

## **NAPA RIVER WATERSHED SEDIMENT TMDL: RESPONSES TO PEER REVIEW COMMENTS**

*The Technical Report (TR) for the Napa River Watershed Sediment TMDL and Habitat Enhancement Plan was sent to peer reviewers Robert J. Naiman and William Rahmeyer on February 17, 2006. After that February 17, 2006 draft Board staff revised the Basin Plan amendment and Staff Report. Professor Naiman submitted his comments on March 9, 2006; Professor Rahmeyer responded on April 19. Their reviews are in Appendix A.*

*On June 30, 2006, staff released a Proposed Basin Plan amendment and Staff Report for public comment. The June 30 documents included revisions made in response to some of the peer reviewers' comments. Documents that staff propose for adoption by the Water Board (January 23, 2007) contain all revisions made in response to all comments.*

*This Response to Peer Review Comments document shows, in ~~strikeout~~ and underline, deletions and additions to the June 30, 2006 documents. Earlier changes made in response to peer review comments that were incorporated in the June 30 documents are discussed and presented herein; however they are not shown in underline and strikethrough.*

### **Responses to Comments from Professor Naiman**

In our responses to comments and questions raised by Professor Naiman, numbering is sequential. Page numbers refer to the 2/17/06 draft of the Technical Report that he reviewed.

#### **General Comments and Concerns**

**Comment N-1: "As a whole, much of the information in the documents is well researched, the general conclusions founded on solid facts, the rationale for needing to reduce sediment loads justified in light of salmon habitat, and some of the recommended approaches are reasonable. The authors have done a good job in addressing and articulating a highly complicated issue that has implications going far outside the perennially wetted channels. I have visited the Napa River and its tributaries several times, and concur that sediment loads and channel incision are too severe to adequately support steelhead and Chinook salmon for the long-term. Spawning and rearing habitat, as well as general environmental conditions, are not optimal for these and other native aquatic species. Recommendations contained in the Technical Report need to be adopted – but are only a start – if the river network is to re-attain a reasonable ecological vitality. Additional restoration of riparian and adjacent off-channel aquatic habitats will be needed too."**

We appreciate Professor Naiman's support for this complex project, and we agree that significant riparian and flood plain restoration are key to success in restoring the fishery and maintaining a healthy watershed. In the draft report reviewed by Professor Naiman, we did not describe three large-scale stream-riparian habitat restoration projects that are now being planned or implemented in the Napa River watershed. When these projects are considered,

they should address the concerns expressed in this comment. We have edited the Staff Report, Section 6.4, Approaches to Achieve Allocations, Channel Incision, to include descriptions of these projects:

### **Channel Incision**

... Restoration of natural bar-pool topography and channel flood-plain connectivity also may be needed to protect other rare or threatened species, including California freshwater shrimp, that are distributed solely or primarily in the Napa River and lower tributary reaches. Additionally, streamside land uses, public works infrastructure, and utilities are threatened by the high rates of bank erosion associated with channel incision processes along the Napa River. Three large scale stream-riparian restoration projects are being planned or implemented in the Napa River watershed that will address the adverse impacts of channel incision:

- 1) The Rutherford Napa River Restoration Project, initiated by the Rutherford Dust Society, which involves actions to enhance stream-riparian habitat conditions and reduce fine sediment delivery rates within a 4.6-mile long reach of the Napa River from Zinfandel Lane to Oakville Cross Road. The first phase of implementation within the upper 1.3 miles of this reach has been funded and will be constructed in the dry season of 2008. In the upper 1.3 miles, steep terrace banks will be setback, and inset floodplains will be created over approximately 3,500 feet of banks that are rapidly eroding at present. The created floodplains are designed to be inundated during the 1.5-year flood event. In the above described areas, native riparian plant species will be re-established and maintained, and invasive species will be removed. A large remnant side-channel will be re-connected with the mainstem channel, and be graded at an elevation, such that it is continuously inundated during the wet season. Other remnant side channels will be graded so that they are inundated during 5-to-10-year flood events. 4,100 feet of existing agricultural levees will be setback 50 feet, reconstructed, and within the setback native riparian species will be re-established and maintained. Also, 35 engineered log jams will be installed to force bar-riffle-pool units to form, as needed to enhance streambed topography in sub-reaches that are now dominated by run-pool habitats. The landowners within the reach, working with the County, are forming an assessment district to fund required project monitoring and anticipated future maintenance efforts.
- 2) Similar to the Rutherford Napa River Restoration Project, another stream-riparian habitat enhancement and sediment reduction project is now being planned in the adjacent downstream reach, which is 9 miles long and extends from Oakville Cross Road to Oak Knoll Avenue. Funds have been obtained to develop a conceptual plan for restoration of this reach, which will be completed in the fall of 2008. For this project, the areas within the reach that have functional floodplains and complex channel habitat will be identified and considered as potential reference models to guide restoration efforts

elsewhere in the reach, where the channel is unstable and widening in response to the recent phase of down-cutting. Channel enhancement efforts that may be considered in development of the conceptual plan for restoration include: a) bank setbacks and re-vegetation; b) increasing channel sinuosity to facilitate re-establishment of stable bed elevation and the formation of bar-riffle-pool units; c) construction of inset floodplains; d) levee relocation; and e) re-establishment of remnant side channels. In riparian corridors throughout the reach invasive plant species would be eradicated and native riparian species would be re-established.

- 3) The Fish Friendly Farming Environmental Certification Program, which involves implementation of farm plans certified as protective of water quality and salmonid fisheries by NOAA Fisheries and the Water Board. Within the past two years, 7,000 acres of vineyards and a similar amount of adjacent undeveloped rural acreage in the Napa River watershed have been certified under the program. We expect the amount of acreage certified under the program to double within the next two years. Farm plans prepared under the program address all aspects of farming operations that may influence water quality and fisheries habitat conditions. With regard to the impacts of channel incision on sediment delivery to channels and habitat complexity, as a condition of certification under the Fish Friendly farming Program, farmers agree to establish and maintain a riparian corridor setback throughout the property that is equal in width to four times bankfull channel width (as estimated from regional stream flow gauging at sites where channels are neither down-cutting or filling-in). In most cases, this will involve a passive restoration approach, by allowing channels that are now incising and widening to erode (without intervention), and dynamically re-establish stable width-to-depth ratios, pool-bar topography, inset floodplains, and to re-establish riparian under-story and canopy species on stream banks and flood plains. As part of the approved farm plans, invasive plant species are removed from the property, native plant species are planted in the riparian corridor, and vegetation maintenance plans are established to control invasive plant species.

We strongly support the above efforts being undertaken by Rutherford DUST Society that are being planned or implemented to enhance ecological functions of stream and riparian habitats along the Napa River and in its tributaries. Adopting a channel restoration approach at the reach scale for treatment of channel incision and associated bank erosion, as is proposed in the Rutherford and Oakville-to-Oak Knoll reaches, has several potential advantages including, but not necessarily limited to the following:

- Higher cost effectiveness than hard engineering approaches
- Greater likelihood of long-term success
- Lower long-term maintenance costs
- Enhanced aesthetic and recreational values

- The potential to reverse some of the significant adverse ecological impacts of incision on stream-riparian ecosystems
- A much more favorable position with regard to regulatory permit reviews and approvals

Furthermore, by implementing a project on a channel reach scale it should be possible to balance sediment supply and transport capacity throughout the reach (e.g., one landowners bank and/or bed stabilization solution does not become another's problem). Also, by adopting a channel restoration approach on a large scale, there appears to be a very high potential to receive significant public funding to support the design and implementation.<sup>36</sup> From our standpoint as a potential funding agency, or in acting in an advisory capacity to others, we will be strong advocates for the adoption of ecologically superior design alternatives in the Rutherford and Oakville-to-Oak Knoll reaches that results in meaningful enhancement of the stream-riparian ecosystem. To this end, we also support ~~consideration of~~ adoption of standards to guide the design process and evaluate the ecological success of the river restoration project that is implemented, as have been put forward recently by Palmer et al. (2005).<sup>37</sup>

#### Footnotes:

<sup>36</sup>Public funding to-date from State Coastal Conservancy, Napa County Measure A funds, ~~and CDFG~~ California Department of Fish and Game, and the Water Board ~~to support for~~ development and implementation of a restoration design actions in the Rutherford and Oakville-to-Oak Knoll reaches has been over ~~\$500,000~~ \$2,700,000; more than 90% of the total costs thus far.

<sup>37</sup>This paper can be obtained online at [http://nrrss.umd.edu/Publications/Palmer et al 2005 JAE.pdf](http://nrrss.umd.edu/Publications/Palmer%20et%20al%202005%20JAE.pdf)."

Professor Naiman states that "Those parts of the Plan relating to salmon habitat enhancement provide a foundation for restoring steelhead and Chinook populations—but they do not go far enough." He listed three major concerns in this area:

**Comment N-2: "It is dangerous to imply that the population declines are due largely to poor spawning habitat and channel incision. There are many other important factors that could be major contributors to the declines (e.g., disease, ocean conditions, fishing, temperature, and so forth). It may be more persuasive to argue that improving spawning and rearing conditions are essential and critical steps in the recovery process. What if the assumptions underpinning proposed actions are wrong or do not provide a demonstrable recovery in the populations? Nevertheless, linking actions to reduce TMDL with salmon enhancement activities is essential."**

We did not intend to imply "that the population declines are due largely to poor spawning habitat and channel incision." Instead, as you suggest later in your comment, we intended to make the point that "improving spawning and rearing conditions are essential and critical steps

in the recovery process.” In response, we made modest changes (e.g., use of the words “a” versus “the”, and “key” versus “primary” limiting factor) to the June 30, 2006 draft of the staff report (Detailed Problem Statement, Section 2.2) to clarify that:

- a) We conclude that high concentrations of fine sediment in the bed of Napa River and its tributaries cause significant decreases in growth and survival of juvenile steelhead and Chinook salmon during all freshwater life stages, and as such, is one of several significant factors that limit steelhead and salmon run sizes in Napa River watershed.
- b) We conclude that channel incision has greatly reduced the quantity and quality of spawning and rearing habitat for Chinook salmon in the Napa River watershed, and therefore incision appears to be a key factor limiting Chinook salmon run size.

The Detailed Problem Statement (Section 2.2) contained within the staff report now reads as follows:

## **2.2 Detailed Problem Statement**

We reviewed available information to conclude that there has been a significant decline in the distribution and abundance of steelhead and coho salmon in the Napa River and its tributaries since the late 1940s (U.S. Fish and Wildlife Service, 1968; Anderson, 1969; and Leidy et al., 2005). The U.S. Fish and Wildlife Service (1968) estimates that the Napa River watershed once supported runs of 6,000–8,000 steelhead, and 2,000–4,000 coho salmon, and that by the late 1960s, coho salmon were extinct in the watershed, and the steelhead run had reduced to about 1,000 adults.<sup>3</sup> At present, the steelhead run is estimated at less than a few hundred adults (Emig and Rugg, pers. com., 2000 and Leidy et al., 2005).

Much less information is available to evaluate status and trends in population of Chinook salmon in Napa River. We are not aware of any historical research that has been conducted to determine whether Chinook salmon are native to Napa River. However, recent studies in Sonoma and Putah creeks, which border Napa River, document the historical occurrence of native fall-runs of Chinook salmon in both streams (Dawson, 2002 and Yoshiyama et al., 2000). These streams have flow regimes that are similar to Napa River, and up until recent decades, Sonoma, Putah, and Napa all had gravel-beds and bar-pool channels that could have provided abundant spawning and rearing habitat for Chinook salmon. Considering the above information, we conclude that it is likely that the Napa River also supported a native fall-run of Chinook salmon. In recent years, we estimate that a few hundred or more Chinook salmon spawned in the Napa River.<sup>4</sup>

In 1990, based on evidence of widespread erosion (USDA Soil Conservation Service, 1985; White, 1985) and the resulting threat to fish habitat (Cordone and Kelly, 1961), the Water Board listed the Napa River as impaired by sedimentation. The primary impetus for listing was concern regarding the decline since the 1940s in abundance and distribution of steelhead trout.

To improve understanding of current fisheries habitat conditions and the significance of sediment pollution relative to other factors that may be limiting populations of steelhead and salmon, the Water Board partnered with the State Coastal Conservancy to provide funding for the *Napa River Basin Limiting Factors Analysis* (Stillwater Sciences and Dietrich, 2002). The limiting factors study documented two adverse impacts of sediment pollution on steelhead and salmon habitat. The first impact is due to a high concentration of fine sediment deposited in the

streambed, which adversely affects spawning and rearing habitat for both species. The second impact is due to channel incision, which occurs primarily in the mainstem and lower tributaries and affects Chinook salmon to a much greater extent (because most steelhead spawn further upstream in the tributaries). These sediment-related impacts are discussed below:

- Documentation of low permeability values at potential spawning sites for salmon indicates a high concentration of fine sediment in the streambed. Successful salmon and steelhead reproduction depends on adequate water flow through gravel in order for eggs to hatch and larvae to grow. If fine sediment clogs the gravels, flow is very slow, egg mortality can be very high, and few young fish (fry) may emerge from the streambed. Low gravel permeability is predicted to cause high rates of mortality between spawning and emergence at potential spawning sites in Napa River and its tributaries.
- High concentration of fine sediment in the streambed also can cause significant decreases in growth and survival of juvenile salmonids during freshwater rearing by reducing availability of vulnerable prey species and increasing activity level, aggressive behavior, and attacks between juvenile salmonids (Suttle et al., 2004).
- Juvenile steelhead use open spaces between clusters of large cobbles and/or boulders as winter refuges from predators and high flows (Hartman, 1965; Chapman and Bjorn, 1969; and Meyer and Griffith, 1997). As the concentration of fine sediment in streambed increases, quality of winter rearing habitat is significantly diminished with consequent adverse impacts to survival.
- Scour of spawning gravel during commonly occurring peak flows (e.g., bankfull) can be a significant source of mortality to incubating eggs and larvae of salmon and trout species (McNeil, 1966; Montgomery et al., 1996). Human actions that increase rate of sediment supply, and/or cause it to become finer, will cause the streambed to become finer, facilitating an increase in mean depth and/or spatial extent of scour (Carling, 1987).
- Active and rapid channel incision in mainstem Napa River and lower reaches of its major tributaries has greatly reduced quantity of gravel bars, riffles, side channels, and sloughs, and has greatly decreased frequency of inundation of adjacent flood plains. These features and processes provide essential spawning and juvenile rearing habitat for Chinook salmon, which reside primarily in the mainstem Napa River. Therefore, channel incision appears to be a key factor limiting Chinook salmon run size. Channel incision, and associated bank erosion in areas underlain by thick alluvial deposits, also appears to be a significant source of sediment delivery to Napa River. Shallow groundwater stored in the valley floor adjacent to incised channel reaches is more rapidly depleted during the spring and summer, causing spring and summer baseflow persistence to be reduced, and the quantity and quality of cold pools (e.g., those fed by groundwater inputs) to be diminished.
- Much lower frequency of inundation of adjacent flood plains, as a result of channel incision, contributes to a variety of adverse impacts to aquatic and riparian habitat including:
  - a) Diminished extent of riparian vegetation on the valley floor

- b) Very poor conditions (in most locations) for recruitment of young stands of riparian tree species, decreasing the diversity of vegetation/habitat types on the valley floor
- c) Diminished complexity of channel and flood plain topography (e.g., loss of side channels, sloughs, and other flood plain wetland habitats)
- d) Over the long-term, reduced rates of input of large woody debris to channels (e.g., large/old trees are not being replaced at the rate that they are falling into the channels).

The above changes in vegetation and topography greatly diminish food supply and refuge habitats for fish and other aquatic species in the Napa River and lower tributary reaches. Deposition and storage of fine sediments on the valley floor is also greatly reduced, as is the filtration of nutrients and other natural and synthetic chemical constituents.

In addition to the threat high concentrations of fine sediment in the streambed pose to fish populations, the Limiting Factors Analysis identified other factors that are critically important to the health of steelhead populations. Each of the following stressors can adversely affect steelhead growth and survival in Napa River watershed:

**Habitat Access:** A large number of structures (dams, road crossings, weirs, etc.) have been constructed in Napa River tributaries (Dietrich et al., 2004). Many of these structures present direct or indirect (e.g., flow-related) barriers and/or impediments to adult steelhead spawning migration into the tributaries and/or the migration of juvenile steelhead out of the tributaries on their journey to rear in the ocean. Although available information is insufficient to develop an accurate estimate of how much steelhead habitat is blocked by all man made structures built in channels, at a minimum, the scale of the problem is illustrated by examining the effects of large municipal water supply dams. We note that four municipal reservoirs constructed on Kimball Canyon, Bell Canyon, Conn Creek, and Rector Creek drain 17 percent of the watershed. Prior to dam construction, each of these tributaries provided high quality spawning and rearing habitat up and downstream of these dams. In addition to the above described dams, several other privately owned dams are built on stream channels, and there are an unknown number of road crossings and other structures that block or impede fish migration to suitable spawning and rearing habitat elsewhere in the watershed.

**Physical Habitat Structure:** The occurrence and frequency of deep pools in Napa River tributaries has decreased during the historical period. Deep pools with good cover provide high quality holding habitat for adult steelhead during their spawning migrations, essential summer habitat for older juvenile steelhead, and may also provide important winter high-flow refuge habitat for older juvenile steelhead. The number of older and/or larger, juvenile steelhead that can be produced is quite important because there is a strong relationship between size of juvenile steelhead when they migrate to the ocean, and proportion that successfully return to spawn. This is because larger fish are better able to evade predators and to survive the long migration to the ocean. Pools appear to be less frequent in tributaries than we would expect to have occurred under historical conditions, when large woody debris would have created obstructions in the channels and caused deep pools (with good cover) to be formed. The amount of large wood in channels also appears to be low when compared to similar streams draining watersheds covered by mixed evergreen forests. Large wood is a primary agent for the formation of deep pools, complex cover, and retention of spawning gravels in channels that provide significant amounts of potential habitat for

steelhead. Habitat in tributary streams draining mixed evergreen forests, primarily those located on the west side of the watershed and those draining Howell Mountain, have been simplified as a result of a reduction in amount of large wood in the channels (Stillwater Sciences and Dietrich, 2002).

**Low Summer Flow and Elevated Temperature:** Typical summer water temperatures in tributaries<sup>5</sup> are stressful to juvenile steelhead and flow persistence over riffles is poor. Low or no flow over riffles greatly reduces the supply of drifting aquatic insects produced in riffles, which typically provide the primary source of food for juvenile steelhead. Poor baseflow persistence and stressful water temperatures act in a synergistic fashion, and appear to severely limit growth of juvenile steelhead during the summer months. Reduction in growth rate is important because smaller juvenile trout experience much higher rates of mortality during all phases of freshwater rearing, ocean migration, and during ocean rearing life stages. Therefore, poor juvenile growth rate during the summer in the freshwater environment has the potential to greatly reduce the number of adult steelhead that ultimately return from the ocean to spawn in the Napa River watershed<sup>6</sup>.

Following completion of the *Napa River Basin Limiting Factors Analysis*, University of California, Berkeley, in partnership with the University of Florida and with the assistance of Napa County, developed a high-resolution digital topographic map to accurately map the locations and extent of channels and reservoirs throughout the Napa River watershed. Dietrich et al. (2004) identified over 1,000 dams within the watershed, over 400 of which are located on tributary channels that drain approximately 30 percent of the total land area (Map 1). These dams exert a significant influence on routing of physical products (water, heat, nutrients, sediment, and wood), and the movement of fish and aquatic wildlife through channels in the Napa River watershed<sup>7</sup>. Because dams capture all of the coarse sediment delivered to channels above dams (and some of the fine sediment), it is likely that dams are affecting or influencing the channel incision and associated bank erosion that has been documented in the mainstem of the Napa River and along the lower reaches of its tributaries.

Based on the results of the *Napa River Basin Limiting Factors Analysis* and the other sources cited above, we conclude that the narrative water quality standards for sediment, settleable material, and for population and community ecology are not attained as a result of erosion and sedimentation in the Napa River and its tributaries. As such we are required to develop a total maximum daily load (TMDL) for sediment.

In Chapter 3, we present the sediment source analysis to further refine our description of current channel conditions with regard to erosion and sedimentation, and to address the following sediment-related questions:

- What are the relationships between sediment input to channels, channel sediment transport capacity, and streambed permeability values in Napa River and its tributaries?
- How important are natural processes and human alteration of the land with regard to input of fine sediment to channels?
- Is channel incision and associated bank erosion, a large source of sediment input to channels? How does this source compare/rank in relation to other natural and human generated (anthropogenic) sediment sources?

Footnotes:

<sup>3</sup> Similarly, Anderson (1969) estimated that the steelhead run in the Napa River watershed numbered 1,000 to 2,000 in the late 1960s.

<sup>4</sup> The Napa County RCD conducted formal surveys to estimate number of adult Chinook salmon entering the river to spawn, and to estimate number of spawning sites. These surveys were conducted in November and December of 2004 within a three-mile long reach of the mainstem near Rutherford (J. Koehler, unpublished data). During the fall–winter of 2004, Napa County RCD documented over 100 adult salmon in the Rutherford sub-reach.

<sup>5</sup> As part of the Limiting factors analysis, stream temperatures were continuously monitored from early August 2000 through early October 2001 at 22 sites in 13 tributaries, and 5 sites in 3 reaches of mainstem Napa River. Typical daily average temperatures during summer were between 59-68°F. Temperature data and analysis are presented in *Napa River Basin Limiting Factors Analysis* (Stillwater Sciences and Dietrich, 2002).

<sup>6</sup> We have not determined the extent to which poor baseflow persistence can be explained by natural conditions versus human water uses. However, considering the ecological significance of reduction in growth rate, follow-up research is now in progress to confirm whether poor summer growth is a spatially extensive phenomena in some or all water year types, and whether poor summer growth can be offset by high rates of growth during the spring and fall. These studies will be completed by the fall of 2006.

<sup>7</sup> Because most of the more than 400 mapped on-channel dams are upstream of natural limits of steelhead spawning, only a small percentage of the dams are direct structural barriers to steelhead migration. However, considering the large number of dams and large percentage of watershed draining into reservoirs, it appears that dams may exert significant indirect influence(s) on steelhead and salmon migration through a reduction in baseflow magnitude and/or duration downstream of the dams in some tributaries and/or reaches of mainstem Napa River.

**Comment N-3: “Developing simple probabilistic models of adult salmon recovery based on improved egg-to-fry survivorship and conservative estimates of survivorship at other key life history stages are essential exercises in determining if the proposed actions will work and, if so, estimating how long it will take before a population can reach a sustainable (or predetermined) size. These models are simple to construct and should be used to illustrate the process of population recovery.”**

While we agree these types of models are useful, available information is lacking to develop defensible estimates for Chinook salmon survivorship during early, fry, and smolt life stages in relation to current values versus proposed numeric targets for permeability and redd scour in the Napa River watershed.

Lacking the quantitative information described above, we rely instead on the results of the *Napa River Basin Limiting Factors Analysis* (Stillwater Sciences and Dietrich, 2002), which provides a sound conceptual model for Chinook salmon population dynamics in the Napa River watershed. Stillwater Sciences and Dietrich (2002) conclude that there has been a substantial reduction in the quantity and quality of spawning and rearing habitats for salmon (e.g., floodplains, side channels and sloughs, riffles, and gravel bars), as a consequence of channel incision, and that this is a key limiting factor for Chinook salmon in the watershed. Bed and bank erosion associated with incision is also a significant source of fine sediment to the Napa

River. The only ecologically sound approach to reduce bed and bank erosion rates along the Napa River is to implement large scale channel habitat enhancement projects (as described in our response to comment N-1), which will also enhance spawning and rearing habitat quantity. In summary, we conclude that implementation of the above described habitat enhancement projects will support the establishment of a self-sustaining run of Chinook salmon. Finally, we note that attainment of the redd scour target is predicated on achievement of the TMDL and substantial enhancement of habitat complexity, which we discuss further in our response to comment N-24.

**Comment N-4: “Understanding the population status of steelhead and Chinook will take many years of continuous monitoring, and this needs to be carefully delineated in the plan and agreed to by all parties involved. This is essential if adaptive responses to sediment loads are to be implemented in the future. Further, survivorship of salmon at various life stages is enormously variable and their complex life cycles add even more variability. The vagaries of the 'total' environment that they experience in their lifetime can frustrate the best restoration strategies. I urge the Water Quality Control Board to pay particular attention to implementing an effective monitoring plan for steelhead and Chinook that is statistically robust and to financially support that plan.”**

We agree that it is essential to understand population status of steelhead and Chinook salmon in the Napa River watershed, and population dynamics in response to proposed management actions and natural disturbances. We indicate our support for such a monitoring and research program in the discussion of Adaptive Implementation contained in the Basin Plan amendment. We also understand however, as you point out above, that such a monitoring and research plan needs to be carefully considered, and developed in partnership with other key public agencies whose policies and actions will be affected by the results (e.g., at a minimum, the County of Napa, the California Department of Fish and Game, and the National Marine Fisheries Service).

Considering the need to achieve consensus among these agencies, and the fact that our Basin Plan amendment relates primarily to the sediment impairment listing, we propose instead that fisheries monitoring and research be developed as part of the collaborative process that we call for to jointly resolve water supply reliability and fisheries conservation concerns (Basin Plan Amendment, Table 5.2, Recommended Actions to Protect or Enhance Baseflow). A stronger plan will emerge as a result of such collaboration and agreement. In our meetings with these agencies, we have indicated our interest in receiving a grant proposal to pay for the first three years of monitoring to estimate smolt production and adult spawning, provide an initial basis for development of quantitative population dynamics models, and support development of local institutional capacity to continue the fish population and habitat monitoring and analysis program in future years.

**Comment N-5: “Throughout the Technical Report channel incision is given high priority for treatment (restoration). This is a daunting and expensive task but no concrete strategies are articulated on how this will be accomplished without further harming the salmon. I can only**

**envision that the incisions will need to be gradually filled over a number of years and the additional sediment retained in some manner. How will this be accomplished?"**

We addressed this concern in our response to comment N-1, which shows revisions to Section 6.4, Approaches to Achieve Allocations, Channel Incision.

**Comment N-6: "Nowhere in the Amendment or in the Technical Report are the statistical considerations of monitoring and system recovery addressed. How will progress toward achievement of numeric targets and load allocations be determined without a valid and robust statistical design? This needs to be carefully and thoughtfully articulated."**

Regarding determining achievement of the proposed target value for streambed permeability: Based on review of Zar (1999), we calculate that if 112 or more of the 200 potential spawning sites that will be monitored (e.g., the number of sites that we will measure permeability) exceed the proposed target value of 7000 cm/hr, we can reject the hypothesis that the true population median for spawning gravel permeability in Napa River watershed is less than or equal to 7000 cm/hr, at a level of significance of  $\alpha = 0.05$ .

Unfortunately, available information is insufficient to estimate the required sample size, and/or the proportion of sites that would need to exceed the proposed target value in order to conclude with a high degree of statistical confidence that the numeric target for redd scour is attained. Working with local public agencies, we intend to conduct a pilot monitoring program to develop estimates of the mean and standard deviation for redd scour under current conditions, as needed to develop a valid and robust statistical design for the monitoring program to evaluate attainment of the redd scour target. Ultimately, we would like to estimate mean scour within 1 cm of actual population value, at a power  $\geq 0.80$  and a level of significance of  $\alpha = 0.05$ . A stratified, random approach to sampling will be used to select riffles where we will measure streambed scour in the pilot monitoring program. This is because we hypothesize that there are statistically significant differences between the mean scour values based on whether a reach is incising, aggrading, or in dynamic equilibrium.

**Comment N-7: "Annual precipitation patterns play a key role in determining annual sediment loads. How will variations in annual precipitation be incorporated into the overall strategies for TMDL and salmon habitat enhancement – especially over the 20+ years that the plan will be in effect?"**

To address your comment, we added the following text to the June 30, 2006 draft of the Staff Report (Section 5.2, Approach to Development of the Linkage Analysis):

Most total maximum daily loads for sediment in natural stream channels are expressed in terms of mass per unit area per unit time. We propose an alternative approach of expressing the TMDL as a percentage of the natural background rate of sediment input to channels. We have taken this approach because:

- a) Napa River has a Mediterranean climate and active tectonic setting, therefore, natural sediment loads are highly variable and native stream biota are adapted to large infrequent sediment pulses associated with natural disturbances (e.g., large storm events, wildfires, and major earthquakes).
- b) Native stream biota are not adapted (however) to chronic increases in fine sediment load caused by land use activities that disturb vegetation cover and/or infiltration capacity of soil (e.g., road-related erosion, agriculture, construction, timber harvest, livestock grazing, etc.). Under the natural sediment input regime, fine sediment input would be very low in most years, and the amount of fine sediment stored in the channel would be rapidly reduced (following a large disturbance) back to levels favorable for spawning and rearing.

Therefore, to emulate natural sediment dynamics and adaptations of native biota to infrequent pulse disturbances (but not to chronic press disturbances), we recommend that the TMDL be expressed as a percentage of natural input rate to channels (e.g., natural load) to emulate the pattern and magnitude of natural sediment inputs under current conditions where management actions may dominate sediment regime<sup>23</sup>.

#### Footnotes:

<sup>23</sup> Also by expressing the TMDL and allocations by source as a percentage of natural background, the focus of sediment monitoring shifts to measurement of sediment input rates to channels and determining which sources are natural or human-caused. With this focus, it is possible to rapidly evaluate progress toward attainment of the TMDL, and the effectiveness of management practices toward this end.

With regard to the habitat enhancement plan and adaptive updates in response to inter-annual variation in precipitation, please see our responses to comments N-3 and N-4.

### ***Specific Comments and Questions***

**Comment N-8: “TR9: The statement that “Spawning habitat quality does not currently appear to be a primary factor limiting steelhead or salmon run size” is confusing because, if it is not a limiting factor, why go to all the trouble of reducing fine sediment inputs to improve stream bed permeability for spawning?”**

We intended to say that: “Spawning habitat quality does not currently appear to be *the* primary factor limiting steelhead or salmon run size.” We did not intend to say: “Spawning habitat quality ....*a* primary factor limiting ....”

To avoid such confusion, we removed this sentence from the Detailed Problem Statement (Section 2.2) that was presented in the June 30 draft of the staff report.

To further clarify, note that we conclude that high concentrations of fine sediment (e.g., primarily sand) in the bed of Napa River and its tributaries cause significant decreases in growth and survival of juvenile steelhead and salmon during all freshwater life stages, and as such fine sediment deposition is one of several significant factors that limit steelhead and salmon run sizes in Napa River watershed.

**Comment N-9: "TR9: Channel incision *might* be a primary factor limiting Chinook run size but I doubt that it is the only major one. Also, avoid using subjective words like "appears" when there are no data presented to support the assertion."**

The sentence you reference in the peer review draft of the Staff Report (Detailed Problem Statement, Section 2.2) was written as follows:

"Therefore, channel incision appears to be the primary factor limiting Chinook salmon run size."

We concur with your comment, and therefore we revised the June 30, 2006 draft of the Staff Report (Detailed Problem Statement, Section 2.2) to read as follows:

"Therefore, channel incision appears to be a key factor limiting Chinook salmon run size."

"Appears" is supported by analysis presented in the *Napa River Basin Limiting Factors Analysis* (Stillwater Sciences and Dietrich, 2002).

**Comment N-10: "TR Figs 1 & 2: These figures are not complete. Disease, exotic predators, over-fishing, toxics, and other factors also may be "potential limiting factors." However, I can see using these figures if it is made clear that they are illustrating potential limiting factors within the scope of the proposed activities and where the limiting factors act within the respective life cycles. Further, Chinook also are affected by the lack of LWD and by high summer temperatures in the mainstem river."**

Point taken. We have deleted figures 1 and 2 from the revised Staff Report.

**Comment N-11: "TR11: It would be useful to mention how many km (or a percentage of the total rearing and spawning habitat) are blocked by structures."**

In response to your comment, we have revised the Staff Report (Section 2.2, Detailed Problem Statement, Habitat Access), as shown in the response to comment N-2.

**Comment N-12: "TR11: Here and other places in the TR it is said that summer temperatures are stressful to juvenile steelhead. What are the temperatures? How close are they to lethal or sub-lethal conditions?"**

We agree that this is important information. Accordingly, we have added the following footnote to the June 30 draft of the staff report (Footnote 5 to the discussion of "Low Summer Flow and Elevated Temperature" in the Detailed Problem Statement):

<sup>5</sup> As part of the limiting factors analysis, stream temperatures were continuously monitored from early August 2000 to early October 2001 at 22 sites in 13 tributaries, and 5 sites in 3 reaches of mainstem Napa River. Typical daily

average temperatures during summer were between 59–68°F. Temperature data and analysis are presented in *Napa River Basin Limiting Factors Analysis* (Stillwater Sciences and Dietrich, 2002).

With regard to suitability of temperatures, we note that: a) the authors of the *Napa River Basin Limiting Factors Analysis*, state, “We found that summer water temperatures were typically warm, but generally not high enough to be acutely lethal to steelhead....” (Stillwater Sciences and Dietrich 2002, p. 47); and b) available information is not sufficient to determine whether low growth rates in the summer (which are influenced in part by temperature) exert a significant influence on subsequent survival and growth of juvenile steelhead, and ultimately, on the number and fitness of juvenile steelhead that migrate from the watershed to the ocean.

**Comment N-13: “TR13: Since I am not an expert on estimating sediment loads, I become concerned when I see that a 'rapid sediment budget' provides only "approximate estimates" of rates and sizes delivered to channels. How approximate are those estimates? The proposed plan relies heavily on them and a lot will be asked of landowners and public agencies to control erosion rates. How good are the estimates that underpin what is being proposed? This should be clearly articulated in the TR.”**

For other watersheds in northern California and the Pacific Northwest where rapid sediment budget techniques have been used, and where monitored sediment yields are available for comparison, estimates from the two approaches are within a factor of two or closer in all cases (Reid and Dunne, 1996). Based on this information, we added the following footnote (Footnote 8) to June 30 draft of the Staff Report (Section 3.1, Introduction):

<sup>8</sup>Estimated rates are expected to be within a factor of two of actual values. (Reid and Dunne, 1996)

**Comment N-14: “TR Fig 4: The pictures are not useful, especially to someone not trained in what to look for. Upon first glance, I thought the 1998 photo showed better conditions because there was more riparian development! If the pictures are kept in the document, then I suggest adding labels to point out key features that you want to highlight. If that is not adequate, then I would consider showing actual data on environmental conditions.”**

Figure 4 has been revised to include arrows to direct readers to the features we wish to highlight.

**Comment N-15: “TR Figs 5 & 6: I do not find photos like these to be useful unless information is given in the legend or in the text on the spatial extent or magnitude of these problems.”**

Table 7a in the Staff Report (Section 3.6, Findings) provides information regarding the magnitude of sediment delivery to channels from gullies and road-related erosion. This information is as follows:

**Table 7a: Mean Annual Sediment Delivery to Napa River at Soda Creek (1994-2004) from Non-Point Sources**

| <b>Source</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Estimated Mean Annual Delivery Rate (metric tons/yr)</b> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Land areas upstream of dams</b> (e.g., fine sediment discharge from reservoirs)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                             |
| ▪ Natural Processes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 7,000                                                       |
| ▪ Human Actions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 11,000                                                      |
| <b>Land areas downstream of dams</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                             |
| ▪ Natural Processes:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 92,000                                                      |
| ▪ Human actions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                             |
| o Channel incision and associated bank erosion                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 37,000                                                      |
| o Road-related sediment delivery (all processes)                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 55,000                                                      |
| o Surface erosion associated with vineyards and/or livestock grazing                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 37,000                                                      |
| o Gullies and shallow landslides associated with vineyards, and/or intensive historical grazing                                                                                                                                                                                                                                                                                                                                                                                                                        | 30,000                                                      |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>269,000</b>                                              |
| Notes: Drainage area for Napa River at Soda Creek = 584 km <sup>2</sup> . Estimates above do not include sediment deposited and retained in tributary reservoirs, which includes all gravel and sand, and most of the finer sediment input to channels located upstream of the reservoirs. Approximately 104,000 metric tons per year of sediment are deposited in tributary reservoirs, 48,000 metric tons per year of which is derived from natural processes. Above estimates are rounded to the nearest thousandth |                                                             |

**Comment N-16: “TR25: The method used to estimate grain size distributions of sediment inputs (i.e., visual observation) is very weak and probably biased. Perhaps there is an easy but more quantitative approach that can be used?”**

Visual observations played a minor role. We relied primarily on sampling and quantitative analysis of grain sizes. For example, we collected and analyzed samples (average sample size = 100 kilograms) at 12 sites, located at the base of hillsides that are adjacent to channels, to estimate size distributions of inputs from gullies, landslides, colluvial bank erosion, and road crossing erosion. Size distribution for sediment input from channel incision and associated bank erosion is based on WET (1990), which is derived from sampling the banks and bed of Napa River. To estimate grain size distributions for sediment input to channels from surface erosion (e.g., vineyard, rangeland, and road-related sheetwash), we reviewed published soil survey data (USDA, 1978) which include grain size distributions for all soil series occurring in

the watershed. We then subtracted a coarse fraction, which we infer was not eroded and/or conveyed to channels via sheetwash, based on field observations of the grain sizes comprising small fans or bars deposited before reaching a natural channel.

In response to this comment, we added additional information regarding our methods to the June 30, 2006 draft of the Staff Report (Section 3.4, Approach to Measurement of Sediment Input to Channels). This section now reads as follows:

#### **6) Size Distributions for Sediment Input from all Significant Delivery Processes**

For sediment input to channels from gullies, shallow landslides, colluvial bank erosion, and road-crossing erosion, during the summer of 2003, we collected and analyzed samples of colluvium from toes of landslides at 12 sites selected to describe sediment grain-size distributions for each of the four upland terrain units. Soil pits about 0.5-to-1.0 meters in diameter were dug with a pick and/or shovel. Samples were collected on tarps, and dried in the field as needed. Hand pressure was used to break apart cohesive aggregate of finer particles. Samples were then processed by hand and wire brush in the field through 64 mm, 11.2 mm, and 2 mm sieves. Particles collected on the 64 mm sieve were inspected visually to confirm that they were gravels, and not cohesive aggregates of finer soil particles, prior to weighing in the field. Samples by size class were then weighed with a hanging balance suspended from a tree. Splits, representing about one-eighth of the total sample weight collected on the 11.2-and-2 mm sieves were also wet sieved in the lab to insure that cohesive aggregates of finer particles were not represented in our 64-to-11.2 mm, and 11.2-to-2 mm size classes. The average weight of the sample collected at each site was approximately 100 kilograms.

For sediment input to channels from stream terrace bank erosion and channel bed erosion (channel incision), we used available information describing grain size distributions for bed and bank deposits collected at several locations along Napa River during the late 1980s (WET, 1990).

For sediment input to channels from road surface erosion (e.g., cut bank, inboard ditch, and the surface of dirt roads), based on field observations of fine gravel deposits in inboard ditches, and review of soil survey information for Napa County (USDA, 1978), we assume that inputs from sheetwash erosion of cutbanks, inboard ditches, and surfaces of dirt roads are composed of 50 percent fine gravel, and 50 percent sand, silt, and clay.

For sediment input to channels from surface erosion of hillsides in vineyards and/or rangelands, based on review of soil survey information (USDA, 1978) and field observations of grain sizes comprising coarse lag deposits in the channels of rills and/or small alluvial fans, we estimate that inputs are composed of 25 percent fine gravel, and 75 percent sand, silt, and clay.”

We also note that although the number of samples, and average sample size are small in relation to the calculated sediment input rates and the size of the Napa River watershed, we find that estimated values for percent coarse ( $\geq 11.2$  mm) and percent fine ( $< 11.2$  mm) do not vary substantially among defined terrain types and/or for surface erosion processes, suggesting that at this level of classification (e.g., percent coarse and fine), the potential error in estimating overall rates of fine and coarse sediment inputs to channels is not significant. For example, the 95 percent confidence interval around the mean value for percent coarse sediment by terrain type and/or erosion process is  $78.3 \pm 12.8$  percent.

**Comment N-17: “TR31 (and elsewhere in TR): Describing streambed permeability as 'good, fair or poor' is subjective and has no meaning unless they are defined in the document. Also, characterizing long reaches in such a manner may not be justified as salmon can find and use localized areas of upwelling or downwelling.”**

In response to this comment, we have added the following footnote to Staff Report section 3.5, Tributary and Mainstem Study Areas:

<sup>17</sup>In referring to predicted values for permeability, good corresponds to  $\geq 7000$  cm/hr, fair equals 3000-to-6999 cm/hr and poor  $< 3000$  cm/hr.

We concur that “salmon can find and use localized areas of upwelling or downwelling.” This is why we only sampled pool tail/riffle head sites, which are localized areas of upwelling or downwelling. Within this group, we measured permeability where dominant particle size of surface layer of the streambed was 16-to-64 mm (for steelhead), and as large as 128 mm (for Chinook salmon). We sampled all sites meeting these criteria throughout study reaches typically  $> 40$  bankfull channel widths in length.

**Comment N-18: TR Fig 9: “The dams need to be identified on the image.”**

We have added arrows to Figure 9 in the Staff Report to identify the dams.

**Comment N-19: TR32: How was streambed permeability measured?**

Methods for measurement of streambed permeability are presented in Appendix 8 (page A8-1) of the *Napa River Basin Limiting Factors Analysis* (Stillwater Sciences and Dietrich, 2002), and in Napolitano (unpublished report, 2006).

**Comment N-19: TR Fig 14: “The relationship appears to be largely driven by one point at ~9,000 cm/hr. Before I’m convinced that there is a relationship between permeability and the sedimentation index, I would need to see more data at the lower range of the sedimentation index.”**

Following completion of the peer review draft of the staff report, we were able to obtain permeability data for additional tributary sites in Napa River watershed (Stillwater Sciences, unpublished data, 2004). For one of these sites, upper York Creek, we also are able to calculate the sedimentation index. We added this point to the revised graph (formerly Fig. 12, Median permeability as a function of sediment supply and transport, now numbered Figure 14), in the Staff Report (Section 3.6, Findings). Upper York Creek has an estimated sedimentation index of 1600, which is in the middle range for the sedimentation index, and a reach median permeability value equal to 6900.  $R^2$  for the revised linear regression has a value equals 0.65.

Adding this point does not cause a significant change to the y-intercept or slope of the regression. Including data for upper York Creek, the regression relationship is developed from 10 stream reaches spanning a broad range of channel types and sizes (e.g., drainage area = 4-to-200 square kilometers, slope = 0.002 to 0.06), and a twenty-five-fold range in sediment supply (e.g., 74 to 1,938 metric tons per square kilometer). We conclude this relationship and McNeil and Ahnell (1964) support our finding that low streambed permeability values are explained at least in part by a high concentration of fine sediment in the streambed.

**Comment N-20: “TR Table 5: The ranges given under Total Input Rate do not always reflect the data given in the column for the specific sites. Likewise for the sample sizes (N). Am I missing something?”**

In the June 30 draft of the Staff Report, we revised Table 5 to correct these minor typographical errors.

**Comment N-21: “TR46: Eventually sediments currently trapped behind dams will reach the Napa River, and I would expect that it may occur this century. Should this be addressed in the TR?”**

Professor Naiman raises an important question. Approximately two-thirds of the total land area that drains into reservoirs, drains into one of four municipal water supply reservoirs: Bell Canyon Reservoir, Lake Hennessey, Rector Reservoir, and/or Milliken Reservoir. Most of the over 400 on-channel reservoirs we have identified are nested above these reservoirs. Predicting how fast these four reservoirs might fill with sediment should shed some light on the potential significance of sediment management priorities, both during the next few decades (the TMDL implementation timeframe), and over the longer-term (i.e., the next 100 years).

In order to develop a response to the question, we prepared a simple model to predict how fast reservoirs may fill-up with sediment. Considering measured sedimentation rates for Bell Canyon, Rector, and Milliken reservoirs over the approximately fifty to eighty years since reservoir construction, and adding the conservative assumption that in future years these rates could be twice as great, we estimated the year when half of reservoir storage capacity would be lost to sedimentation. For Lake Hennessey, since we do not have information to estimate sedimentation rate, we used estimated sediment input rates to channels as a proxy.

| Reservoir | Drainage Area (km <sup>2</sup> ) | Year Constructed | Storage Capacity (ac-ft) | Storage Capacity (tonnes) | Sedimentation Rate (t/km <sup>2</sup> /yr) | Half-filled (# of years) | Calendar year |
|-----------|----------------------------------|------------------|--------------------------|---------------------------|--------------------------------------------|--------------------------|---------------|
| Bell      | 14.2                             | 1959             | 2050                     | 3793716                   | 110                                        | 607                      | 2566          |
| Hennessey | 139.9                            | 1946             | 31000                    | 57368394                  | 510                                        | 201                      | 2147          |
| Rector    | 27.7                             | 1946             | 4600                     | 8512729                   | 383                                        | 201                      | 2147          |
| Milliken  | 24.1                             | 1923             | 1980                     | 3664175                   | 63                                         | 605                      | 2528          |

Note: 1 ac-ft of sediment = 1234 m<sup>3</sup>. To convert ac-ft of storage capacity to tonnes, we estimate a bulk density for reservoir deposits = 1.5 tonnes/m<sup>3</sup>. We do not have a measured sedimentation rate for Lake Hennessey, and therefore, we use estimated rate of sediment input to channels located upstream of Hennessey, and have reduced this rate by 15 percent to account for reservoir trap efficiency. Actual sedimentation rate for Hennessey is likely much lower, as a result of sediment deposition in a very large number of nested dams located upstream of this reservoir.

Based on this analysis, we conclude that even if sedimentation rates are twice as high in future years (as compared to rates since construction), it will take more than one hundred to several hundred years for any of the four reservoirs we evaluated to lose half its capacity. Therefore, we conclude that given the current rates of sediment delivery to reservoirs, a significant increase in sediment delivery to the Napa River as a result of reservoir filling is not likely within the next few hundred years or more. At present, we estimate that total sediment discharge through dams accounts for 6 percent of the total supply in the Napa River at Soda Creek (see Table 7a in the Staff Report, reproduced in the response to comment N-15). Almost all of the sediment discharged through dams (under present conditions) is in the silt and clay size classes. In contrast, almost all fine sediment deposited in the bed of the Napa River and its tributaries is in the sand and fine gravel size classes.

However, our results do suggest that the capacity of Rector and Hennessey reservoirs could be reduced by 10 percent-or-more sometime within the next 50 years as a result of sedimentation, should sediment delivery to upstream channels remain at current rates or increase. For smaller on-channel reservoirs, whether or not nested above larger municipal reservoirs, these structures also need to be regulated to control the quantity and quality of sediment discharged to downstream water bodies. We are working with the State Water Resources Control Board, Division of Water Rights, through their North Coast Instream Flow Policy initiative, to see that such a program is developed and implemented to address these and other habitat protection and restoration issues that are associated with on-channel dams. The above information is now summarized in the Staff Report (Section 3.6, Findings) as follows:

- Sediment deposition in tributary reservoirs equals approximately 40 percent of the total sediment delivery to channels in the Napa River watershed, or approximately 104,000 metric tons per year (Table 8). In order to evaluate whether there is a risk sometime in the near future of these reservoirs filling up, and sediment discharges to the Napa River thereby increasing, we developed a simple model to estimate how fast the four largest reservoirs in the watershed – Hennessey, Rector, Milliken, and Bell - could fill-up in future years. Hennessey, Rector, Milliken, and Bell reservoirs collectively drain about 2/3 of the total land area in the watershed that drains into reservoirs. Also, most of the more than 400 on-channel dams we have identified drain into one of these four

reservoirs. Based on our analysis, we conclude that even if sedimentation rates are twice as high in future years (as compared to rates since construction), it will take more than one hundred to several hundred years for any of the four reservoirs we evaluated to lose half its capacity. Therefore, we conclude that given the current rates of sediment delivery to reservoirs, a significant increase in sediment delivery to the Napa River as a result of reservoir filling is not likely within the next few hundred years or more. However, our results do suggest that the capacity of Rector and Hennessey reservoirs could be reduced by 10 percent-or-more sometime within the next 50 years as a result of sedimentation, should sediment delivery to upstream channels remain at current rates or increase.

**Comment N-22: “TR Figs 15-18: I may be reading these incorrectly. Nevertheless, it appears that sediment input rates are lower downstream than they are upstream. If true, how can this be so, especially if channel incision is a large sediment source?”**

In these figures, we present sediment input rate to the entire channel network, and in most cases, also to channels located downstream of dams. In both cases, input rates are expressed per unit drainage area, which does not change because the point of comparison is the same in both cases (e.g., the named tributary mouth or mainstem Napa River location). Since reservoirs trap all gravel and sand—and much of the finer sediment—delivered from upstream channels, input rates per unit drainage area downstream of dams, by conservation of mass are always smaller than for the entire channel network.

**Comment N-23: “TR52 and Table 7: Earlier in the TR it was stated that channel incision was the highest priority but, in Table 7, input rates from roads, surface erosion, and gullies are estimated to be nearly as large or larger sources than incision. Surface erosion from roads and vineyards are each equal to that from incision – so why are they not the highest priority?”**

Actions to reduce fine sediment supply from significant sediment sources associated with land uses (e.g., roads, surface erosion, and gullies) must *also* be accomplished in order to achieve suitable conditions for salmonid spawning and rearing in the Napa River and its tributaries. By stating the priority for treatment of channel incision, we do not imply that other sources do not have to be reduced by a significant amount. The proposed Basin Plan calls for 50 percent reduction across the board in rates of sediment input from all significant human caused sources (e.g., surface erosion, gullies, channel incision, and roads).

As indicated in the staff report, channel incision and associated bank erosion causes significant adverse impacts to both the **quality** and **quantity** of salmonid habitat in Napa River and lower reaches of its tributaries. Channel incision diminishes the **quantity** of habitat by causing significant reductions in the frequency of riffle, gravel bar, and side channel habitat, and disconnection of the channel from its flood plain. Incision has also caused a significant increase in fine sediment supply, which adversely affects spawning and rearing habitat **quality**. With regard to the other significant sediment inputs associated with land uses, although these also adversely affect habitat quality, they do not cause or contribute to a significant reduction in habitat quantity. Furthermore, the only feasible approach for addressing the channel incision

problems is through a channel restoration approach that re-establishes width-to-depth ratios and sinuosity values that are conducive to the formation of alternate bars and a modest flood plain. The proposed remedy—channel restoration—enhances both the quality and quantity of spawning and rearing habitat for salmonids in Napa River and lower reaches of its tributaries. Proposed major stream and riparian habitat restoration projects are described in detail in response to comment N-1 above.

**Comment N-24: “TR54: Maintaining adequate high-quality juvenile habitat is as important as maintaining streambed permeability and protecting against redd scour. All three need to be improved in concert. Ignoring habitat will negate all the positive steps taken with streambed permeability and reduced scour.”**

We concur. We hypothesize that actions to rehabilitate streambed topography (e.g., alternate bars, riffles, and side channels) and re-establish a modest flood plain are needed in order to attain the proposed numeric target for streambed scour. This is because these high quality habitat features for juvenile salmonids also play a major role in the distribution of shear stress along the channel, and therefore, are needed to re-establish dynamic equilibrium between channel sediment transport capacity and supply.

**Comment N-25: “TR60: It is not clear how one can "conclude that moderate to high rates of survival ( $\geq 50\%$ ) for eggs and larvae from spawning to emergence may be necessary to achieve a self-sustaining wild spawning run [of Chinook] in the Napa River" without conducting basic life history modeling or projections. This topic is more fully addressed under General Comments & Concerns.”**

Please see our response above to comment N-3.

**Comment N-26: “TR63: How long would it take to achieve the streambed permeability and reduction in redd scour targets? Please provide an estimate that can be supported by the data available.”**

This is a good question, and review of the empirical relationship we developed between spawning gravel permeability and sediment supply (scaled for stream power) may provide some insight. In that regression, the values for sediment input rate to channels that are input into the equation are the estimated average values over the most recent decade. The strong negative relationship ( $R^2 = 0.65$ ) between decadal average sediment input rate (scaled for stream power) and the estimated reach-median values for spawning gravel permeability suggests that the amount of fine sediment stored in the bed of the Napa River and its tributaries is small relative to the average annual input rate to channels, and that the fine sediment stored in channels is rapidly replaced by new sediment input to the channel network. From the data we infer that the lag time between a reduction in sediment input rate to channels and the reduction in concentration of fine sediment stored in tributary and mainstem reaches may be a decade or less. Therefore, considering the amount of time we have proposed to implement management

measures to reduce anthropogenic sediment supply by 50 percent (by 2025), we estimate that the spawning gravel permeability target would be achieved by 2035.

With regard to redd scour, assuming the narrative performance standard for channel restoration is achieved by 2025 (as called for in the implementation plan), implicit in our conceptual model (e.g., following restoration, sediment transport capacity will be in balance with supply, and consequently, average scour depth will be  $\leq 15$  cm), the redd scour target also will be achieved by 2035.

**Comment N-27: “TR General Comment: There are many other aquatic organisms comprising the aquatic community in the Napa River. Other than freshwater shrimp, these are never mentioned. Perhaps a table can be provided listing other organisms, giving projections as to how they might respond to sediment control measures.”**

To address this comment, we have added Section 4.4 to the staff report, as follows:

#### **4.4 Potential Responses of Other Fish and Aquatic Wildlife Species**

Expected responses of other fish and aquatic wildlife species to actions to reduce fine sediment supply and enhance habitat complexity that are needed to attain proposed numeric targets are as follows:

| <b><u>Species</u></b>               | <b><u>Expected change in relative abundance</u></b> | <b><u>Hypothesized mechanism(s)</u></b>                                                                                                                                                                                                                                               |
|-------------------------------------|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Riffle Sculpin</u>               | <u>Small to Moderate Increase</u>                   | <u>Increase in riffle area and frequency; decrease in embeddedness; increase in large woody debris</u>                                                                                                                                                                                |
| <u>Hardhead</u>                     | <u>Neutral to Moderate Increase</u>                 | <u>Increase in backwater habitat leading to increases in survival of fry; decreases in scour and embeddedness leading to increase in survival-to-emergence; reduction in deep-pool/run habitat favored by smallmouth bass would lead to lower rates of predation on hardhead fry.</u> |
| <u>Sacramento Pikeminnow</u>        | <u>Neutral to Moderate Increase</u>                 | <u>Increase in floodplain habitat and large woody debris contributing to higher rates of over-winter survival; decrease in deep-pool run habitat leading to less competition with smallmouth bass for prey</u>                                                                        |
| <u>Sacramento Sucker</u>            | <u>Neutral to Small Increase</u>                    | <u>Increase in area of shallow/slow backwater habitat and large woody debris leading to increases in survival during early fry rearing stages</u>                                                                                                                                     |
| <u>California Freshwater Shrimp</u> | <u>Neutral to Small Increase</u>                    | <u>Increase in relative abundance is dependent upon an increase in proportion of channel length where channel is free to form its own bed and banks, and</u>                                                                                                                          |

|                                                     |                       |                                                                                                            |
|-----------------------------------------------------|-----------------------|------------------------------------------------------------------------------------------------------------|
|                                                     |                       | <u>specifically at outside bends to form deep pools with undercut banks and overhanging roots.</u>         |
| <u>Smallmouth Bass, Bluegill, and Green Sunfish</u> | <u>Small Decrease</u> | <u>Decrease in deep-pool run habitat area may reduce relative abundance of these introduced predators.</u> |

Expected fish species responses summarized above are based on our review of proposed restoration project actions (see Section 6.5, Channel Incision), and life history requirements for above fish species as described in Moyle (2002). For California freshwater shrimp, expected response is based primarily on association of freshwater shrimp with deep pools with undercut banks and overhanging roots."

**Comment N-28: "TR72-82: I found this section to be unconvincing – largely because of the phrases used to convey that changes would be implemented. Rather than saying that "we will ...[do something]" -- a positive, proactive approach – phrases like "we hope to ... cooperate" and so forth are used. This left me with the sinking feeling that, in the end, nothing will be accomplished. I suspect that the Water Quality Control Board will receive the same message unless the wording is more positive and proactive."**

The Staff Report and Basin Plan amendment recommend that the Water Board use its regulatory authorities to achieve a 50 percent reduction in sediment input to channels from land uses by 2025.

**Comment N-29: "TR75: Where are activities by the Rutherford DUST Society described? It is not clear what is being supported."**

This project is now described in Staff Report Section 6.4, Approaches to Achieve Allocations, Channel Incision. Language describing the Rutherford DUST Society is included in our response to comment N-1.

**Comment N-30: "A3: I was surprised to see that historic stream cleaning of large woody debris and channelization were not listed as a primary agent for simplification of the physical habitat structure. These certainly must have occurred in the past."**

We agree that this is a significant factor. Our list of hypothesized causes for channel incision, contained in the Problem Statement in the Basin Plan amendment, includes "straightening of some mainstem channel reaches, filling of side channels" and "intensive removal of large woody debris."

Comment N-31: "A4: It would be informative for the reader to know how much of the Napa River watershed is blocked by dams and how much potential salmon habitat lies above the dams."

As we stated in our response to comment N-2, this information is now included in Staff Report section 2.2, Detailed Problem Statement, Habitat Access.

Comment N-32: "A5: Table 3 is not inherently clear; please provide a better legend."

We have revised Table 3, separating it into tables 3a and 3b, as follows:

**Table 3. TMDL and Load Allocations.**

| Source Category                                                                               | Estimated Reductions Needed (%) | Load Allocations (% Natural Load) |
|-----------------------------------------------------------------------------------------------|---------------------------------|-----------------------------------|
| Land areas upstream of dams                                                                   |                                 |                                   |
| — Natural processes                                                                           | 0                               | 5                                 |
| — Human actions                                                                               | 50                              | 4                                 |
| Land areas downstream of dams                                                                 |                                 |                                   |
| <u>Natural processes</u>                                                                      | 0                               | 62                                |
| <u>Human actions</u>                                                                          |                                 |                                   |
| Channel incision and associated bank erosion                                                  | 50                              | 13                                |
| — Roads                                                                                       | 50                              | 18                                |
| Surface erosion associated with vineyards and grazing                                         | 50                              | 12                                |
| Gullies and shallow landslides associated with vineyards, and/or intensive historical grazing | 50                              | 10                                |
| — Construction Activities                                                                     | 50                              | 1*                                |
| TMDL                                                                                          |                                 | 125                               |
| *Preliminary estimate subject to revision.                                                    |                                 |                                   |

**Table 3a. Load Allocations**

| Source category | Load during 1994-2004 | Estimated reductions | Load allocations |
|-----------------|-----------------------|----------------------|------------------|
|-----------------|-----------------------|----------------------|------------------|

|                                                                                                                                    | <u>Metric<br/>tons/year</u> | <u>Percentage<br/>of Natural<br/>Background</u> |           | <u>Metric<br/>tons/year</u> | <u>Percentage<br/>of Natural<br/>Background</u> |
|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------|-----------|-----------------------------|-------------------------------------------------|
| <u>Land areas upstream of<br/>dams</u>                                                                                             |                             |                                                 |           |                             |                                                 |
| ▪ <u>Natural<br/>processes</u>                                                                                                     | <u>7,000</u>                | <u>4.8</u>                                      | <u>0</u>  | <u>7,000</u>                | <u>4.8</u>                                      |
| ▪ <u>Human actions</u>                                                                                                             | <u>11,000</u>               | <u>7.5</u>                                      | <u>51</u> | <u>5,000</u>                | <u>3.6</u>                                      |
| <u>Land areas<br/>downstream of dams</u>                                                                                           |                             |                                                 |           |                             |                                                 |
| ▪ <u>Natural<br/>processes</u>                                                                                                     | <u>92,000</u>               | <u>63</u>                                       | <u>0</u>  | <u>92,000</u>               | <u>63</u>                                       |
| ▪ <u>Human actions:</u>                                                                                                            |                             |                                                 |           |                             |                                                 |
| o <u>Channel<br/>incision and<br/>associated<br/>bank erosion</u>                                                                  | <u>37,000</u>               | <u>25</u>                                       | <u>51</u> | <u>18,000</u>               | <u>12</u>                                       |
| o <u>Roads</u>                                                                                                                     | <u>55,000</u>               | <u>38</u>                                       | <u>51</u> | <u>27,000</u>               | <u>18</u>                                       |
| o <u>Surface erosion<br/>associated with<br/>vineyards and<br/>grazing</u>                                                         | <u>37,000</u>               | <u>25</u>                                       | <u>51</u> | <u>18,000</u>               | <u>12</u>                                       |
| o <u>Gullies and<br/>shallow<br/>landslides<br/>associated with<br/>vineyards,<br/>and/or intensive<br/>historical<br/>grazing</u> | <u>30,000</u>               | <u>20</u>                                       | <u>51</u> | <u>15,000</u>               | <u>10</u>                                       |
| <u>TOTAL</u>                                                                                                                       | <u>269,000</u>              |                                                 |           | <u>182,000</u>              | <u>123</u>                                      |
| <u>Note: Above estimates for loads, percent reductions, and allocations are rounded to two significant figures</u>                 |                             |                                                 |           |                             |                                                 |

**Table 3b. Wasteload Allocations for Urban Runoff and Wastewater Discharges**

| <u>Point Source<br/>Category</u>                                   | <u>Current Load</u>         |                                                 | <u>Reductions<br/>needed<br/>(percentage)</u> | <u>Wasteload Allocations</u> |                                              |
|--------------------------------------------------------------------|-----------------------------|-------------------------------------------------|-----------------------------------------------|------------------------------|----------------------------------------------|
|                                                                    | <u>Metric<br/>tons/year</u> | <u>Percentage of<br/>Natural<br/>Background</u> |                                               | <u>Metric<br/>tons/year</u>  | <u>Percent of<br/>Natural<br/>Background</u> |
| <u>Construction<br/>Stormwater-Order<br/>No. 99-08-DWQ</u>         | <u>500</u>                  | <u>0.3</u>                                      | <u>0</u>                                      | <u>500</u>                   | <u>0.3</u>                                   |
| <u>Municipal<br/>Stormwater NPDES<br/>Permit No.<br/>CAS000004</u> | <u>800</u>                  | <u>0.5</u>                                      | <u>0</u>                                      | <u>800</u>                   | <u>0.5</u>                                   |
| <u>Industrial<br/>Stormwater NPDES</u>                             | <u>500</u>                  | <u>0.3</u>                                      | <u>0</u>                                      | <u>500</u>                   | <u>0.3</u>                                   |

| <u>Point Source Category</u>                                                                                                                                                | <u>Current Load</u>     |                                         | <u>Reductions needed (percentage)</u> | <u>Wasteload Allocations</u> |                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------------------------|---------------------------------------|------------------------------|--------------------------------------|
|                                                                                                                                                                             | <u>Metric tons/year</u> | <u>Percentage of Natural Background</u> |                                       | <u>Metric tons/year</u>      | <u>Percent of Natural Background</u> |
| <b><u>Permit No. CAS000001</u></b>                                                                                                                                          |                         |                                         |                                       |                              |                                      |
| <b><u>Caltrans Stormwater- Order No. 99-06-DWQ</u></b>                                                                                                                      | <b><u>600</u></b>       | <b><u>0.4</u></b>                       | <b><u>0</u></b>                       | <b><u>600</u></b>            | <b><u>0.4</u></b>                    |
| <b><u>Wastewater Treatment Plant Discharges<sup>a</sup></u></b>                                                                                                             |                         |                                         |                                       |                              |                                      |
| <b><u>City of St. Helena NPDES Permit No. CA0038016</u></b>                                                                                                                 | <b><u>30</u></b>        | <b><u>&lt;0.1</u></b>                   | <b><u>0</u></b>                       | <b><u>30</u></b>             | <b><u>&lt;0.1</u></b>                |
| <b><u>Town of Yountville/CA Veteran's Home NPDES Permit No. CA0038121</u></b>                                                                                               | <b><u>30</u></b>        | <b><u>&lt;0.1</u></b>                   | <b><u>0</u></b>                       | <b><u>30</u></b>             | <b><u>&lt;0.1</u></b>                |
| <b><u>City of Calistoga NPDES Permit No. CA0037966</u></b>                                                                                                                  | <b><u>40</u></b>        | <b><u>&lt;0.1</u></b>                   | <b><u>0</u></b>                       | <b><u>40</u></b>             | <b><u>&lt;0.1</u></b>                |
| <b><u>TOTAL</u></b>                                                                                                                                                         | <b><u>2500</u></b>      | <b><u>2</u></b>                         |                                       | <b><u>2500</u></b>           | <b><u>2</u></b>                      |
| <b><u>a. For wastewater treatment plant discharges, compliance with existing permit effluent limit of 30 mg/L of TSS is consistent with these wasteload allocations</u></b> |                         |                                         |                                       |                              |                                      |
| <b><u>Note: Above estimates for loads, percent reductions, and allocations are rounded to two significant figures</u></b>                                                   |                         |                                         |                                       |                              |                                      |

**Comment N-33: "A17: Nowhere in the Amendment or in the TR are the statistical considerations of monitoring addressed. How will progress toward achievement of numeric targets and load allocations be determined without a valid and robust statistical design? This needs to be carefully and thoughtfully addressed."**

We have addressed this concern in our response to comment N-6.

**Comment N-34: "A17: It is fine that landowners and designated agents do some of the implementation monitoring but they should not be the only ones responsible for doing it. It is essential that the Water Board be closely involved (and responsible) too."**

We concur. Upslope effectiveness monitoring (e.g., estimation of sediment delivery rates to channels) necessarily involves field inspection of farms, ranches, roads, and other land use activities as needed to estimate inputs associated with land use activities and natural processes; Water Board staff expect to carry out these inspections. Similarly, regulatory agency certifications under the Fish Friendly Farming Environmental Certification Program involve field inspection of farm (e.g., vineyard) management practices and their effectiveness.

**Comment N-35: "A17: Annual precipitation patterns play a key role in determining annual sediment loads. How will variations in annual precipitation be incorporated into the overall strategies for TMDL and salmon habitat enhancement?"**

Please see our response above to comment N-7.

**Comment N-36: "A18-19: As discussed at the beginning of this document, the plan for assessing the status of steelhead and Chinook salmon is inadequate. Additionally, although native fish communities are occasionally mentioned, their status or responses are not addressed here or in the TR."**

Please see our response to comment N-4 above.

## Responses to Comments from Professor Rahmeyer

**Comment R-1: “There are limitations to the data collection and methods used in this report. I suggest that the technical report address the limitations. There needs to be a discussion of why transport models were not used to determine the sediment budget, and a detail explanation of what was done instead. The explanations of your 3/29/06 Email should be included in the technical report. They greatly help understand the scope and nature of the study. ”**

On 3/29/06 we emailed Professor Rahmeyer as follows:

With regard to evaluating relationship between sediment input rate and fine sediment deposition, given constraints of funding, we selected spawning gravel permeability, as a response variable (for comparison to sediment input rate)...We focused almost exclusively on the analysis of sediment inputs to channels. Also, with regard to imbalances between sediment transport capacity and supply, the evidence of active and/or recent downcutting of mainstem Napa River and lower alluvial reaches of its tributaries is overwhelming, and most likely attributable to a wide array of direct modifications of the channels by humans during the recent past (e.g., aggressive levee building in 1950s and 1960's, straightening of some mainstem channel reaches, extensive removal of large wood from the channel), and also to the effects of coarse sediment capture by dams (in particular those on Conn and Rector Creeks). Understanding the relative significance of these management actions would and/or will require extensive studies. The present-day legacy of recent or ongoing incision is complex channel response, some reaches are downcutting, others appear to be downcutting and widening, others are widening, still others are widening and filling. In rare instances, a new dynamic equilibrium may have been established (e.g., within a short sub-reach of the 4.5 mile Rutherford Project Reach. Finally, although incision has not occurred outside of the alluvial fan and valley reaches of tributaries, based on our analysis of sediment inputs and inferred relationship to streambed permeability, we conclude that even in these channels (which appear to have very high sediment transport capacities given their slopes and drainage areas), there has been an increase in the amount of sand that is stored in the streambed with negative effects to rearing and spawning habitat for steelhead.

In response to this comment, we added additional information to the Staff Report as presented in our responses to comments R-6 and R-12 below.

**Comment R-2: “My initial concern for both the technical report and the enhancement plan is that it is not clear where the supporting data, results, field measurements, and documentation can be found. Supporting documentation and methodology was later provided that must be appended to and referenced by the 2/17/06 Technical Report. The**

**report does need additional explanation and comments about the appended supporting documentation.”**

In response to this comment, we added additional information regarding our methods to the June 30, 2006 draft of the Staff Report (Section 3.4, Approach to Measurement of Sediment Input to Channels). Also, the methods document that we provided to you is now cited in the technical report and is available upon request (Napolitano, 2006).

**Comment R-3: “Assuming that additional information will be added to the report on the methods and procedures that were used to calculate the TMDL and to decide that a 50% reduction would work, some discussion needs to be added about the accuracy of the calculations and the permissible range of application.”**

With regard to estimating the accuracy of sediment input rate calculations, please see response above to Professor Naiman’s comment N-13, where we address this issue.

As we stated in the previous response, we have included information regarding methods and procedures in the Staff Report. Staff Report section 5.2, Approach to Development of Linkage Analysis, where we evaluate the sediment load reduction needed to attain numeric targets, describes our rationale:

In order to determine what percentage above natural background sediment load is needed to attain sediment-related water quality standards, we reviewed previously adopted sediment TMDLs for stream channels in the California Coast Range, and found two sediment TMDLs that have been adopted where a the TMDL is expressed as a percentage of natural background load. These TMDLs were developed based on comparison to a reference watershed or reference time-period where water quality standards are/were attained. These two sediment TMDLs are:

- 1) For Redwood Creek in Humboldt County, where a reference watershed was used; and
- 2) For Noyo River on the Mendocino Coast where a reference time period was used.

In both cases, a reference state was identified where salmonid populations are/were robust, and inferentially, where water quality objectives for sediment-related parameters are/were attained. For Redwood Creek, the sediment load corresponding to robust steelhead and salmon populations equals 117 percent of natural background. For Noyo River, the sediment TMDL equals 125 percent of natural background. Similar to Napa River watershed, the primary goal of these TMDLs is the recovery of salmon and steelhead runs.

Of the two watersheds, Noyo shares more attributes in common with Napa including similar uplift rate and average annual rainfall, common occurrence of weak sedimentary rocks that are susceptible to substantial increases in sediment supply in response to land use disturbances, and predominance of road-related

erosion, gullies, and channel incision as significant human-caused sediment sources. Although hard volcanic rocks are also common in Napa River watershed, this terrain type is not as sensitive to land use disturbances, and therefore, absolute increases in sediment supply from land use activities in the hard volcanic rock terrain type are much lower. As such, elevated sediment loads in Noyo and Napa rivers are primarily a product of interactions between land use disturbances and weak sedimentary rocks being uplifted at similar rates. Therefore, Noyo River under historical conditions (circa 1940s) - when there was a modest increase in sediment load (e.g., 125 percent of natural background) and robust steelhead and salmon runs - appears to be suitable reference watershed for evaluating assimilative capacity of Napa River for sediment.

Achieving a TMDL equal to 125 percent of natural background in Napa River, during a future period with similar climate conditions to the 1994-2004 measurement period, would require average annual sediment supply be reduced by about one-third from current value to approximately 325 metric tons per km<sup>2</sup> per year. Inputting this load into the regression relationship between spawning gravel permeability and sedimentation index (Figure 12), we calculate that median value for spawning gravel permeability in lower Napa River<sup>1</sup> would be 6600 cm/hr, which is approximately equivalent to the proposed numeric target for spawning gravel permeability. Redd scour potential also would be reduced by an unknown but significant amount as a function of reducing the sediment supply by one-third (from current load), and as a consequence of increases in riffle, gravel bar, slough, and flood plain habitat areas recommended as part of the implementation plan to reduce sediment supply from channel incision (Chapter 6).

**Comment R-4: "It needs to be made clearer where sediment samples were made and what the limitations were for the collection sites. The report needs to discuss the results of any analysis of the sediment samples for size distribution and sediment characteristics."**

We address this issue in our response above to Professor Naiman's comment N-16.

**Comment R-5: "The various coefficients used in the USLE method need to be further documented. I do not remember any discussion of the length slope factor used with the method. The accuracy of the yield results and the range of reasonable application need to be addressed. How confident are the authors with the method results?"**

Information on the length slope factor is included in an unpublished paper prepared by staff and available from the Water Board (Napolitano, 2006):

Based on field observations during watershed reconnaissance, we estimate average slope lengths of 200 feet for vineyards and 400 feet for rangelands. We

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<sup>1</sup> In mainstem Napa River at Soda Creek which corresponds approximately to the downstream limit of salmon spawning habitat in mainstem, and where streambed slope is close to the lower limit for gravel-bedded channels, and hence, particularly sensitive to deposition of sand in the streambed.

subdivided all mapped vineyards and grasslands into three slope steepness categories, less than 5 percent, 5-to-30 percent, and greater than 30 percent, in accord with the slope categories considered in the Napa County Conservation Regulations. For the less than 5 percent slope category, we use 2 percent as the value that is input to the model. For the 5-to-30 percent category, we use 20 percent as the value that is input to the model. For the greater than 30 percent category, we use 35 percent as the value that is input to the model. All calculated LS values are calculated from Table 2 in USDA (1994).

With regard to assessing the accuracy of the surface erosion rates in vineyards and rangelands using the USLE equation, we note the following. The equation used to calculate the length-slope factor in the USLE model is based on measurements of soil erosion in agricultural field plots with surface slopes of 3 to 18 percent and slope lengths of 30 to 300 feet (Wischmeier and Smith, 1978). Results of recent studies evaluating accuracy of the LS factor for predicting soil loss on much steeper slopes, 40 to 60 percent, in plots 35-to-200 feet in length, support the conclusion that the LS factor calculated for the USLE model provides accurate estimates of average annual soil loss on slopes up to 60 percent (Liu et al., 2001). These results suggest that the values for LS factor that we applied are reasonable.

**Comment R-6: “The technical report needs to further discuss channel morphology and specifically focus on the process of channel response. Channel incision is a response to an unbalance in the system, and it is not a cause. Channel incision can only be controlled or be controllable (see key point, page 5 of the report) by changing the unbalance or cause of the channel incision.”**

To address this comment, we added the following information to Section 3.5 (Tributary and Mainstem Study Areas):

Within the Rutherford Reach, riffles provide most of the potential spawning sites for salmon and/or steelhead. The median grain size of surface layer of the streambed at riffles in the Rutherford Reach is 8-to-32 mm. A much more detailed description of channel conditions and inferred response to disturbances is contained in Box 1. Typical channel conditions in the Rutherford reach are illustrated in Figures 12 and 13.

**Box 1: Detailed physical description of the Napa River and historical channel changes**

The current episode of channel incision along the Napa River and/or in the lower reaches of its tributaries is a relatively recent phenomenon. Based on review of aerial photographs taken in 1965, we have documented that the floodplain of the Napa River, over much of its length, was coincident with the valley floor at this time. Also as can be seen in the photographs, the Napa River typically had a much broader, shallower, and much more complex channel that was characterized by large and complex gravel bars that alternated with riffles, and pools. Side channels and sloughs also were common along the Napa River through 1965.

Although vestiges of this complex habitat still are present locally today, typically the Napa River is now much narrower, deeper, and much less complex. Throughout most of its length, the bed of the Napa River is 15-to-25 feet lower than the valley floor. Much of this down-cutting has occurred subsequent to 1965. Even fairly large floods are now contained within its banks in most reaches, and/or by constructed levees which further increase water depth within the channel during large floods. Where the channel has cut down deeply, it is usually much too narrow now for alternate bars to form. Instead, pools and deep runs are the dominant features in the river bed. Riffles, characterized by gravel deposits and swift water at low flow are small and infrequent. Deeply weathered clayey bedrock also is exposed locally in the river bed in some of the deep runs and pools. In at least one location in the Rutherford Reach, the clayey bedrock forms a sill across the river bed that is a few feet in height, and which may be indicative of a zone active downcutting of the river bed. Deposits of sand are extensive in the deep runs and pools, and beneath the surface of the stream-bed in most riffles. Stream banks throughout the reach are typically poorly vegetated, very steep, and comprised primarily of sand and finer grained alluvial deposits with lesser amounts of gravel.

In the Rutherford Reach, where the channel is being studied intensively to support implementation of enhancement projects, a phase of rapid channel down-cutting has already occurred over 90 percent or more of the reach, and now channel widening is inferred as the dominant response with lesser amounts of down-cutting or aggradation accompanying the widening (Phillip Williams & Associates, 2003). In much of the remainder of the reach, the channel appears to have re-established a dynamic equilibrium between sediment supply and transport capacity, such that it is not widening, down-cutting, or aggrading at present. The complex habitat that was common in 1965 is typical in the sub-reaches that are in dynamic equilibrium today, albeit with a much narrower floodplain. Figures 12 through 13 illustrate channel conditions in the Rutherford Reach.

We hypothesize that the current episode of channel down-cutting (channel incision) is in response to the following disturbances including: a) a suite of direct alterations to the river channel and/or its floodplain (e.g., levee building, channel straightening, filling of side channels, removal of debris jams, historical gravel mining, and dredging); b) construction of four large tributary dams between 1939 and 1959 that capture runoff and coarse sediment delivered from approximately 20 percent of the land area in the watershed; and c) land-cover changes that have increased peak flows in the river (e.g., vineyards, rural residences, commercial buildings, and roads). Each of the above actions may contribute to down-cutting either through increasing the capacity of the river to transport sediment or by decreasing its supply of coarse sediment (e.g., tributary dam construction).



**Figure 12: Aerial photograph of the Rutherford Reach of the Napa River** showing the channel from about 2000-7500 ft. downstream of Rutherford Cross Road. This aerial photo was taken in 2002. Direction of flow is from left to right. Upstream of the first set of arrows, the channel is much wider and shallower and habitat is much more complex than elsewhere in the photo, and characterized by gravel bars and riffles (light colored arcs) that with pools. Between the two sets of arrows, the channel is deeper, somewhat narrower, and habitat is less complex than immediately upstream, and here the channel is actively widening and filling in. In contrast to other areas shown in the photograph, downstream of the second set of arrows, the channel is much narrower and less complex, and pools and deep-runs are dominant habitats.

**(A) Complex Channel Habitat at Rutherford Cross Road**



Photo Credit: Phillip Williams & Associates

**(B) Degraded Channel Habitat near Zinfandel Lane**



Photo Credit: Phillip Williams & Associates

**Figure 13: Ground photographs of the Rutherford Reach of the Napa River:** Habitat complexity varies substantially in the Rutherford Reach of the Napa River. (A) The upper photo illustrates conditions in an atypical sub-reach where the habitat is quite complex. There is a large gravel bar in the middle of the photo, with adjacent shallow, fast moving water, flowing over a riffle, which then transitions into a deep pool. Adjacent to the channel, there is good riparian cover including both younger and older trees. Also, in this reach, the river is connected to its floodplain, behind and beyond the gravel bar. (B) In contrast, in the lower photo, showing the channel near Zinfandel Lane, and in much of the Rutherford reach, the channel and the habitat are much more uniform. The channel is straighter, the banks are steeper, the depth and velocity of water does not change much, and there are no gravel bars.

Detailed descriptions and photographs of channel form in mainstem Napa River and how channel form varies in relation to qualitative classification of channel dynamics (e.g., incising, widening and incising, widening and aggrading, and dynamic equilibrium) are presented in *A Conceptual Plan for the Stabilization and Restoration of the Napa River, Rutherford Reach* (Phillip Williams & Associates, 2003). Unpublished cross-section and longitudinal profile data, and pebble counts to describe grain size distribution of the surface layer of the streambed are also available (Napa County RCD, 2004, unpublished data).

With regard to the process of channel response, we also note that in the 1950s and 1960s, levees were constructed throughout much of the length of the Napa River within rural areas to protect agriculture from flooding. Beginning in the late 1940s and continuing through the early 1960s four large tributary dams were constructed, cutting off coarse sediment supply from 17 percent of the watershed area draining into the Napa River. During this same period, the lower Napa River in its estuarine reach was intensively dredged to reduce flood risk in the City of Napa and to enhance river navigation. These and perhaps other mechanisms including intensive removal of large woody debris from the channel appear to have altered the balance between coarse sediment supply and transport capacity. For example, channel straightening reduces channel length (and therefore increases channel slope), increasing stream power available for sediment transport. Levee building increases the depth of water over the streambed by several feet during large, infrequent floods (e.g., recurrence intervals of 20 year or more) that would otherwise spill onto the floodplain after exceeding bankfull depth. This likely contributed to a significant increase in stream power during large floods. Tributary dams in contrast trap a significant portion of the natural coarse sediment supply, which also could provide significant positive feedback for incision.

**Comment R-7: “Another subject that needs to be explained on the basis of channel response is woody vegetation, introduced on page 11 of the technical report. The report needs to explain what has caused the change in vegetation. The change in vegetation is a response, so the cause of the response needs to be addressed. Any solution to the problems caused by the change in vegetation has to include changes or corrections to the cause. Could channel incision be contributing to the loss of vegetation by changes in groundwater? Also, the absence of woody debris often results in increased velocity, sediment transport, and erosion. Removal of woody debris also decreases the energy loss of a channel and reduces deposits, especially fine sediment.”**

When we refer to “large wood” as in the statement, “The amount of large wood in channels appears to be low when compared to similar streams draining watersheds covered by mixed evergreen forests,” **large wood** refers to large woody debris loading into channels, and was not intended to describe change in the character and/or extent of riparian vegetation along channels. Levee building and/or channel incision have greatly reduced the frequency and extent of valley floor flooding, allowing agricultural

expansion into the riparian corridor, and thereby reducing its width and diversity. Similarly, channel width has decreased in most locations as the bed has cut down through former gravel bars, which have been converted into narrow stream terraces that are covered by mature native riparian tree species (as opposed to a mosaic of young-to-old forest patches prior to incision).

We added text to the Staff Report section 2.2, Detailed Problem Statement, describing relationships between channel incision and vegetation:

- “Much lower frequency of inundation of adjacent flood plains, as a result of channel incision, contributes to a variety of adverse impacts to aquatic and riparian habitat including:
  - a) Diminished extent of riparian vegetation on the valley floor
  - b) Very poor conditions (in most locations) for recruitment of young stands of riparian tree species, decreasing the diversity of vegetation/habitat types on the valley floor
  - c) Diminished complexity of channel and flood plain topography (e.g., loss of side channels, sloughs, and other flood plain wetland habitats)
  - d) Over the long-term, reduced rates of input of large woody debris to channels (e.g., large/old trees are not being replaced at the rate that they are falling into the channels).

**Comment R-8: “The technical report needs to list the channel geometries, the flow rates, flow depths, channel slopes, channel roughness factors for the different channel reaches. Were all of the input rates, incision rates, etc made for the same annual flows? This is not clear. What are the annual flows for the different reaches? How were the annual flows determined? The technical report discusses channel incision but needs to include related information on channel widening or narrowing, changes in slope and channel sinuosity. The technical report needs to include a discussion and conclusions about the influence of the reservoirs on the sediment problems.”**

Please see our responses above to comments R-1 and R-2 where we present our methods and approach for estimation of channel incision rates, which do not depend upon measurement of flow depths, channel slopes, channel roughness factors, and is independent of flow magnitude. Instead, we rely on a forensic approach using even age vegetation communities, manmade structures, and time sequential aerial photographs to estimate the timing for the start of incision and cumulative volume of erosion since that time. This approach is described in detail in Napolitano (2006), which we provided for your review. Please see our response above to R-6 where we provide additional information regarding channel conditions and response including channel narrowing and widening and slope and sinuosity. Please also see our response above to comment N-21 (from Professor Naiman) where we address the issue of dams.

**Comment R-9: “The presence of channel incision and the lowering of the channel bed have an additional affect on channel slope and the flow depth and velocity. This needs to be discussed. A lowering of the channel bed by erosion could produce increased permeability and the reduced presence of fine sediment. The reasons that fine sediment has increased in the bed need to be explained. Is it possible that since sediment is being trapped by reservoirs, road crossings, and diversion structures, a flood event caused the erosion of the channel beds? And then does it follow that because of the slope change due to bed erosion (increase in depth and decrease in velocity), lesser flows can not transport enough sediment? Is it possible that reservoirs, etc are prohibiting the necessary “maintenance flows” or flow peaks needed to prevent the buildup of fine sediment?”**

Our response to comment R-6 discusses the effect of incision on channel slope, flow depth, and velocity. As noted in that comment, channel response, at the reach scale, is highly variable and dominated at present by channel widening and/or filling consequent to an earlier period that was dominated by down-cutting. As summarized in the Basin Plan amendment (in the section titled “Sources” and in Table 2) although 30 percent of the watershed drains into reservoirs, human actions downstream of dams are contributing enough sediment that the total and fine sediment load are substantially elevated above natural background amounts. While the reservoirs dampen peak flows, we hypothesize that substantial changes in hillside land cover and drainage (as a consequence of development of rural residences, roads, and vineyards) are causing equal or greater amplification of peak flows in the Napa River.

**Comment R-10: “The enhancement plan (page 2) discusses that dams have caused or contributed to incision. There needs to be more information about the reservoirs and their location and influence of the sediment problems. A detailed map that shows the location of reservoirs, reaches of channel incision, any diversion structures, etc would be very helpful. Both the enhancement plan and technical report need to discuss the influence of the dams on the hydrology of the annual flows, floods, and the reduction or elimination of maintenance flows.**

Please see our response above to comment N-21 (from Professor Naiman) where we discuss the influence of reservoirs on sediment supply. Please also note that we have prepared maps of the reservoirs (Maps 1 and 2), and these are included as part of the staff report. The locations of actively incising, aggrading, and equilibrium reaches have been mapped in the Rutherford Reach, and this information is presented in Phillip Williams & Associates (2003).

**Comment R-11: “Both the enhancement plan and the technical report need to include additional information about the channel incision and answer any questions about**

the stability of the channels. Active bed erosion and head cuts could be significant problems.”

Revisions to the Staff Report shown in our response to comment R-6 include this information.

**Comment R-12: “Section 3.6 of Chapter 3 of the technical report develops a relationship between stream power and permeability. However, the definition of the stream power used in this report needs to be clearly defined and justified. The definition that I have inferred is one of drainage area times slope. The variable DA used in the figures needs to be defined. However, the key factors or variables in stream power are velocity, depth, and slope. The report needs to justify not using or including velocity and depth in developing a relationship with permeability. The relationships (figures) need to define the channel parameters and flow variables that they are limited to.”**

We appreciate the opportunity to clarify our definition and the basis for it. We define the term “stream power index” as being equal to the product of upstream drainage area multiplied by streambed slope. Stream power is typically defined as a product of stream flow discharge multiplied by channel slope. To clarify our basis for using drainage area as a proxy for discharge, we have revised Staff Report section 3.4, Approach to Measurement of Sediment Input to Channels, as follows:

***Relationship Between Sediment Supply, Transport Capacity, and Streambed Permeability***

To explore the relationship between sediment input to channels and streambed permeability<sup>15</sup>, we compared average annual sediment input rates to reach-median values for streambed permeability measured in seven reaches of the four study tributaries, and in one reach of mainstem Napa River, located near Rutherford.

Streambed permeability values typically reflect a balance between fine sediment supply and transport capacity, therefore, we also estimated stream power. Stream power is defined as the rate of energy expenditure by water as it flows through a channel. Stream power is directly proportional to the product of streamflow discharge multiplied by water surface slope (Smith and Bretherton, 1972). In our analysis, we define a stream power index that is equal to streambed slope multiplied by drainage area, which we use as a proxy for streamflow discharge in our analysis<sup>16</sup>. We measured streambed slopes throughout the length of each reach where we measured permeability. All of the reaches we surveyed were greater than 40 bankfull channel widths long. We also calculated the land area draining into each reach using the three-meter digital elevation model. We did not estimate values for bankfull discharge because streamflow gaging data were not available at most of our sites.”

Footnotes:

“<sup>15</sup>Considering constraints of funding, we selected streambed permeability as a response variable for comparison to sediment input rate because: a) permeability measurement is fast and repeatable, allowing us to collect data throughout the watershed; and b) there is an inverse relationship between concentration of fine sediment (primarily sand grains) in the streambed and permeability (McNeil and Ahnell, 1964).

“<sup>16</sup>Our estimates of total stream power provide only a rough estimate of the fraction available to transport sediment. This is because flow energy is also expended through internal friction within the fluid, and friction along the channel boundaries caused by grain roughness, large obstructions (like debris jams, bedrock outcrops, bridge piers, etc.), and/or other changes in channel width, depth, and direction of flow encountered along the length of the channel. Stream flow data are lacking for most of the reaches we surveyed. Therefore, as an alternative to estimating bankfull discharge in each of our study reaches, we used drainage area as a proxy for bankfull discharge, as bankfull discharge is proportional to drainage area.”

**Comment R-13: “Chapter 3 and the Tables of Chapter 3 of the report appear to use different units for sediment rate with the use of t, tonnes, and metric tons with the rates. Table 5 of the report has units of A/t and A/T. Are they the same? The report needs to be consistent with units.”**

Please see our response to Professor Naiman’s comment N-20, where we address this comment.

## References

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