segments within the RMZ require mitigation by extending the RMZ on the opposite side of the existing waters. The Panel notes that there is no empirical basis presented to show how or if this prescription is related to minimizing sediment production from roads.

b. Disturbance Index

The final prescriptions indicate that THP operations may not increase the disturbance index above 150%. The Panel cannot currently assess the appropriateness of this measure because the definition of the disturbance index is undergoing revision and has yet to be subject to third-party review.

c. Hillslope Management

As discussed above, with respect to the issue of hillslope management, the Panel notes that instead of producing maps of areas with a high risk of mass wasting, as part of the final prescriptions, a checklist was developed to identify areas at very high risk of mass wasting.³⁸ Following the development of this checklist, all prescriptions contained wording to the effect that no timber harvest be permitted unless on-site geologic assessment is conducted by a California licensed geologist working with the RPF and the appropriate prescriptions are developed with due consideration of risk to the resource.³⁹ The Panel notes that the full onus on prescriptions thus lies with the licensed geologist. In the revised prescriptions, however, there is no guidance as to how licensed professionals should weigh the risks of adverse effects against the benefit of timber harvest. It is therefore unclear to the Panel how the Watershed Analysis, which shows that timber harvest and roads result in significant increases in sediment production, enters into the prescription process.

Furthermore, the Panel notes that the Watershed Analysis Peer Review Panel wrote, "Watershed analysis is based on scientific principles, however, management prescriptions that follow watershed analysis, and the specific operational details of individual timber harvest plans, fall in the realm of professional practice, *not science*" (italics added).⁴⁰ The Watershed Analysis Peer Review Panel thus tacitly endorses a disconnect in scientific method between watershed analysis

³⁸ PALCO, 2002, p.10

³⁹ PALCO, 2002, p.13

⁴⁰ Watershed Analysis Peer Review Panel, 2002, p. 2

and consequent prescriptions. The Panel also recognizes that professional practice must often operate in the absence of science-based information. In this case, however, it is clear that a lack of scientific support in the early stages of planning has been passed on to later stages of planning, and ultimately dropped to create a situation in which resource management activities are unsupported by science.

d. In Summary

The Watershed Analysis showed that timber harvest and associated management activities, primarily road construction, contribute significantly to increases in sediment production. There was considerable uncertainty associated with some of the estimates, and some dispute over the reliability of the estimates (Reid and Lisle, 2001). However, even if one accepts the Watershed Analysis estimates, the sediment production increases due to harvesting and management were significant.

The Watershed Analysis suggested that road sediment production and sediment production due to mass wasting be targeted in efforts to limit sediment production due to harvest activities. In the case of mass wasting, this translated to a general statement about thinning being more effective than clearcutting on steep slopes. Apart from this statement, the Analysis did not provide any quantifiable information on the effectiveness of suggestions for limiting sediment production that could be incorporated into prescriptions.

In addition, the Panel notes that the prescriptions developed from the Watershed Analysis do not address the problem of overall cumulative impact, either in terms of timber harvest, length of roads, or watershed wide sediment production. The prescriptions focus on attempts to contain sediment production using unproven methods while continuing harvest at a high rate. Even if one accepts the uncertain estimates from Watershed Analysis, the link between the Watershed Analysis and the prescriptions developed from it remains unclosed.

E. Policy Considerations

The following suggestions are put forward as policy options to consider to make the Watershed Analysis procedure more effective as a feedback mechanism protective of water quality. One option is for the Watershed Analysis to strive to quantify the location specific impacts of timber harvest practices on different geologies and morphological landforms. This quantification should be in terms of models supported by measurements from monitoring. These impacts can then be used to optimally plan watershed wide timber harvests while meeting basin plan goals.

Unlike most environmental assessment documentation, the watershed analysis does not provide a comparison of different land management practices alternatives, or evaluate alternative locations and footprints, including a no use alternative. Therefore, a second policy consideration for improving Watershed Analysis would be inclusion of alternatives, including a null or no use alternative, as is common in Environmental Impact assessment. The impact from alternatives representing a range of harvest rates, road construction rates could be quantified using models and measurements. These alternatives would then be available to inform policy choices

regarding harvest within the watersheds based on the risk of basin plan and TMDL goals being exceeded.

The third option involves framing a disturbance index. The disturbance index seems to be a quantity that attempts to capture with a single metric the combined disturbance to a watershed from multiple effects (i.e. harvest acres, road miles). There is a danger in attempting to simplify impact down to a single metric because the weighting between different impacts varies from case to case. Nevertheless if this is to be done, the quantities entering a metric need to be carefully chosen. The following guiding principles may be useful in selecting quantities for inclusion in a disturbance index metric:

- The measurements should be simple and easily verifiable.
- The quantity measured should not be confounded by other processes.
- The quantity measured should be pertinent to the beneficial use under consideration.

PART THREE: Applicability of Sediment Budget Models

A. Description of Sediment Budget Models

In the Phase I Panel Report,⁴¹ the Panel made some evaluative comparisons between the Modeled Sediment Budget (O'Connor 2002) and the Empirical Sediment Budget (Reid 1998 and 2000) used to calculate sediment inputs to the river network resulting from timber harvest. During the January 23, 2003 Regional Water Board hearing, there appeared to be some uncertainty over the Panel's characterization of these differences. Consequently, in this Phase II report, the Panel has sought to clarify our findings regarding these two models. We have also included a discussion of the WEPP model, as it is the basis for much of O'Connor's Modeled Sediment Budget.

1. Empirical Sediment Budget model (Reid 1998, 2000)

The Empirical Sediment Budget model (Reid 1998, 2000) uses aerial photos to establish the relationship between timber harvest area and landslide area, and to identify the degree to which landslides are coincident with timber harvest. To operate the model, the user examines aerial photos and records the area of landslides and the area that has been logged, and classifies landslides as either on logged or non-logged areas. The user carries out a simple statistical test (the Chi squared test) to identify whether there is a significant correlation between areas that have been harvested in the last 15 years and areas that have subsequently experienced landslides. For example, if 30% of a watershed has been harvested, and 30% of observed landslides are on harvested areas then the Panel would not find a significant correlation (the landslide distribution would appear to be due to random chance or some other unexplained factor). However, if for example we observed 70% of the landslides on the 30% of the watershed that had been harvested that would strongly suggest that the relationship between timber harvesting and landslides was not due to chance. The Chi squared test would confirm or reject this at a specified level of statistical significance.

In the Empirical Sediment Budget model, we would then calculate the increase in landslides on logged compared to non-logged land. In the study of Bear Creek watershed already carried out by Reid, this relationship is a factor of 9.6 (that is, there are 9.6 times more landslides per square mile on logged areas of the watershed compared with non-logged areas). Using this documented relationship, the Empirical Sediment Budget model then calculates the area of watershed that can be harvested in a year that will only result in a 20% or less increase in landslide area. The model assumes that turbidity is directly proportional to landslide area (i.e. a 20% increase in landslide area results in a 20% increase in suspended sediment reaching the stream network).

a. Strengths of the Empirical Sediment Budget Model

This model has several strengths in this application that the Panel finds to be noteworthy. It establishes the degree of relationship between land use (timber harvest) and landsliding in a robust and statistically defensible way. It is very simple to apply, requiring only aerial photos.

⁴¹ Humboldt Watersheds Independent Science Review Panel, 2002.

Finally, it is not prone to much operator subjectivity, error, or bias. The only element of potential operator subjectivity, error, or bias in the process is in measuring the area of timber harvested and the area of landslides in the aerial photos. These measurements are relatively simple to carry out, unlikely to vary much between different operators, and easily verifiable by independent parties. Because the only professional judgement required is to delineate the harvested area from an aerial photograph, two technical staff using the Empirical Sediment Budget model approach would be unlikely to differ in their estimations of allowable harvest rate by more than 10-20%, so comparison of their photographs would make verification of accuracy by a third party straightforward.

b. Weaknesses of the Empirical Sediment Budget Model

The disadvantage of the current version of the Empirical Sediment Budget model in this application is that it assumes that the only factor influencing sediment yield is landsliding, and that the only way to reduce landslide area is to reduce timber harvest rate. It does not account for sediment reductions using other methods (e.g. improving roads, using different logging methods), though this feature could be added using data from the effectiveness monitoring program. The assumption that harvest rate is directly proportional to sediment yield is supported by Klein's data (Klein, 2003). Data are not yet available showing the relationship between harvest rate and sediment yield where sediment reduction treatments such as those used by PALCO are employed.

2. Modeled Sediment Budget (O'Connor 2002) and WEPP

The Modeled Sediment Budget (O'Connor 2002) approach uses several different numerical models and field techniques to predict a sediment budget for all parts of the watershed, including sediment input into streams. The main numerical model used in this approach is the Water Erosion Prediction Project model (WEPP). WEPP has a large number of physical parameters required as inputs. Users are advised by the WEPP manual to measure these parameters directly, since they are subject to great variability. However, standard assumed parameters on the WEPP website that are derived indirectly from USDA soils maps can also be used as inputs.

Table 3 compares the inputs required by WEPP to the inputs required by the Reid model. As shown below, the WEPP model requires more parameters, and especially more assumed parameters, than the Reid model, which relies on only two measured inputs.

Table 3. Comparison of WEPP and Reid model inputs and applicability of WEPP to forested watersheds⁴²

Input Parameter	WEPP Model Input parameter measured on site, assumed from secondary data, or not required	Reid Model Input parameter measured on site, assumed from secondary data, or not required
Hillslope properties: – Profile – Harvest area – Landslide area	MEASURED NOT REQUIRED NOT REQUIRED	NOT REQUIRED MEASURED MEASURED
Soil properties (for two layers): – Saturated hydraulic conductivity – Average capillary potential – Effective porosity – Initial volumetric moisture content – Soil moisture deficit	ASSUMED ASSUMED ASSUMED ASSUMED ASSUME	NOT REQUIRED NOT REQUIRED NOT REQUIRED NOT REQUIRED NOT REQUIRED
Surface properties: – Depression storage – Manning’s n roughness coefficient	ASSUMED ASSUMED	NOT REQUIRED NOT REQUIRED
Soil erosion properties: – Rill erodibility – Inter-rill erodibility	ASSUMED ASSUMED	NOT REQUIRED NOT REQUIRED
Land management factors: – Crop type – Row density – Tillage methods – Harvest date	MEASURED MEASURED ASSUMED MEASURED	NOT REQUIRED NOT REQUIRED NOT REQUIRED NOT REQUIRED

Note: Assumed values are values taken from WEPP database, based on statewide soils data. The user assumes that the values are representative for their field conditions.

a. Strengths and Weaknesses of WEPP

WEPP simulates Hortonian (infiltration-excess) overland flow. In other words, it simulates only runoff that occurs when rainfall intensity exceeds soil infiltration capacity. This is a common process in the Midwest and on relatively flat farmland areas, which is where WEPP is primarily used. However, rainfall patterns in the five watersheds area are more likely to result in ‘return overland flow’ in which water infiltrates the soil in an upslope area, then accumulates in the soil until storage capacity is exceeded, at which point water seeps out onto the surface downslope of the infiltration area (typically in a hollow or concavity above a Class III stream) and runs off from there. Return overland flow dominates in upland forested areas where rainfall typically occurs as high frequency, low duration events, as is the case in Humboldt County, which limits the applicability of WEPP to these watersheds. The WEPP manual states that WEPP is unsuitable for complex watersheds, partly for this reason.

⁴² Compiled from WEPP website and Reid 1998 and 2000

WEPP is generally well-suited for making comparisons of the effects of changes in watershed land use. For example, it is relatively well suited to running scenarios of different harvest areas and assessing the resulting percentage change in erosion and sediment yield, provided that infiltration excess overland flow is the dominant process (which is not the case in Humboldt County). However, while one may carefully compare WEPP output for one land use scenario with WEPP output for another scenario, one must be very careful comparing absolute sediment yields from WEPP with sediment yields from other sources, as PALCO does in the Freshwater Watershed Analysis. This is because within a pair of WEPP simulations, the errors and uncertainties will be essentially the same. This means in turn that most change in output is due to the parameter (land use) being changed. However, if we compare a WEPP sediment yield with a sediment yield from another source (say a road crossing evaluation), we are comparing two outputs from different models, with different sources of uncertainty and error. There is a great danger in this case that the difference in output is due to those errors and uncertainties rather than due to the physical processes.

b. Strengths of Modeled Sediment Budget

The Modeled Sediment Budget approach is in some respects closer to that recommended by the Dunne Report (Report 46). In theory, it is a more thorough approach; that is it allows the user to isolate all sediment sources, determine which are the most important (e.g. road erosion, landslides etc) and assess the implications of reducing each source.

c. Weaknesses of Modeled Sediment Budget

The difficulty with the Modeled Sediment Budget is that it is much more complicated than the Empirical Sediment Budget model. It therefore carries problems with it that the Panel has concluded currently makes it an unreliable and unverifiable model for assessing the impact of timber harvest on water turbidity. The Panel notes seven main problems with this model:

1. To take advantage of its more complex modeling approach compared with the Empirical Sediment Budget model, it requires large amounts of data that are difficult to obtain. Examples include soil erodibility, infiltration capacity, and soil creep rate data.
2. These parameters vary greatly (in some cases over several orders of magnitude) over the watershed, requiring very large numbers of measurements to obtain reasonable average values. For some key parameters, hundreds of field or laboratory measurements might be needed to obtain accurate averages over an entire watershed.
3. Many input variables are highly prone to bias depending on the sampling methods and measurement methods used.
4. There is subjectivity in assigning different processes to either 'man-made' or 'natural' causes (for example PALCO's current assumption that all deep-seated landslides are 'natural').
5. Many measures are prone to operator subjectivity and professional judgment, making verification and quality assurance of data collection difficult, a potential problem in a contested and controversial environment. For example, measuring volume of sediment stored in channels is subject to great operator subjectivity.

6. Where collecting such large numbers of input parameters is not feasible given time and money constraints, the user is forced to make educated guesses as to key inputs based on literature values. Such guesses are prone to bias and hard to verify or repeat.
7. In many cases there are competing sub-models that can be used (for example choice of numerous sediment transport equations). Selection of one model over another is often subjective, and can result in orders of magnitude variations in the predicted sediment yield. Different operators could potentially make credible cases for differing models that resulted in large differences in predicted sediment yield.

Due to the issues discussed above, the Panel concludes that two skilled operators using the Modeled Sediment Budget model approach could easily produce and justify allowable harvest rates that varied from each other by several hundred percent.

B. Differences between Empirical and Modeled Sediment Budget Models

The fundamental difference between the Empirical Sediment Budget model and Modeled Sediment Budget model approaches is that the Empirical Sediment Budget model is very simple. Some critics might argue that it is too simple, with harvest rate as the only variable with which to reduce sediment delivery to rivers; however, it is easy to apply and verify, and difficult to distort. Conversely, the Modeled Sediment Budget model approach is sophisticated and has several variables that can be adjusted, but is very expensive and difficult to apply, prone to operator bias and subjectivity, and difficult to verify.

Some commentators have observed that the Modeled Sediment Budget model approach is more state-of-the-art than the Empirical Sediment Budget model, meaning that the Modeled Sediment Budget approach utilized more modern numerical modeling methods. This is true in an academic sense. However, any model is only as good as its input data. Where the data are limited, more sophisticated models are often less accurate than simpler empirical models such as the Empirical Sediment Budget model. The Dunne Report also makes the case for using numerical models to estimate causal linkages between land use activities and risk to resources such as water quality. However, it is important to qualify this (as the Dunne Report does) with the caveat that where complex models are used they should be operated by independent third parties, rather than by consultants hired by one side or the other. In addition, they stress that such models should be transparent, in that data and assumptions must be clearly stated and open for discussion.

A central problem with the PALCO sediment budget is that it combines estimates of sediment yield from numerous different sources using different approaches, often with assumed rather than measured input data. This creates the possibility that apparent differences in sediment yield may be due to the differences between the approaches and assumptions than the physical processes themselves. In addition, there is a lack of transparency and accountability in the application of these approaches that makes it very hard for independent third party observers to verify the assumptions and values used.

C. Policy Considerations

With respect to the use of different models to predict the impact of timber harvest on water quality, the Board has at least two options that favor different time scales. In the long-term, analysts could seek to use stochastic, physically-based spatially-distributed numerical models as suggested in the Dunne Report. However, such models need to be selected, operated and interpreted by well-qualified scientists and subject to transparent third party peer review. Two problems, however, render this approach disadvantageous in the near-term. First, data needed to drive models of this type are currently unavailable. Second, acquiring this data would require long periods of time. Therefore, the models are unlikely to accurately predict timber harvest-sediment production relationships in the near future. We also recognize that the agency capacity needed to take this approach would take time to develop.

In the near term, analysts could use empirical models such as that developed by Reid. This model has a higher near-term likelihood of accurately predicting sediment production related to timber harvest and roads than the modeled (O'Connor) approach because the data required to run this model can be collected immediately from aerial photographs.

QUESTION D

To the extent resources allow, evaluate the degree to which the recommendations presented in the Dunne Report No. 46 are appropriate for the Five Watersheds, and determine how these recommendations might be implemented over short, intermediate and long term time frames.

A. Recommendations of Dunne Report

The Dunne committee was convened in 1998 by the California Department of Forestry and Fire Protection to review scientific evidence for cumulative impacts on water quality in Freshwater Creek. The Committee published its findings in July 2001. The report went beyond the initial brief and addressed wider issues of inadequacies in assessments of cumulative effects of timber harvest on water quality. The Panel Committee presented a series of recommendations for improving the way that these assessments are made. The recommendations made the case for a complete transformation of the CWE assessment process.

The two main thrusts of the report were:

- a recommendation that CWE assessments be performed using spatially referenced (for example, GIS-based) computer models to develop risk-based assessments of different timber harvest scenarios, and
- a recommendation that due to the skill level and need for transparency in the development and application of these models, CWE assessments should be carried out by a central agency body rather than by a combination of logging companies and agency staff.

In essence, the Dunne report called for a modernization of the CWE assessment process that would take the process away from ‘postage stamp’ scale qualitative assessments by Registered Professional Foresters to much broader watershed scale assessments using GIS-based spatial analysis.

1. Report Recommends Use of GIS-Based Spatial Analysis

In the vision put forward by the Dunne report, CWE assessment would be carried out by a central body of skilled scientists and mathematicians. These experts would use GIS-based spatial models of the relevant physical processes operating over entire watersheds (for example, canopy interception, runoff, erosion, sediment transport, landslides). They would run several different timber harvest scenarios (for example, using different logging rates, logging methods, and mitigation measures in different parts of the watershed) and apply external drivers to the modeled watershed (e.g. sequences of wet or dry weather, rainstorms of different frequency and magnitude). Such models would be stochastic (also known as probabilistic) rather than deterministic.

Stochastic models include an element of randomness to characterize the uncertainty in real world measurements of variables such as rainfall, soil moisture and pore water pressure, topography, soil strength, and soil erodibility. Stochastic models present their results using a set of outcomes derived from multiple simulations of the inputs. The range of outcome values quantifies uncertainty in the outcomes and allows an assessment of risk. Stochastic models stand in contrast to deterministic models, which do not incorporate randomness or uncertainty into either their input or output. Deterministic models, in contrast, take single representative (e.g. average) values of soil, topographic, and meteorological variables and produce a single result that is in most cases highly sensitive to the input. Therefore, two qualified and experienced scientists can use their professional judgement to select the input values and produce two strikingly different sets of model results for the same scenario.

One way of running a stochastic model is to use the means and standard deviations of the input variables, select values randomly from those distributions (i.e. individual numbers are random, but the pattern of numbers generated has the same distribution as the real world population that is being modeled), and then run the model many times to produce a range of outputs. This approach to modeling real world complexity is known among scientists as Monte Carlo simulation. It has a history that dates back to the Manhattan Project in World War II, and has been more recently used in fields ranging from structural engineering to toxicological risk assessment, but those involved in watershed assessment have been slow to adopt the method.

Rather than express the output as a single deterministic number (e.g. tons of soil eroded per acre logged), the stochastic model results are expressed in terms of the likelihood or probability of a particular course of action exceeding a certain threshold. For example, under logging scenario A there would be a 20% likelihood that sediment yield would exceed 5 tons per acre, whereas under scenario B there would be a 70% likelihood of exceeding the same threshold. Under the Dunne report recommendations, these kinds of differences would be evaluated against the potential benefits to make decisions about timber harvest plans

2. Panel Conclusion: Models Need Third Party Review

Because any model can be fine-tuned by adjusting variables and used to advocate particular management or policy decisions, the Panel finds that it is essential to put in place a mechanism to ensure that models and their results are used appropriately. Ideally, modeling would be performed by independent scientists rather than those with a financial or other interest in the results, and their assumptions, data, and results would be rigorously peer reviewed by other independent experts. The complete input data files, computer software, and raw output files would be available for public examination in order to make the process as transparent as possible. Regulatory authorities such as the Regional Board would reject the results of models for which all of the input data and any underlying assumptions are not clearly documented. This is not the case now. The Panel has also found it impossible, despite repeated requests for clarification and data, to clearly identify the input and assumptions in soil erosion and landslide models being used by PALCO. Under such conditions it is impossible to review the adequacy and legitimacy of any computer model or its results.

B. Applicability of Dunne Report Recommendations to the Five Watersheds

The Dunne report explicitly states that its recommendations raise issues that are wider than just the Freshwater Creek Watershed. In the cover letter by Henry Vaux, Associate Vice President of the University of California Division of Agriculture and Natural Resources, the Dunne Panel wrote, “The blue ribbon Panel recognized at the outset that the Freshwater Creek watershed raised issues that were broader than just a single watershed. The Committee elected, therefore, to widen the scope of its assignment and evaluate the entire system of cumulative impacts assessment as defined in the State Forest Practices Act and in other regulations.” Thus, the report is highly applicable to all watersheds in Northern California and beyond, but we found no evidence that this recommendation was followed. However, the time required to implement the recommendations of the Dunne report would pose a problem relative to the current rate at which the Five Watersheds are currently being logged. Many of the report's recommendations will require a significant amount of time, money, and political will in order to be implemented as advised.

C. Implementation of the Dunne Report Recommendations

The Dunne report makes 11 specific recommendations on which the Panel comments below.

1. The creation of a new unit within a state agency to carry out CWE assessments, moving the process away from industry.

Panel response to 1: The Panel is not currently charged with making suggestions as to administrative structure. However, we do support the concept of third party review and assessment of CWE.

2. Recruitment and training of conceptual leaders and implementers of true, watershed-scale CWE analysis to work for the aforementioned unit.
3. Recruitment of individuals with management ability and experience to be involved in CWE analysis.

Panel response to 2 and 3: The Panel concurs with the notion that more personnel, skilled in CWE assessment both as conceptual leaders and with management ability are needed in the process. CWE are the critical issue because it is the integrated effect of large-scale disturbances over these watersheds that is the problem, and the workforce needs to recognize this. In the Panel's opinion this is not complex and does not require a larger number of highly skilled (post Ph.D.) scientists. Rather, it requires a concerted application of a common sense approach of looking at the big picture and closing the feedback loop through using monitoring to continuously check whether prescriptions are working and making adjustments if they are not.

4. Abandonment of the use of thresholds to assess CWE impacts and the ‘mitigate out of existence’ theory (using sediment credits to offset sediment production from timber harvests).

5. Movement to risk based assessments of CWE rather than binary assessments (yes or no answers to cumulative effects).

Panel response to 4 and 5: We share the Dunne Report's concern about the 'mitigate out of existence' or sediment credit philosophy that, while being central to PALCO's THPs, is currently untested and lacks the empirical data to earn the support of the scientific community. The Panel finds that use of risk-based assessments is more scientifically justifiable than use of fixed thresholds in modeling scenarios, because deterministic (single answer) model outputs artificially conceal the parameter uncertainty and error that are inherent in any mathematical model of a natural process. It is more realistic to consider differences in the likelihood of exceeding a certain level associated with different logging rates and methods.

6. Movement to watersheds, not THPs, as the appropriate scale for CWE assessments.

Panel response to 6: We strongly support this recommendation. CWE assessment is much more appropriately carried out at the wider scale. With respect to the five watersheds, watershed-wide CWE assessment could be performed as a pilot project in this area using already available data and models.

7. Creation of specialty CWE training and certification before allowing RPFs or other licensed professionals to participate in assessment of CWEs in a THP.

Panel response to 7: We support this recommendation. The Panel is concerned that people with inadequate training and understanding of wider CWE issues are currently making decisions about CWEs.

8. Support of scientific research aimed at solving problems of CWE assessment. Support of training to maintain levels of expertise.
9. Development of an interagency plan to monitor resources such as water quality, based on appropriate experimental design of monitoring programs and statistically rigorous hypothesis testing.

Panel response to 8 and 9: We strongly support these recommendations. The Panel is supportive of having agency personnel or an independent third party conduct the hypothesis testing and monitor the effectiveness of sediment reduction activities. We believe this would effectively promote transparency and legitimacy. If PALCO scientific personnel lead this effort, these principles would be much harder to achieve. The Panel is also concerned about the amount of time PALCO has taken to establish monitoring programs, and that while during this time, THP approvals have proceeded without the benefit of monitoring results. Because of this, the feedback loop must be closed.

10. State should obtain permanent funding for CWE unit and scientific research to support it.
11. State should take leadership role in supporting public debate on CWEs and should defend its own employees and citizens who contribute to the debate.

Panel response to 10 and 11: The Panel supports these recommendations.

In general, the Panel supports the recommendations of the Dunne report, in particular its call for wider scale and more scientifically rigorous CWE assessments. However, we are concerned that the changes are unlikely to help preserve water quality in the five watersheds, because planning and implementation of THPs for these areas is well advanced. There may be a case for using the five watersheds as a pilot study for GIS-based models to assess CWEs, but in many respects this exercise would be retrospective since the scenarios to be assessed have in many cases already been implemented on the ground.

IV. CONCLUSION

A. Panel Findings and Conclusions

1. Findings and Conclusions for Question A

The Panel finds that the logical foundation of the HCP/SYP/THP processes in terms of water quality suffers from four significant weaknesses:

- The plans have goals and stipulations that are only incidentally related to the attainment of water quality standards and are not enforceable.
- The plans have goals and stipulations that are contradictory and cannot be maximized simultaneously.
- The plans are based upon untested assumptions about the effectiveness of planned actions.
- Many of the current processes and procedures are unclear, subjective and lacking impartial review.

The Panel suggests that arriving at sound policy and best science practice involves closing the feedback loop of monitoring, analysis and prescriptions. The Panel has determined that it is illogical to continue to make decisions on significant land use management practices (i.e. approval of THPs) without monitoring having demonstrated their effectiveness. In particular, the Panel suggests that:

- The design of monitoring schemes should be the responsibility of the regulatory agencies or an independent audit agency, not the discharger, and should be subject to third party peer review.
- Results of monitoring should be provided in a timely manner to all interested parties.
- Monitoring should be initiated and the efficiency of sediment reduction measures demonstrated before harvest activities are approved.

2. Findings and Conclusions for Question B

a. Rate of Recovery

The Panel concludes that specific rates of recovery (ROR) of the beneficial uses of water cannot be calculated for the five impaired watersheds with the current information available for two reasons:

- Disturbances in the watersheds from roads and logging continue at a high rate despite attempts by PALCO to apply protective and mitigative measures to counter them.
- Effectiveness monitoring data on the outcome of protection and mitigation is generally lacking. Consequently, it is currently unknown whether continued disturbances outweigh protection and mitigation, or vice versa.

The Panel points out that the type of information needed to determine ROR is dependent on a set of requirements including both policy decisions and a solid science-based monitoring program. Some key information/decision-making needs are:

- A quantitative definition of “recovery.”
- A definition of “background” characteristics against which environmental parameters can be monitored.
- A well-defined and stated suite of water quality and fish habitat conditions to be monitored.
- A scale at which environmental variables are monitored and regulated (e.g. stand, vs. watershed).

b. Effectiveness of HCP in Protecting Water Quality

The Panel concluded that at least several years of application of the HCP will be needed, followed by the time that elapses before a major storm event occurs, to test the protection and mitigation offered by HCP. Because the answer may thus be in the range of 10 to 20 years, or longer, the Panel notes that results may come too late to provide feedback to adaptive management efforts in these watersheds. However, results could prove useful to future programs in other watersheds.

c. Application of Rate of Recovery to the TMDL Process

The Panel concludes that TMDLs could be developed for the five Humboldt County watersheds using an approach that combines work by Klein (2003) and Trush (presentation to Panel, 5/5/03). The Panel suggests that this strategy is consistent with the NCRWQCB mandate to develop TMDLs for water quality, and recognizes that turbidity and water temperature are key water quality characteristics that affect salmonid production, one of the beneficial uses to be protected. This approach links rate of harvest and/or road density to turbidity exceedence levels, which is related to chronic turbidity thresholds for anadromous salmonids.

3. Findings and Conclusions for Questions C

Even if fully implemented as envisaged, the Panel concludes that the HCP/SYP/THP structure cannot be relied upon to meet water quality objectives. Further, because the HCP/SYP/THP process has not been implemented in a manner consistent with its design, there are serious negative implications for water quality, flooding, and CWEs. The most critical failing stems from the practice of continuing to approve harvest plans without the requisite watershed analyses.

In particular, the Panel points out that the SYP process, as currently structured, cannot be relied upon to provide a science-based assurance that water quality will be protected. First, the SYP process does not involve reporting of planned harvest on a watershed-by-watershed basis. Second, even if the above analyses were performed, there is not a transparent linkage between SYP calculations and subsequently promulgated THPs. If the SYP is to be used as a valid tool in water quality protection, the Panel suggested several strategies for making the process workable.

a. Differences between Empirical and Modeled Sediment Budget Models

The Panel points out that while the Modeled Sediment Budget model approach may use more modern numerical modeling methods than the Empirical Sediment Budget model, a model is only as good as its input data. Where the data are limited (as is the case with the five watersheds), more sophisticated models are often less accurate than simpler empirical models. As such, the Panel suggests that in the long term, one option is for Board staff to use stochastic, physically-based spatially-distributed numerical models as suggested in the Dunne Report, with the caveat that such models should be selected, operated and interpreted by well-qualified personnel and subject to transparent third party peer review. The Panel also recognizes however that the agency infrastructure to take this approach will take time to develop, and that answers are needed now. The Panel therefore suggest that the Empirical Sediment Budget model be used as an interim approach, and that the data required to run this model be collected immediately.

4. Findings and Conclusions for Question D

In general, the Panel supports the deliberations and findings of the Dunne report. In particular, the Panel supports the call for wider scale and more scientifically-rigorous CWE assessments. However, the Panel is concerned that the changes are unlikely to help preserve water quality in the five watersheds in the near-term, because planning and implementation of THPs for these areas is well-advanced. There may be a case for using the five watersheds as a pilot study for GIS-based models to assess CWEs, but in many respects this exercise would be retrospective since the scenarios to be assessed have in many cases already been implemented on the ground.

B. Final Comments

Looking back across both phases of its work, the Panel finds significant shortcomings in the science basis of the current system of water quality protection and identifies several policy implications for the Regional Water Board's consideration. The Panel also notes that the May 5th workshop convened as part of the effort to prepare this report modeled, to a large extent, the kind of civil, transparent discussion that is needed to strengthen environmental decision-making for the five Humboldt watersheds. The Panel looks forward to discussing its findings with the Regional Water Board later this month.

The Panel expresses its appreciation to the efforts of Regional Water Board staff, PALCO, the HCP implementing agencies, watershed scientists, residents and other stakeholders who contributed to this effort.

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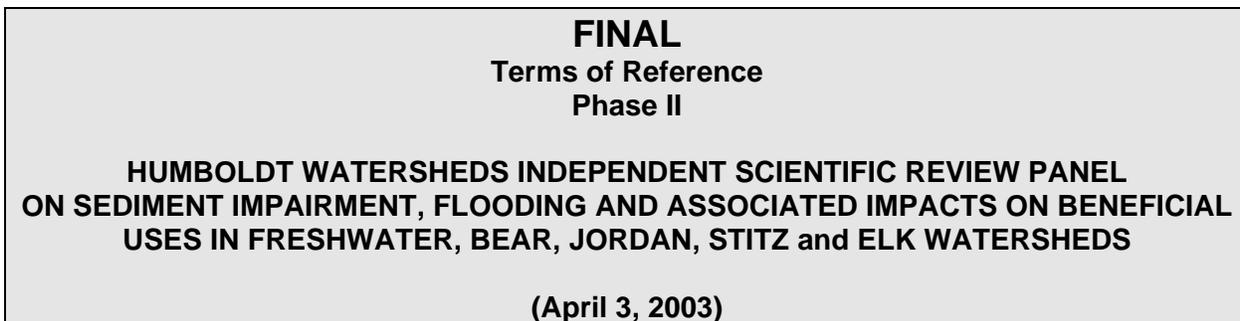
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VI. APPENDICES

APPENDIX 1 - Phase II Terms of Reference



I. PURPOSE

The North Coast Regional Water Quality Control Board (Regional Water Board) is convening Phase II of the Humboldt Watersheds Independent Scientific Review Panel (Panel) to address a follow up set of questions. The Regional Water Board's objective for this Phase II effort is to strengthen the science basis for their decision-making for protecting and restoring the sediment impaired beneficial uses of waters in the Elk River and Freshwater, Bear, Jordan, and Stitz Creek watersheds (Five Watersheds) in Humboldt County, California. In particular, the Panel is being asked to evaluate (1) protections in the Habitat Conservation Plan (HCP) and Sustained Yield Plan (SYP) for Pacific Lumber Company lands with respect to protecting and restoring beneficial uses of water in these Five Watersheds and (2) evaluate how the report prepared by a University of California Committee, chaired by Professor Thomas Dunne, entitled "A Scientific Basis for the Prediction of Cumulative Watershed Effects" (Dunne Report No.46) can be utilized in the Five Watersheds.

Background of the Panel

Phase I

The Regional Water Board originally convened the Panel in August 2002 to address three questions in order to assist them in fulfilling their mission to protect and restore sediment impaired beneficial uses of waters in the Five Watersheds. The Panel's Phase I assignment is detailed in Appendix A of the Terms of Reference (TOR), dated August 6, 2002. The three questions posed in the Phase I TOR are included below:

1. Please review the provided documents, and any other relevant information, regarding calculation of appropriate rates of timber harvest that would not impede recovery from excess sediment loads and would not cause or contribute to exceedence of water quality objectives. Please discuss the technical strengths and weaknesses of the varying approaches described in some of these documents to address harvest rate and flood severity, as well as any other reasonable approaches to calculate a rate of harvest for each of the five watersheds that is protective of water quality, which considers natural and other anthropogenic sediment sources.

2. What options are available (e.g. dredging, and modification of activities resulting in, or reducing, sediment delivery) that can be immediately implemented and will be effective in lessening the adverse flooding conditions and impacts to beneficial uses? Please discuss the potential benefits, limitations, and tradeoffs of these options for each watershed.
3. What additional data or piece(s) of information, if any, will be useful in the future for refining approaches to address the above issues? This can include monitoring information, modeling exercises, etc.

To answer these questions, the Panel began an intensive deliberation process consisting of significant literature review, technical analysis and personal communication via email and conference calls. The Panel conducted face-to-face deliberations in Eureka, California, from October 9 -11, 2002. During that time, the Panel participated in a site visit and over flight of all Five Watersheds, received input from the stakeholders and other watershed scientists, and discussed the three questions assigned by the TOR. The Panel endeavored to make use of available data and worked to evaluate the quality of science and made recommendations for strengthening future analysis.

The Panel conducted extensive deliberations via email and teleconference from October through December 2002, and produced a final report entitled, “Final Report on Sediment Impairment and Effects on Beneficial Uses of the Elk River and Stitz, Bear, Jordan and Freshwater Creeks” on December 27, 2002. Three of the panelists presented a summary of their findings at the January 23, 2003 Regional Water Board meeting. Their presentation was followed by extensive public comment. On January 24, 2003, following their own deliberations, the Regional Water Board passed five motions relative to the Panel’s findings and indicated that the Panel should be tasked to respond to a new set of questions. The questions would be posed in a draft Phase II TOR which would be presented to the Regional Water Board for their review at a future Board meeting.

Phase II

As noted above, the Regional Water Board members passed a motion to develop Phase II of the Scientific Review Panel and emphasized that a review of the HCP/SYP and appropriate existing documents should be included in the next phase to determine effectiveness of existing mitigations in restoring the beneficial uses of water in the sediment impaired watersheds. The Regional Water Board requested that the Panel review the levels of protection in the HCP/SYP, especially the manner in which the HCP/SYP address rate of recovery of beneficial uses of water. The Chairperson of the Regional Water Board suggested that the Phase II questions be developed by Regional Water Board staff with input from the Facilitated Watershed Working Group.

Following the January 23, 2003 hearing, the Regional Water Board Executive Officer asked the Panel to provide their comments on the Regional Water Board’s motions and suggest potential questions to be addressed under a Phase II Terms of Reference. The Panel provided a response (Attachment A), dated February 11, 2003, which Regional Water Board staff presented to the stakeholders at a February 13, 2003 public meeting for the Freshwater Creek and Elk River Total Maximum Daily Load (TMDL) development. During and after the meeting, staff worked

closely with stakeholders and CONCUR, Inc., to develop and refine a set of candidate questions that could be addressed as part of Phase II.

These options were presented to the Regional Water Board at their February 27, 2003 meeting, at which time a presentation was made on behalf of the Panel by Dr. Scott McCreary of CONCUR, Inc. Following questions from the Regional Water Board members as well as the general public, the Board directed staff to develop a draft Phase II Terms of Reference which focuses on review of the HCP/SYP and the Dunne Report No. 46 and includes convening of an information-gathering meeting in which agency staff bring forth data to help inform the Phase II deliberations. The following discussion provides the framework for those questions.

Contextual Background

Elk River and Freshwater, Bear, Stitz, and Jordan Creeks are listed, or are contained within watersheds, on the Clean Water Act 303(d) List as impaired⁴³ by sediment. The HCP for the Pacific Lumber Company lands includes an Aquatics Conservation Plan, which contains important prescriptions for recovery of fish habitat. The HCP/SYP was drafted to address the requirements of federal and state endangered species laws for protection of aquatic endangered species on a property-wide scale over the life of the HCP/SYP, and to allow issuance of an incidental take permit⁴⁴. The HCP/SYP was not specifically drafted to protect all beneficial uses of water of individual watersheds, nor was it drafted to address all requirements of the Water Quality Control Plan for the North Coast Region (Basin Plan) or the Porter-Cologne Water Quality Control Act. It was anticipated that HCP/SYP protection measures would provide ancillary benefits to water quality. Still, the HCP/SYP supporting documents⁴⁵ specifically state, “Because the proposed HCP/SYP is not designed specifically to address impaired waters to meet the water quality criteria, additional restrictions and BMPs may be required later by the TMDL process.”

Public testimony and stream channel measurements suggest that the sediment impairment in Elk River and Freshwater Creek has significantly reduced channel capacity, contributing to increased frequency and magnitude of flooding. Sediment impairment also means that water quality objectives are not being met. Water quality objectives are intended to protect many beneficial uses in each stream supporting such use. Similar sediment impairment issues have also impacted wildlife habitat in Bear, Jordan, and Stitz Creek watersheds. These issues will be addressed as part of the TMDL process for each watershed. It would be useful to the Regional Water Board for the Panel to conduct a review of the existing HCP/SYP protection measures in the context of evaluating the rate of recovery of all beneficial uses and the abatement of nuisance flooding conditions in Elk River and Freshwater Creek.

⁴³ Impairment is a term from Section 303(d) of the federal Clean Water Act, which requires states to identify waterbodies that do not meet water quality standards and are not supporting their beneficial uses.

⁴⁴ “Take” is harm to a threatened or endangered species, and is defined in the federal Endangered Species Act. An “incidental take” is the taking of a federal or state listed species, if such taking is incident to, and not the purpose of, carrying out otherwise lawful activities.

⁴⁵ Found on page 3.4-13 of the Final Environmental Impact Statement/ Environmental Impact Report.

Overview of the HCP/SYP/THP Planning Process

The HCP, signed March of 1999 is neither a stand alone nor a static management document. The HCP Aquatics Conservation Plan (Section 6.3) includes interim measures that are to be revised through the Watershed Analysis and Adaptive Management processes specified in the HCP. The Watershed Analysis process (Section 6.3.1) is to be conducted in each of the watershed assessment areas within the first five years of HCP implementation. Following each watershed analysis, watershed-specific prescriptions (Section 6.3.2.2) are to be developed to replace the interim prescriptions of the original HCP. Additionally, prescriptions are subject to revision through the Adaptive Management process (Section 6.3.6) after which the adapted prescriptions become part of the HCP. This process is currently underway and some of the prescriptions have already been revised.

The HCP specifies that effectiveness monitoring (Section 6.3.5.2) of specific prescriptions be measured through both instream and hillslope monitoring. Effectiveness monitoring would be conducted to determine if the specific prescriptions, as applied to the hillslopes, result in the intended and necessary protection of aquatic values. The effectiveness monitoring can lead to modification in prescriptions through adaptive management. Trend monitoring (Section 6.3.5.3) is intended to determine if the watersheds are achieving the target instream conditions. All THPs developed for lands covered by the HCP/SYP must follow the applicable HCP/SYP prescriptions.

In 1999, at the request of the California Department of Forestry and Fire Protection, the University of California Committee, chaired by Dr. Thomas Dunne, also prepared a written review⁴⁶ (Flooding Report) of a 1999 Pacific Lumber Company document entitled “An Analysis of Flooding in Elk River and Freshwater Creek Watersheds, Humboldt County, California.” The review discusses conclusions that could be made and could not be made regarding changes in flooding due to timber harvesting. Since the report was produced, the body of relevant watershed data has grown, and a review of all information may allow further evaluation of linkages between nuisance flooding conditions and effectiveness in the protection measures applied to hillslopes via the HCP/SYP process.

Cumulative Effects Analysis/Dunne Report No. 46

Individual THPs are to be designed and implemented to comply with the management prescriptions specified in the most current iteration of the HCP/SYP and the management prescriptions required by watershed analysis, while still adhering to the Forest Practice Rules. The Forest Practice Rules (FPR) require that a Cumulative Watershed Effects Analysis (FPR Sections 898 and 1034) be conducted as part of THP preparation. To conduct such an analysis, the THP preparer is to consider the interaction of the proposed activities with impacts of past, present and reasonably foreseeable future projects and propose appropriate mitigation measures.

In June 2001, the University of California Committee on Cumulative Watershed Effects, chaired by Professor Thomas Dunne, released a report titled "A Scientific Basis for the Prediction of

⁴⁶ This report was provided to the Panel as part of their Phase I deliberations.

Cumulative Watershed Effects" (Dunne Report No. 46)⁴⁷. The Dunne Report No. 46 reviews how cumulative watershed effects (CWEs) are considered in the context of the THP process, and general guidelines established by the California Department of Forestry and Fire Protection for evaluating CWEs. The Dunne Report No. 46 also provided recommendations on how to improve cumulative watershed effects analyses for use in the development and review of THPs.

One measure of CWEs is the Disturbance Index specified in the HCP (HCP Section 6.3.4.3). This is an index developed to allow assessment of management induced ground disturbance as a percentage of a watershed assessment area over a 10-year period. The HCP further specifies that once a Disturbance Index of 20% is reached, only those practices with reduced ground disturbance will be allowed.

The Disturbance Index may in turn be adjusted as part of post-watershed analysis prescription process. The adjusted approach to the Disturbance Index is to be based on the sediment budget and the ratio of management versus background sediment production with a threshold of 150%. The Disturbance Index could be an important measure of impact both within the HCP/SYP process and as part of TMDL development and implementation. It would be useful in reviewing the HCP/SYP to have an evaluation of the effectiveness, as well as any recommendations for improvement, of the disturbance index used within the HCP as a potential tool in protecting water quality.

Questions for the Panel to Address

Given that the HCP/SYP was not designed to address TMDL issues, the Regional Water Board requests the Panel to review the (1) specifics of the HCP⁴⁸/SYP management measures and their scientific basis for achieving water quality standards contained in the Basin Plan, including timeframe for achievement; and, to the extent resources allow, (2) assess how the Dunne Report No. 46 can be implemented in the Five Watersheds. Critical documents need to be reviewed by the Panel to ensure that the Panel can frame its analysis in useful terms for consideration by the Regional Water Board. These critical documents⁴⁹ include, but are not limited to, the Environmental Protection Agency "Guidance for Developing TMDLs in California." The Panel assessment should also include a review of existing monitoring data in relation to both interim and watershed-specific HCP/SYP prescriptions. To the extent practicable, documents will be provided early to the Panel for their review.

Specifically, the Regional Water Board requests the Panel:

⁴⁷ This report was distributed to the Panel as part of their Phase I deliberations in August 2002.

⁴⁸ HCP review should include related documents, including the streamlined watershed analysis methods, the post watershed analysis and any prescriptions that may have changed as a result of decisions arising from the adaptive management process.

⁴⁹ The Panel will be receiving many documents, in addition to the two cited, before and during the technical information-gathering meeting discussed herein. To the extent practicable, documents should be provided to the Panel early and, where possible, summaries provided with the document.

- Examine the cause and effect relationship linking protective measures undertaken through the HCP/SYP/THP process and the actions needed to ensure protection of water quality, including clear discussion of the logic of the relationship.
- Evaluate whether a specific rate of recovery of the beneficial uses of water, as identified in the Basin Plan, can be determined, as this determination will be needed along with the timeframe for recovery, to allow appropriate load allocations through the TMDL process.
- Evaluate the water quality protection measures provided by the HCP/SYP (including the intended performance under full versus the current level of implementation) in the context of the water quality standards specified in the Basin Plan. Comment, from a science perspective, on the way in which the HCP/SYP and the corresponding watershed analysis/adaptive management process does or does not address the Basin Plan standards over selected periods of time.
- To the extent resources allow, evaluate the degree to which the recommendations presented in the Dunne Report No. 46 are appropriate for the Five Watersheds, and determine how these recommendations might be implemented over short, intermediate and long term time frames.

Technical Meeting to Inform Panel Review And Deliberations

To inform these efforts, the Panel will participate in an information gathering meeting with Pacific Lumber Company staff, HCP/SYP signatory agency staff, Regional Water Board staff, as well as individual watershed scientists at the Panel's request, as appropriate. In advance of this meeting, participants will be asked to provide a concise index of documents for the Panel to review. Documents may include peer reviewed articles, unpublished technical reports or monitoring results, or informal documents such as memoranda or field notes. Participants will be asked to provide copies of all documents contained on the document index to ensure the Panel reviews the most pertinent and up to date documents. Copies of the documents will be available to all participants. The documents submitted to the Panel should contain information about recent revisions to the prescriptions, the efficacy of the prescriptions implemented to date, monitoring results, plans to further develop this information or a concise description of how monitoring results and/or other analyses are incorporated into decision-making processes.

Given the complexity and amount of existing data on this topic, participants will be strongly encouraged to provide summaries or identify specific sections or updates of more voluminous documents, where possible. Data or monitoring results should be provided in a format that will be clear and useful to both the Panel and other staff present. The meeting, to the extent possible, will focus only on those documents submitted in advance to the Panel. The objective of the meeting will be to establish a productive forum for exchange of information focused on the work underway in the five watersheds and the scientific basis for how the processes involved (e.g. watershed analysis, management prescriptions, THP's, and adaptive management changes) have worked together to protect, ameliorate problems, or restore the beneficial watershed uses.

To recap, the steps in the Phase II deliberative process are as follows:

- Panel requests documents

- Documents are submitted to the Panel
- Panel conducts a preliminary review of documents and develops a set of questions/discussion points to guide the meeting
- Information gathering meeting convened to discuss documents
- Panel deliberates and draft initial report
- Panel reviews, revises, and finalizes report
- Panel presents report in dialogue with the Regional Water Board (contingent on funding)

ATTACHMENT A

MEMORANDUM

To: Ms Susan Warner, Executive Officer, North Coast Regional Water Quality Control Board

From: Independent Scientific Review Panel for Five Humboldt Watersheds (Andrew Collison, Bill Emmingham, Fred Everest, Bill Haneberg, David Tarboton, Richard Marston, and Robert Twiss)

Subject: ISRP Response to the Regional Water Board's Motions of January 24th and Potential Phase II Activities

Date: February 11, 2003

We are writing in response to your letter of February 3, 2003 in which you wrote that you are interested in hearing from the panel on:

- An analysis of the Regional Water Board's motions
- Questions to be addressed under a new Terms of Reference for Phase II
- Ideas on structuring the delivery of a Phase II report to facilitate scientific discussion outside a regulatory setting

Independent Scientific Review Panel responses are offered in the context of our mission to help evaluate and strengthen the scientific basis for protecting and restoring water quality in the five Humboldt Watersheds and our role to help evaluate the degree to which current plans and monitoring can be effective in assuring the recovery of the impaired watersheds.

I. ANALYSIS OF MOTIONS

Motion 1. Sensitive watershed nomination.

We have no specific comment on this motion.

Motion 2. Gathering information for the refinement of the empirical sediment budget and model sediment budget approaches.

From the discussion that followed our presentation, it became apparent that the distinction between these approaches, was not clearly communicated. In a Phase II, the Panel could further clarify these distinctions, with special reference to the data and interpretations needed to apply each one. We could develop a matrix showing the extent and quality of existing data, and offer our estimate of the time and resources required to secure the data and interpretations needed. The Panel could also examine and clarify the nature of the empirical rate factor L, for example as discussed in California Geological Survey comments in the memo sent to you by Dr. Davis on January 22, 2003.

Motion 3. Support for GIS analysis.

This motion requested that the Panel assist the Regional Water Board staff with the GIS effort. In the suggestions for possible Phase II topics below we give details of possible GIS analysis focused on assembling and interpreting GIS information to help visualize the relationship of the HCP/WA/THP monitoring programs to the Board's water quality-related needs, and GIS methods for developing sediment production coefficients from various source areas. The letter from James F Davis, California State Geologist, to William Massey dated January 22, 2003 giving comments on our Phase I final report indicated that it is important to subdivide individual watersheds based upon the relative potential for mass wasting and other considerations. This letter noted that data should be gathered in a transparent and repeatable way to provide a supportable foundation for calculation of sediment production. This is consistent with our suggestion of calculating separate sediment production coefficients for different land area classes. GIS provides a natural system to facilitate the transparent and repeatable analysis that is required. The California State Geologist letter also notes that CGS has published background landslide information for some of the watersheds in question. This data would be important to incorporate into the GIS analysis.

Motion 4. Directs staff to use the HCP as a mechanism for implementing requirements on water quality.

The panel recognizes the importance of the HCP as a mechanism for implementing water quality requirements and recognizes the importance of regulatory agencies working together to achieve watershed protections. The panel received the letter from James F Davis, California State Geologist to William Massey dated January 22, 2003 and notes that this letter contains several constructive and insightful comments related to sediment impairment of these watersheds and sediment production from lands undergoing timber harvest. This letter provides common ground that could serve as a basis for building up cooperation. No detailed monitoring data from recent years was presented to the Panel. The question is therefore still unanswered as to the degree to which the HCP can be an effective mechanism to ensure recovery of these watersheds.

Motion 5. Develop Panel Phase II including review of HCP.

In Phase I, the Regional Water Board asked us to review specific documents related to timber harvest rates and the meeting of water quality standards. The list did not include the Habitat Conservation Plan (HCP). Following our presentation, many of the agencies involved in the HCP regulatory process stated that the HCP process, which they administer, is comprehensive and does protect water quality in watersheds undergoing timber harvest. We acknowledge that our Phase I review of the HCP process was not comprehensive. In our suggestions for the Phase II terms of reference we include review of HCP documents and other documents referred to during the board meeting (e.g., the Dunne report). In anticipation of this being part of Phase II, we suggest that stakeholders be asked to provide the documents and reports describing the specific implementation of HCP measures for the five watersheds in question to facilitate this review.

II. POSSIBLE TOPICS THE PANEL COULD ADDRESS IN PHASE II

The following are a list of candidate topics that the Panel could address as part of Phase II. The Panel has listed activities that it feels flow logically from the Phase I Report and the subsequent comments received. Given the budget and resources currently available for Phase II, the Panel

would NOT be able to undertake all topics listed below. However, we hope this document will be helpful to staff in informing Phase II.

A: Review of Habitat Conservation Plan, Watershed Assessment, Timber Harvest Plans (HCP/WA/THP)

Although the HCP/WA/THP documents were not a focal issue during Phase I activities of the Panel, these merit a thorough examination during Phase II. In Phase II, the Panel could review the documents describing the specific implementation of the HCP/WA/THP as they relate to sediment production and control for the five watersheds in question.

Specific questions/issues that could be addressed:

- Will implementation of HCP/WA/THP prescriptions sufficiently address issues of water quality and allow water quality standards to be met in the five watersheds. What is the time frame for recovery?
- Is there evidence of the effectiveness to date, specifically with regard to water quality, of HCP/WA/THP prescriptions that have already been implemented in the five watersheds?
- The empirical basis for the co-efficients used in the O'Connor modeling approach could be reviewed and assessed from an independent perspective.
- Clarification of the distinctions between empirical and modeling approaches described in Phase I. Development of the matrix referred to in our discussion of Motion 2 above and an assessment of the empirical basis for the rate factor L.
- Assessment of the sediment debit/credit approach. A central element of Timber Harvest Plans is the calculation of sediment debits and credits. This process is very sensitive to the assumptions used to calculate sediment credits, and we propose that these assumptions be assessed.

Rather than have the panel seek out the relevant documents from the voluminous information available (which would be inefficient), it would be better to have the board and stakeholders identify the specific documents that describe the specific quantitative implementation, not general methodology, of the HCP/WA/THP methods as they are or were applied to the watersheds in question so that the panel can focus its effort on the substantive parts of this methodology that pertain to water quality in these five watersheds.

B: Review Current Monitoring Plans, their Implementation and Results

Sediment is generated due to a combination of natural processes and landscape disturbance in several forms. Monitoring is central to any efforts to identify and quantify different sediment sources, and if necessary mitigate impairments to beneficial use of water for four reasons:

1. to help identify a background reference rate of suspended sediment concentration
2. to identify the significance of different sources of disturbance relative to background rates
3. to identify deviations and events that exceed background levels
4. to establish the effectiveness of mitigation techniques and Best Management Practices (BMPs) as part of an adaptive management plan that ensures that water quality is not impaired

Each of these aims can be viewed as a potential task for the panel:

1. review existing monitoring data to determine what is already known, and advise on establishment of a monitoring program to fill in the gaps on what is not known concerning background sediment rates
2. advise on the creation or adaptation of a robust monitoring program to identify deviations from background
3. review existing efforts to monitor the effectiveness of BMPs

The resulting information would help the Regional Water Quality Board's policy making by;

1. Providing peer review and guidance to the RWQCB's own monitoring efforts, as well as the efforts of stakeholders
2. Provide a strategic overview of all monitoring activities to ensure that the different monitoring programs are compatible, and comprehensive.

C: Support the Regional Board with GIS assistance

The Panel could help direct the Regional Board's GIS operations in the following ways:

1. Upon completion of the Panel's more thorough review of the HCP, Watershed Analyses, water-quality aspects of THPs, and monitoring data sets, we could develop a list of potential GIS layers that would support evaluation of this material. Some layers would be contextual (e.g. watershed boundaries, surficial geology, topography), and some might be directly related (e.g. maps of stream buffers, THP footprints, MWAS, location of monitoring sites). This would include the data mentioned in the CGS letter (Davis, January 22, 2003).
2. Work with the Board's GIS staff to assemble and interpret GIS layers (e.g. maps) available, and assist in the Panel's use of GIS in its Phase II report.
3. Upon completion of the Panel's further description of the two modeling approaches, help develop potential GIS layers that would help support use of each of the two modeling approaches, such as possible GIS methods for developing sediment production coefficients from monitoring.
4. Work with GIS staff to identify key GIS gaps, and take steps to see if important layers can be obtained from cooperators, or if they can be developed de novo by the staff.
5. Report on the general status of GIS data (available vs. missing) vis a vis potential support of each of the two modeling approaches. We could comment on metadata, and advise on the degree to which GIS layers are adequate in terms of topic, geographic extent, date, accuracy, and level of resolution.
6. Work with the board's GIS staff to assist the Panel in evaluation of the HCP, Watershed Analyses, THP, and Monitoring data. To the extent feasible, use GIS to help visualize and analyze the usefulness and relationship of the HCP/WA/THP/Monitoring programs to the Board's water-quality related needs.
7. Recommend next-steps for the Board's GIS program that would support the Panel's Phase II recommendations.

D: Review the Dunne report

In June 2001, the University of California Committee on Cumulative Watershed Effects, chaired by Professor Thomas Dunne, released a report titled "A Scientific Basis for the Prediction of Cumulative Watershed Effects" (hereafter termed the "Dunne report"). The California Department of Forestry and Fire Protection (CDF) asked the U.C. Committee to address two questions: 1) Does a scientific basis for cumulative watershed effects (CWEs) exist? and 2) How should analyses and predictions be made? The report reviews how CWEs are considered in the context of the THP process, and general guidelines established by the CDF for evaluating CWEs.

As part of Phase II work by the ISRP, we propose to evaluate the degree to which the recommendations of the Dunne Report are appropriate for the five watersheds (Freshwater, Elk, Bear, Jordan, Stitz), and how these recommendations might be implemented over short, intermediate, and long-term time frames. Some of the specific recommendations in the report (Chapter 5) to be evaluated by the ISRP include:

- developing "spatially-registered mathematical models" to calculate the likelihood (expressed as a statistical probability) of damages to resources;
- shifting the emphasis to reducing hazards rather than accurate, precise, robust predictions, accepting some uncertainty as part of the CWE process;
- running models with different scenarios to evaluate various land management options
- focusing CWE analyses on watersheds 40 to 80 square miles in area, a scale at which the full range of upland and lowland environments is encountered;
- using results of model scenarios to determine the allowable rate of harvest or rate of disturbance and best management practices, and evaluating the kinds of models that are optimal in light of existing economic realities and regulatory time frames;
- submitting THPs with this information.

The panel could assess how consistent specific HCP/CWA/THP documents for the five watersheds, considered under task A, are with these recommendations.

E. Assist with the Development and Refinement Sediment Rating Curves

The panel recommended that, due to the natural variability in suspended sediment concentration with water discharge, deviation from background be defined as deviation from a suspended sediment rating curve rather than fixed as a single concentration. To be an effective measure, it will be necessary to establish sediment rating curves for watersheds in the area, taking into account changes in geology and topography, because different basins will have different background sediment yields. This will require a literature review to identify available data, and the development of a strategy for establishing rating curves (for example, how many different curves would be needed for the Humboldt watersheds?). The adoption of any specific regulatory threshold or acceptable deviation is a policy decision and not a scientific question. The Panel can, however, advise the board on the scientific basis for any standard that it might consider. Turbidity standards based on rating curves will also have to allow for the effects of rare but significant events such as large earthquakes or major storms, which have the ability to significantly impact sediment production even under background conditions. This will require a review of ongoing and published research on sediment production in these watersheds over geologic time scales.

III. SUGGESTIONS FOR STRUCTURING THE DELIVERY OF A PHASE II REPORT

This section outlines potential suggestions for structuring the delivery of a Phase II. The overall aim is to elevate the level of scientific analysis and to strengthen the science basis for the Board's decision-making.

Accordingly, we would like to ensure that any Phase II Panel Report is thoughtfully considered on its merits, and that sufficient time is allotted to consider the implications of its report before policy decisions are made.

The Panel recognizes that numerous scientists have devoted a significant amount of effort to addressing these issues throughout the past few decades, and the Panel would like to make use of and build upon this collective knowledge where possible.

Option One: Technical Workshop

In considering the best forum for presenting the Phase II results, the Panel suggests organizing a one-day technical workshop, at which to present the results to other technical experts. This workshop would be held prior to any Board hearing and would be outside the regulatory setting. Such an arrangement would enable Board staff and other stakeholders, including their respective technical staff to focus on the technical analysis and the scientific implications, rather than any immediate regulatory implications. It also provides the opportunity for the Panel to clarify certain technical questions that may arise.

Option Two: Board-sponsored Study Session

This would be a variant on the first option, and would be a Board-sponsored study session, which Board members attend. However, unlike the last meeting, there would be no recommendations considered, or formal testimony taken.

Strategic Considerations:

Timing of the Meeting in relation to the status of the report: One option is to conduct this technical workshop prior to finalizing the Phase II report so that questions and input received could be used to inform the Panel's final analysis or conclusions. A second option is to conduct the technical workshop once the report has already been finalized and signed off by the Panelists, but have Board staff record the questions/comments of stakeholders and take them into consideration, as appropriate, in developing the corresponding staff report and next steps.

Participation in the Meeting: A second consideration is whether this workshop would be open to all members of the public, or whether it would be more effective to invite a select group of individuals with more technical expertise who could represent a broad range of views.

APPENDIX 2 - Invitation from ISRP and CONCUR to Stakeholders to Participate in May 5, 2003 Technical Workshop, 4/28/03

Dear Stakeholders

This email follows up a letter dated April 3rd in which the North Coast Regional Water Board (NCRWQCB) invited you to submit suggestions on specific documents for the Independent Scientific Panel (the Panel) to review, and to invite your participation in the upcoming technical meeting planned for May 5th, 2003. This email is to confirm this meeting will be held on Monday, May 5th, 2003 from 11:30AM to 6:00PM at the Wharfinger Marina in Eureka and to transmit the proposed meeting agenda (Attachment 1).

I. PURPOSE OF MEETING

The purpose of the May 5th meeting is to clarify or elaborate upon written documents that have been submitted for review in order to inform the Panel's Phase II deliberations. The Panel envisions this meeting as an opportunity to hear from the technical experts who have been involved in the development, review and implementation of the HCP in order to understand and clarify the cause and effect relationships envisioned in the HCP watershed protection measures and to identify any measures that could be taken by the Regional Water Board to restore beneficial uses in these five watersheds.

II. SUBMISSION OF DOCUMENTS

In response to the April 3rd letter, we received over 50 submissions from 11 organizations and individuals (see Attachment 2) in total. In formulating the agenda, the Panel agreed that each of the 11 submitting organizations/individuals be allotted time to briefly: (1) summarize key content of their submissions as they relate to the questions laid out in the TOR and (2) briefly explain any relevant findings, monitoring results, underlying assumptions, and analysis that would be useful to the Panel is addressing the questions outlined in the Terms of Reference (see Attachment 3).

The primary focus of the meeting is on the presentation of basic scientific and technical information, including monitoring data and maps, that would help inform the Panel's deliberations on the questions laid out on page 7 of the attached Terms of Reference.

The panelists are particularly interested in understanding how the HCP process is actually working, rather than how it might be expected to work in the best of all cases. For example, the Panel wants to understand where water quality monitoring stations have been established and what data they have produced to date; how calculations and statistical analyses are used to rigorously establish the significance of monitoring data relative to the regional water board's goals; what criteria are used, data collected in the field, and calculations performed in the office to identify "avoided" erosion; and what experts and criteria are used to identify potentially unstable slopes and assess the risks posed by different activities on those slopes.

III. PROPOSED AGENDA AND FORMAT OF THE MEETING

We have worked in collaboration with the Panel to compile an agenda based upon the materials submitted. As you will see from the attached agenda, we have allocated a few minutes after each presentation for the Panelists to ask pertinent follow up questions or seek needed clarification.

Should other workshop participants have comments or questions, we are asking that they record those comments on a 3 by 5 index card and submit them to CONCUR. CONCUR will in turn review these with Panelists. At points in the meeting, the Panel will review those questions/comments and use them to inform any follow up questions, as appropriate.

IV. YOUR PARTICIPATION

We have tried to sequence the presentations in a way that flows logically from the documents submitted. Given the full agenda, there is little room for flexibility. However, if you have an unavoidable scheduling conflict, please let us know, and we will attempt to accommodate a slight timing shift. Please confirm by Tuesday, April 29th whether or not you will be able to attend. This confirmation should be a simple email to Rebecca at rebecca@concurinc.net.

V. NEXT STEPS

Upon completion of the technical meeting, the Panel will meet the morning of May 6th to debrief and begin its deliberation. Future deliberations will be conducted via email and teleconference.

If you have any comments or questions, please give email or give us a call at 510.649.8008. Please note, both Scott and I will be out of the office from Wednesday, April 30th to Friday, May 2nd. During this time, please leave a message with Amy LeBlanc who can be reached at the same number or by email at amy@concurinc.net. We will be checking in with her and will respond to you, as needed.

As always, many thanks for your support in this process.

Best regards,
Scott McCreary and Rebecca Bryson

APPENDIX 3 - Final Agenda, May 5, 2003 Technical Workshop

FINAL AGENDA

Humboldt Watersheds Independent Scientific Review Panel Phase II Technical Workshop Wharfinger Marina, Eureka, CA

Monday, May 5, 2003: 11:30 p.m. to 6:00 p.m.

TIME	PRESENTER	DISCUSSION TOPICS
11:30 AM	CONCUR	<ul style="list-style-type: none">Welcome, Introductions and Background
11:45 PM	PALCO <i>Jim Branham</i> <i>Jeff Barrett</i> <i>Matt O' Connor</i> <i>Kate Sullivan</i>	<ul style="list-style-type: none">HCP sediment reduction measuresFish abundance in the five watershedsFactors affecting floodingWater quality monitoring
12:30 PM	Questions from Panel	
12:40 PM	CDF <i>Bill Synder</i> <i>John Munn</i>	<ul style="list-style-type: none">THP Process ReviewPeak Flow Analysis (FW and Elk)Comments on the U.C. (Dunne) Report
1:00 PM	Questions	
1:05 PM	Wildlife Agencies <i>Bill Condon (DFG)</i> <i>John Clancy (NMFS)</i>	<ul style="list-style-type: none">Monitoring, Adaptive Management and PrescriptionsWatershed Analysis
1:45 PM	Questions	
2:00 PM	BREAK	
2:15	Questions from Panel to the HCP Implementing Parties	

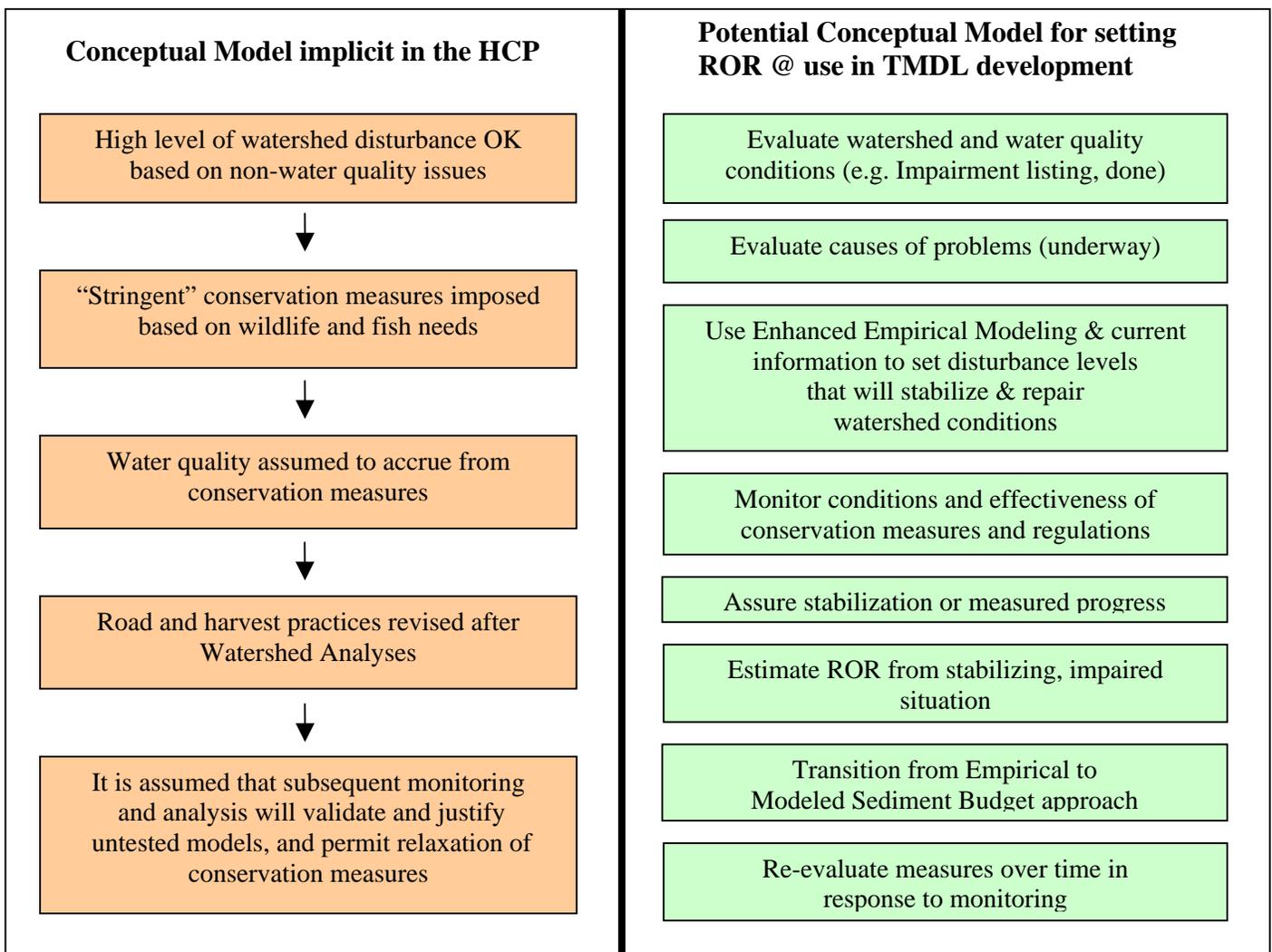
2:40 PM	Patrick Higgins Consulting Fisheries Biologist	<ul style="list-style-type: none"> • Freshwater Creek PL WA Fisheries Module Dissenting Report
2:55 PM	Questions	
3:00 PM	CGS Gerald Marshall Bill Short Tom Spittler Mike Reichle	<ul style="list-style-type: none"> • Review of Landslide and Mass Wasting Issues Associated with PALCO's HCP and Freshwater Creek Watershed Analysis • Methods of Determining Sediment Budgets for TMDLs in the 5 watersheds • Comments on UC (Dunne) Report
3:20 PM	Questions	
3:25 PM	Humboldt Watersheds Council <i>Jesse Noell</i> <i>Kristy Wrigley</i>	<ul style="list-style-type: none"> • Effectiveness of Mass Wasting Avoidance Strategy • Increased Flow in Freshwater Creek
3:35 PM	Questions	
3:40 PM	Regional Water Board <i>Adona White</i> <i>Dave Parsons</i> <i>Matthew Buffleben</i>	<ul style="list-style-type: none"> • Refinement of Landscape Characterization for Prevention of Sediment Delivery • Stream crossings • Monitoring
3:50 PM	Questions	
4:00 PM	BREAK	
4:15 PM	Patrick Vaughan Engineering Geologist California State Parks	<ul style="list-style-type: none"> • Sediment Source Module • Response and Recovery of the Eel river, California to Floods in 1955, 1964, and 1997.
4:30 PM	Questions	
4:35 PM	<i>Randy Klein,</i> Hydrologist	<ul style="list-style-type: none"> • Duration of Turbidity and Suspended Sediment Transport in Salmonid-bearing Streams, North Coastal California • Turbidity Analysis
4:45 PM	Questions	
4:50 PM	<i>Bill Trush,</i> McBain and Trush	

5:05 PM	Questions
5:10 PM	Brief Summary of Key Points (CONCUR)
5:15 PM	Final Questions from the Panel
5:55	Overview of Next Steps
6:00 PM	Adjourn

APPENDIX 4 - Comparison of Conceptual Models

In developing its TMDL strategy, the Regional Water Board will be developing a conceptual model to illustrate its key assumptions, hypotheses, and expectations for water quality protection and recovery. A conceptual model is a working hypothesis, and is the centerpiece of an adaptive management approach. It need not be overly complex, but should strive to make assumptions and expectations clear and visible for public review, and for checking the progress of strategies over time.

In regard to the timber harvest issue, the following diagram is intended to compare the conceptual model which appears to the Panel to underlie the HCP/SYP/THP approach with one more closely aligned with the recommendations of this report.





California Regional Water Quality Control Board

North Coast Region

Winston H. Hickox
Secretary for
Environmental
Protection

William R. Massey, Chairman



Gray Davis
Governor

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TO: Susan A. Warner
Executive Officer

FROM: David Hope, RPF #2614
David Leland, PE #46713
Mark Neely, CEG #1582

DATE: August 12, 2003

SUBJECT: REQUIREMENTS OF THE FOREST PRACTICES ACT AND BUSINESS AND PROFESSIONS CODES FOR PRACTICING FORESTRY, ENGINEERING, AND GEOLOGY FOR PURPOSES OF ISSUANCE OF: "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."

On June 27, 2002, the North Coast Regional Water Quality Control Board (Regional Water Board) directed staff to convene a team of independent scientific experts to provide input regarding sediment impairment in the Freshwater, Bear, Jordan, and Stitz Creeks, and Elk River watersheds. The panel was convened in August of 2002, and, produced the "Final Report on Sediment Impairment and Effects on Beneficial Uses of the Elk River and Stitz, Bear, Jordan and Freshwater Creeks" on December 27, 2002. The Supervising Geologist at the Department of Conservation, California Geological Survey raised a concern that, while the panelists are noted experts in their respective fields, none of them were licensed in California. After consultation with the Department of Consumer Affairs, Board for Professional Engineers and Land Surveyors, and the Board of Forestry and Fire Protection, Professional Foresters Registration office, you sought and received professional review of the document by the undersigned staff, duly licensed in our respective disciplines.

On January 24, 2003, the Regional Water Board passed five motions relative to the Panel's findings and directed the Panel to respond to a new set of questions as part of a Phase II. In response to inquires on whether Phase II would constitute practice of geology, the Executive Officer of the Board for Geologists and Geophysicists responded that Phase II would constitute the practice of geology. Therefore, you sought the professional review of the Phase II document by the undersigned staff, duly licensed in our respective disciplines.

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We have reviewed the attached document and determined that the report has investigated the questions posed to the Independent Scientific Review Panel in a manner consistent with the State of California professional codes for our respective disciplines. The analyses and discussions presented in the report rely on and employ techniques in accordance with practices generally accepted by other scientists, geologists, engineers, and foresters practicing under similar conditions in California.

David Hope

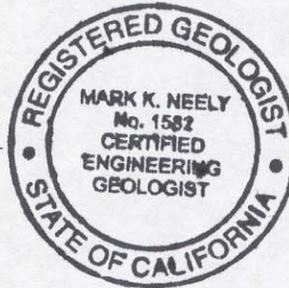
David Hope
Registered Professional Forester #2614



Date: 8/12/03

Mark Neely

Mark Neely
Certified Engineering Geologist #1582



Date: 8.12.03

David F. Leland

David F. Leland
Professional Engineer-Civil #46713



Date: 12 Aug 03

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