Staff Response
to
Peer Review Comments
on the
Peer Review Draft Staff Report
To Support the Technical Sediment
Total Maximum Daily Load
For the Upper Elk River

July 19, 2013

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

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Introduction

Staff for the North Coast Regional Water Quality Control Board (Regional Water Board) submitted a draft of the *Staff Report to Support the Technical Sediment Total Maximum Daily Load for the Upper Elk River* (Peer Review Draft Staff Report) to four independent scientific peer reviewers on March 4, 2013. Peer reviewer selection was facilitated by State Water Resources Control Board staff through a contract with the University of California. Information on the State Water Resource Control Board's peer review process is available at: http://www.waterboards.ca.gov/water_issues/programs/peer_review/

Table 1 provides the names, affiliations and primary areas of expertise of each of the four reviewers selected to evaluate the scientific bases of the Peer Review Draft Staff Report.

Table 1. Independent scientific peer reviewers names, affiliations, and field of expertise.

Name	Affiliation	Field of Expertise
Dr. Timothy Stark	Stark Consultants, Inc. P.O. Box 133, Urbana, Illinois, 61803	Slope Stability
Dr. Sondra Miller	Department of Civil Engineering Boise State University 1910 University Drive Boise, Idaho 83725-2060	Water Quality
Dr. Greg Ruggerone	Natural Resources Management Inc. 4039 21st Avenue West, Suite 404 Seattle, Washington 98199	Fisheries
Dr. Victor Baker	Department of Hydrology and Water Resources J.W. Harshbarger Building, Room 122 1133 E. James E. Rogers Way The University of Arizona Tucson, Arizona 85721-0011	Hydrology

The reviewers were asked to comment on fourteen conclusions made in the Peer Review Draft Staff Report as they relate to six specific topics. Reviewers were also asked to recommend any additional scientific issues that should be part of the assessment. Finally, reviewers were asked to assess whether the technical TMDL was based upon sound scientific knowledge, methods, and practices. The topics and questions posed to reviewers were:

Topic I. Nature of the Water Quality Problem;

Conclusion 1. Anthropogenic sediment loading has resulted in habitat changes, impacts to beneficial uses, and increase in nuisance flooding.

Topic II. Desired Numeric and Narrative Target Conditions;

Conclusion 2. The instream desired target conditions represent desired conditions supportive of beneficial uses including fisheries uses and domestic and agricultural water supplies.

Conclusion 3. Historical measurements by USGS from 1954-1965 on the upper mainstem Elk River provide an appropriate basis for the desired target conditions to prevent nuisance in upper mainstem, lower North Fork and lower South Fork Elk River.

Conclusion 4. The hillslope desired target conditions represent conditions in which sediment sources are likely to be controlled by addressing controllable water quality factors.

Conclusion 5. The watershed desired target conditions support watershed and stream processes and functions for beneficial use protection.

Topic III. Sediment Source Analysis;

Conclusion 6. The sediment source analysis reasonably quantifies the timing and magnitude of natural and management-related sediment source categories.

Conclusion 7. Little South Fork Elk River provides a reasonable reference watershed for Upper Elk River.

Topic IV. Sediment TMDL, Load Allocations and Margin of Safety;

Conclusion 8. 125% of natural sediment loading is a reasonable estimate of the sediment loading capacity for Upper Elk River and is likely to be supportive of beneficial uses of water.

Conclusion 9. The load allocation strategy appropriately represents 1) that a portion of the loading capacity is currently taken up by the instream sediment deposits in the middle reach of Elk River and 2) that a change in the volume of instream deposits resulting from recovery of the middle reach may result in a greater portion of loading capacity available for management-related sediment loads.

Conclusion 10. The margin of safety will ensure beneficial uses are protected and it reasonably accounts for uncertainty in the estimates of the sediment source analysis, the loading capacity, and seasonal variation.

Topic V. Slope Stability Modeling and Resulting Landslide Hazard Maps;

Conclusion 11. The 4-meter Digital Elevation Model (DEM) generated from the bare-earth Light Detection and Ranging (LiDAR) points using kriging is a reasonable technique to model hillslope stability in the project area to maximize representative elevations and definition of actual geomorphic features while reducing topographic artifacts and computation time required for model application and other spatial analyses.

Conclusion 12. SHALSTAB and PISA represent reasonable models for predicting potential shallow landslide hazards, in common usage with proven performance in forest mountainous terrain.

Conclusion 13. The model testing resulted in determination of appropriate thresholds for breaks in potential instability classes that balance the goals of maximizing correct landslide prediction and minimizing over prediction of unstable area.

Topic VI. Identification of Additional Beneficial Uses of Water for the Elk River Watershed.

Conclusion 14. The Wetland Habitat (WET), Flood Peak Attenuation/Flood Water Storage (FLD), and Water Quality Enhancement (WQE) beneficial uses exist in Elk River.

Other Topics: “Big Picture” Questions

(a) In reading the technical reports and proposed implementation language, are there any additional scientific issues that should be part of the scientific portion of the proposed rule that are not described above? If so, comment with respect to the *TMDL Summary and Implementation Framework* and *Beneficial Use Amendment* given above.

(b) Taken as a whole, is the scientific portion of the proposed actions based upon sound scientific knowledge, methods, and practices?

The request letter with instructions to peer reviewers is included as Appendix A. The peer reviewers’ comment letters are also included as Appendices B to E.

Regional Water Board staff appreciates the thorough reviews provided by these reviewers. Their comments and insight have prompted us to clarify and improve the staff report in several areas in preparation for its future release as a public review draft of the Technical TMDL Staff Report (Public Review Draft Staff Report). In this response to comments document (Response to Comments), each reviewer’s comments are reproduced in full as submitted. Regional Water Board staff’s corresponding response follows each comment. Several tables and figures from the Peer Review Draft Staff Report are reproduced to aid in the response. Other new tables and figures are also included here to aid in the response. For consistency, all tables and figures are numbered sequentially within this document. Any citations included in staff responses are referenced at the end of the document. Where applicable, the information presented in the staff responses will be incorporated in the Public Review Draft Staff Report.

The following format is used to present the reviewer's comments and Regional Water Board staff responses:

Topic Heading (I –VI)

Conclusion Subheading (1-14)

[**Reviewer Last Name] [Conclusion number].[Comment number**]:
[."Reviewer Comment"].

[*Staff Response*]: [Staff response to comment].

Topic I. Nature of the Water Quality Problem

Conclusion 1. Anthropogenic sediment loading has resulted in habitat changes, impacts to beneficial uses, and increase in nuisance flooding.

Baker Comment 1.1: "The supporting science for this finding is found in Chapter 3: Problem Statement of the Draft Staff Report for the Upper Elk River Sediment TMDL (not in "Chapter 2" as stated in Appendix 2 for the letter of 7/17/13)."

Staff Response: Between the drafting of the Regional Water Board's letter requesting peer review (letter dated 7/17/13) and the completion of the Peer Review Draft Staff Report for the Upper Elk River Sediment Total Maximum Daily Load (Peer Review Draft Staff Report), chapter renumbering occurred. Staff regrets any confusion caused by this discrepancy in numbering.

Baker Comment 1.2: "The supporting science for assertion/finding number 1 is solid. Considerable evidence is presented in support of this finding."

Staff Response: Comment noted.

Baker Comment 1.3: "The comparative study involving two managed subbasins and a reference subbasin (Little South Fork Elk River) clearly documents the role of timber harvest activities on generating vastly increased turbidity levels downstream."

Staff Response: Comment noted.

Baker Comment 1.4: "Well documented observations also support the impacts of timber harvesting activities on degraded salmonid habitat, instream conditions, water supplies, and other beneficial uses."

Staff Response: Comment noted.

Baker Comment 1.5: "There are also informative data sets that document significant reductions in channel cross-sectional areas and reduction in pool depths during 1997-2011 at sites on the upper main-stem Elk River, the lower North Fork, and the Lower South Fork (e.g., Figures 3.9 through 3.13, and 3.15 through 3.18)."

Staff Response: Comment noted.

Baker Comment 1.6: "There is some confusion in that that [*sic*] some location numbers for the South Fork listed on Figure 3.17 (SB2, SB3, SA4, SA3, SA2, and SA1) do not match up in an obvious way with map locations on Figure 3.14, which shows South Fork cross sections numbered 14 through 22."

Staff Response: Staff recognizes that the numbering of the South Fork cross-section locations, as presented in the Peer Review Draft Staff Report, was confusing. The Public Review Draft Staff Report will include revisions to Figures 3.14 - 3.18, to ensure better clarity and consistency in the cross-section naming conventions.

Baker Comment 1.7: "Though the scientific knowledge, method, and practices presented in the Staff Report provide a sound basis for assertion/finding number 1, there are some details that could receive more attention in regard to future actions. For example, the report notes that excessive sediment deposition occurred on the floodplain for the period 1993-1998, a time when many landslides were triggered in the watershed. I think there should have been more analysis of the actual events during this time period."

Staff Response: The following information will be incorporated in the Public Review Draft Draft Staff Report.

The winter storm events of 1995-1998, influenced by a combination of El Nino and La Nina weather patterns, were significant in the Humboldt Bay area, including in the Elk River watershed. Hydrologic Years 1998, 1996, and 1995 (as measured in Eureka) ranked second, third, and sixth, respectively, for greatest annual precipitation over the 63 year period of record from 1949-2012. The months of December and January for 1996 and 1995 ranked first and third, respectively, for greatest precipitation during this same 63 year period.

The Peer Review Draft Staff Report evaluates sediment loading from 1955-2011. Table 4.31 and Figure 4.21 (reproduced below as Table 2 and Figure 1, respectively) identify the 1988-1997 time period as that with the greatest sediment loading of all the time periods analyzed. Approximately half of the sediment loading from this period is associated with landslide-derived sediment delivery. Of all the time periods, 1988-1997 had the greatest volume of annual sediment delivery associated with landslides. It is staff's assumption that the majority of the landslides that are first visible on the 1997 aerial photos were triggered during the winters of 1995-1997, considering the precipitation record. Specifically, significant rainfall fell throughout central and northern California from December 26, 1996 through January 3, 1997, with the heaviest and warmest rains on New Year's Eve and into New Year's Day.

Table 2. Summary of Upper Elk River volumetric loading ($yd^3/mi^2/yr$) by sediment source category for analysis time periods (as reproduced from Table 4.31 of the Peer Review Draft Staff Report).

		Sediment Loading ($yd^3/mi^2/yr$)						
	Source Category	**1955-1966**	**1967-1974**	**1975-1987**	**1988-1997**	**1998-2000**	**2001-2003**	**2004-2011**
Management	Low Order Channel Scour	67	23	14	21	32	12	14
	Bank Erosion	43	46	49	52	54	54	57
	Streamside Landslides	227	159	30	265	294	294	217
	Open Slope Shallow landslides	189	82	6	201	118	51	5
	Road-related Landslides	99	29	15	307	3	20	25
	Management discharge sites	30	60	80	65	39	39	39
	Skid Trails	4	12	11	12	26	15	15
	Treatment of Management Discharge Sites	0	0	0	0	13	4	24
	Road Surface Erosion	52	78	87	137	55	56	17
	Harvest Surface Erosion	2	6	2	5	6	5	4
	Total management-related Loading	**713**	**495**	**292**	**1,065**	**639**	**551**	**417**
Natural	Bank Erosion	9	9	9	9	9	9	9
	Small Streambank Landslides	26	26	26	26	26	26	26
	Shallow Hillslope Landslides	30	30	30	30	30	30	30
	Deep seated Landslides	3	3	3	3	3	3	3
	Total Natural Loading	**68**	**68**	**68**	**68**	**68**	**68**	**68**
	Total Loading	**781**	**563**	**360**	**1,133**	**707**	**619**	**485**
	Percent of Natural Loading	**1150%**	**828%**	**530%**	**1668%**	**1040%**	**911%**	**714%**

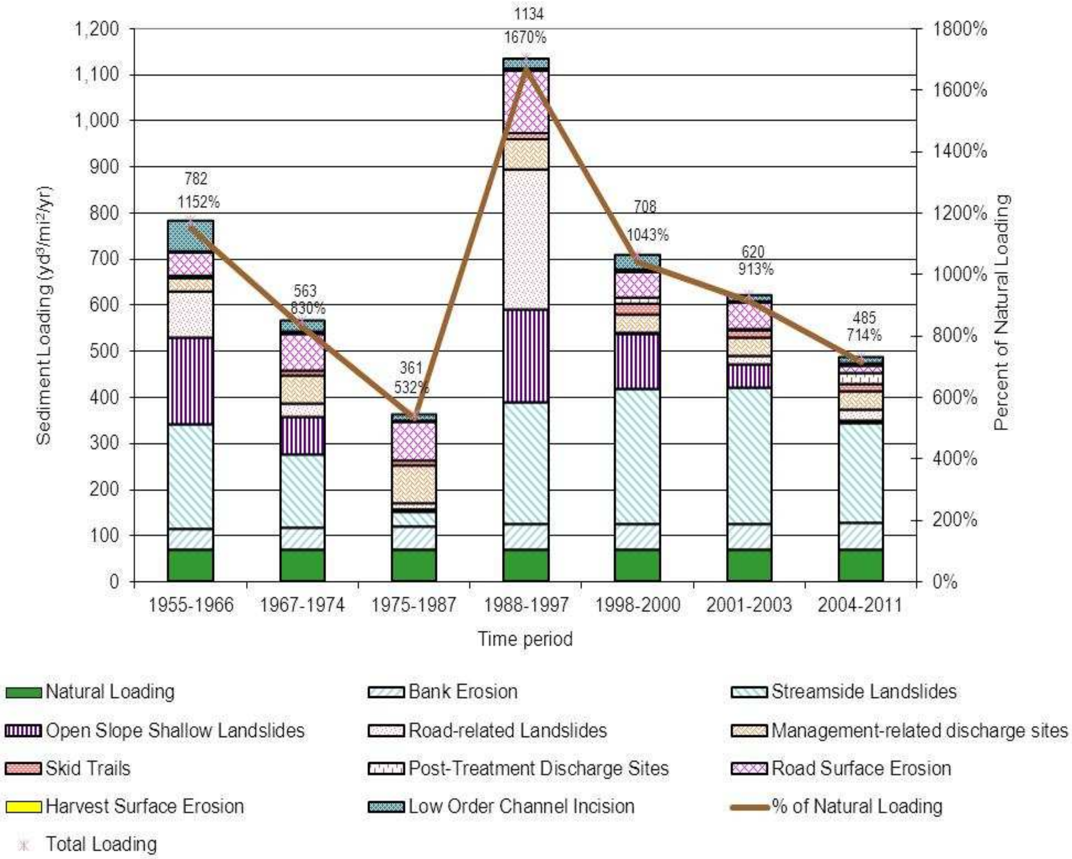

Figure 1. Upper Elk River loading by source category for analysis time periods (as reproduced from Figure 4.21 of the Peer Review Draft Staff Report)

Issues related to the landscape's response to storm history and timber harvesting impacts in the Elk River have led to the development of a number of studies/reports that document the significance of the storm and flood magnitudes in Elk River. These reports were considered in the development of the Peer Review Draft Staff Report and previous Regional Water Board regulatory and non-regulatory efforts in Upper Elk River.

Another large storm event occurred during December 27-28, 2002. This storm resulted in the greatest intensity precipitation measured in Eureka during the 63 year period of record. The storm was of such intensity that several previous records were exceeded, including the 24-hour maximum. The December 2002 storm produced 6.85 inches of rain in one day. Additionally, records were broken for the 2, 3, 4, 5, and 15-calendar day maximums over the period of December 14-28, 2002. According to analyses described in Northern Hydrology and Stillwater (2012) (included as Appendix 3-D to the Peer Review Draft Staff Report) the peak discharge associated with the December 28, 2002 event was approximately 3700 cfs. This corresponds to a recurrence interval of approximately 25 years (see Staff Response to Baker Comment 1.8 for further information).

Baker Comment 1.8: "There is a statement on page 3-10 that the 1964 flooding event that impacted much of northern California did not significantly change channel cross-sectional areas for the Elk River. However, to attach particular importance to this is unwarranted without a regional comparison of specific processes and response in the Elk River basin to those of other basins during various extreme precipitation events."

Staff Response: The weather patterns during December 1964 and January 1965 caused significant flooding in many watersheds in north coastal California, including in the adjacent Eel River watershed. Included here is a comparison of the Eel River watershed to the Elk River watershed with respect to flooding response. For context, a significant snow pack in the higher elevations of the Eel River watershed coupled with warmer storm(s) produced a "rain on snow" event that resulted in dramatic increases in peak stages and discharges in the watershed. However, there was less snow pack in the Elk River watershed.

Heavy (2-3 times normal) precipitation fell in November 1964 which led to higher than normal soil moisture in watersheds throughout the North Coast. Additional rains in the first half of December (1-2 times normal) maintained soil moisture and resulted in substantial snow accumulation at elevations above 4,500 feet. High intensity rainfall occurred over a five day period preceding December 23 (e.g., 50 inches measured in the Mattole River with 15 inches measured on December 22). Rains into late January 1965 sustained streamflows (Geologic Survey, 1971a).

Due to the intense rainfall and rain-on-snow events, dramatic peak stages and discharges occurred in the Eel River watershed. Rainfall exceeded 20 inches in 48-hours which in some places produced runoff that sent stages 5-15 feet above previous record stages, resulting in major damage to river valleys throughout the Eel River basin. Sediment and debris eroded from the landscape blocked bridges and culverts, causing water to overtop and divert around them. Sediment deposition on the floodplain was commonly measured at several feet, including in homes, stores, and automobiles. Towns along the Eel River were devastated (Geologic Survey, 1971b).

The 1964 storm event both had less dramatic effect in the Elk River watershed and was a less significant event in the Elk River hydrologic record. It likely had less dramatic effect because there was not a significant snow pack to contribute to stream flow. As described by Patenaude (2004), USGS instantaneous annual peak discharges from 1958-1966 (Table 3) were evaluated as part of a flood frequency analysis. The exceedence probabilities for a range of discharges were estimated (Figure 2) and the recurrence interval calculated (Table 4). The 1964 peak discharge on Upper Mainstem Elk River was 3430 cfs, which is equivalent to a 10-year event (3456 cfs).

Further described by Patenaude (2004), and presented in Table 3.2 of the Peer Review Draft Staff Report, the USGS cross-sectional areas within the bankfull channel did not diminish between 1959 and 1965. Patenaude also presented channel bed elevations from the USGS, indicating that between 1964 and 1965, low-water streambed elevations differed by +0.7 feet. Comparing the relatively stable elevations of 1958, 1959 and 1960 to 1967 measurements, the channel had aggraded approximately 1 foot.

Staff appreciate the point raised by Dr. Baker and will expand upon this discussion in the Public Review Draft Staff Report.

Table 3. Instantaneous annual peak stages and discharges as measured by USGS on Upper Mainstem Elk River (reproduced from Patenaude (2004) Table 3).

Date	Peak Stage (ft)	Peak Discharge (cfs)
2/12/58	22.80	2790
2/14/59	27.62	3220
2/8/60	22.12	2090
2/11/61	22.58	2160
1/19/62	22.34	2120
4/12/63	23.02	2220
1/20/64	27.13	2950
12/22/64	28.09	3430
1/4/66	27.43	3270
12/5/66	26.71	3110

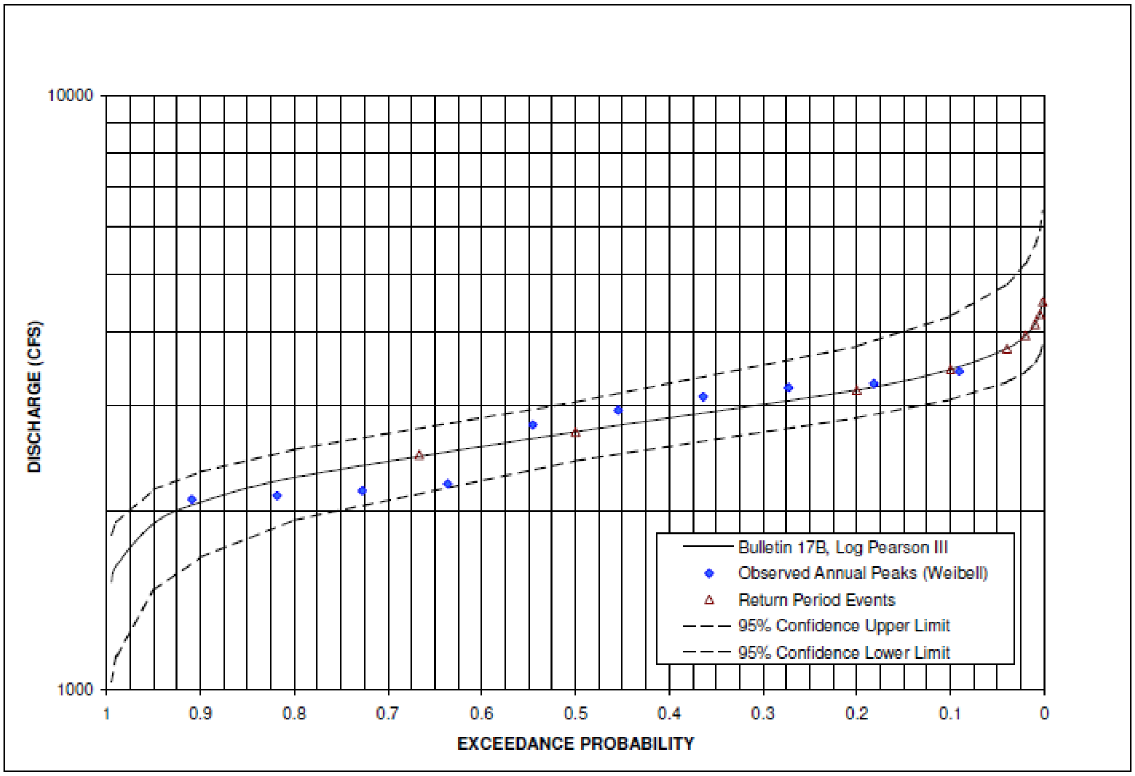

Figure 2. Estimated probable discharge events for Upper Mainstem Elk River from PEAKFQ Log-Pearson III Frequency Distribution (reproduced from Patenaude (2004) Figure 5).

Table 4. Summary of estimated probable discharge events for Upper Mainstem Elk River (reproduced from Patenaude (2004) Table 4).

Annual Exceedence Probability	Recurrence Interval (years)	Estimated Discharge (cfs)
0.667	1.5	2483
0.500	2	2713
0.200	5	3191
0.100	10	3456
0.040	25	3748
0.020	50	3942
0.010	100	4119
0.005	200	4284
0.002	500	4486

Baker Comment 1.9: "The fact that the very detailed survey data on channel cross-sectional area change covers the time period from 1998-2011 means that the critical time period of excessive sediment deposition (1993-98, as noted above) was not included in the surveys. This omission is important in regard to a complete understanding of the role of extreme events in the sediment loading issues for the Elk River watershed. Subsequent findings and assertions will emphasize or assume average conditions, and it is my concern, on the scientific basis that I have been charged to review, that there may be inadequate understanding of the role of extreme events, and that the time period 1993-1998 could well contain important evidence in regard to extreme events that impacted the watershed."

Staff Response: Staff concurs that the collection and analysis of cross-sectional data prior to and during the 1993-1998 period would have provided additional information on the role of extreme events in the sediment loading processes at work in the Elk River. Unfortunately, staff is unaware of any cross-sectional information that was developed during that time.

However, anecdotal observations provide insight into changes during that critical time period. The observations were corroborated by Regional Water Board staff via interviews conducted in 1998 (Dudik, 1998). The Public Review Draft Staff Report will provide a more explicit acknowledgement of the lack of quantitative channel measurements during the 1993-1998 time period.

Baker Comment 1.10: "By restricting the presentation of the extensive measurements *of* [sic] channel changes to cross-sectional area data, the report fails to document quantitatively the relative importance of other hydraulic geometry factors, specifically the relative importance of channel narrowing versus channel bed aggradation. It would be scientifically more relevant to present the actual cross sections in order to evaluate the evolutionary sequence of complete hydraulic geometry change, not just the cross-sectional area change."

Staff Response: The Public Review Draft Staff Report will include an appendix containing the available cross-sectional surveys. In some cases, the data submittal format used by Pacific Lumber Company and Humboldt Redwood Company limits the ability of Regional Water Board staff to more fully analyze cross-section information for the full period of record. Specifically, data was previously submitted in a summary form as pdf files, and did not include the actual surveys and benchmark information needed to conduct such an analysis.

Recent Regional Water Board monitoring and reporting programs have addressed this limitation in part by requiring submittal of a more robust data set. The monitoring program developed to evaluate compliance with and effectiveness of the TMDL implementation program will contain specific data submittal requirements to facilitate the necessary analyses. Data submittal requirements for cross section analysis would include such things as spreadsheet copies of surveys, survey notes, and benchmark location and true elevations based upon surveyed controls. In order to be useful within a scientific and regulatory context, summary analyses must be supported by submittal of the full data set to allow independent evaluation of the data.

Baker Comment 1.11: "The report makes qualitative statements about (1) bank colonization by invasive species (which might well promote channel narrowing) and (2) both bed and overbank sedimentation (the former promoting lower channel depth at bankfull stage). These issues cannot be separated and related to the general question of causes for increased overbank flooding solely in terms of cross-sectional area change. Again, it would be scientifically more relevant to present the actual cross sections in order to evaluate the evolutionary sequence of complete hydraulic geometry change, not just the cross-sectional area change."

> *Staff Response*: Staff agrees that issues of streambank vegetation and sediment deposition are interrelated. The Peer Review Draft Staff Report (page 3-11) briefly describes the interaction between sediment deposition and instream vegetation and their combined effect on channel roughness.
>
> See Staff Response to Baker Comment 1.10 regarding site specific cross section data.

Ruggerone Comment 1.1: "Chapter 3 of the Staff Report provides a variety of information showing that sediment loading has caused habitat changes in the river, impacts to beneficial uses, and increased nuisance flooding. Much of the information is anecdotal, but together these observations consistently show substantial impacts in the watershed caused by sediment loading. For example, residents report that stream pools used for domestic water extraction have been filled with sediment, and that turbidity levels now take substantially longer to decline following a storm. Overbank flooding reportedly occurs more frequently now in response to the documented reduction in the channel capacity and cross-sectional area of the river. Photographs show significant sediment deposition in some areas (e.g., burial of apple tree trunk) and encroachment of vegetation into the stream channel. Minimum volumes of deposited sediments were estimated for storage reaches.

"The report documents the presence of salmonids, including coho, Chinook, steelhead, and cutthroat trout in the Elk River. No systematic monitoring of fishes has been conducted in the watershed, but Appendix 3B does contain information from periodic sampling of adult and juvenile salmon to show that salmonids are present.

"Salmonid habitat quality was examined in the Staff Report in relation to sedimentation and water quality, and these data show degraded salmon habitat. Percent fines <0.85 mm is an indicator of salmon egg-to-fry survival. Survival declines rapidly, on average, when percent fines (<0.85 mm) increases above 10% (see review by Jensen et al. 2009). Most of the sampled stations had fine sediment much higher than 10%. There was no consistent increasing or decreasing trend over time among all stations from the late 1990s to 2009, indicating no improvement in spawning habitat quality over time following the period of high sedimentation in the 1980s. The report should clarify whether the samples were taken in areas of potential spawning habitat."

> _Staff Reponses_: Staff agrees with this comment. An appendix presenting the monitoring methods, including the relationship between sample location and areas of potential spawning habitat, will be included as part of the Public Review Draft Staff Report. A more thorough description of the data collection methods used to develop the Problem Statement will contribute to a greater understanding of the quality and quantity of the monitoring data available to staff.

Ruggerone Comment 1.2: "Additional sediment size indicators were presented indicating poor habitat quality for spawning salmonids, and for insect production (salmonid prey). Moderately deep pools provide key rearing habitat for salmonids. For example, Sharma and Hilborn (2001) reported that coho density increased with the density of pools and decreased with greater density of roads. Anecdotal information provided in the report indicated depth of pools declined after more intense logging and flooding events in the 1980s and 1990s. Monitoring of pools since 2000 indicates a gradual deepening of pools, although most are still less than 3 ft deep. In addition to providing rearing for juvenile salmonids, pools also provide holding areas for adult salmonids as they return to spawn.

"The Severity of Ill Effects analysis (SEV) provides evidence that high levels of turbidity in the river often cause sublethal or more detrimental effects. A key component of this analysis is that SEV and turbidity values were provided for the reference stream, Little South Fork Elk, where logging-related impacts have been much less over time. This comparison provides important evidence that the sediment and turbidity impacts in the Upper Elk River are related to logging activities.

"Unfortunately, spawning habitat quality and pool quality data were apparently not collected and reported for the reference stream, Little South Fork Elk. A comparison between the impacted watershed (e.g., North Fork Elk River) and a reference stream having relatively little logging-related (Little South Fork Elk) is a powerful tool for quantifying logging-related effects in addition to describing the anticipated adverse effects such as severe sedimentation."

> _Staff Response:_ Staff agrees that the collection and reporting of instream data for the reference stream, Little South Fork Elk, would be a powerful tool for quantifying land use effects over time. BLM and the California Department of Fish and Wildlife do not currently conduct salmonid habitat surveys within the Upper Little South Fork Elk River due to the presence of a natural migration barrier at the lower end of the Little South Fork Elk River subbasin. As such, sediment quality data for the reference stream were not available to staff when developing the Upper Elk River Sediment TMDL. However,

because conditions in the Upper Little South Fork Elk River provide important points of comparison to the managed subbasins, sediment quality and pool depth monitoring in the Upper Elk River will be recommended as a component of the monitoring program developed to evaluate compliance and effectiveness of the TMDL implementation program.

Miller Comment 1.1: "A list of eighteen beneficial uses of the Elk River was identified in the Staff Report. Three of these beneficial uses included water supply, aquatic habitat, and recreation. Water supply impairment was further sub-divided into municipal, domestic, and agricultural uses of the Elk River. It was clearly identified in the Staff Report that these beneficial uses of the Elk River have been impaired due to increased sediment loading. Clear evidence of water quality impairment presented in the Staff Report supports the need for remedial action in order to restore beneficial uses of the Elk River."

Staff Response: Comment noted.

Miller Comment 1.2: "Impairment – and eventual loss – of domestic and agricultural water supplies is the most notable result of increased sediment loads in the Elk River. Suspended sediment was thoroughly monitored in both time and space throughout the Elk River. The predominant sediment size fraction – determined using standard, well-accepted methods – was classified as sand and silts and, both defined as being fine-grained. Residents and agricultural producers – for whom the Elk River is the primary water source – experienced water system pumping failure and clogging during periods of increased rainfall frequency and intensity. This resulted in the need to provide alternate water supplies until such time as this beneficial use can be restored. Residents identified offensive taste and odor problems in water supplies resulting from increased sediment loading. These nuisance problems are secondary when compared to potentially more significant health related issues including increase loading of pathogenic organisms – e.g., *Giardia*, *Cryptosporidium*."

Staff Response: The water quality of the Elk River is listed as impaired due to sedimentation, only. As such, the TMDL analyses focus on the effect, fate and transport of sediment. Nonetheless, staff recognize that there is a potential relationship between excessive sedimentation and the altered biota that fine sediment supports, including its potential to store pathogenic cysts. A brief discussion of the relationship between sediment and pathogens will be added to the Public Review Draft Staff Report. In addition, it will reiterate that the focus of the TMDL is on the direct effect of sediment on the beneficial uses of water, rather than on indirect (but related) impacts. Further, the Regional Water Board's surface water ambient monitoring program (SWAMP) will continue to monitor for pathogens, as necessary.

Miller Comment 1.3: "Fine sediment has also significantly reduced the aquatic habitat of the Elk River. The Elk River serves as an important freshwater habitat for several species of salmon and trout. These fish require mainly gravel areas for effective spawning, which have been covered by fine sediment. The size of spawning pools has been significantly reduced due to sediment settling, further reducing aquatic habitat. Suspended sediment absorbs light energy and serves to increase water temperatures. This further affects migration and spawning of sensitive fish species.

"Beneficial recreational uses of the Elk River include both contact – swimming, wading, and fishing – and non-contact – picnicking, hiking, camping, and boating – activities. As the size of spawning pools has been reduced by increased sediment load, so too has the size of similar swimming pools been reduced in the Elk River. Stagnant water flows due to stream channel size reduction promotes anaerobic degradation that can potentially result in offensive odors, further impairing beneficial recreational uses."

> *Staff Response*: Comment noted.

Miller Comment 1.4: "Increased sediment loads were shown in the Staff Report to be the driving cause of impairment to the Elk River. The potential effects of other parameters were not included or discussed to a large extent within the Staff Report."

> *Staff Response*: See Staff Response to Miller Comment 1.2.

Miller Comment 1.5: "The primary source of sediment is non-point runoff, which could carry with it additional water quality stressors. For example, land use within the Upper Elk River sub-basin includes agriculture in which fertilizers and pesticides are commonly used. Excessive nutrients – primarily phosphorus – could equally be impairing water quality in the Elk River, which could be a significant source to Humboldt Bay. Similarly, their persistent and hydrophobic nature causes pesticide sorption to mineral and organic sediment surfaces, resulting in unaccounted loadings of contaminants with potentially deleterious health effects beyond those of suspended sediment."

> *Staff Response*: See Staff Response to Miller Comment 1.2 regarding the focus of the TMDL analysis. Staff appreciate the reviewer pointing out the potential interaction between fine sediment and other pollutants, including nutrients, pathogens, and pesticides. A brief discussion of this relationship will be included in the Public Review Draft Staff Report.

Miller Comment 1.6: "The increased frequency of nuisance flooding presents the potential for unintentional discharges of fuel, household cleaners and solvents, and untreated municipal wastewater. The residential and agricultural land use within the Elk River watershed points to the potential for individually small – though collectively significant – sources of gasoline, diesel, and pesticide use and storage. The Staff Report does not mention any municipal wastewater treatment facilities located within the Elk River floodplain or address whether there exists adequate protection. These issues are an indirect consequence of nuisance flooding of the Elk River."

> *Staff Response:* Staff agrees that nuisance flooding does have the potential to cause indirect impacts associated with discharges of materials found around residential and agricultural lands. One of the primary goals of the TMDL is to abate and prevent nuisance conditions through a coordinated hillslope and instream restoration strategy. While there are no municipal wastewater treatment facilities within the Elk River floodplain, many of the residential properties rely on individual onsite wastewater treatment systems. Damage to individual water systems is one of many factors that has caused the Regional Water Board to define the flooding as a nuisance condition under the Porter-Cologne Water Quality Control Act (Porter Cologne). Flood damage to roads, homes, outbuildings, and fields also meet the definition of nuisance under Porter Cologne.

Miller Comment 1.7: "A solid record of suspended solids monitoring performed by stakeholders since 1998 was demonstrated in the Staff Report. Stakeholders included affected citizens, volunteer groups, involved industries, and water quality managers. Relevant water quality parameters – turbidity, suspended sediment, and stream flow – were rigorously monitored over time and space within the Elk River watershed. The combination of quantitative – e.g., Figure 3.9 showing stream channel cross-sectional change – and qualitative – e.g., Figure 3.5 showing an apple tree buried in over 2 feet of sediment – measures demonstrate that increased suspended sediment in the Elk River has caused *nuisance or adversely affected beneficial uses*. This evidence further supports the Porter Cologne definition of nuisance."

> *Staff Response*: Comment noted.

Miller Comment 1.8: "Turbidity measurements were used to compare two sub-basins with managed timber harvesting practices in place – contributing to increased sediment loading – to another sub-basin without managed timber harvesting practices in place – i.e., Figure 3.31. A linear regression was used to fit data for the three sub-basins and determine relative impact of managed timber harvesting practices on turbidity in the Elk River. Despite the uncertainties associated with the reasonable assumption to use linear regression, the resulting impacts are significant for the two managed sub-basins. Assuming a 65 percent error in the linear fit, turbidity projections are increased significantly *more than 20 percent above naturally occurring background levels*."

> *Staff Response*: Study subbasins were described in Appendix 4-A of the Peer Review Draft Staff Report to allow for comparison between subbasins with differing management history. As pointed out by the reviewer, the Peer Review Draft Staff Report did not describe the level of uncertainty associated

with fitting the turbidity data from the compared subbasins with linear regressions. At this time, staff find that a more appropriate comparison of turbidity in three study subbasins is based upon the cumulative distribution function (similar to that described by Klein, et a. 2011), in which the whole data population is represented rather than a sample. This eliminates the issues of uncertainty associated with fitting a regression model to the data. The Public Review Draft Staff Report will be revised according to the analysis described below.

Turbidity from the three study subbasins were compared for the same time period of Dec 1, 2003 – May 31, 2004. Turbidity was measured at 10 minute intervals using DTS-12 probes located on booms, placing the sensor at a depth of approximately 60% of stage (Manka, 2004). For each of the stations, the turbidity values were ranked in descending order and the exceedence probability was calculated for each turbidity value as:

$$\text{Exceedence Probability} = m / (n+1)$$

where, m = rank and n = total number of observations.

The relative turbidity values for the two managed subbasins (Corrigan Creek and South Branch North Fork Elk River) were compared with that of the reference subbasin (Upper Little South Fork Elk River) for the range of observed turbidity values as shown in Figure 3 and for select percent exceedence turbidity values as shown in Table 5. Over the range of values evaluated, there was greater than a 20% difference between the observations in both of the managed study subbasins and those of the reference subbasin. Based upon this analysis, staff finds that the water quality objective for turbidity (e.g., no more than 20% above background) is exceeded in portions of Upper Elk River.

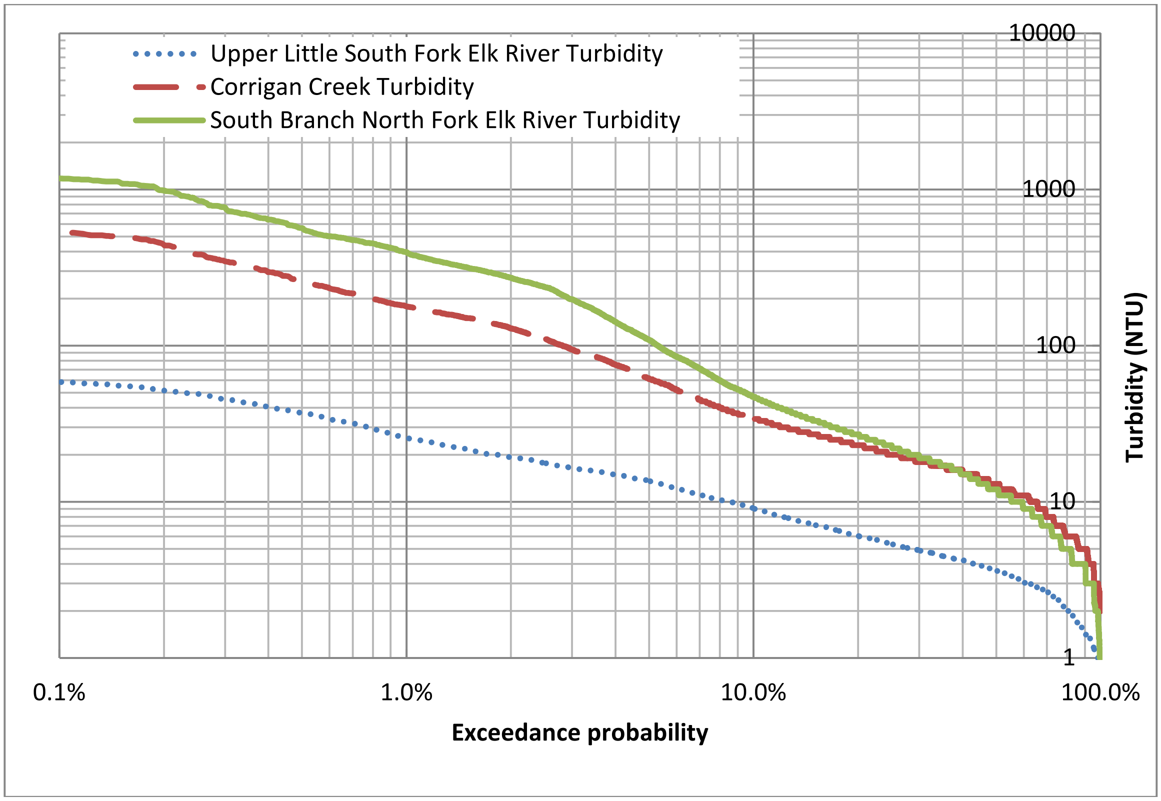

Figure 3. Turbidity duration curves for December 2003-May 2004 for three study subbasins in Upper Elk River.

Table 5. Select exceedence probability turbidity values for study subbasins in Upper Elk River.

Exceedence Probability	Upper Little South Fork Elk River	Corrigan Creek	South Branch North Fork Elk River	% Difference (Little South Fork, Corrigan Creek)	% Difference (Little South Fork, South Branch North Fork)
0%	73	724	1553	895%	2033%
1%	26	178	397	591%	1439%
10%	9	34	47	274%	417%
25%	5	20	23	273%	329%
50%	4	13	12	259%	231%
75%	2	7	6	195%	153%
90%	1	5	4	242%	174%

Miller Comment 1.9: "Work over the last 15 years has resulted in the Staff Report herein peer-reviewed for its scientific basis. Care has been taken in preparation of the Staff Report to exhaustively evaluate the quantitative and qualitative measures of increased sediment loading in the Elk River. The methods used and their execution in developing the Staff Report is scientifically sound."

Staff Response: Comment noted.

Miller Comment 1.10: "Additional scientific issues not currently included have been identified and suggested for considered inclusion in the Staff Report."

Staff Response: See Staff Responses to Miller Comments 1.1 through 1.9.

Stark: No Comments on Conclusion 1.

Topic II. Desired Numeric and Narrative Target Conditions

Conclusion 2. The instream desired target conditions represent desired conditions supportive of beneficial uses, including fisheries uses and domestic and agricultural water supplies.

Baker Comment 2.1: "The supporting science for these findings is in Chapter 6: Numeric Targets of the *Draft Staff Report for the Upper Elk River Sediment TMDL* (not in "Chapter 4" as stated in Appendix 2 for the letter of 7/17/13)."

Staff Response: See Staff Response to Baker Comment 1.1.

Ruggerone Comment 2.1: "Chapter 5 describes the desired sediment loading capacity for the watershed and Chapter 4 describes the estimates of sediment loading from natural versus management-related events (largely logging-related activities), and Chapter 6 describes numeric targets. Natural loading from all sediment sources loading is estimated to be 68 yd3/mi2/yr, whereas the long-term management-related loading was estimated to be 976 yd3/mi2/yr. The desired sediment loading level is 120% of the natural loading, or 82 yd3/mi2/yr. Thus, a 97-98% reduction in contemporary management-related sediment is necessary to meet the TMDL. The desired date for achieving the reduction is 2033.

"Nine instream habitat indicators and desired target conditions for sediment were shown in Table 6.2. The indicators provide indices of stream conditions relevant to the sediment issue that support salmonids. A number of the indicators simply identify an improving trend in the condition. While an improving trend in number of pools, for example, should be beneficial for salmonids, it may take a number of years before an improving trend can be determined."

Staff Response: Monitoring of instream habitat indicators will be conducted to track progress toward attainment of water quality objectives and beneficial use protection and restoration. The TMDL recognizes that recovery of some habitat conditions, such as an increasing number of pools, is likely to take a number of years. The TMDL establishes a 20-year timeframe for attainment of a number of these indicators. If during this period progress is not being made toward attainment of the instream targets, additional implementation measures will be identified, including but not limited to pool enhancement by placement of large wood, for example.

Ruggerone Comment 2.2: "The target metric for % fines <0.85 may be somewhat high (<14% fines), based on the recent review by Jensen et al. (2009), although there is considerable variability in the fines relationship with salmonid egg to fry survival. For example, Jensen et al. reported that salmon egg-to-fry survival increased from ~38% at 14% fines (<0.85 mm) to ~56% at 10% fines. Improvements in percentage fines should be a key metric for evaluating changes in habitat quality for salmonids in the Elk River. The reported protocols identify sampling of both active salmonid redds and nonactive spawning areas. Percentage fines is expected to be less in active salmonid redds versus non-active spawning areas because fines are displaced when salmonids prepare redds."

Staff Response: Staff agrees that the numeric target for percent fines <0.85 mm could more appropriately be set at <10% based on the data presented in the Jensen et al. review cited above. The target value of <14% for percent fines <0.85 mm included in the Desired Conditions Report was developed according to the following rationale*:*

"This desired condition value was chosen as it is roughly the midpoint between the 8% of Platts et al. (1979), the 9.6% to 12.3% of McNeil and Ahnell (1964), the 11% recommended target of Peterson et al. (1992), the < 12% properly functioning condition value of NMFS (1996), the < 14% of Tappel and Bjornn (1983), the 17.1% of Magee et al. (1996), and the 17.3 to 23.2% range of Burns (1970). This value takes into account that the recommended value of 11% fines < 0.85 mm from Washington (Peterson et al. 1992; NMFS 1996) is lower than would be expected in California. The same justification applies to the < 12% fines < 0.85 mm properly functioning condition of NMFS (1996), which was based on studies from Washington State. On the other hand, the roughly 17% fines < 0.85 mm seen in unmanaged Godwood Creek of Northern California beginning in 1967 (Burns 1970) is probably too high given the tremendous sediment loads discharged to streams as a result of the 1964 storms. In addition, Tappel and Bjorn (1983) predicted that 15% fines < 0.85 mm, in combination with about 27% fines < 9.5 mm, would provide an average of 50% survival-to-emergence for steelhead and an average of 80% survival-to-emergence for Chinook salmon. The choice of 50% emergence can be justified because redds with at least 50% emergence success would probably be considered productive by most biologists (Kondolf 2000).

The work by Cederholm et al. (1980) was not used in choosing the desired condition value because the samples were taken during the spawning season when stream flows were high. High stream flows, and correspondingly high *velocities, result in a higher amount of fine sediment suspended in the water column. Regional Water Board staff expect that this condition results in a smaller amount of very fine sediment particles present in the substrate during high flows then would otherwise be present during low flow conditions*."

Staff review of Jensen et al (2009) indicates the <10% has an emergence success rate in Chinook of approximately 67% and a coho emergence success rate of approximately 37%. To ensure the target value supports at least 50% emergence success, as identified in the Desired Conditions Report, in coho and Chinook species present in Elk River, staff agree that the numeric target for percent fines <0.85 is most appropriately set at <10%. The Public Review Draft Staff Report will reflect a target of <10% for percent fines ≤0.85 mm in size.

Ruggerone Comment 2.3: "The presence of large woody debris (LWD) is highly important for creating more complex habitats, such as pools, that are utilized by salmon. Key habitats include pools and pool tailouts where spawning may occur. The LWD metric is important to monitor. Increasing LWD may be a slow process without specific actions, therefore the program might consider using a few local trees to cost-effectively create LWD that can be fixed in specific locations as a means to scour sediment and create pool habitat (Roni et al. 2002, 2008). A number of indicators are suggested for pool habitats, which are known to support higher densities of salmonids such as juvenile coho salmon (Sharma and Hilborn 2001). Pools will also provide holding areas for adults as they migrate upstream to spawn."

Staff Response: The Peer Review Draft Staff Report addresses the importance of large woody debris (LWD) to the development of habitat complexity in the stream system. First, it identifies the importance of developing appropriate management goals and prescriptions applicable in riparian areas for all classes of watercourses across the landscape. Second, it establishes specific riparian area protection measures meant to guide the design of individual management activities so as to promote robust ecological functioning. Specifically, this includes the implementation of management activities which result in the quality and quantity of timber stands capable of delivering large wood to streams. The Peer Review Draft Staff Report defines "functional" riparian area widths for different classes of watercourse in terms of site potential tree height.

The application of hillslope prescriptions are also recommended in the Peer Review Draft Staff Report to ensure that large diameter trees located on unstable slopes with access to the stream system remain in place to ensure the delivery of LWD to the stream in the event of slope failure.

In addition, staff intends that the Elk River Recovery Assessment, as described in the Peer Review Staff Report, identify feasible restoration actions to recover ecosystem function, abate nuisance flooding, and improve salmonid habitat. As part of that effort, there will be an evaluation and pilot implementation of the placement of wood structures designed trap sediment and improve habitat.

Ruggerone Comment 2.4: "Many of the instream indicators are based on trend analysis over time. Ideally, baseline conditions should already be established for these metrics. It would be worthwhile to measure these indicators in multiple streams that have been impacted plus in a reference stream such as Little South Fork Elk River where logging-related impacts have been less. The reference stream might provide a benchmark for documenting improvements."

Staff Response: Staff agrees that the monitoring program developed to evaluate compliance and effectiveness of the Upper Elk River TMDL implementation program should include collection of instream habitat parameters in Little South Fork Elk River. The development of this data set will facilitate the evaluation of compliance and effectiveness of the Upper Elk River TMDL implementation program and will be described in the Public Review Draft Staff Report.

In 2003, a number of landowners began to develop and implement a relatively extensive instream monitoring program in the Upper Elk River watershed in response to Regional Water Board and other agencies' regulatory requirements. The data set collected under these monitoring programs provides one of the most complete sets of "baseline" information available for a coastal stream in Northern California. Unfortunately, as is the case with most streams in California, no comprehensive set of instream data for the Upper Elk River is available for the time period prior to the commencement of land management practices that resulted in the impairment of beneficial uses of water (see Staff Response to Baker Comment 1.6).

Ruggerone Comment 2.5: "Indicators in addition to those in Table 6.2 would be useful to document habitat changes associated with sedimentation. For example, the Program should consider the Benthic Index of Biological Integrity (B-IBI). This index has been used in a variety of watersheds as a measure of water quality and salmon habitat quality. The approach has been adopted for streams in Northern California (Rehn et al. 2005)."

Staff Response: The Regional Water Board is very supportive of the development and use of biological indicators for assessing stream health. The diversity and vigor of biological communities reflect watershed conditions and can be good indicators of the overall quality of the water and habitat it supports. The Regional Water Board has been and continues to be involved in the development and use of benthic macroinvertebrates (BMI) for stream assessment, including the development of the North Coast Index of Biotic Integrity (NCIBI) (Rehn et al. 2005) as a biological indicator. The NCIBI is very useful when assessing stream conditions for urban or agricultural impacts. The NCIBI can also be used to test for potential toxic impacts or to monitor point-source discharges.

To examine the relationship between NCIBI scores and impacts specifically associated with timber harvesting, an addendum to the NCIBI included timber harvesting as an explicit stressor (Rehn et al. 2008). Whereas NCIBI scores were shown to decrease with urban and agriculture activities (Rehn et al. 2005), NCIBI scores did not decrease as timber harvest in a watershed increased. The reasons for the diverging relationships are not clear, especially since individual NCIBI metrics responded strongly and negatively to increasing percent sand and fine substrate measures in NCIBI study reaches (Rehn et al. 2005). But generally, the NCIBI does not appear to be a very responsive determinant of impacts from timber harvest in North Coast streams.

Ruggerone Comment 2.6: "An increasing trend in the quality of the riparian area is identified as a desired target. Riparian buffer widths were discussed in the Staff Report but there was no mention of a riparian buffer requirement in managed areas. As discussed in the report, a riparian buffer of ~40 m or more would be beneficial (Beechie et al. 2003) and should be considered as a means to reduce sediment loading."

Staff Response: The Peer Review Draft Staff Report identified riparian areas based upon widths equivalent to two site potential tree heights on Class I and II watercourses and one site potential tree height on Class III watercourses. The Peer Review Draft Staff Report did not specify management activities or limitations within those riparian areas. However, the report did identify a numeric hillslope target and associated implementation measures designed to ensure that management within the riparian zone is conducted in a manner which supports the improvement and maintenance of the ecological services provided by a functioning riparian zone, including: 1) delivery of wood to the channel for sediment metering, stabilization, and to provide habitat elements; 2) slope stability to minimize sediment delivery associated with landslide features; and, 3) ground cover to ensure sediment control.

Ruggerone Comment 2.7: "In order to achieve the desired turbidity reduction in streams, the Program calls for a maximum average harvest rate of 1.5% in Class I subbasins. This metric is based on a statistical relationship involving many watersheds, but Fig. 6.4 shows that turbidity levels in the Elk River watershed are higher at a specific harvest rate than other watersheds. Therefore, implementation of the 1.5% harvest rate in the Elk River watershed will have a less desirable effect on turbidity than implied by the model that uses data from all watersheds. In other words, a lower harvest rate may be needed to achieve the desired turbidity level in the Elk River watershed."

Staff Response: Staff acknowledges that, as depicted in Figure 6.4 of the Peer Review Draft Staff Report, the regression model underestimates the turbidity effects as compared to the observed levels at Elk River stations. However, staff proposes as a measure of cumulative watershed effect, the annual average harvest rate (based upon clear-cut equivalent area) within Class I subbasins not exceed 0.4% annually at the beginning of TMDL implementation, and reach an annual maximum of 1.5% over time as instream and upslope sediment load allocations are achieved. During that progression, monitoring will help to identify if modification of the targets are warranted, including modification of the proposed harvest rate interim and final targets. See also Staff Response to Ruggerone Comment Big Picture a) and b).

Ruggerone Comment 2.8: “Apparently the harvest rate cap (1.5%) only applies to Class I subbasins, and not to smaller Class II and III subbasins that are located upstream of Class I subbasins. Harvest rates should be defined for the smaller subbasins since sediment will eventually flow down to the larger Class I subbasins.”

Staff Response: The Peer Review Draft Staff Report (page 6-5) identifies a hillslope target for Class II and III watercourses associated with harvest-related peak flow increases. The target is based upon preventing increases in peak flow that result in an increase of suspended sediment loads. The Peer Review Draft Staff Report documents the correlation between suspended loads and the increase in turbidity values. The discussion associated with the hillslope target indicates that to control suspended sediment loads to no more than120% of background (in conformance with the load allocations), peak flow increases cannot increase more than 10% in 10 years. Staff’s analysis shows that this target can be achieved by limiting canopy removal to no more than 20% in 10 years (equating to an annual average harvest rate of 2%) in Class II and III watercourses.

Ruggerone Comment 2.9: “The numeric target calling for zero human-caused migration barriers for salmonids by 2018 (e.g., culverts) is an important worthwhile target. Implementation of this desired condition will be key.”

Staff Response: Comment noted.

Miller: No Comments on Conclusion 2.

Stark: No Comments on Conclusion 2.

Conclusion 3. Historical measurements by USGS from 1954-1965 on the upper mainstem Elk River provide an appropriate basis for the desired target conditions to prevent nuisance in upper mainstem, lower North Fork and lower South Fork Elk River.

Baker Comment 3.1: "Inadequate information was provided in the Staff Report itself to evaluate fully topic 3 (nuisance flooding), since the relevant data for the USGS measurements are in a document (Patenaude, 2004) that was *not* [sic] available to me."

"Nevertheless, it does seem scientifically reasonable that the reduced channel capacity that is well-documented by the channel cross section surveys described in Chapter 3 can account for the observed increase in frequency for overbank flooding. Moreover, historic conditions prior to the onset of the increased overbank flooding do serve as scientifically reasonable target conditions. Nevertheless, my inability to see the actual USGS data and consider it in the light of other information from the Staff Report limits my confidence in regard to assertion/finding number 3."

> *Staff Response*: Staff concurs that data relative to the USGS measurements should be readily accessible to the reader and regrets its omission in the Peer Review Draft Staff Report. The Public Review Draft Staff Report will include as an appendix the 2004 North Coast Regional Water Quality Control Board Staff Report, "Preliminary Evaluation of Flooding in Lower Elk River" authored by J.R. Patenaude. This report contains, in part, the data necessary to allow comparison of historic USGS measurements with measurements made post 1998.

Ruggerone Comment 3.1: "The staff report provides evidence that cross-sectional area changes did not occur in 1958, 1959, and 1965 even though there was a major highwater event in 1964. Cross sectional area was greatly reduced when remeasured in 2003 (Table 3.2), leading to a ~35% decrease in the channel capacity. Some logging occurred during and prior to the 1954-1965 period of channel measurements, therefore the target conditions based on the 1954-1965 time period may not reflect channel capacity of a pristine watershed."

> *Staff Response:* Staff acknowledges that Upper Elk River has been managed for industrial timber harvesting activities for the past 150 years. As such, the target conditions for bankfull channel capacity do not represent pristine conditions. It is not the goal of the TMDL to regain pristine conditions, but rather a functional ecosystem that can support beneficial uses of water and prevent nuisance conditions. The nuisance flooding conditions are influenced by the reduction in channel conveyance and were first identified as an impairment in the mid 1990's. As such, pristine conditions are not necessary

to ensure prevention of nuisance; rather, the target is tied to containment of the 1.5-2 year expected flow event.

Miller: No Comments on Conclusion 3.

Stark: No Comments on Conclusion 3.

Conclusion 4. The hillslope desired target conditions represent conditions in which sediment sources are likely to be controlled by addressing controllable water quality factors.

Baker Comment 4.1: "In contrast to topic 3, the Staff Report documentation in regard to topic 4, "Hillslope Target Conditions," is both extensive and detailed. Appropriate target conditions are outlined for 10 management-related sediment source categories, and sound scientific arguments are provided for each, supported by authoritative reports and peer-reviewed scientific papers. Thus, I conclude that finding/assertion 4 is based upon sound scientific knowledge, methods, and practices."

Staff Response: Comment noted.

Ruggerone: No comments on Conclusion 4.

Miller: No comments on Conclusion 4.

Stark: No comments on Conclusion 4.

Conclusion 5. The watershed desired target conditions support watershed and stream processes and functions for beneficial use protection.

Baker Comment 5.1: "The watershed target conditions (topic 5) are based on statistical studies relating turbidity levels to timber harvest rates. Given the focus on defining targets in terms of water quality-standards, this provides a scientifically reasonable approach to setting the watershed desired target conditions. Thus, I conclude that finding/assertion 5 is based upon sound scientific knowledge, methods, and practices."

Staff Response: Comment noted.

Baker Comment 5.2: "Buried in the report section that provides the numeric hillslope target for cumulative watershed effects (maximum timber harvest rate of

1.5%) derived for the sediment source category "Cumulative Watershed Effects" (pages 6-16 to 6-17) is a statement that embodies far more science (as opposed to engineering methodology and practice) than anything else in Chapter 6 of the Staff Report. This statement is a conclusion of the 2002 Independent Scientific Review Panel (ISRP) regarding effectiveness monitoring and periodic assessment. The ISRP concluded that, "…no analysis could predict with certainty what combination of measures and logging rate restrictions would ensure the protection of water quality and recovery of impaired watersheds. The best that could be done is to **postulate a plan based on the best available information, continually test that plan using a combination of compliance, effectiveness, and trend monitoring; and revise the plan in a timely and appropriate manner based on monitoring results** (bold emphasis added)."

"The program outlined in bold from the previous paragraph is a well-stated scientific **methodology**, which is exactly what this reviewer has been charged to assess. From a scientific perspective, the implementation of the program indicated by this statement will be far more important for the [sic] achieving protection of water quality and recovery of the impaired watershed than is the justification of some arbitrary numeric target to meet a current regulatory standard.

"I emphasize that the scientific program indicated in *bold* above was "buried" in this chapter because the explanatory statement for topics 3-5 in Appendix 2, i.e., the charge to the reviewers, specifically states, "The numeric indicators and desired target conditions will be compared to monitoring data so as to evaluate watershed health recovery over time." Nowhere in the chapter under review do I find this statement, which would, in part, support a scientific methodology (to be fully scientific one would also have to add "revise the plan" etc., as was done in the ISRP report statement highlighted above in bold). In Table 6-2, which deals with Instream Habitat Indicator and Target Conditions for Sediment there is a column headed "Monitoring/Sampling Notes." This explains how monitoring is to be done, but otherwise there is nothing about revising the TMDL in the light of what is learned from the monitoring.

"So my general conclusion has to be that the proposed desired numeric and narrative target conditions can indeed be justified on the basis of current scientific knowledge and engineering practice as a best first approximation to what might be scientifically hypothesized, which is the start of a scientific methodology, but does not of itself constitute a scientific methodology. The entire program of identifying numeric indicators is not a scientific methodology unless it incorporates the general philosophy outlined in *bold* above (from the 2002 ISRP report), i.e., that it is a part of a program that incorporates continual evaluation of those numeric indicators in the light of what is continually being learned from appropriate monitoring of exactly the outcomes important to achieving the desired environmental conditions in the Elk Creek watersheds."

Staff Response: Staff will include the Independent Scientific Review Panel (ISRP) reports as appendices to the Public Review Draft Staff Report and will cite key elements of the ISRP report in the body of the staff report to make them readily accessible to the reader.

The Public Review Draft Staff Report will also include a more robust description of the proposed implementation and monitoring programs needed to restore beneficial uses of water and abate nuisance conditions in the Upper Elk River, including an adaptive management framework as recommended by the reviewer.

Though not described in the Peer Review Draft Staff Report, the current plan for implementation of the Upper Elk River TMDL, is to establish a single Waste Discharge Requirement for the whole Upper Elk River watershed (Watershed WDR) which establishes the permit conditions necessary to control, prevent, and remediate sediment discharges from timber operations and associated activities (including restoration) in a manner consistent with the TMDL. The Watershed WDR will update and consolidate existing WDRs, Cleanup and Abatement Orders, and Monitoring and Reporting Requirements. The Watershed WDR is intended to facilitate implementation and monitoring of actions necessary to comply with the TMDL load allocations and targets, water quality standards and other Basin Plan requirements. The Watershed WDR is proposed to apply to all timberland owners in the Upper Elk River watershed.

The Peer Review Staff Report (Source Analysis and Numeric Targets) identifies implementation measures Regional Water Board staff believe to be a reasonable suite of foreseeable compliance measures necessary to control the discharge of sediment from land management activities. The load allocations, reductions, schedule, targets, and implementation measures, as identified in the Peer Review Draft Staff Report, are summarized for the reader's ease in Table 6 below. Additionally, staff has identified project level monitoring to track progress toward attainment of the targets.

Similar to the adaptive process described by the ISRP (2002 & 2003), Freedman, et al (2008) describe an approach to adaptive TMDL implementation to ensure that there is a continual reassessment of the TMDL, its endpoints, its allocations, its implementation strategy and, sometimes, the underlying water quality standards. Freedman, et al (2008) describe that in the adaptive mode, an initial TMDL is developed with identification of priority controls which are initially implemented with the dual intent of reducing pollutant loads and providing learning opportunities. Monitoring is conducted and the new information is used to make refinements to the analytical tools and assessments, and the TMDL control plan is reassessed leading to a new set of priority controls identified and implemented. This adaptive implementation process continues to improve water quality but is constructed using the principal of "learning while doing" until standards are achieved.

Staff has identified four primary types of monitoring to inform progress toward attainment of the TMDL, load allocations, water quality standards, beneficial use protection and prevention of nuisance conditions. The types of monitoring identified for Upper Elk River include implementation, project, trend, and effectiveness and are described below. The results of the project, trend and effectiveness monitoring may inform whether modifications are warranted in either the Watershed WDR developed to implement the Upper Elk River TMDL or if some component of the TMDL itself should be modified.

1. Implementation Monitoring – intended to assess if the individual sediment control practices and overall sediment control strategy are implemented as designed and intended. This has been referred to in some cases as compliance monitoring.

2. Project monitoring – tracks progress toward attainment of the Numeric Hillslope Targets. Primarily consists of monitoring conditions before and after management measures are implemented, as associated with individual projects. Results will be pooled over time to evaluate trends toward attainment of numeric hillslope targets.

3. Trend monitoring - implemented across the landscape and documents how conditions are changing as a result of the implementation program. A monitoring network should be established with a sufficient number of stations to be able to discern changes in the measured conditions. The trend monitoring network, given sufficient intensity of stations, will serve to measure the effectiveness of the overall TMDL implementation strategy at reducing sediment loads.

4. Effectiveness monitoring - designed to assess whether the sediment control implementation measures have the desired effect in preventing, interdicting, or minimizing sediment waste discharges. Within the Upper Elk River TMDL monitoring structure, effectiveness monitoring should be conducted when landowners select to do focused studies to test individual targets or implementation practices. If landowners believe there is sufficient uncertainty associated with an assumption, finding or conclusion that forms the basis for loading capacity, allocations, or targets, then they are encouraged to develop and implement effectiveness monitoring to test the validity of the assumption, finding or conclusion. Well-designed effectiveness monitoring will help determine if modifications of the implementation strategy are warranted. Depending on the results, modifications to individual sediment control practices may be appropriate and/or revision of the sediment loading estimates may be warranted.

Table 6. Summary of Upper Elk River TMDL management-related sediment categories, allocations, reductions, schedule, numeric targets, implementation measures and project-related monitoring concepts.

<table>
<tr><th>Management-Related Sediment Source Category</th><th>2011 Load ($yd^3/mi^2/yr$)</th><th>Load Allocation ($yd^3/mi^2/yr$)</th><th>Percent Reduction</th><th>Schedule to Attain Load Allocation</th><th>Numeric Targets</th><th>Implementation Measures</th><th>Project Monitoring</th></tr>
<tr><td>Headward Incision in Low Order Channels</td><td>14</td><td rowspan="4">9.4</td><td rowspan="4">97%</td><td rowspan="4">20 years</td><td>Zero increase in existing drainage network.</td><td>No tractor crossings in unchanneled swales.
Limit peak flow changes to avoid collapse of soil pipes.
Retain/replant trees along center line of swale and areas of subsurface flow paths.</td><td>Track changes in channel head location before and after management influences.</td></tr>
<tr><td>Bank Erosion</td><td>57</td><td>Decreasing trend in length of unstable channel.</td><td>Stabilization measures</td><td>Track length of streambank that is unstable within monitoring reaches.</td></tr>
<tr><td rowspan="2">Streamside Landslides</td><td rowspan="2">217</td><td>Limit harvest-related peak flow increases in Class II and III watercourse catchment areas to 10% in 10 years.</td><td>Limit canopy removal to 20 percent in ten years within individual catchments.</td><td>Define Class II and III drainage catchments, associated drainage area, and track annual canopy removal.</td></tr>
<tr><td>All road segments are hydrologically disconnected from watercourses.</td><td>Stormproof and hydrologically disconnect all road segments</td><td>Verify road segments are hydrologically disconnected from watercourses to the maximum extent practicable.</td></tr>
<tr><td>Open Slope Shallow Landslides</td><td>5</td><td rowspan="2">1.0</td><td rowspan="2">97%</td><td rowspan="2">7 years</td><td>Decrease in management-related open-slope landslide delivery in conformance with load allocation.</td><td>100% of timber harvest areas are evaluated using a combination of best available landslide hazard map and onsite evaluation by professional geologist.</td><td rowspan="2">Maintain a landslide inventory across ownership with comprehensive updates following triggering events[1] and at a maximum of 5 year intervals. Ensure that landslides identified through any means including THP layout, road inspections, periodic aerial photo and field inventories all are included in a centralized landslide database with consistent attributes.</td></tr>
<tr><td>Road Related Landslides</td><td>25</td><td>Improving trend in stability of roads to comply with load allocation.</td><td>100% of road construction, site treatments, and restoration areas are evaluated using a combination of best available landslide hazard map and evaluation by geologist.
All mainline roads stormproofed by 2013 and all roads stormproofed by 2018.</td></tr>
</table>

[1] Triggering event is a significant earthquake or rainfall event capable of resulting in landslides. Some recent programs have relied upon 2" of rainfall per 12 hours or 3" of rainfall per 24 hours. The definition of a triggering event for use associated with the Upper Elk River TMDL Implementation Program will be defined as the WDR program is further developed.

Management-Related Sediment Source Category	2011 Load ($yd^3/mi^2/yr$)	Load Allocation ($yd^3/mi^2/yr$)	Percent Reduction	Schedule to Attain Load Allocation	Numeric Targets	Implementation Measures	Project Monitoring
Deep Seated Landslides	N/A				Zero increase in discharge from deep seated landslide due to management-related activities.	100% of deep seated features identified. 100% of hydrologic modification to features are prevented or are minimized, and appropriate mitigation action is undertaken. Improving trend in quality and quantity of trees capable of metering sediment discharges from body and toes of deep seated landslide features.	Develop an inventory of deep seated features and activity levels across each ownership in the watershed. Describe measures to prevent, minimize and mitigate hydrologic modification and to promote trees on body and toes of deep seated features.
Management Discharge Sites	39	1.3	97%	5 years	No new management discharge sites created.	Prevention	Track management discharge sites before and after implementation of management measures
Skid Trails	15	0.54	97%	20 years	Treatment of all controllable management discharge sites.	Maintenance of a complete inventory of existing management discharge sites. Prioritization based upon risk to water quality.	Maintain and manage an inventory of sediment discharge sites across each ownership in the watershed. Inventory to be updated following triggering events and at a maximum of 5 year intervals. Ensure that management discharge sites identified through any means including THP layout, road inspections, period aerial photo and field inventories all are included in a centralized management discharge site database.
Treatment of Management Discharge Sites	24				Minimize post-treatment discharges to <0.25% of treated volume.	Proper site evaluation, design, equipment, timing, erosion control, oversight, maintenance. 100% of site treatments and restoration areas are evaluated using a combination of best available landslide hazard map and evaluation by geologist.	Track post treatment discharge volume via void measurements. If ocular estimates are used, correlate them to volumetric void measurements.
Harvest Surface Erosion	4	1.4	97%	5 years	N/A	Harvested areas have ground cover in the form of vegetation, slash, mulch, or other appropriate materials sufficient to prevent surface erosion.	Verify ground cover is sufficient to prevent sediment mobilization within harvested areas.
Road Surface Erosion	17				Decrease road surface erosion toward load allocation.	All segments of road are surfaced with pavement, rock, slash, mulch, straw, or other adequate materials. Filtration of all road surface drainage to prevent the discharge of sediment to watercourse. Decreasing trend in winter-period use of	Verify road segments are surfaced with material appropriate for use. Verify that road drainage is adequately filtered prior to entering a watercourse and prior to road use during wet weather. Track road daily use and rainfall

Management-Related Sediment Source Category	2011 Load (yd³/mi²/yr)	Load Allocation (yd³/mi²/yr)	Percent Reduction	Schedule to Attain Load Allocation	Numeric Targets	Implementation Measures	Project Monitoring
						roads.	during wet weather.
Instream Deposits	2,354	0	100%	10 years	Bankfull channel conveyance capacity: 2,250 cfs on Upper Mainstem; 1,172 cfs on Lower North Fork; and 1,015 cfs on Lower South Fork	Identify and implement feasible recovery actions, including potentially: dredging; new channel construction; off-channel detention basin; levee building, removal or set-back; vegetation management; infrastructure improvements; creation of inset floodplains; high flow channels; and placement of large woody debris	To be developed depending on identified implementation measures
Riparian Areas	N/A				Improving trend in quality of riparian stands to provide: 1) delivery of wood to channels for sediment metering, stabilization, and to provide habitat elements, 2) slope stability to minimize sediment delivery associated with landslide features, and 3) ground cover to ensure sediment control.	Design silvicultural prescriptions within riparian areas to ensure the promotion of riparian processes to 1) delivery of wood to channels for sediment metering, stabilization, and to provide habitat elements, 2) slope stability to minimize sediment delivery associated with landslide features, and 3) ground cover to ensure sediment control. Riparian areas are defined as two site potential tree heights for Class I and II watercourses and one site potential tree heights for Class III watercourses.	Description of measures to promote riparian processes associated with timber harvest and road construction operations. Track stand conditions within riparian areas.
Cumulative Watershed Effects	N/A				The maximum timber harvest rate is 1.5% of a Class I subbasin area and 1.5% of each individual ownership.	Limit annual average canopy removal to harvest rate to approximately 0.4% annually within Class I subbasins at the beginning of TMDL implementation, and increase up to an annual maximum of 1.5% over time as instream and upslope sediment load reductions are achieved.	Track annual canopy removal within TMDL Class I subbasins and across ownership.

Ruggerone Comment 5.1: "Please see comments regarding instream targets under Conclusion 2 above. Watershed target conditions generally provide for improved conditions for salmonids if fully implemented. However, many of the targets call for an improving trend in the condition rather than a specific metric. As noted in the Staff Report, the outcome of the effort to control sedimentation can be uncertain, therefore monitoring is needed to make sure the Program is on track. Decision points for guiding an adaptive management process should be developed to better ensure that changes can be made if needed and that the desired beneficial conditions will be met."

Staff Response: See Staff Response to Baker Comment 5.2.

Ruggerone Comment 5.2: "The TMDL process only addresses sediment related issues. The status of salmonids in the watershed might improve to the extent that sediment related impacts in the Upper Elk River have been highly influential. However, other factors may also constrain salmonid production, such as conditions in the lower Elk River, the estuary, or ocean. For these reasons, improvements in the status of salmonids ultimately requires a landscape or watershed-wide approach that addresses all factors that may be affecting salmonid population viability (e.g., Roni et al. 2002, Beechie et al. 2003)."

Staff Response: Comment noted. It is because of other variables beyond sediment conditions in Elk River, that staff did not identify a population target condition.

Miller: No Comments on Conclusion 5.

Stark: No Comments on Conclusion 5.

Topic III. Sediment Source Analysis

Conclusion 6. The sediment source analysis reasonably quantifies the timing and magnitude of natural and management-related sediment source categories.

Baker Comment 6.1: "The supporting science for these findings is in Chapter 4: Sediment Source Analysis for the Upper Elk River TMDL of the *Draft Staff Report for the Upper Elk River Sediment TMDL* (not in "Chapter 3" as stated in Appendix 2 for the letter of 7/17/13)."

Staff Response: See Staff Response to Baker Comment 1.1.

Baker Comment 6.2: "This is a data-rich analysis. A great variety and quantity of data collection have been involved in the sediment source analysis. These data are reasonably quantified in terms of timing and magnitude for AVERAGE sediment loading from various sources within a broad set of categories. The aerial photographs used to quantify the source categories do come from time periods from 1955-2011, as noted in the explanatory statement for findings 6 and 7, but there are really many subperiods represented in the 20 or so datasets. There is not a continuous set of observations for the entire 1955-2011 time period that was generated according to a uniform data-collecting protocol, as would be appropriate for a scientific methodology. Nevertheless, the various data sets seem to have been thoroughly and competently analyzed."

Staff Response: Staff agrees that a continuous set of observations generated according to a uniform data-collecting protocol for the 1955-2011 time period would provide for a more robust analysis. However, as is almost always the case in this sort of regulatory setting, that level of data was unavailable to staff. There were a variety of protocols employed in the data collection efforts which informed the source analysis. Staff made efforts to account for these differences across space and time to provide common metrics for comparison.

Baker Comment 6.3: "The study employs an "Empirical Sediment Budget Approach" for quantifying sediment production. This is a sound scientific methodology, and it is well supported in the peer reviewed literature. On balance I conclude that finding/assertion 6 is based upon sound scientific knowledge, methods, and practices."

Staff Response: Comment noted.

Ruggerone: No comments on Conclusion 6.

Miller: No comments on Conclusion 6.

Stark: No comments on Conclusion 6.

Conclusion 7. Little South Fork Elk River provides a reasonable reference watershed for Upper Elk River.

Baker Comment 7.1: "As noted above, the use of the control basin of Little South Fork Elk River is a big plus for the study. This basin can reasonably be presented as a reference watershed in regard to estimating the long-term average sediment loading from natural sources. Thus, I conclude that finding/assertion 7 is based upon sound scientific knowledge, methods, and practices."

Staff Response: Comment noted.

Baker Comment 7.2: "The sediment source analysis revealed that the largest management-related loading occurred during the 1988-1997 time period. This period also included the 1993-98 period of excessive sediment deposition downstream from the source areas. Thus, my concerns about understanding the extreme events, noted above, also apply to these topics.

Staff Response: See Staff Response to Baker Comment 1.4.

Ruggerone Comment 7.1: "The Little South Fork Elk River is within the Headwaters Forest Reserve and it is described as a watershed having much less timber-related impacts. Comparisons of stream conditions in the Upper Elk River with those in a much less impacted reference stream, such as the Little South Fork Elk River, is highly desirable. To facilitate this comparison, additional information on the soil types and slope gradients could have been provided to show that the Little South Fork Elk River is representative of the Upper Elk River in terms of its natural sediment loading rate.

Staff Response: Appendix 4-A, in the Peer Review Draft Staff Report, describes the Study Subbasin Approach used in the TMDL analyses. The Study Subbasin Approach compares Corrigan Creek and South Branch North Fork Elk River to Upper Little South Fork Elk River conditions to discern the influence of management on sediment-related parameters. Appendix 4-A presents a comparison of the drainage areas, lithology, slope gradient, aspect, and rainfall estimates for the three subbasins.

Ruggerone Comment 7.2: "The Little South Fork Elk River is a relatively small watershed, therefore the Staff Report did not use it as a reference stream for the shallow hill slope analysis. This seemed reasonable. As noted above, other analyses could have benefited from comparison with data collected in the Little South Fork Elk River, but apparently no data were available (e.g., spawning habitat quality and pool quality)."

Staff Response: See Staff Response to Ruggerone Comment 1.2

Ruggerone Comment 7.3: "The text on page 4-10 (2nd paragraph) did not match information in Table 4.2."

Staff Response: The text in paragraph 2 and 3 on page 4-10 describes the results of the PWA surveys conducted in Upper Little South Fork Elk River. Due to discrepancies in drainage areas associated with channel formation assumed by PWA, versus those identified by staff and described in Appendix 4-C, staff relied on the applicable portions of the surveys. Table 4.2 reflects the adjusted survey results. In the Public Review Draft Staff Report, staff will drop reference to Table 4.2 in Paragraph 3 to minimize confusion.

Miller: No Comments on Conclusion 7.

Stark: No Comments on Conclusion 7.

Topic IV. Sediment TMDL, Load Allocations and Margin of Safety

Conclusion 8. 125% of natural sediment loading is a reasonable estimate of the sediment loading capacity for Upper Elk River and is likely to be supportive of beneficial uses of water.

Baker Comment 8.1: "The supporting science for these findings is in Chapter 5: Upper Elk TMDL Sediment Loading Capacity and Load Allocations of the *Draft Staff Report for the Upper Elk River Sediment TMDL* (not in Chapters 5 and 7 as stated in Appendix 2 for the letter of 7/17/13). Chapter 5 also included the linkage analysis."

Staff Response: See Staff Response to Baker Comment 1.1.

Baker Comment 8.2: "In regard to topic 8, the Staff Report sets the TMDL loading capacity at 120% of natural background sediment loading, not 125%, as stated in assertion/finding number 8. Aside from this relatively minor adjustment, I conclude that the 120% figure is scientifically [*sic*] reasonable, and that assertion/ finding number 8 is based upon sound scientific knowledge, methods, and practices."

Staff Response: The TMDL loading capacity is proposed at 120% of natural background sediment loading with a margin of safety, not 125% as identified in the Peer Review Request letter dated 7/17/12. Staff regrets the misstatement contained in Conclusion 8.

Ruggerone comment 8.1:" The target of 120% of natural sediment loading represents a significant decline in the loading of sediment in the Upper Elk River. If achieved, this significant reduction in sedimentation should translate to improvements in habitat conditions for salmonids. However, as noted above, habitat improvements may require actions such as placement of LWD to help create pools. A passive off-hands approach, which seems to be the preference, will likely take longer time to improve habitat for salmonids."

Staff Response: See Staff Response to Ruggerone Comments 2.3 and 2.6.

Miller: No Comments on Conclusion 8.

Stark: No Comments on Conclusion 8.

Conclusion 9. The load allocation strategy appropriately represents 1) that a portion of the loading capacity is currently taken up by the instream sediment deposits in the middle reach of Elk River and 2) that a change in the volume of instream deposits resulting from recovery of the middle reach may result in a greater portion of loading capacity available for management-related sediment loads.

Baker Comment 9.1: "In considering topic 9 it is clear that the load allocation strategy appropriately represents the 2 factors noted in explanatory notes associated with these two assertions/findings. I conclude that finding/assertion 9 is based upon sound scientific knowledge, methods, and practices."

Staff Response: Comment noted.

Ruggerone: No comments on Conclusion 9.

Miller: No comments on Conclusion 9.

Stark: No comments on Conclusion 9.

Conclusion 10. The margin of safety will ensure beneficial uses are protected and it reasonably accounts for uncertainty in the estimates of the sediment source analysis, the loading capacity, and seasonal variation.

Baker Comment 10.1: "My reading of the explanatory notes that accompany topics 8-10 in Appendix 2, i.e., the charge to the reviewers, indicates that the Staff Report employs an *engineering methodology* to arrive at a calculation of the sediment loading capacity of the Upper Elk Creek watershed. This methodology has elements of best practice engineering, including a "margin of safety." As such it can be appropriately matched to regulatory standards and prove defensible in legal proceedings as 'best practice." As a preface to my comments on these topics, note that my review task relates to science issues, specifically hydrology and geomorphology, so the following comments need to be understood in this light.

"In the engineering methodology applied to the TMDL the "margin of safety" (topic 10) is used to quantify the uncertainty in the TMDL calculation. As stated in the Summary section of the Staff Report (page xvi), "A margin of safety ensures that the total maximum allowable load never results in exceedence of ambient water quality objectives, considering seasonal variation and other factors." It is my view that it is not possible to ensure such a result unless there is a program of monitoring, testing of the hypothesized TMDL, and revision of the TMDL in light of what is learned. To claim the ability in advance "to ensure" that the TMDL will never exceed the ambient water quality standards is inherently nonscientific. Scientifically speaking, the proposed TMDL to be generated by the methodology in this program will afford an excellent hypothesis toward something that could likely achieve the desired outcome. But like all scientific hypotheses this must be subject to testing and revision. For this reason I must can say that finding/assertion number 10, while based on sound scientific knowledge and *engineering practice and methodology, is not based on sound scientific methodology*."

> *Staff Response*: Comment noted. See Staff Response to Baker Comment 5.2 for a discussion of implementation and monitoring measures anticipated to be included in the Public Review Draft Staff Report, as well as a discussion of adaptive implementation.

Ruggerone Comment 10.1: "The Staff Report states, 'The Upper Elk TMDL incorporates a margin of safety (MOS) through use of conservative assumption. Attainment of the numeric objective for turbidity provides the basis for the loading capacity established for the Upper Elk TMDL. The linkage analysis finds that on average and over a range of rainfall years, 124% of natural sediment loading would result in attainment of the turbidity objective.

"In order to achieve the desired turbidity reduction in streams, the Program calls for a maximum average harvest rate of 1.5% in Class I subbasins. This metric is based on a statistical relationship involving many watersheds, but Fig. 6.4 shows that turbidity levels in the Elk River watershed are higher at a specific timber harvest rate than other watersheds used in the model. Therefore, implementation of the 1.5% harvest rate in the Elk River watershed will have a less desirable effect on turbidity than implied by the model that uses data from all watersheds. In other words, a lower harvest rate may be needed to achieve the desired turbidity level in the Elk River watershed."

> *Staff Response*: See Staff Response to Ruggerone Comment 2.7.

Ruggerone Comment 10.2: "Apparently the harvest rate cap (1.5%) only applies to Class I subbasins, and not to smaller Class II and III subbasins that are located upstream of Class I subbasins. Harvest rates should be defined for the smaller subbasins since sediment will eventually flow down to the larger Class I subbasins."

Staff Response: *See Staff Response to Ruggerone Comment 2.8.*

Ruggerone Comment 10.3: "As noted in the report, there is uncertainty in the outcome from the proposed measures. Will a 1.5% harvest rate be sufficient to substantially reduce the sediment loading rate? Monitoring is necessary to ensure progress towards the intended goals."

Staff Response: See Staff Responses to Ruggerone Comment 2.7 and Baker Comment 5.2.

Miller: No Comments on Conclusion 10.

Stark: No Comments on Conclusion 10.

Topic V. Slope Stability Modeling and Resulting Landslide Hazard Maps

Conclusion 11. The 4-meter Digital Elevation Model (DEM) generated from the bare-earth Light Detection and Ranging (LiDAR) points using kriging is a reasonable technique to model hillslope stability in the project area to maximize representative elevations and definition of actual geomorphic features while reducing topographic artifacts and computation time required for model application and other spatial analyses.

Baker Comment 11.1: "The supporting science for these findings is in Stillwater. 2007. *Landslide Hazard in the Elk River Basin, Humboldt County, California*, which was provided as Appendix 6-D.

"The 2005 LIDAR survey campaign that is described in Appendix 2-B looks to have been state-of-the art. The Stillwater 2007 report appropriately justifies the selection of kriging as the method for interpolating from the irregularly spaced bare earth point data from the 2005 LIDAR survey to a regular spaced grid of elevation data, thereby generating the 4-m DEM. The reasonable alternative methods were evaluated and found to be less appropriate for the goals of the landslide hazard study. Thus, I conclude that assertion/finding number 11 is based upon sound scientific knowledge, methods, and practices."

Staff Response: Comment noted.

Stark Comment 11.1: **"**This section presents my review of the 4-meter Digital Elevation Model (DEM) generated from the bare-earth Light Detection and Ranging (LiDAR) points using kriging as a reasonable technique to model hillslope stability in the project area to maximize representative elevations and definition of actual geomorphic features while reducing topographic artifacts and computation time required for model application and other spatial analyses.

"One of my recent doctoral students, Kamran Akhtar (Akhtar, 2011), used DEMs and kriging to develop three-dimensional (3D) slope geometries from topographic data for input to a new 3D limit equilibrium slope stability model. As a result, I am familiar with generating DEMs from LiDAR and the kriging method. In March of 2005, Sanborn (2005) was contracted by Space Imaging to perform a LiDAR survey in the Humboldt Bay Area in Northern California. LiDAR data in the form of 3D positions of a dense set of masspoints was used to develop a DEM of the area.

"Based on my experience and the reports prepared by Sanborn (2005) and Pacific Watershed (2006), it is my opinion that the use of LiDAR to develop DEMs using kriging is based upon sound scientific knowledge, methods, and practices. Thus, the use of DEMs and kriging is a reasonable technique for modeling hillslope geometry to capture representative elevations and geomorphic features for the slope stability analyses discussed below. The DEMs models described above were used as input for the slope stability analyses performed using SHALSTAB and PISA to predict areas of stability and potential instability."

Staff Response: Comment noted. Staff assumes that the comment is intended to refer to the report prepared by Stillwater Sciences (2007), rather than Pacific Watershed (2006).

Ruggerone: No comments on Conclusion 11.

Miller: No comments on Conclusion 11.

Conclusion 12. SHALSTAB and PISA represent reasonable models for predicting potential shallow landslide hazards, in common usage with proven performance in forest mountainous terrain.

Baker Comment 12.1: "The Stillwell 2007 study modeled shallow landslides using two distributed, physically based models, one deterministic (SHALSTAB) and the other one probabilistic (PISA). Variations of the original versions of these models were employed to allow for spatial variations in soil depth, among other added parameterizations. The SHALSTAB model was originally developed in the late 1990s, subsequently modified and improved over the next decade or so, and applied with considerable success to many study areas in California, Washington, and Oregon—all documented through peer-reviewed papers published in the top scientific journals for this area of research. This model clearly employs sound scientific methodology, derived in a geophysical manner from first principles. Thus, I conclude that assertion/finding number 12 is based upon sound scientific knowledge, methods, and practices."

> *Staff Response*: Comment noted. Additionally, staff assumes that the comment is intended to refer to the report prepared by Stillwater Sciences (2007), rather than Stillwell (2007).

Baker Comment 12.2: "The PISA model employs a state-of-the-art geotechnical engineering approach. As with many standard geotechnical approaches, it is well documented through technical reports from the engineering firm that developed it (Haneberg Geoscience). This is standard practice in soil mechanical engineering, so the approach looks to be exactly what one should expect for a competent engineering approach to the problem, i.e., that the results will be defensible in legal proceeding as "state-of-the-art", etc.

"It is commendable that the Stillwater 2007 study employed both basic geophysical science and geotechnical engineering approaches to the landslide prediction problem in the Elk River Basin. Moreover, the testing of performance for the various models revealed that the best formulations of each resulted in negligible differences in regard to the prediction of landslide hazard at the scale required for this study."

> *Staff Response*: Comment noted.

Stark Comment 12.1: "This section presents my review of the limit equilibrium slope stability models SHALSTAB and PISA and whether or not they are reasonable models for predicting potential shallow landslide hazards, in common usage with proven performance in forest mountainous terrain, and are reasonable to estimate hillslope instability in an effort to predict Elk River sediment potential.

"Both SHALSTAB and PISA are commonly used to predict potential shallow landslide hazards in forested mountainous terrain and are relevant to other slope applications, such as dam and levee slopes and landfill final cover systems, because they are based on the infinite slope model. SHALSTAB and PISA are deterministic (Dietrich et al. 2001) and probabilistic (Haneberg 2004, 2005), respectively, slope stability models.

“The infinite slope method is the simplest stability method because the many assumptions result in the slope being modeled as a block on an incline. The analysis assumes the slope extends infinitely in all directions and sliding occurs along a plane parallel the slope face. Because the slope is infinite, the stresses along planes A-A’ and B-B’ in Figure 1 are the same and cancel each other. This results in a simple expression to calculate factor of safety. Other major assumptions in the method include:

- Potential failure surfaces are parallel to the ground surface which is dubious in mountainous terrain,
- Shallow subsurface flow is parallel to the ground surface which is dubious because of the variability of infiltration
- Soil properties, e.g., unit weight and shear strength, above the planar failure surface are assumed to be homogenous or constant, which may not be the case in mountainous terrain
- The factor of safety is constant along the failure surface, which may not be appropriate
- Slope angle is constant, which is dubious in mountainous terrain,
- Depth of soil is small compared to the lateral dimensions of the slope so 3D effects are not significant.
- Root strength is neglected.
- Peak strength values are used to model the slope soil.
- Resisting forces at the downslope end of the block are ignored, which is conservative especially if tree roots are present.

“The infinite slope method is more appropriate for cohesionless soils but can also be used for cohesive soils. The assumptions above usually result in a conservative estimate of factor of safety which means that some areas that are predicted to be stable may not be and will contribute to the sediment load.”

> *Staff Response*: The purpose of the slope stability modeling in the Upper Elk TMDL is to provide a landscape scale planning tool that objectively identifies areas prone to shallow landsliding. The modeling was not intended to develop landslide production estimates. Rather the results of the model are used in comparison with landslide inventories to determine 1) the relative proportion of different classes of landslides and 2) the amount of landscape within different instability classes. It is through the validation tests that the model’s performance, with the inherent assumptions, is evaluated. Additional site-specific analyses can further inform the stability of individual project areas.

Stark Comment 12.2: “The results of the stability analyses were compared with Upper Elk River landslide inventories so the analyses appear reasonable.”

> *Staff Response*: Comment noted.

Stark Comment 12.3: "In summary, SHALSTAB and PISA represent reasonable models for predicting potential shallow landslide hazards in forest mountainous terrain and are in common usage with proven performance in this application. However, some detailed comments are presented below for improving the analyses if future analyses are performed, such as using a more rigorous slope stability analysis than an infinite slope analysis, stress dependent shear strength, and partially saturated soil behavior."

Staff Response: Comment noted.

Ruggerone: No comments on Conclusion 12.

Miller: No comments on Conclusion 12.

Conclusion 13. The model testing resulted in determination of appropriate thresholds for breaks in potential instability classes that balance the goals of maximizing correct landslide prediction and minimizing over prediction of unstable area.

Baker Comment 13.1: "The rigorous program of model performance was undertaking using statistical p-tests within a hypothesis testing framework to see (1) if the shallow landslide models predict greater potential slope instability at known slide locations than at random positions in the landscape, and (2) if the models are better predictors of instability than predictions based solely on hillslope gradient. Results did show quite positive indicators for both of these performance measures. Thresholds were also established from the sampling approach to determine a threshold for managing the landslide hazard by minimizing the tradeoff costs between (1) that of incorrectly classifying landslides, versus (2) that of over predicting potentially unstable areas. This methodology has also been published in important peer-reviewed scientific literature for study sites in the same regional setting as Elk River. Thus, I conclude that assertion/finding number 13 embodies best scientific knowledge, methodology, and practice."

Staff Response: Comment noted.

Stark comment 13.1: "This section presents my review of the thresholds for determining the instability classes presented in Stillwater Sciences (2007) to determine if the thresholds balance the goals of maximizing correct landslide prediction and minimizing over-prediction of unstable area. This is important because timber harvest operations should probably not be allowed in areas of high landslide hazard."

Staff Response: Staff agrees that instability thresholds are important to guide appropriate timber harvest operations. Further, timber harvest operations should avoid areas of high landslide hazard or be conducted in a manner as to not further reduce stability or wood loading. The Peer Review Draft Staff Report did not specify silvicultural limitations within different stability classes. Those specifics are anticipated to be developed and included as prescriptions within the Watershed WDR being developed to implement the TMDL in Upper Elk River and summarized in Chapter 7 of the Public Review Draft Staff Report.

Stark Comment 13.2: "Some of the key factors contributing to slope instability are listed below so the instability thresholds should reflect at least some of these factors:

- slope gradient,
- soil thickness especially for cohesive slopes,
- canopy because it reduces infiltration,
- rainfall,
- soil strength, pore-water pressure, and unit weight, and
- geologic formation.

"Stillwater Sciences (2007) uses four slope models to predict potential shallow landslide hazards in the Elk River basin. Two of the models are deterministic and based on SHALSTAB, i.e., SHALSTAB and SHALSTAB.V while the other two models are probabilistic and are PISA and PISA.V. SHALSTAB.V is similar to SHALSTAB but includes more parameters to describe spatial variability in soil depth. PISA.V is a second version of PISA that uses a 4-m grid of variable soil depths as used in SHALSTAB.V but includes probabilistic analyses. All other parameters and probability distributions used for PISA.V are identical to that described for PISA.

"SHALSTAB uses values of log(q/T) to delineate areas of slope instability. Specifically, high, moderately high, and moderate potential instability are represented by areas where log(q/T) is less than or equal to -3.1, -2.8, and -2.5, respectively. These preliminary classes are based on suggested log(q/T) thresholds reported for SHALSTAB applications in other areas (Dietrich et al 2001, Montgomery et al. 1998). The pattern of potential instability predicted by SHALSTAB and SHALSTAB.V is similar, where areas with relatively high potential for shallow instability generally occur on steep convergent slopes.

"SHALSTAB is an infinite slope stability model with a steady-state hydrologic model so the following coupled hydrologic-slope stability equation is used to calculate the factor of safety:

$$\frac{q}{T} = \frac{\rho_s}{\rho_w} * \left(1 - \frac{\tan\theta}{\tan\phi'}\right) * \frac{b}{A} * \sin\theta$$

where:

$\sin\theta$	= hydraulic head gradient, dimensionless
θ	= slope angle, degrees
ϕ'	= effective stress angle of internal friction of soil mass along failure plane, degrees
ρ_s	= soil bulk density, mass/volume
ρ_w	= water bulk density, mass/volume
q	= effective precipitation, volume
T	= downslope transmissivity which is related to saturated hydraulic conductivity
A	= drainage area
b	= width of outflow boundary.

"Inspection of this equation shows the hydrologic ratio, q/T, captures the magnitude of effective precipitation (represented by q) relative to the subsurface downslope transmissivity (represented by T). The larger the ratio of q/T, the greater the likelihood that the ground will saturate and be more prone to slope instability. The topographic ratio b/A*sinθ describes the effects of convergent topography on concentrating runoff and elevating soil pore water pressure, which effectively reduces soil shear strength.

"This brief background shows that using values of q/T to delineate areas of different slope instability is reasonable and represents a sound scientific approach or method because of the large impact that precipitation and transport of the precipitation have on slope stability.

"PISA and PISA.V also utilize an infinite slope stability model with probabilistic features so the spatial distribution and magnitude of probability of failure can be calculated and are shown in Figures 3-3 and Figure 3-4, respectively, of Stillwater Sciences (2007). Values of probability of failure are a common output of probabilistic slope stability analyses and are commonly used to delineate ranges of potential instability. Therefore, using values of probability of failure to delineate areas of different slope instability is reasonable and represents a sound scientific approach or method."

Staff Response: Comment noted.

Stark Comment 13.3: "In summary, the use of q/T and probabilities of failure are suitable and logical parameters to delineate areas of potential shallow landsliding in forest mountainous terrain. However, some detailed comments are presented below for improving the analyses if future analyses are performed, such as using a p-test value lower than 0.5 (for example, p<0.3) and different sampling criteria to assess the accuracy of the probabilistic stability analysis."

Staff Response: Comment noted. See Staff Response to Stark Comment A.11.

Stark Comment Topic V Summary: "The Elk River watershed has supported commercial timber operations since the late 1800s but intensive clear-cut logging beginning in 1986, followed in the 1990s with years of larger-than-average rainfall, have resulted in widespread landsliding, erosion, and river sedimentation. I reviewed the above documentation and it is my opinion that the slope stability analyses and assessments are based upon sound scientific knowledge, methods, and practices. In short, the use of:

- 4-meter Digital Elevation Models from bare-earth Light Detection and Ranging (LiDAR) points using kriging is a reasonable technique to model hillslope geometry in stability analyses.
- SHALSTAB and PISA represent reasonable models for predicting potential shallow landslide hazards and are in common usage in forest mountainous terrain.
- The stability models resulted in reasonable classes of slope instability that balance the goals of maximizing correct landslide prediction and minimizing over-prediction of unstable area. This is accomplished using values of q/T for the SHALSTAB analyses and probabilities of failure for the PISA analyses."

Staff Response: Comment noted.

Ruggerone: No Comments on Conclusion 13.

Miller: No Comments on Conclusion 13.

Stark Appendix A - Comments related to Slope Stability Modeling and Resulting Landslide Hazard Maps.

Stark Comments A.1 through A.19 were provided in Appendix A to the Stark Review.

Stark Comment A.1: "This appendix presents some specific review comments on the Pacific Watershed (2006), Stillwater Sciences (Stillwater, 2007), and Staff (State, 2013) reports. My approach to this review is to favor action over no action because of the current status of the Upper Elk River. As a result, many/most of these specific comments should be considered to be suggestions for future improvement and research to identify the locations of potential instability and more importantly to estimate the potential Elk River sediment load under different natural and management scenarios."

> *Staff Response*: Comment noted. Staff appreciates the clarity the reviewer has offered with respect to developing a watershed restoration strategy utilizing the currently available work products and making refinements to the strategy over time as it is tested through stressing storms and appropriately designed watershed studies. See also Staff Response to Baker Comment 5.2 for a description of the general approach to developing a strategy based upon the best available information and making modifications over time.

Stark Comment A.2: "Review of Appendix 4E - Pacific Watershed (2006): This section presents my review comments on the report in Appendix 4-E of (State, 2013) titled: "*Landslide Hazard in the Elk River Basin, Humboldt County, California"* prepared by Stillwater Sciences in Arcata, California.

"As discussed below, there should be a strong correlation between the three forest age classes presented in this report and landslide sediment production and delivery that could be included in the stability analyses to relate slope instability to Elk River sediment load. Table 19 of this report shows the sediment load from each forest class and each forest class canopy is used to develop a canopy coverage coefficient. Therefore, changes in canopy coverage can be related to potential slope instability and Elk River sediment load which could be used to select areas for limiting timber harvesting.

"For example, it appears increasing sediment delivery is derived from younger harvest ages which may suggest reducing timber harvesting in these areas versus older harvest ages (see Table 19 of this report). This could also be reflected in the stability analyses by using different shear strength parameters for young and older harvest areas."

> *Staff Response:* The reviewer refers to two documents in this comment. First, Appendix 4-E [Streamside Landslide Assessment, excerpted from "Freshwater Creek TMDL Sediment Source Assessment, Phase I." prepared by Pacific Watershed Associates (2006)] and second, Appendix 6-D ["Landslide Hazard in the Elk River Basin, Humboldt County, California", prepared by Stillwater Sciences (2007)]. Table 19 is from Appendix 4-E (PWA, 2006).
>
> Attainment of the load allocation for landslides and streamside landslides (which includes bank erosion) will require an effective landslide prevention strategy be implemented across the watershed. In an effort to translate the load allocations and provide implementation guidance, staff identified the numeric hillslope target for riparian areas as "[I]mproving trend in quality of riparian stands capable of providing…slope stability to minimize sediment

delivery associated with landslide features." The program of implementation will identify that timber harvest activities need to be conducted in a manner as to achieve the riparian hillslope target and the allocations. PWA (2006) clearly identifies increasing volume per slide and increasing frequency of slides associated with decreasing stand age. A copy of Peer Review Draft Staff Report Table 4.12, which presents this data, is re-produced below for the reader's convenience (Table 7).

Table 7. Survey results from streamside landslide survey (PWA, 2006) (as reproduced from Table 4.12 of the Peer Review Staff Report).

Forest Type	Unmanaged Old growth[1]	Advanced Second Growth	Recently Harvested Areas
Watershed	Little South Fork Elk River	Upper Freshwater Creek	Little Freshwater Creek
Length of inventoried stream channel (miles)	2.5	3.2	3.3
No. large (>10yd^3) / small (<10yd^3) landslides[2,3]	7 / 7	15 / 14	21 / 27
1975-1987 (13 years)		3 / 2.8	2 / 2.6
1988-1997 (10 years)		9 / 8.4	11 / 14.1
1998-2003 (5 years)		3 / 2.8	8 / 10.2
Volume Sediment delivered from large landslides (yd^3)	308	1056	4791
Average volume per larger slides (yd^3/slide)	44	70	228
Volume sediment delivered from small landslides (yd^3)[4]	35	70	135

[1] Numbers reflect adjusted survey described in Section 4.3.
[2] Totals for all photo periods.
[3] Assuming the proportion of the small slides per photo period to the total small slides, for each area, was consistent with that of the large slides.
[4] Assuming an average small slide volume of 5 yd^3

Staff anticipates that as part of the program of implementation, GIS analyses overlaying the predicted landslide instability classes with riparian areas will be used to help identify areas where special precautions in timber harvesting are warranted. The Watershed WDR being developed to implement the Upper Elk River TMDL will include measures to achieve the target condition of increasing stand age within riparian areas. These measures will be summarized in Chapter 7 of the Public Review Draft Staff Report.

Stark Comment A.3: "Finally, management practices can influence slope stability so including typical management practices in the stability analyses via input parameters such as infiltration, soil shear strength, slope gradient, etc., may be beneficial for better landslide hazard mapping. This could be accomplished by creating different categories of landslide causation mechanisms for small landslides to correlate management practice and landslide volume or sediment production."

Staff Response: The purpose of the landslide hazard mapping efforts associated with the Upper Elk River TMDL are to provide a planning tool for land managers and the Regional Water Board. The available data did not allow for the suggested analyses. The described approach may be well suited for site specific use and can be used, over time, to inform adaptive implementation.

Stark Comment A.4: "Review of Appendix 6D – Stillwater Sciences (2007): This section presents some detailed comments on the report in Appendix 6-D of (State, 2013) titled: "*Landslide Hazard in the Elk River Basin, Humboldt County, California"* prepared by Stillwater Sciences in Arcata, California for improving the analyses if future analyses are performed."

Staff Response: See Staff Response to Stark Comment A.1.

Stark Comment A.5: "Section 1 - Introduction: When considering landslide hazard assessment it is important to recognize that landslides usually do not reoccur in the same location because the prior movement has reduced the driving stresses so areas of no prior sliding and thick colluvium should be emphasized to predict areas of future landsliding."

Staff Response: Staff will include a discussion of the interaction between driving forces, prior movement, and thickness of overlying colluvial material in the prediction of future sliding in Chapter 7 (Implementation) of the Public Review Draft Staff Report. This concept will also be reflected in the development of the conditions related to slope stability in the Upper Elk WDR.

Stark Comment A.6: "Section 1.2.4 – Sediment Sources: The majority of sediment delivered to the North Fork Elk River system originates from landslides so using Best Management Practices, e.g., geowebs in road construction, may reduce landsliding and sediment generation."

Staff Response: The purpose of the TMDL implementation program is to ensure that sediment loading is reduced to achieve the load allocations and not exceed the loading capacity, thus recovering water quality and the beneficial uses that depend on it. Some general sediment control measures are identified throughout the Peer Review Draft Staff Report and are summarized in Table 6 of this Response to Comments (see Staff Response to Baker Comment 5.2).

Additional control measures will likely be identified in the Watershed WDR and others will be implemented on individual projects at the discretion of landowners. Staff encourages all forms of innovation and tools for prevention and minimization of sediment delivery, including measures to provide surfacing and stability in road beds, such as geowebs, as the reviewer suggested.

Stark Comment A.7: "Section 2.1 – Geomorphic Terrains: Currently four main attributes are being used to define geomorphic terrains in the Elk River Project Area based on their role in regulating erosion and transport processes: geology, hillslope gradient, channel gradient, and vegetation cover type. It is recommended that colluvium depth and change in canopy cover be included. For example, Figure 1-3 includes canopy removal coefficients that could be included in generating landslide hazard maps."

Staff Response: Staff concurs that information describing both colluvial depth and changes in canopy would support a more rigorous analysis of the potential effects of timber harvesting on stability. This approach could be used to inform land use decisions and to help develop and monitor the effects of management measures taken to meet target conditions

As described in Stillwater (2007), soil thickness strongly affects relative slope stability by supporting vegetation that increases root strength and by influencing the role of subsurface to overland flow. Soils are typically thinnest on ridges and thickest in unchanneled valleys, but spatial variation in soil thickness is impractical to measure over large areas, thus is rarely incorporated into deterministic hillslope stability models.

Dietrich et al. (1995) developed a variation of the basic SHALSTAB that incorporates variability in soil depth called SHALSTAB.V. A soil production and transport model to predict soil depth was used to develop a grid of soil depths for input into SHALSTAB.V. The USDA Soil Survey (Arcata Office) observations conducted in the Bridge Creek subbasin corroborated the distribution of soil depths resulting from the soil production and transport model; the model-predicted soil depths in Bridge Creek are provided in Figure 4, below. Further refinements to the soil depth grid could be made over time with the collection of site-specific data from areas where equipment access is feasible and ground disturbing activities are already proposed.

Unfortunately, reliable stand age information was not readily available across the Upper Elk River watershed when the landslide hazard models were initially run and the results produced. However, the models could be used by landowners to inform their land management activities in the future. Staff is supportive of change in canopy being used in future model runs, particularly where land management activities are proposed that would reduce canopy in a high hazard class area. The results could be used to determine whether or not a specific proposed management activity is appropriate for the site.

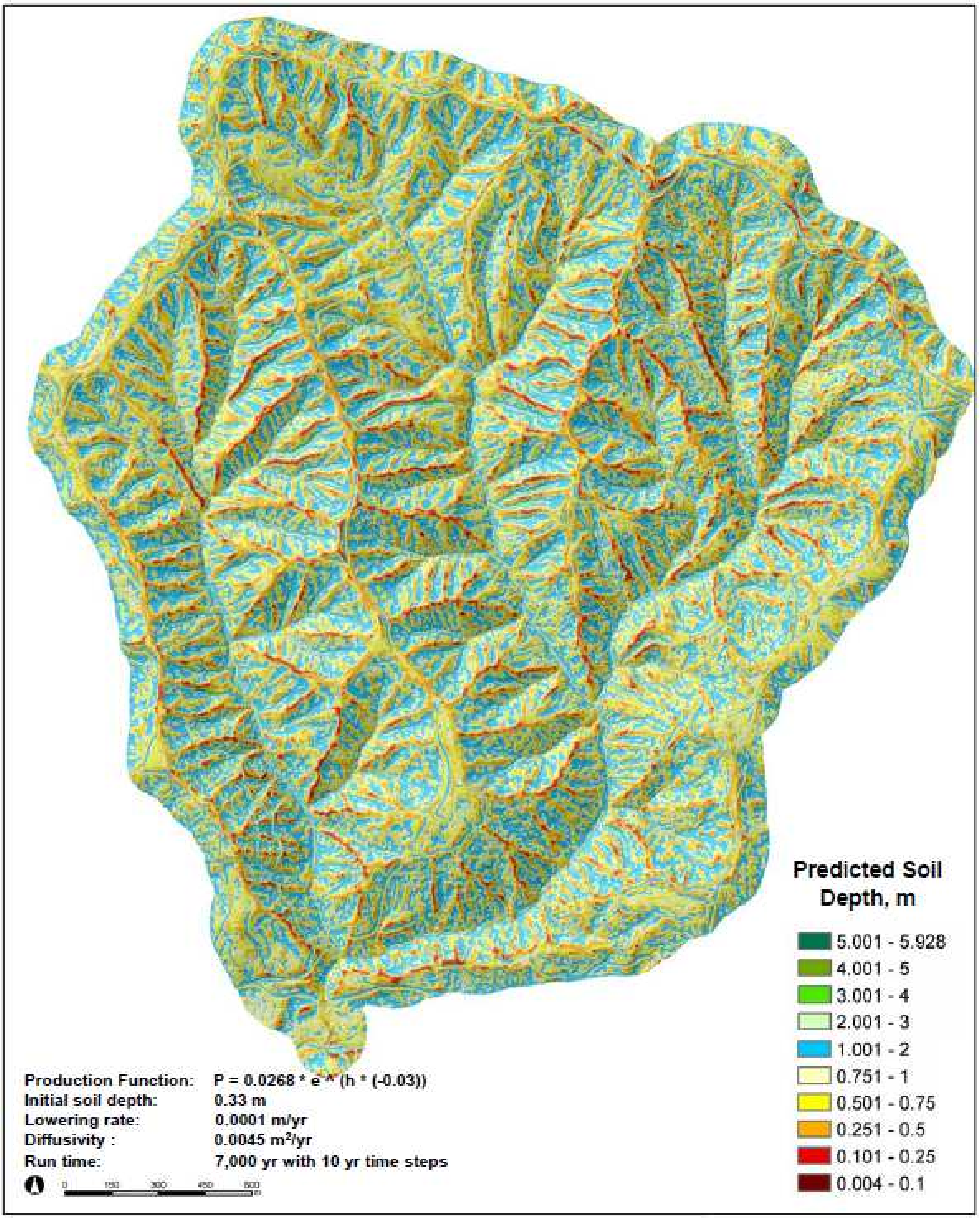

Figure 4. Predicted soil depth based upon soil production and transport model for the Bridge Creek subbasin in Upper Elk River (Figure provided by Stillwater Sciences).

Stark Comment A.8: "Section 2.3.2.1 – SHALSTAB: The following are some suggestions for refining the input parameters used in the SHALSTAB analyses:

1. Do not increase effective stress friction angle, ϕ', to reflect root strength because soil will be saturated and possible near the liquid limit.

2. Do not use peak strength, i.e., peak friction angle, peak ϕ', for colluvium because prior downslope movement of colluvium usually results in mobilizing a post-peak strength, e.g., residual friction angle.

3. Include partially saturated seepage in stability analyses instead of using saturated hydraulic conductivity."

> *Staff Response:* As described in Stillwater (2007), the angle of internal friction was set to a relatively high value of 45 degrees, in part, to compensate for the absence of root strength. Dietrich et al. (1995) describe that if cohesion is not considered, it is useful to set the friction angle equal to 45 degrees. This is because it is a high value that reduces the overall area of potential instability relative to that which would be predicted with the more common lower values (perhaps in the mid-30 degrees). To some extent, this makes up for the lack of cohesion in the problem (by making slopes as steep as 20 to 27 degrees stable). Stillwater (2007) used likely values to define worst case conditions, a standard approach to infinite slope analysis.
>
> It appears the reviewer is suggesting that many areas prone to failure have already failed and thus a smaller value of angle of internal friction is more appropriate to represent post-failure conditions. A lower value would result in more areas being predicted as potentially unstable. However it may be more representative of post-failure conditions. Refinements to the peak friction angle may be made during future analyses.
>
> The simulation was designed to model worst-likely-case scenario by using a value for hydraulic conductivity that represents saturated conditions. The reviewer's suggestion to rely on partially saturated seepage would define conditions other than worse-case.

Stark Comment A.9: "Section 2.3.2.2 – SHALSTAB.V: Soil thickness strongly influences slope stability and determining how much soil is involved in the slide mass. Future analyses should include modeling the partially saturated nature of the colluvium to better predict depths and magnitude of infiltration. In addition, field observations should measure colluvium depths so isopach maps can be generated because LiDAR does not provide an estimate of soil depth. This can be facilitated using handheld probes that can be quickly inserted into the colluvium to measure depth, e.g., http://www.grainger.com/Grainger/DICKEYJOHN-Soil-Compaction-Tester-2LBB3 or http://www.southernstates.com/catalog/p-3377-stainless-steel-deepcore-probe-soil-sampler-36.aspx."

> *Staff Response*: Staff concurs with the reviewer's suggestion that modeling of soil thickness would provide additional information about slide production. However, as described in Staff Response to Stark Comment A.7, such information is not currently available. Staff appreciates the suggestion to use hand-held tools for developing site specific data of soil depth; though, there are likely many places within the landscape of Upper Elk River in which the bottom of the colluvium is exceeded by the probe length.

Stark Comment A.10: "Section 2.3.3 – Deep-Seated Landslide Models: I think the physical factors controlling deep-seated mass movement are well understood, i.e., not poorly understood as reported, and many physical models, e.g., SLOPE/W and SLIDE, are available to assess deep-seated landslide hazards. However, deep-seated slides are not a [*sic*] sensitive to short rainfall events because of the time required to infiltrate the larger slide mass. If field data indicates a large number of deep-seated slides, a more rigorous model could be implemented.**"**

> *Staff Response:* Stillwater described that the processes responsible for deep seated landsliding are not understood at sufficient resolution to accurately predict potential instability with a mechanistic model. Stillwater (2007) employed models to predict the locations and activity levels of potential deep seated features based upon surface topography, specifically surface roughness (DSLED-Rough) and drainage area per unit contour width (DSLED-drain), instead of relying on process-based mechanistic models. While validation of the results was precluded over the whole watershed, the pilot subbasins were mapped sufficiently to compare signatures of deep seated features from aerial photographs and the model results. There is a level of agreement between the model results and the deep seated signatures, as Figures 3-14 and 3-15 of Stillwater (2007) indicate (reproduced below as Figures 5 and 6). However, to test the models will require a more objective and rigorous validation test with more detailed mapping and inventory of the type, boundaries, and activity level of deep seated features in Upper Elk River. The existing mapping is simply not accurate enough to distinguish the activity level of deep-seated features. That said, there are areas of Upper Elk River with a concentration of deep seated features where focused field evaluations and tests of the deep seated model described in Stillwater (2007) may be feasible. Further, additional site-specific analyses could be conducted using process-based models, as suggested by the reviewer, to evaluate potential movement of identified features. Such efforts will

necessarily be the result of partnerships between the Regional Water Board, landowners, and others.

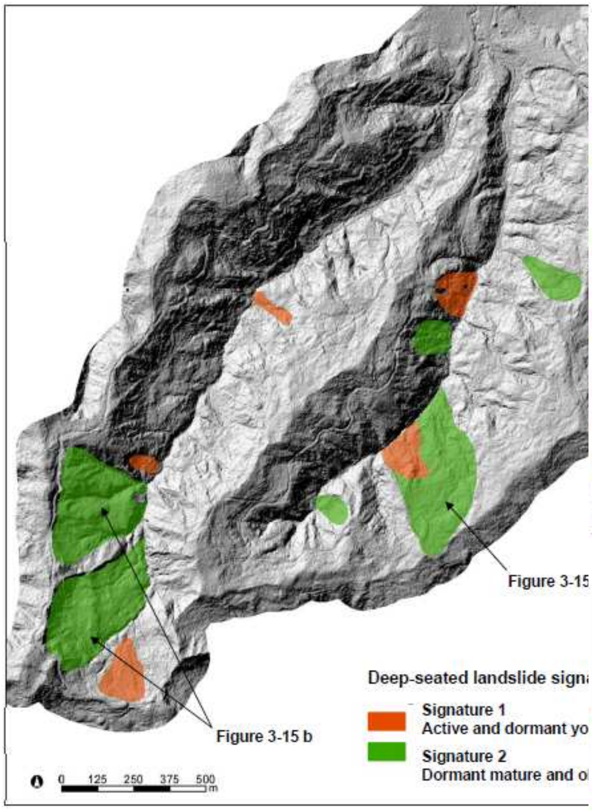

Figure 5. Deep seated landslide signatures in Railroad Gulch (as reproduced from Stillwater (2007) Figure 3-14).

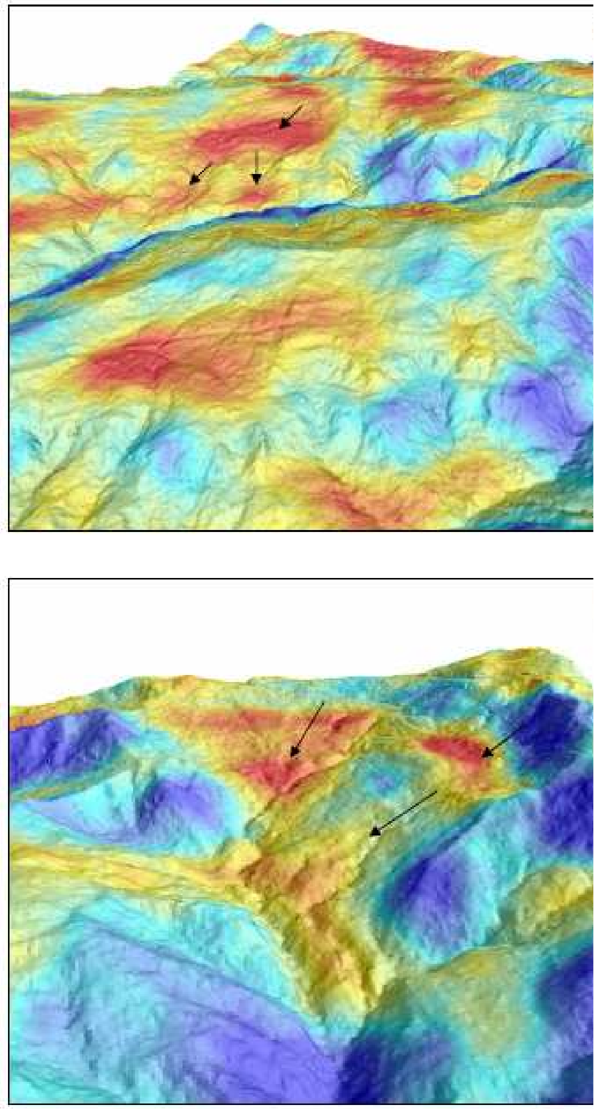

Figure 6. DSLED Rough results in the vicinity of mapped deep seated landslides in Railroad Gulch (as reproduced from Stillwater (2007) Figure 3-15).

<u>Stark Comment A.11</u>: "Section 2.4.1 - Hypothesis Testing: As mentioned above, the p-test value should be varied and different sampling criteria used to assess the accuracy of the probabilistic stability analysis. The following discusses the importance of using different p-test values and sampling criteria on the hypothesis testing.

"Section 2.4.1.1 - Hypothesis Testing: Using different p-test values (e.g., P < 0.4, P < 0.3, etc.) would yield a higher confidence of the instability prediction of a random point being lower than a known landslide point."

> _Staff Response_: The p-value is the smallest level of significance that would lead to rejection of the null hypothesis. P-values vary from 0 to 1, with a value of 0 indicating a test where predicted instability is always greater at a slide than at the 5,000 random points. A p-value of <0.5 indicates that the model predicts greater instability at a landslide than at more than half of the 5,000 random points. The percentage of p-values <0.5 were summarized for each model validation test. Different threshold p-values can be selected to change the rigor of the test.
>
> The reviewer suggests that a lower p-value would better assess the accuracy of the probabilistic stability analysis. Staff concurs that a lower p-value would indicate that the model was a better predictor of instability at slide locations as compared to random points.
>
> Unfortunately, there is uncertainty associated with the mapping of known landslide locations because the available landslide inventory data did not separate landslide initiation points versus runout areas, as discussed in Stillwater (2007). The stability models predict areas associated with landslide initiation. As such, Stillwater selected a cautionary approach to the validation test to ensure a robust test in which there could be certainty in the results. A lower p-value would result in less certain results.
>
> As improvements are made in landslide mapping techniques, including reproducible designation of slide initiation points as well as runout areas, the subsequent data contained on the LiDAR-based topography can be refined, potentially allowing the use of lower p-values in future validation tests.

Stark Comment A.12: What is the % area (relative to the gross area) of landslides? When selecting random points, are landslide points selected randomly too? The % area of landslide locations will affect the p-test value because instability of a random point is more likely to be greater than the computed instability at a known landslide point compared to other randomly selected points.

"For example (assume random points can be selected anywhere in the site): if Z_i is selected randomly at a known landslide location (selected luckily) and Z_j is instability of a known landslide location (selected intentionally), the chance of $Z_i \geq Z_j$ is higher. Thus, the p-test value is affected by the % known landslide area because the greater the % area of known landslides the greater the chance of selecting a known landslide location during the random selection (Z_i). Therefore, the null hypothesis can be rejected incorrectly (because p-value > 0.5) when the

% of known landslide area is high.

"In summary, it is important to know/show the landslide information and how they sample the landslide points to obtain the p-test value. This is needed to better understand the validation process. "

> *Staff Response*: Two separate hypothesis tests were conducted to evaluate the accuracy of the model as a predictor of instability at slide locations as compared to random points, as described in Stillwater (2007). The first was based upon potential instability at individual points based on a 4-m grid cell and the second based upon maximum instability within a 8-m radius of points.
>
> Appendix B of Stillwater (2007) provides the model values at 1) the landslide initiation points and 2) the maximum instability value within an 8m radius of the initiation point. Appendix C of Stillwater (2007) provides the p-test results for each of the landslides versus 5,000 random points for 1) the initiation point and 2) the maximum instability within an 8-m radius. The chance of the random point being the landslide point is very low and is unlikely to affect the results of the p-test.
>
> The evaluation of the relationship between cumulative percent of watershed area in different instability classes and cumulative fraction of landslides in different instability classes is presented in Figures 3-9 through 3-11 of Stillwater (2007) (reproduced below as Figures 7 through 9). The evaluation conducted to develop this figure did not rely on the use of a p-test analysis. Rather, it was a comparison of the most unstable value within 8-m at the landslide versus the most unstable value within 8-m of randomly selected points based upon a sample size of 5,000.

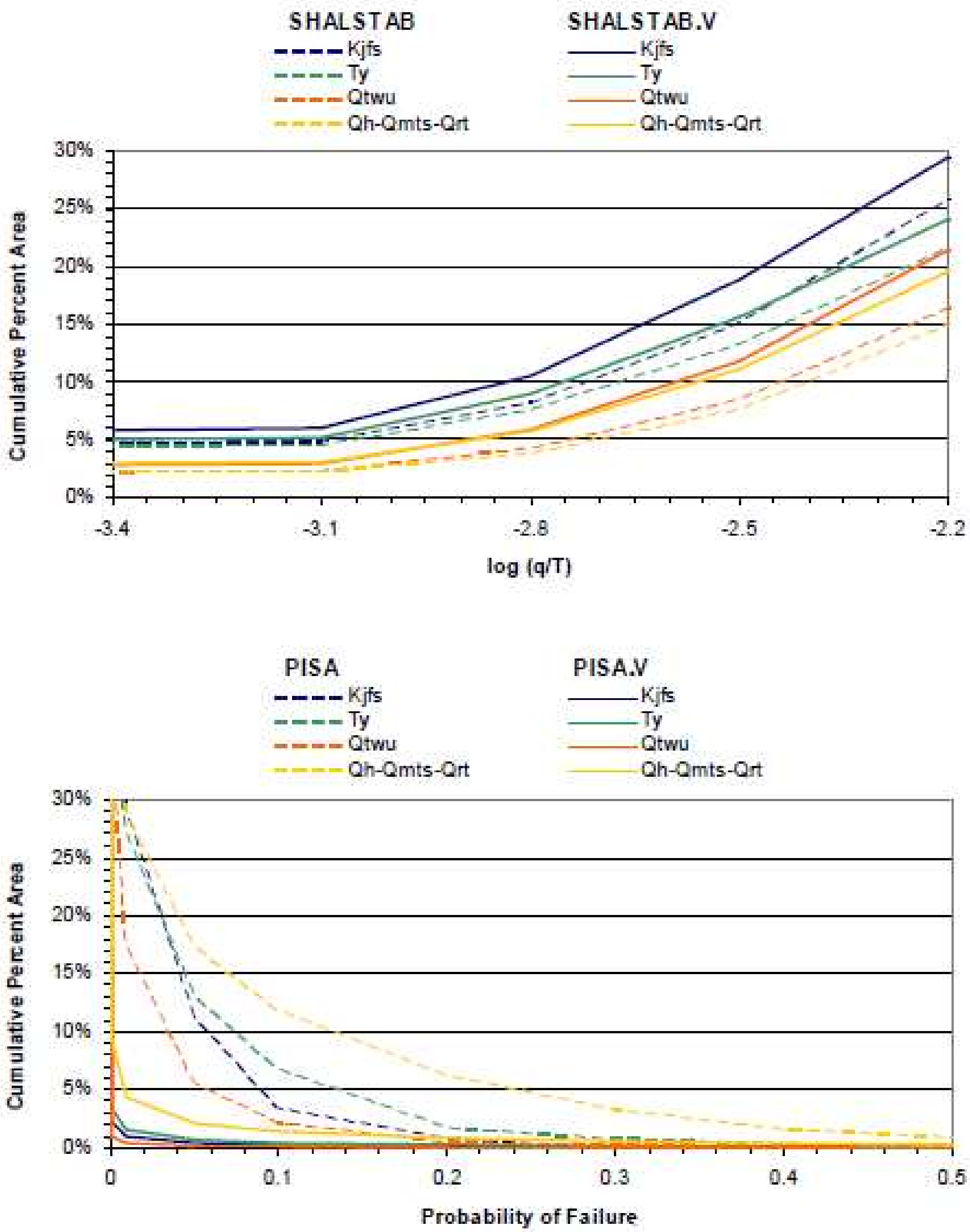

Figure 7. Cumulative percent of watershed area in instability classes: a) SHALSTAB and SHALSTAB.V, b) PISA and PISA.V (reproduced from Stillwater (2007) Figure 3-9).

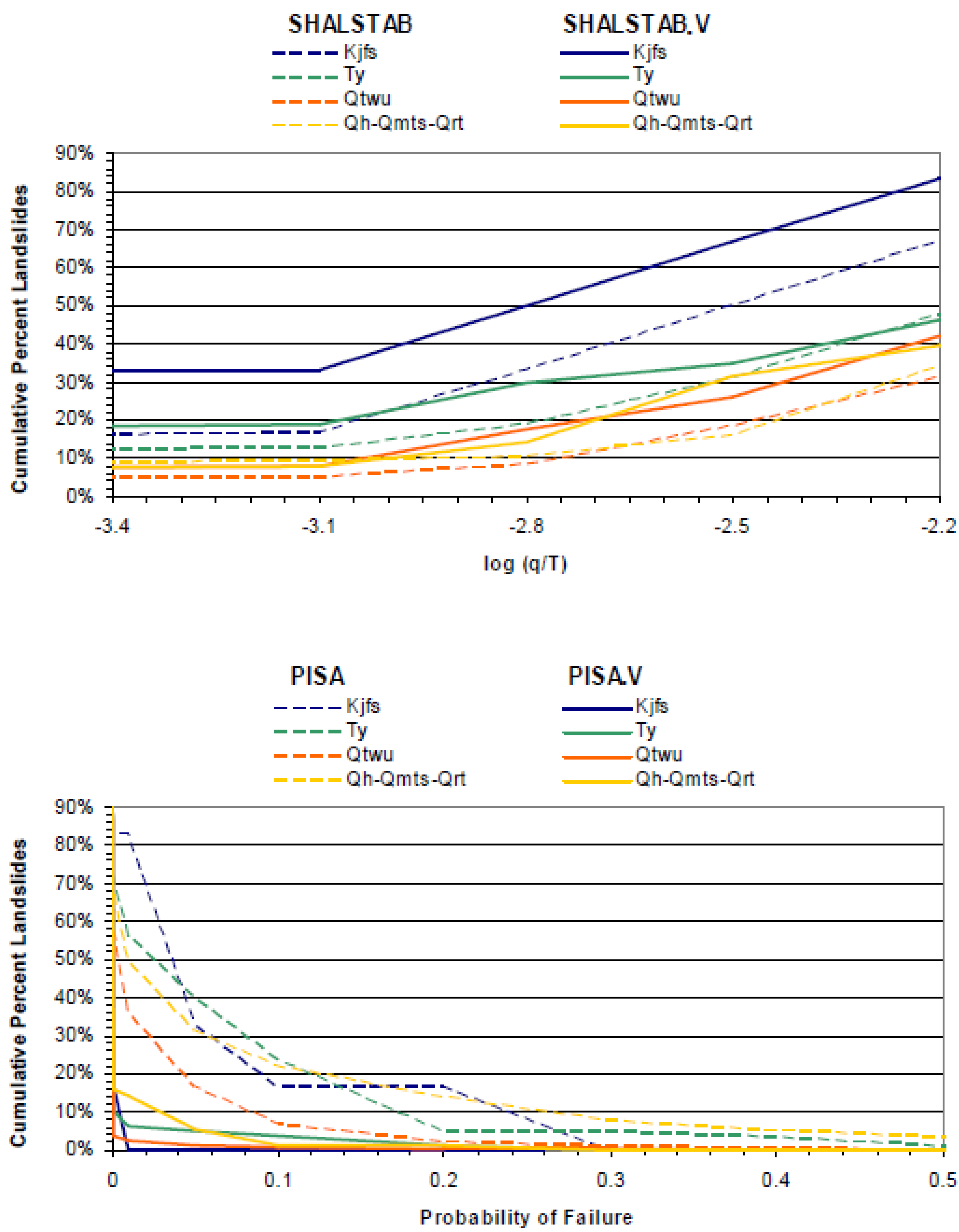

Figure 8. Cumulative percent of landslides in instability classes: a) SHALSTAB and SHALSTAB.V, b) PISA and PISA.V (reproduced from Stillwater (2007) Figure 3-10).

<u>Stark Comment A.13</u>: "Section 2.4.1.3 – Potential Instability Thresholds: Is there any evidence to support the assumption *A* = *B* in this cost analysis?"

<u>Staff Response</u>: The assumption is used as the basis for identifying potential threshold values, as presented in Table 3-6 of Stillwater (2007) (reproduced

as Table 8 below). However if, for example, the Regional Water Board deems the cost of incorrectly classifying landslides as stable greater than the cost of over predicting unstable areas, then the instability thresholds may be defined based upon cumulative percent slides rather than percent area. Alternative threshold values to those based upon the assumption A=B may be identified based upon the relative cumulative percentages presented in Figures 3-9 through 3-11 of Stillwater (2007) (Reproduced as Figures 7-9 of this document).

Table 8. Confidence intervals for threshold values and associated cumulative fraction of slides and area classified by the threshold value (as reproduced from Stillwater (2007) Table 3-6).

Model	Geologic terrain	Threshold potential instability[2]			Cumulative fraction of slides ($RS(x)$)[3]			Cumulative fraction of area ($RL(x)$)[4]		
		Upper limit	Expected value	Lower limit	Upper limit	Expected value	Lower limit	Upper limit	Expected value	Lower limit
Shalstab	Qh-Qmts-Qrt	-2.33	-2.06	-1.80	0.85	0.74	0.58	0.57	0.45	0.33
Shalstab	Qtwu	-2.47	-2.32	-2.18	0.66	0.59	0.52	0.43	0.36	0.30
Shalstab	Ty	-3.79	-2.51	-2.04	0.83	0.65	0.35	0.54	0.37	0.07
Shalstab V	Qh-Qmts-Qrt	-2.42	-2.12	-1.80	0.84	0.72	0.57	0.52	0.40	0.29
Shalstab V	Qtwu	-2.51	-2.35	-2.20	0.66	0.59	0.52	0.42	0.35	0.29
Shalstab V	Ty	-2.97	-2.48	-1.93	0.80	0.62	0.43	0.55	0.35	0.19
PISA	Qh-Qmts-Qrt	0.237	0.174	0.134	0.70	0.57	0.44	0.31	0.24	0.17
PISA	Qtwu	0.060	0.055	0.050	0.55	0.49	0.41	0.27	0.22	0.17
PISA	Ty	0.145	0.092	0.073	0.68	0.57	0.42	0.31	0.25	0.14
PISA V	Qh-Qmts-Qrt	0.268	0.143	0.062	0.75	0.31	0.18	0.16	0.04	0.00
PISA V	Qtwu	0.030	0.021	0.020	0.53	0.46	0.33	0.14	0.09	0.02

[1] Determined by maximizing $RS(x)$-$RL(x)$. Confidence intervals calculated from bootstrap sampling with more than 5000 iterations.
[2] Upper limits reflect greater potential instability. Upper and lower limits are 95% confidence interval.
[3] Cumulative fraction of slides located within areas classified as equal to or more unstable than the threshold potential instability value.
[4] Based on cumulative fraction of random points located within areas classified as equal to or more unstable than the threshold potential instability value.

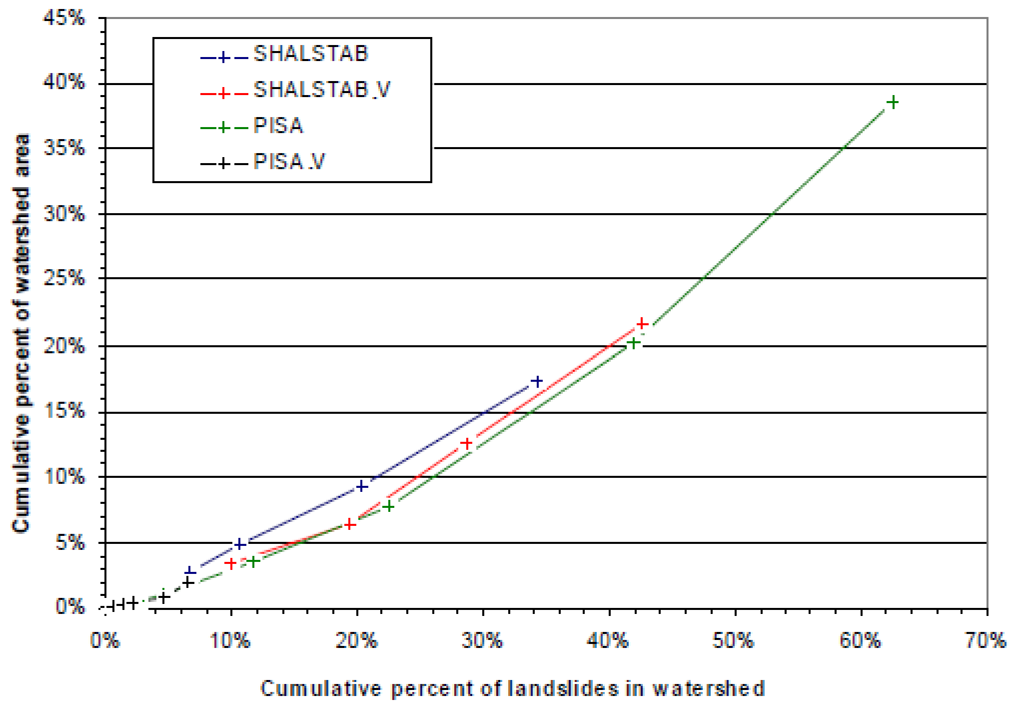

Figure 9. Cumulative percent of watershed areas as a function of the cumulative percent of the number of landslides (as reproduced from Stillwater (2007) Figure 3-11).

Stark Comment A.14: "Section 3.2.1 - Model performance based on p-tests: Does P > 0.5 or P ≤ 0.5 provide enough evidence to determine whether or not the model is performing well? Is there any evidence besides P > 0.5 to validate the conclusion that the model is performing well?"

> *Staff Response*: The hypothesis tests were developed to provide objective and repeatable measures of model performance. Stillwater (2007) used the p-test as the primary indicator of performance relative to landslide locations. Those resulting performance levels were then compared amongst the four models evaluated.

Stark Comment A.15: "Tables 3-2 through 3-4: These tables are simply confusing, see below. The information provided does not show a clear objective/conclusion. For example, knowing 32% of the time SHALSTAB.V is performing better than another model and 33% worse by comparing p-test values does not seem convincing."

> Staff Response: Staff agrees that the tables presenting comparative model performance in the different terrains are difficult to understand, initially. However, they do indicate that for the different terrains, SHALSTAB.V tends to perform better than SHALSTAB and PISA performs better than PISA.V, as represented by the p-tests.

Stark Comment A.16: "Table 3-5: What does cumulative area mean? Is it the landslide area? Total area? Please provide additional detail on the area terms?"

> *Staff Response*: Cumulative area represents the cumulative watershed area in different instability classes as represented by a random sample of 5,000 points. It does not represent landslide area.

Stark Comment A.17: "Figures 3-3 and 3-4 – PISA v. PISA.V: These two figures use a range of probability of failure of 2 % to 100%. Figure 3-3 indicates there are considerable areas of potential slope instability but Figure 3-4 shows there is little area of potential instability. Thus, Figure 3-4 could be used to infer that timber harvesting could occur throughout the area. A detailed explanation of the difference in these two figures should be discussed and recommendations for timber harvesting presented."

> *Staff Response*: The probability of sliding as predicted by PISA is shown in Figure 3-3 and by PISA.V in Figure 3-4 of Stillwater (2007). As noted by the reviewer, Figures 3-3 and 3-4 include a large range for probability of failure in the greatest instability class indicated in the legend, with PISA.V (Figure 3-4) encompassing significantly smaller areas. It is notable that PISA.V does not perform well, especially in the Wildcat Formation (Table 3-1) which comprises the majority of Upper Elk River. For this reason, staff anticipates that PISA.V, in the application described in Stillwater (2007), is not well-suited for use in Upper Elk River. That said, it may prove somewhat useful at the project-scale, especially in the Hookton Formation where it tends to perform better than in the other formations. Table 3-5 provides ranges of instability that appear to be more useful. To be included in Chapter 7 (Implementation) of the Public Review Draft Staff Report and the Watershed WDR development, staff anticipates identifying thresholds of instability based upon the validation test results that reflect landslides in Upper Elk River, rather than thresholds developed for other areas.

Stark Comment A.18: "Figures 3-1 and 3-2 – SHALSTAB v. SHALSTAB.V: These two figures use a range of q/T to indicate areas of potential slope instability. There is much closer agreement between these two analyses than observed for the PISA and PISA.V analyses in Figures 3-3 and 3-4. A detailed explanation of the difference between Figures 3-1 and 3-3 and Figures 3-2 and 3-4 should be presented because the comparison in Tables 3-2 through 3-5 is confusing at best. Table 3-5 is really difficult to comprehend."

> *Staff Response*: The log q/T values, as predicted by SHALSTAB are shown in Figure 3-1 and by SHALSTAB.V in Figure 3-2 of Stillwater (2007). As pointed out by the reviewer, the two variations of SHALSTAB demonstrate much greater agreement than the two variations of PISA. Tables 3-2 through

3-4 provide comparative performance of all the models based upon lower p-values for the three dominant geologic terrains in Upper Elk. Table 3-5 describes the cumulative area and cumulative number of slides associated with different instability classes for each of the models in the different geologic terrains. Staff regrets the difficulty the reviewer had in comprehending Tables 3-2 through 3-5, especially Table 3-5. Revisions to Chapter 7 (Implementation) of the Public Review Draft Staff Report will provide a detailed explanation and interpretation of the information contained in the Figures and Tables depicting the stability classes and validation results associated with each of the models.

Stark Comment A.19: "Section 4.1 – Uses and Limitations: The landslide hazard mapping presented does not directly address potential sediment delivery from landslide-prone areas to the Elk River. As mentioned above, one missing parameter is measurements of soil thickness throughout the area. This may be able to be facilitated with some handheld probes that can be quickly inserted into the colluvium to measure depth, e.g., http://www.grainger.com/Grainger/DICKEYJOHN-Soil-Compaction-Tester-2LBB3 or http://www.southernstates.com/catalog/p-3377-stainless-steel-deepcore-probe-soil-sampler-36.aspx."

Staff Response: Staff appreciate the reviewer's desire to address sediment production rather than just potential landslide occurrence. With respect to soil thickness, see Staff Response to Stark Comment A.9.

Topic VI. Identification of Additional Beneficial Uses of Water for the Elk River Watershed

Conclusion 14. The Wetland Habitat (WET), Flood Peak Attenuation/Flood Water Storage (FLD), and Water Quality Enhancement (WQE) beneficial uses exist in Elk River.

Baker Comment 14.1: "The supporting science for these findings could not be found in the *Draft Staff Report for the Upper Elk River Sediment TMDL*). There is no chapter entitled "Proposed Beneficial Uses of Water of the *Draft Staff Report for the Upper Elk River Sediment TMDL*". There was some limited material on this topic in Appendix 1-B "Proposed Revision to the Identification of Beneficial Uses for the Elk River Watershed." This appendix cites relevant scientific literature on the ecological function of wetlands, specifically in regard to FLD and WQE enhancement. Moreover, it documents the presence of wetlands in the Elk River watershed.

"Appendix 1-B was incomplete, and concludes with a staff recommendation to identify additional beneficial uses for WET in the Lower Elk River subwatershed as well as the identification of existing beneficial uses for WQE and FLD. I conclude that this finding is based upon sound scientific knowledge, methods, and practices."

> *Staff Response*: Since the development of the Peer Review Draft Staff Report, staff have identified that a single action TMDL approval will be pursued. As a result, actions identified in the Peer Review Draft Staff Report outside the scope of the Watershed WDR proposed as the implementation mechanism for the TMDL will be removed from the Public Review Draft Staff Report. That includes identification of the three wetland-related beneficial uses in Upper Elk River and the proposed hydrology objective. These potential actions require amendment of the basin plan and will be prioritized for basin planning action under the next triennial review process, currently scheduled for 2014.

Ruggerone Comment 14.1: "Wetland habitats provide important functions for salmonids and for stream conditions, as described in Appendix 1B. Appendix 1B provides information and specific locations of wetlands in the Elk River watershed. Wetlands are identified in the lower Elk River e.g., http://107.20.228.18/Wetlands/WetlandsMapper.html. It is reasonable to include WET, FLD, and WQE as beneficial uses in the Elk River."

> *Staff Response*: Comment noted.

Miller: No comments on Conclusion 14.

Stark: No comments on Conclusion 14.

Other Topics: "Big Picture" Questions

(a) In reading the technical reports and proposed implementation language, are there any additional scientific issues that should be part of the scientific portion of the proposed rule that are not described above? If so, comment with respect to the *TMDL Summary and Implementation Framework* and *Beneficial Use Amendment* given above.

(b) Taken as a whole, is the scientific portion of the proposed actions based upon sound scientific knowledge, methods, and practices?

Baker Comment Big Picture a.1: "The report does not directly discuss the issue that a major source of the sediment problems of the Elk River system derives from a combination of management practices and what probably were extreme storm events in the early 1990s. This suggests that a major pulse of sediment was imposed in this time period and that temporary storage and remobilization of this sediment could likely be an important factor."

Staff Response: Staff agrees that the water quality impairments in Upper Elk River are a result of past management practices and wetter than average storm events and annual rainfall in some years. The Problem Statement characterizes the beneficial use and water quality conditions in Upper Elk River while providing context in terms of land management history. The Source Analysis identifies how sediment loading has varied with landuse and storm history. In a previous comment, the reviewer suggested that more discussion of the storm history was warranted. Staff will make revisions in the Public Review Draft Staff Report to include such a discussion (see response to Baker Comment 1.7).

Staff will modify the Public Review Draft Staff Report to more clearly convey that natural factors make the watershed inherently erodible and that intensive and extensive land management activities (especially between 1986-1997) caused the landscape to be particularly vulnerable when subject to wetter than average storm events and annual rainfalls. The results were widespread landsliding and other management-related sediment delivery to streams. The transport capacity of the middle reach of Elk River was overwhelmed and a significant portion of the sediment load was stored in the channel, on its banks and on the floodplain. The volume of this stored sediment is estimated as the largest sediment source under the TMDL and a 100% reduction identified as necessary to abate nuisance flooding conditions, restore water quality, and protect beneficial uses. As described in the implementation strategy, remediation of this stored sediment is crucial to the recovery of ecological function in the Upper Elk River watershed. Further, until it is remediated, activities with the potential to deliver additional sediment loading to the stream channel must be carefully controlled.

Additionally, the Peer Review Draft Staff Report identifies an abundance of bank erosion and streamside landslide sources, especially from Class II and III (low order) watercourses. While these sources appear to be primarily related to erosion following soil pipe collapse and gullying within watercourses, there is observed storage of material farther down in these low order watercourses and within the Class I subbasins. The remobilization of this material is not directly addressed by the sediment Source Analysis because reliable storage and transport rates were not readily available. The TMDL load allocation strategy specifies significant reduction from these in-channel sources over the next 20 years. During that time, the implementation of control measures and monitoring should inform estimates of sediment remobilization. Staff has also identified the potential for implementing wood structures to help trap this sediment and to mechanically remove it from the fluvial system.

Staff notes that a stated limitation in the Source Analysis is that it quantifies sediment delivery but does not evaluate channel routing through the system (Peer Review Draft Staff Report pages 4-25, 4-27, and 4-40).

Baker Comment Big Picture a.2: "Another important "Big Picture" issue is that the regulatory framework in which the Elk River issues are being assessed derives from the use of TMDLs, which are defined by USEPA as containing Elk River targets for water quality standards. Many of the Elk River issues (increased flooding, aspects of recreation uses) are not strictly water quality issues. Another way to make this point, perhaps a bit bluntly, is to say that forced adherence to this framework (water quality standards) for a larger, and only peripherally related set of issues (flooding, remediation [*sic*]) is not to pursue the matter in a scientific manner. Specifically it does not employ an [*sic*] scientific methodology."

Staff Response: The TMDL was developed within the framework of USEPA TMDL requirements and state and federal water quality standards. In California, both pollution and nuisance are considered in water quality standards. In addition, a critical component of TMDLs in California is the development of a program of implementation that provides reasonable assurance that all pertinent water quality standards are protected and restored.

As described on page 1-8 and 1-9 of the Peer Review Draft Staff Report, water quality standards include beneficial uses (including recreational uses), water quality objectives to protect those uses, a process to prevent degradation of high quality waters of the State, as well as a program of implementation. The Basin Plan's sediment-related water quality objectives identified on Page 1-11 are generally narrative and cite levels so as to not "cause nuisance or adversely affect beneficial uses." The Peer Review Draft Staff Report documents that increased flooding is the result of decreased channel capacity caused by sediment deposition. The conditions cited by the reviewer (increased flooding, aspects of recreation uses) are intrinsically linked to water quality standards and thus are not peripheral to the sediment issues in Elk River. Consideration of flooding, recreation and remediation and attainment and maintenance of water quality standards is not strictly a scientific matter but is clearly required by California regulation.

Baker Comment Big Picture b.1: "In regard to topic (b), as a scientist, I have been charged to be particularly concerned in this review with the, "…***responsibility to determine whether the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices***" (emphasis added in ***bold italics***). As has been noted in some of my detailed review of individual topics, much of the document is framed, not as a scientific methodology, but as an engineering methodology utilizing scientific knowledge and engineering practice to achieve a regulatory standard. This is obviously a very "Big Picture" issue, and there will be disagreement on it by professionals.

"According to Chapter 1 of the Staff Report, a "complete TMDL" includes an "*Implementation Plan*" and a "*Monitoring/Re-evaluation*". Elements of these are included in the Staff Report as Chapter 7. However, everything I read in regard to monitoring is addressed to see if there is compliance with standards. This is engineering, not science. In science standards must always be questioned. A standard must always be regarded [*sic*] as a hypothesis, and a better standard (hypothesis) should be the goal of the scientific methodology. Monitoring for compliance with the standard is engineering methodology, not scientific methodology. To be scientific the monitoring would have to lead to testing for relevance of the existing standard.

"I can see two ways to address this issue. One is to embrace a scientific methodology, as I have outlined it, though I think that the response may pose severe problems, given the regulatory framework within which the TMDL is being defined.

"The other way to address this issue is to make it very clear to all that the proposed TMDL for the Upper Elk River is the product of an engineering exercise, not a scientific one. Moreover that this exercise works to achieve the best possible estimate of a TMDL for the prevailing circumstances in the watershed, in compliance with current regulatory standards, utilizing best engineering practice, employing the most appropriate existing scientific knowledge, subject to limitations of time and money to perform the analysis, etc. In taking this approach, it should also be made clear to all that circumstances in the watershed are subject to continuous change such that it is impossible to make an absolute prediction in advance of the best possible TMDL that will incorporate un known changes is the future, and that, as in all engineering solutions, one must accept these limitations."

Staff Response: The reviewer's distinction between engineering and scientific methodologies is appreciated. Staff believes, however, that development of a TMDL and the process of TMDL implementation must employ both scientific and engineering methodologies, and that these methodologies compliment rather than conflict with one another. The Regional Water Board employs engineers, geologists, and scientists who are charged with integrating engineering and science for beneficial uses protection and to prevent nuisance conditions.

As the reviewer describes, staff did take an engineering approach, informed by available scientific knowledge, to make our best quantitative estimates of conditions necessary for beneficial use protection, prevention of nuisance and attainment of water quality objectives. Those estimates form the basis of the TMDL in the Peer Review Draft Staff Report. Those estimates also provide the foundation for staff's development of a robust program of implementation that will be further developed in the Public Review Draft Staff Report.

To ensure the TMDL program continues to be scientifically sound, and is effective in attainment of water quality standards, there will need to be monitoring and adaptive implementation. The monitoring should be designed to test, in part, the linkage to reference conditions, the loading capacity, and the adequacy of the numeric targets.

Staff anticipates the need for an effective forum for development and review of monitoring study design and analysis of results. Ensuring that the studies are designed in such a way to truly answer questions is no small task and has been a challenge to Elk River stakeholders in the past. Considering the scientific disagreement over the years, the process needs to be transparent with data widely available for independent verification and exploration by interested parties. Such an effort will require the investment of resources, both time and money, as well as providing sites for study. Staff intends to include a description of this process in the monitoring program in the Public Review Draft Staff Report.

With respect to the reviewer's comment regarding the need to question standards, TMDLs are developed in order to attain and maintain water quality standards. We have no information indicating that standards cannot be achieved in the Upper Elk River watershed. The iterative process associated with adaptive implementation of control measures, restoration activities, and monitoring will allow us to assess progress toward attainment of standards.

Ruggerone comment Big Picture a) and b): "The Staff Report provides a detailed description of how they derived the TMDL, and it is reasonable to assume that achievement of the TMDL would lead to improvements in beneficial uses of the Upper Elk River. Numeric targets in support of the TMDL were described, but a detailed description of the monitoring component has not been developed. Monitoring is essential to ensure that the numeric targets are on track, and to inform decisions under an adaptive management framework. A decision tree should be developed to provide new direction when targets are not being achieved within the desired timeframe. For example, the implementation actions state that "If milestones for load reductions from instream deposits are not achieved, management-related discharges shall not be permitted." What does this mean given that sedimentation is dependent *on* [sic] activities that occurred over many previous years and it cannot be simply stopped?

"Details of the implementation plan are needed. It was not clear to what extent active restoration would occur versus passive restoration following changes in harvest management. The TMDL calls for a tremendous reduction in management-related sedimentation, but it was not clear how specific actions would achieve this target by the desired date, especially since the primary landowners have been implementing sediment control measures since 1997. What are the costs to implement the plan and are monetary resources available to implement the plan?

"The Staff Report focuses on impact related to sedimentation in the Upper Elk River. Clearly, sedimentation has had a significant effect on beneficial uses such as salmon. However, to better achieve salmon restoration in the Elk River, it would be worthwhile to implement a landscape or watershed-wide approach that evaluates and repairs factors identified to be impacting the status of salmonids throughout the entire Elk River watershed, including the estuary. Factors important to salmonids in the Elk River may include issues beyond sedimentation.

"Hydrology is a key factor influencing sediment loading and sediment transport through the watershed, yet relatively little information was provided on the Elk River hydrograph. For example, how might extended periods of low versus high water years affect implementation of the TMDL? Are flows sufficient to scour sediments, especially given that vegetation has encroached into the channel?

"As described above, the proposed actions are based on reasonably sound science. However, additional actions may be needed to speed progress. For example, riparian buffers could be implemented and LWD could be strategically placed in the stream channel to scour the channel and to create pool habitat. A key uncertainty is the extent to which the Program will lead to desired conditions within the specified time frame. Monitoring and adaptive management with specific decision point triggers would help ensure that the Program is successfully implemented."

Staff Response: Staff agree that a robust implementation and monitoring strategy must be developed within an adaptive framework. See Staff Response to Baker Comment 5.2.

Given the geology and geomorphology of the Elk River watershed, passive restoration alone will not lead to attainment of the assimilative capacity of the stream channel. Therefore, with respect to the question of active restoration, the proposed recovery approach is to develop a strategy to implement feasible recovery actions to help contain the 1.5-2 year recurrence interval flows, improve ecosystem function, and to ensure that system is on trajectory toward stability. Such recovery actions may include remediation of the instream deposits, reducing channel constrictions and elevating roadways and infrastructure, and other engineered solutions (see Table 9 below for potential recovery actions and considerations). Implementation of feasible recovery actions in the depositional reach, coupled with sediment load reduction through control of persisting and new sediment discharges, provide a comprehensive approach to recovery in Elk River.

Because the assimilative capacity is currently taken up by the instream deposits, the Regional Water Board cannot justify additional discharges without a strategy and a schedule to ensure the sediment loading comes in line with the loading capacity. Staff's proposed recovery strategy establishes milestones for load reductions from instream sediment deposits. Based on the ISRP report and the Klein et al (2011) study, management of cumulative watershed effects by reduction in timber harvest rate is viewed as a control mechanism necessary to reduce sediment discharges. Therefore, staff proposes that if through voluntary implementation of recovery actions, the milestones for load reductions from instream deposits are not achieved, then step-wise increases in allowable timber harvest rate may not be permitted.

Many years of effort have already been invested in the development of a hydrodynamic model capable of predicting the effectiveness of various sediment remediation techniques to restore hydrologic function in the Upper Elk River watershed. Recently, funds were secured to model the whole lower end of the river (to its discharge to Humboldt Bay) in order to test the feasibility of a suite of sediment remediation techniques (e.g., sediment removal, control of vegetation encroachment on sediment deposits, and sediment diversion to the floodplain). With the results of the feasibility study, a remediation action plan will be developed which prioritizes a series of actions to remediate stored sediment and restore aquatic habitat. Staff views each of these steps as crucial to recovery of the Elk River.

In addition to the load reductions from the remediation of instream deposits, significant reduction in the sediment loading from hillslope sources is identified. The focus of the sediment reduction measures since 1997 has been on hillslope actions, such as: treatment of management discharge sites, reduction in surface erosion from roads, and implementation of timber harvest activities in conformance with endangered species and water quality protection. Important progress has been achieved in reducing sediment discharges from these hillslope sources. However, to date there have been no defined target sediment load reductions; rather, only general goals for reductions from all-time high sediment loading rates. The TMDL load reductions provide new goal conditions necessary to achieve the sediment loading capacity. As described in the Peer Review Draft TMDL Staff Report, the full remediation of instream stored sediment and the reduction in the volume of sediment delivered from ongoing hillslope activities are coupled. Further, the implementation strategy is based on the premise that the amount of allowable cumulative watershed effect (as measured by timber harvest rate) is controlled by the amount of measured progress in sediment source reductions.

To be clear, in the Peer Review Staff Report, staff proposes a conceptual framework in which allowed timber harvest rate is reduced to approximately 0.4% annually within Class I subbasins at the beginning of TMDL implementation, and increases up to an annual maximum of 1.5% over time as instream and upslope sediment load reductions are achieved. The details of the conceptual framework of implementation will be developed in the new watershed WDR and described in Chapter 7 of the Public Review Draft Staff Report.

Staff agrees with the reviewer's assertion that landscape or watershed-wide approaches to salmonid restoration are required in the Elk River watershed. As described in Appendix 3-B of the Peer Review Draft Staff Report, California Department of Fish and Wildlife have conducted salmonid life cycle monitoring in the adjacent watershed of Freshwater Creek and in Martin Slough of Lower Elk River. They have found that over-winter rearing areas of the stream-estuary environment allow coho to grow larger prior to outmigrating to ocean conditions. Further, they have found that seasonally flowing streams, ponds, and wetlands may be important to provide low gradient, low velocity refuge during winter flows. There is great opportunity to enhance these types of habitats in Elk River to provide greater support to beneficial uses. Regional Water Board staff support exploration of such projects. Where possible, the Recovery Assessment (the feasibility study described above) will identify restoration actions to address ecosystem function and habitat enhancement throughout the watershed. That said, the TMDL strategy necessarily focuses on sediment-related impacts as a means of addressing the 303(d) listing.

Staff agrees with the reviewer's statement regarding the importance of hydrology in influencing sediment loading and transport. There are many elements related to sediment transport in Elk River that are not yet well understood, including scour of stored material. The Elk River Hydrodynamic and Sediment Transport Pilot Project (Appendix 3-D) indicates that a 75% reduction in 2003 loading would result in localized scour of stored material. As described in the Peer Review Draft Staff Report, the fate of the scoured material is unknown due to the limited length of river evaluated. The Elk River Recovery Assessment will provide important information on the trajectory of the system, provide insight into the assimilative capacity of the channel in the middle reach of the watershed, and inform important monitoring elements.

Miller: No comments on Big Picture a) or b).

Stark: No comments on Big Picture a) or b).

Table 9. Potential actions alternatives with consideration to salmonid habitat for various life stages and impact on infrastructure and nuisance flooding.

	POTENTIAL ACTIONS							
	Inset Floodplains	Levee Removal or Set-Back Levee	Off-Channel Detention Basin	New Channel Construction	Dredging	Eco Berm	High Flow Channel	Vegetation Management
FISH AND BENEFICIAL USES GOALS								
Growth and survival (G-S)	+	+	+	+/-	+/-	-	+/-	+/-
Rearing habitat ('R)	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Spawning habitat (S)	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+
Infrastructure and nuisance flooding (I)	+	+	+	+	+	+	+	+
MECHANISM								
Reduce suspended sediment concentrations (G-S)	+	+	+	+/-	+/-	-	+/-	+/-
Fine sediment storage outside main channel (G-S, S, R)	+	+	+	+	-	-	+	+
Mobilize bed material (flush fines, scour pools) (S, R)	-	-	-	+/-	+	+	-	+
Channel complexity (R)	NA	NA	NA	+	-	NA	+	+/-
Connectivity between channel and floodplain (R)	+	+	+	+	-	-	+	
Limit deposition of sediment in estuary (R)	+	+	+	+/-	+/-	+/-	+/-	+/-
Flood conveyance (I)	+	+	+	+	+	+	+	+
LOCATION TYPE								
High sedimentation zones	-	-/+	+	+	+	+	+	+
Moderate sedimentation zones	+	+	+	+	+	+	+	+
Bed material anchored with vegetation	-	-	-	+	+	+	-	+
Entrenched channel	+	+	-/+	+	-	-	-	+
Leveed channel	-/+	+	+	+	+	-	+	+
Adjacent floodplain available	-	+	+	+	-	-	+	+
UNKNOWNS								
Suitable location	X	X	X	X	X	X	X	X
Length/area required for effectiveness	X	X	X	X	X	X	X	X
Local channel changes	X	X	X	X	X	X	X	X
Downstream effects	X	X	X	X	X	X	X	X
COST CONSIDERATIONS								
Maintenance			X		X			X
Material volume, quality, length of treatment	X	X	X	X	X	X	X	X
Development of access points	X	X	X	X	X	X	X	X
Land easements/acquisition	X	X	X	X	X	X	X	X
New infrastructure (e.g. bridge, utility relocations)	X	X	X	X	X	X	X	

G/S = Growth & Survival
R = Rearing
S = Spawning
I = Infrastructure, Nuisance flooding

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Appendices