Integrated Water Quality Management Strategy Project Report

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v1.0

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Acronyms and Abbreviations

BMP	Best management practice
BSTEM	Bank Stability and Toe Erosion Model
CalTrans	California Department of Transportation
CARB	California Air Resources Board
CICU	Commercial/Institutional/Communications/Utilities
CONCEPTS	Conservational Channel Evolution and Pollutant Transport System
CTC	California Tahoe Conservancy
EIP	Environmental Improvement Program
EPA	U.S. Environmental Protection Agency
GIS	Geographic information system
IWQMS	Integrated Water Quality Management Strategy (Integrated Strategy)
LSPC	Loading Simulation Program C++ (Watershed Model)
LTBMU	Lake Tahoe Basin Management Unit, (U.S. Forest Service)
NDEP	Nevada Division of Environmental Protection
NDOT	Nevada Department of Transportation
NTCD	Nevada Tahoe Conservation District
O&M	Operations and maintenance
PAT	Packaging and Analysis Tool
SEZ	Stream environment zone
SNPLMA	Southern Nevada Public Land Management Act
SWQIC	Storm Water Quality Improvement Committee
TMDL	Total Maximum Daily Load
TN	Total nitrogen
TP	Total phosphorus
TRPA	Tahoe Regional Planning Agency
UCD	University of California at Davis
USFS	U.S. Forest Service
VBA	Visual Basic for Applications
VMT	Vehicle Miles Traveled

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1. Introduction

The California Regional Water Quality Control Board, Lahontan Region (Lahontan Water Board) and the Nevada Division of Environmental Protection (NDEP) are developing the Lake Tahoe Total Maximum Daily Load (Lake Tahoe TMDL)—a plan for achieving a reduction of fine sediment and nutrients to restore Lake Tahoe's clarity to 97.4 feet. The Lake Tahoe TMDL is organized around a series of questions:

- **What pollutants are causing Lake Tahoe's clarity loss?**
- **How much of each pollutant is reaching Lake Tahoe?**
- **How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?**
- **What are the options for reducing pollutant inputs to Lake Tahoe?**
- **What strategy should we implement to reduce pollutant inputs to Lake Tahoe?**
- **Are the expected reductions of each pollutant to Lake Tahoe being achieved?**
- **Is the clarity of Lake Tahoe improving in response to actions to reduce pollutants?**
- **Can innovation and new information improve our strategy to reduce pollutants?**

As these questions are answered, the plan for restoring the clarity of Lake Tahoe is developed. Additional background of the Lake Tahoe TMDL is in two separate reports; (1) the *Lake Tahoe TMDL Pollutant Reduction Opportunity Report* v2.0 (PRO Report v2.0) (Lahontan and NDEP 2007b), and (2) the *Draft Lake Tahoe Total Maximum Daily Load Technical Report* (Technical Report) (Lahontan and NDEP 2007a).

1.1. Integrated Water Quality Management Strategy Project

The Integrated Water Quality Management Strategy Project (Integrated Strategy Project) is part of the larger Lake Tahoe TMDL effort and answers the questions: **What are the options for reducing pollutant inputs to Lake Tahoe?** and **What strategy should we implement to reduce pollutant inputs to Lake Tahoe?** The Integrated Strategy Project provides the California and Nevada water quality regulatory agencies technically viable, publicly discussed recommendations to inform the development of the implementation plan for the *Final Lake Tahoe TMDL*.

These recommendations begin with answers to the question, **What are the options for reducing pollutant inputs to Lake Tahoe?** Groups of technical experts analyzed potential pollutant reduction opportunities and associated costs. These analyses and findings are provided by groups of experts in the PRO Report v2.0.

An *integrated strategy* combines selected pollutant controls from each of the four primary sources of fine sediment and nutrients to Lake Tahoe. The four primary sources are: (1) urban uplands (urban), (2) forested uplands (forest), (3) atmospheric deposition (atmospheric) and (4) stream channel erosion (stream). Several candidate integrated strategies provided the basis for engaging project implementers and public stakeholders during an extensive public input process. Input and comments from this series of communications helped to guide agency decision makers in development of a *Recommended Strategy*; answering the question, **What strategy should we implement to reduce pollutant inputs to Lake Tahoe?** Table 1-1 provides a perspective on the Integrated Strategy Project's relationship to the larger Lake Tahoe TMDL.

The Recommended Strategy incorporates the best available science and extensive stakeholder input to describe a Basin-wide, non-prescriptive strategy to inform the Lake Tahoe TMDL implementation plan. It provides a plausible and efficient approach to achieve the Clarity Challenge. The *Clarity Challenge* is an interim water quality milestone established by the Lahontan Water Board and NDEP to focus planning efforts on achieving a measurable improvement of lake clarity based on meaningful load reductions. The Clarity Challenge is proposed as a Basin-wide 32 percent fine sediment (of less than 20 microns in diameter) load reduction and is expected to result in 77 to 80 feet of clarity.

The Recommended Strategy is intended to guide implementing agencies in their efforts to achieve necessary load reductions. The Recommended Strategy does not directly translate to recommendations for project-scale application, and implementing agencies are not required to implement the specific pollutant controls contained within the Recommended Strategy. It is intended that more-detailed, geographically specific analyses be pursued for site-scale implementation and budget planning.

Table 1-1. TMDL Questions and Products with Current Effort Highlighted

TMDL phase	Questions	Products
Pollutant Capacity and Existing Inputs	**What pollutants are causing Lake Tahoe's clarity loss?**	Research and analysis of fine sediment, nutrients and meteorology
	How much of each pollutant is reaching Lake Tahoe?	Existing pollutant load to Lake Tahoe from major sources
	How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?	Linkage analysis and determination of needed pollutant load reduction
		Document: TMDL Technical Report
Pollutant Reduction Analysis and Planning	**What are the options for reducing pollutant inputs to Lake Tahoe?**	Estimates of potential pollutant load reduction opportunities **Document:** Lake Tahoe TMDL Pollutant Reduction Opportunity Report
	What strategy should we implement to reduce pollutant inputs to Lake Tahoe?	Integrated Strategies to control pollutants from all sources
		Load reduction allocations and implementation milestones
		Implementation and Monitoring Plans
		Document: Final Lake Tahoe TMDL
Implementation and Operation	**Are the expected reductions of each pollutant to Lake Tahoe being achieved?**	Implemented projects & tracked load reductions
	Is the clarity of Lake Tahoe improving in response to actions to reduce pollutants?	Project effectiveness and environmental status monitoring
	Can innovation and new information improve our strategy to reduce pollutants?	Lake Tahoe TMDL continual improvement and adaptive management system, targeted research
		Document: Future Periodic Milestone Reports

1.2. Using This Report

This report is intended to be a reference to support agency staff in their development of the Final Lake Tahoe TMDL and a source document for technical reviewers and interested stakeholders. It is one of four documents produced by the Lake Tahoe TMDL program to date. Throughout this document, pollutant loads are assumed to be annual averages unless otherwise specified.

Lake Tahoe TMDL document suite

- *Charting a Course to Clarity*, The Lake Tahoe Total Maximum Daily Load
- The *Draft Lake Tahoe Total Maximum Daily Load Technical Report*
- The *Lake Tahoe TMDL Pollutant Reduction Opportunity Report v2.0*
- The *Integrated Water Quality Management Strategy Report* (this report)

The Integrated Strategy Project report does three things:

1. Describes the Recommended Strategy
2. Describes the process for developing the Recommended Strategy
3. Provides results of analyses conducted to support load allocation development

Extensive appendices provide supporting documentation detailing the work described in the main body of the report. The following are chapter summaries of the report's content:

Chapter 2: Recommended Water Quality Management Strategy – The key result of the Integrated Strategy Project including charts describing estimated effects of the strategy on pollutant inputs to Lake Tahoe and estimated costs to implement and maintain recommended pollutant controls.

Chapter 3: Development of the Recommended Strategy – A complete description of the process used to arrive at the Recommended Strategy including descriptions of alternative strategies considered and synthesized input from contributors including stakeholders, researchers and the TMDL team.

Chapter 4: Analyses Supporting Load Allocations – The Results of Geographic Information System (GIS) analyses that combine the Recommended Strategy with existing land uses and jurisdictions. These results are intended to support the establishment of load allocations for the Final TMDL.

Information on the U.S. Environmental Protection Agency's (EPA's) TMDL program is at www.epa.gov/owow/tmdl. Information on the Lake Tahoe TMDL, including the reports noted above, is at http://www.waterboards.ca.gov/lahontan/water_issues/programs/tmdl/lake_tahoe/index.shtml or http://ndep.nv.gov/bwqp/tahoe.htm.

2. Recommended Water Quality Management Strategy

The Recommended Strategy incorporates the best available science and extensive stakeholder input to describe a Basin-wide, non-prescriptive strategy to inform agencies as they create TMDL load allocations and develop an implementation plan. The Recommended Strategy also serves to estimate a practical distribution of potential reductions from each source category. The Recommended Strategy combines pollutant controls from all four major categories of pollutant sources while focusing on reducing fine sediment particles delivered by urban runoff. Implementing the Recommended Strategy is estimated to involve a $1.5 billion capital investment and will achieve the Clarity Challenge, which calls for approximately 32 percent reduction in the Basin-wide fine sediment particle load.

This chapter presents the Recommended Strategy by describing suggested actions for each of the major pollutant source categories and then describes the estimated results of implementing the Recommended Strategy. Chapter three explains the process of technical analysis and stakeholder input used to formulate the Recommended Strategy.

Non-Prescriptive Strategy

The Recommended Strategy is intended to guide implementing agencies in their efforts to achieve required load reductions. The Recommended Strategy does not directly translate to recommendations for project-scale application, and implementing agencies are not required to implement the specific pollutant controls contained within the Recommended Strategy. It is intended that more-detailed, geographically specific analyses be pursued for site-scale implementation and budget planning.

2.1. Source Category Recommendations

The Recommended Strategy incorporates recommendations tailored to each source category because they deposit pollutants into Lake Tahoe via differing mechanisms and at different rates. For each source category, three key elements define the actions within the Recommended Strategy. *Treatment tiers* are groups of pollutant controls that were screened by technical experts to be broadly applicable to the Tahoe Basin. Each source category's treatment tiers can be applied to a portion of the potential opportunities available within the Tahoe Basin. Thus, *Application level* is expressed as a percent of total possible application. For instance, a 75 percent application level of a particular urban treatment tier would mean that three- quarters of the Tahoe Basin's urban areas would be treated with that group of pollutant controls and one- quarter would remain untreated. The treatment tiers can be applied at various application levels to several different *Settings* that are based on Basin-wide physical characteristics and applicable pollutant controls. The Recommended Strategy is based on several assumptions that are described at the end of the section.

Comments and observations about the relative confidence related to each source category's analysis are discussed at the end of each source category section. These comments are based on the TMDL team's interpretation of technical confidence ratings provided by source category experts combined with confidence ratings of the TMDL pollutant budget (Lahontan and NDEP 2007a, p. 5-164).

Urban Runoff Focus

The majority of pollutant loading, and also estimated potential pollution control, come from urban runoff. Thus, this is the area of focus for the Recommended Strategy (Lahontan and NDEP 2007a and 2007b). The Recommended Strategy focuses on advanced practices and innovative technology to control fine sediment particles from the urban runoff source category.

Pollutant Controls Included

Urban pollutant controls are categorized into three treatment tiers that are targeted to four settings. The names of the treatment tiers and example controls include the following:

- **Best Current Practices (Tier 1)** – Detention and retention basins, stormwater vaults, road shoulder stabilization, vacuum sweeping on heavily sanded roads, limited impervious coverage removal and 50 percent completion of private property best management practices (BMPs)
- **Advanced, Intensive Practices (Tier 2)** – Wetland and passive filtration basins, media filters in stormwater vaults, deicing compounds or advanced abrasive (sand) recovery, intensive maintenance of stormwater infrastructure, 100 percent completion of private property BMPs
- **Innovative Technology (Tier 3)** – Active pumping and filtration systems for stormwater applied to urban areas with concentrated impervious coverage (such as *downtown* areas) and Tier 2 treatment applied to urban areas with dispersed impervious coverage (such as many residential areas)

The Recommended Strategy includes these pollutant controls at different application levels in four settings based on configuration of impervious coverage and slope. The areas with concentrated impervious coverage, such as commercial land uses with extensive streets and rooftops, involve a greater application level of the higher treatment tiers. The land uses with more dispersed impervious coverage, such as residential land uses with less pavement and more open space, require less advanced treatments at a lower application level. For each of these settings, Table 2-1 provides the application level included in the Recommended Strategy. Additional information about the mix of pollutant controls included in each treatment tier and the process for deriving these numbers is in Appendix C.

Table 2-1. Application Level for Urban Pollutant Controls Used in the Recommended Strategy

Pollutant controls	Concentrated impervious coverage areas on steep slopes	Concentrated impervious coverage areas on moderate slopes	Dispersed impervious coverage areas on steep slopes	Dispersed impervious coverage areas on moderate slopes
Best Current Practices (Tier 1)	20%	20%	30%	40%
Advanced, Intensive Practices (Tier 2)	–	–	–	40%
Innovative Technology (Tier 3)	50%	50%	–	–
% of Total Area Treated	**70%**	**70%**	**30%**	**80%**

Note: percentages represent the amount of urban area treated with pollutant controls. Hyphens indicate that these controls are not included in the Recommended Strategy for this source category. These percentages are not project-level recommendations; they represent percentages of the entire urban area within the Lake Tahoe Basin.

Table 2-1shows that Basin-wide, 20 percent of the urban area with concentrated impervious coverage on steep slopes would be treated with best current practices (Tier 1). 50 percent of these areas would be treated with innovative technology (Tier 3) pollutant controls. The remaining 30 percent of these areas

would remain untreated. Taken together, the treatment tiers and their application levels to each urban setting compose the Recommended Strategy for the urban source category.

Relative Confidence

The analyses of urban runoff controls are considered of high enough confidence to use for management decisions at the Basin-wide scale. However, an analysis of confidence revealed that the centralized pumping and stormwater treatment systems included in the innovative technology (Tier 3) pollutant controls will benefit from additional analysis future efforts. In particular, many of the design assumptions made in determining the cost and effectiveness of innovative technology treatments such as pumping and filtering stormwater are subject to adjustment as new information becomes available from testing of different designs. In some cases, Tier 3 results are sensitive enough to the assumptions made that sediment removal rates or costs could be adjusted up or down significantly.

Atmospheric Deposition Focus on Stationary Sources

Lower, but significant, pollutant loads and cost-effective treatments are available by controlling stationary atmospheric dust sources. The cost-effective fine sediment load reduction available through enhanced maintenance and operation of nonmobile dust sources leads to recommendations that focus on controls for both paved and unpaved roadways, as well as parking lots and construction sites. Pollutant controls include street sweeping with advanced vacuum sweeping equipment, graveling dirt roads, other dust control efforts for construction and reducing residential wood burning.

The Recommended Strategy focuses on nonmobile sources of dust particles within the atmospheric source category because these sources provide the bulk of fine particles within this source category and because mobile sources predominantly produce nitrogen, not fine particles. Nonmobile sources of fugitive dust, such as both paved and unpaved roads are responsible for more than 88 percent of atmospheric fine particle emissions in the Lake Tahoe Basin (Lahontan and NDEP 2007b, p. 52). Mobile sources, such as vehicles, produce a relatively large amount of Lake Tahoe's nitrogen load but only 1.3 percent of fine particles (Lahontan and NDEP 2007b, p. 52). Nitrogen is one nutrient that can enhance algae growth. But the TMDL Technical Report showed that light absorption by algae is responsible for approximately one-third of lake clarity loss as demonstrated by the Lake Tahoe Clarity Model (Clarity Model) (Lahontan and NDEP 2007a, pp. 3-13 through 3-14). Finally, stationary source controls for fine particles and their associated phosphorus are three orders of magnitude less expensive per ton than mobile sources according to expert analysis provided in the PRO Report v2.0.

Pollutant Controls Included

The Recommended Strategy for atmospheric deposition sources includes controls for paved and unpaved roads, as well as parking lots, construction areas and residential wood burning. They are classified into two treatment tiers by treatment intensity. The *Increased Intensity* treatment tier is generally applied more intensively or extensively than current efforts. This group of pollutant controls was referred to as *Tier 2* in the PRO Report v2.0 and includes the following:

- Every other week street sweeping with vacuum equipment that captures 10 micron particles
- Pave dirt roads at access points
- Speed limits on unpaved roads
- Gravel 50 percent of unpaved roads, including forest roads
- Require adequate soil moisture during earth-moving operations
- Use dust suppressants on exposed soil at road-building projects
- 20 percent reduction in residential wood burning emissions

The second group of controls, called *High Intensity,* is applied more intensively and pollutant load reduction effectiveness is higher. In the PRO Report v2.0, this group of pollutant controls was referred to as *Tier 3*, and it includes the following:

- Weekly street sweeping with vacuum equipment that captures 10 micron particles
- Pave all unpaved roads
- Limit speeds on unpaved roads
- Require adequate soil moisture during earth-moving operations
- Use dust suppressants on roadway and construction projects
- 50 percent reduction in residential wood burning emissions

Table 2-2. Application Level of Pollutant Controls for Atmospheric Sources of Fine Particles Used in the Recommended Strategy

Pollutant control	Basin-wide application level
Increased Intensity (Tier 2)	30%
High Intensity (Tier 3)	50%
Total % Application	**80%**

Note: values represent the percent of total, Basin-wide road length or bare area treated with pollutant controls.

Relative Confidence

The atmospheric science behind these recommendations is an area of lower confidence than other source categories because it has not been studied as long or thoroughly. Water quality studies of the urban and forested uplands in the Lake Tahoe Basin have a long history and excellent body of research that supports the estimates of potential load reduction and costs associated with fine particle controls. The body of research is less well developed in the atmospheric sciences. For instance, the Tahoe Basin's first study relating vehicles and the entrained fine particles they generate was completed in 2005. The results of this work have influenced the Lake Tahoe TMDL, but additional study is necessary to numerically link Vehicle Miles Traveled (VMT) to the fine sediment particle load to Lake Tahoe. An improved understanding of this linkage would allow greater confidence in the Recommended Strategy's recommendation to focus efforts on nonmobile sources such as paved and unpaved roads.

Stream Channel Erosion and Stream Restoration

Multi-objective stream channel restoration programs are well established, and methods do not offer wide latitude in treatment options. Thus, the recommendations for this source category are based on current plans and approaches. The analysis focuses only on fine sediment particles released from stream banks and beds, and does not consider the other potential benefits available from stream or wetland restoration. The analysis is based on the top three fine sediment particle producing streams in the Basin, which are responsible for 96 percent of the fine sediment particle load in this source category (Lahontan and NDEP 2007b, p. 212). These streams, in order of load production, are as follows:

- Upper Truckee River
- Blackwood Creek
- Ward Creek

The Recommended Strategy includes stream restoration because it is very cost-effective and follows the lead of stream management agencies because they are pursuing a broad scope of ecosystem benefits. The TMDL program focuses exclusively on the clarity of Lake Tahoe and should not disturb the multi-objective scope of existing stream restoration programs. The relative contribution to the Basin-wide fine sediment particle load for this source category is relatively small at 4 percent (Lahontan and NDEP

2007a, p. 4-164). The estimated maximum load reduction of the potential pollutant controls fall into a range of 1.7 to 2.7 percent of Basin-wide load (Lahontan and NDEP 2007b, p. 261). However, stream channel restoration provides very cost-effective fine sediment particle reductions (Lahontan and NDEP 2007b, p. 267). The Recommended Strategy includes pollutant controls that match current approaches and objectives.

Pollutant Controls Included

The evaluation of potential load reductions and costs involved with stream channel sources defined two kinds of restoration or treatment approaches. *Unconstrained restoration* of the stream includes a set of treatments that modify planform, increases length and sinuosity, connect floodplain and decrease slope such that a restored condition is eventually reached. These treatments are designed to achieve load reductions as well as other ecosystem objectives such as riparian habitat enhancement, flood control and recreation value. Estimates for these treatments assumed ideal construction access and project sequencing. Typical limitations on property acquisition are not considered in the analysis of unconstrained restoration. The second kind of restoration, *Bank protection,* is a basic set of channel armoring and minor bank slope reductions that increases hydraulic resistance and reduce bank failure. This kind of project does not achieve multiple ecosystem objectives but is very cost-effective in reducing fine sediment particles.

The current and planned future projects under consideration in the Tahoe Basin generally involve a *mixed approach* of unconstrained restoration where possible and simple bank protection on constrained stream reaches. The Recommended Strategy would implement the mixed approach in projects to include 80 percent of the potentially treatable stream channels for the three streams (i.e. an 80 percent application level). The mixed approach and 80 percent application limit recognize that certain project areas could be overly costly or difficult to address.

For the purposes of this analysis, pollutant controls were assumed to include the following distribution *within a project*:

- 45 percent bank protection
- 35 percent unconstrained restoration
- 10 percent bank strengthening
- 5 percent toe stabilization
- 5 percent bank lowering or angle reduction

Relative Confidence

The analysis of stream channel pollutant controls is considered to be of high enough confidence to support Basin-wide management decisions. However, improvements are suggested based on the model applied in the analysis. Load reductions are estimated using the Bank Stability and Toe Erosion Model (BSTEM) by the National Sedimentation Lab. This model is deemed reliable in determining the loading effects for bank protection, but it is less able to accurately estimate the effects of unconstrained restoration. Future, scheduled efforts will use an improved model, Conservational Channel Evolution and Pollutant Transport System (CONCEPTS), to estimate the effects of unconstrained restoration.[1] In addition, the load reductions do not consider the potential for streams and associated wetlands to provide treatment for urban and forest fine sediment particle loads from overbank flows. Tahoe's science organizations have already begun to study the potential water quality benefits of reconnecting floodplains.

[1] For additional discussion of stream channel modeling approaches, see Lahontan and NDEP 2007b, pp. 228 & 248.

Forested Uplands Planned Activities

Federal, state, and some of the larger local management agencies have well-defined, multi-objective restoration programs with established funding and established restoration plans. The TMDL program is focused on the clarity of Lake Tahoe and should not adversely affect the multi-objective scope of existing forest restoration programs. The Recommended Strategy incorporates load reductions from planned or expected activities of multi-objective forest restoration programs. However, these considerations do not include some of the expedited fuels reduction approaches being discussed following the June 2007 Angora Fire, which may have lasting impacts on fuels reduction plans.

Estimates of the potential load reductions available from forested uplands showed a maximum of 7 percent reduction of the overall Basin-wide fine sediment budget (Lahontan and NDEP 2007b, p. 257). The majority of this reduction comes from applying controls at a very large scale on low sediment-yielding forests. Treatment of an area this extensive increases capital costs of forest treatments alone to approximately $3 billion (Lahontan and NDEP 2007b, p. 257). However, there are small, disturbed areas (e.g., unpaved roads, campgrounds and ski runs) where relatively high sediment particle yields and easy access make pollutant controls cost-effective. Therefore, the Recommended Strategy focuses its efforts on disturbed areas and planned activities including restoration and mitigation of impacts.

Pollutant Controls Included

The Recommended Strategy for forested uplands focuses the most effort on easy-access, high pollutant yielding disturbed areas and some additional effort on implementing advanced water quality improvements on small portions of the less-disturbed parts of the forest. The forested uplands were divided into two categories on the basis of a gradient of disturbance. *Moderate to highly disturbed* areas have significantly compacted soils, little to no duff layer and moderate vegetative cover. Examples of these areas can include unpaved roads and trails, ski runs, campgrounds, cut and fill slopes or steep, exposed areas. *Typical Tahoe forested* areas have good soil hydrologic function, well-established plant communities and thick mulch or duff layers. These areas include most places that appear undisturbed, such as areas managed for forest health and second or third growth areas, but that could have legacy impacts from past activity.

Pollutant controls can be specialized to particular land uses (e.g., unpaved roads, campgrounds or ski runs) but can generally be divided into two categories of their own. *Standard BMP treatments* are planned by federal and state land management agencies for their roads, trails and fuels reduction projects. These treatments are referred to as *Tier 1* treatments in the PRO Report v2.0. Examples of these treatments include the following:

- Full, unpaved roadway BMPs (waterbars, armored ditches, rut stabilization) and annual maintenance
- Hydro-seeding and tackifier for ski runs
- Forest treatments implemented with ground-based equipment and required BMPs

Advanced treatments designed to achieve a range of effects from better hydrologic function to complete restoration that will mimic natural conditions as time progresses. These treatments are referred to as *Tier 2* or *Tier 3* treatments in the PRO Report v2.0. Examples of these treatments can include those found under standard BMP treatments, plus the following:

- Mulching and revegetating with seeding or transplanted seedlings on ski runs
- Road re-contouring, tilling, organic soil amendments, mulch, and revegetation with seedlings and seeding
- Urban sediment capture BMP for paved roadways (e.g., stormwater vaults, settling basins)

- Full restoration of legacy roads and trails

The Recommended Strategy applies the pollution controls at different application levels for each of the settings described above. Table 2-3 displays the application level for each treatment tier to each category of forested land. Efforts focus on moderate to highly disturbed areas, and the majority of treatments follow existing requirements. A small fraction of the typical forested area is recommended for treatment. This area is based on rough estimates of the area planned for fuels reduction treatment within the current planning horizon of approximately 20 years.

Table 2-3.Application Level of Pollutant Controls for Forested Upland Sources of Fine Particles Used in the Recommended Strategy

Pollutant control	Moderate to highly disturbed	Typical Tahoe forested
Standard BMP Treatments (Tier 1)	60%	–
Advanced Treatments (Tiers 2 & 3)	20%	5%
% of Total Area Treated	**80%**	**5%**

Note: values represent the percent of total Basin-wide area treated with pollutant controls. A hyphen indicates that this treatment is not included in the Recommended Strategy.

Relative Confidence

The analysis of forest upland pollutant controls is considered to be of high enough confidence to warrant management decisions at a Basin-wide scale. However, some finer points of the modeling analysis and understanding of fire effects have been identified for additional research. The technical experts who provided these analyses have recommended additional research regarding watershed modeling that would include soil properties at a finer spatial scale, additional quantitative analysis of advanced water quality pollutant controls, and exploration of the long-term costs of standard BMPs versus full restoration. This analysis specifically did not attempt to quantify the effects or costs of wildfire or controlled burns. Current efforts both inside and outside the Lake Tahoe TMDL are focused on gaining a better understanding of the pollutant loading effects of fire.

Assumptions

Several assumptions are necessary to develop the Recommended Strategy. The assumptions described below are the most immediate and defining assumptions of this analysis, but the Recommended Strategy also relies on additional assumptions that are captured in the PRO Report v2.0 and in Chapter 3:Development of the Recommended Strategy. Some of the assumptions apply universally, while others are applicable to a specific source category and are marked as such. The assumptions are numbered for reference purposes only and are not ranked in order of importance.

1. The maximum application level for pollutant controls to any given area is 80 percent. This reflects the understanding that project-scale implementation issues occur that cannot be determined at a Basin-wide planning scale. In particular, some areas might not be accessible or are unable to achieve the estimated load reductions. Site-specific challenges such as high groundwater, utility line interference, or bedrock intrusions could also make projects excessively costly in some areas.
2. **Urban:** The minimum application level for the urban Tier 1 pollutant controls is 20 percent. This assumption is necessary because implementers have already completed or are planning projects that will achieve this level within the next few years. While Tier 1 pollutant controls might be retrofitted in the future, they are assumed to be more cost-effective for addressing untreated runoff during this planning horizon.

3. **Forest sources:** As currently planned, approximately15 percent of the Basin's federal- and state-owned forest lands will be treated to reduce forest fuel loads during the next 20 years. Roughly two-thirds of the treated areas will receive standard BMPs for water quality, while the other one-third (5 percent of Basin-wide area) will receive advanced pollutant controls.
4. Street sweeping costs will be distributed between urban and atmospheric source categories. Roadway fine sediment controls are included in both urban and atmospheric source categories because they control fine sediment particle delivery to the Lake via entrained dust deposition and urban runoff. The costs of these pollutant controls are redundantly included in both source categories for this analysis. During implementation these costs will only be necessary once and the overall cost of the Recommended Strategy will be reduced.

2.2. Results

Implementation of the Recommended Strategy is estimated to result in the necessary pollutant load reductions to achieve the Clarity Challenge. The overall pollutant reductions, costs and clarity effects are described in this section. The results account for the combined effect of all controls described in Section 2.1.

Reductions in Fine Sediment Particles

The Recommended Strategy focuses on pollutant controls for fine sediment particles because these particles are responsible for roughly two-thirds of the clarity loss Lake Tahoe has exhibited. Figure 2-1 shows that the Recommended Strategy is estimated to reduce fine sediment particle (smaller than 20 micron) loads to Lake Tahoe by a total of 32 percent relative to the Lake Tahoe pollutant budget presented in the Technical Report (Lahontan and NDEP, p. 4-164).

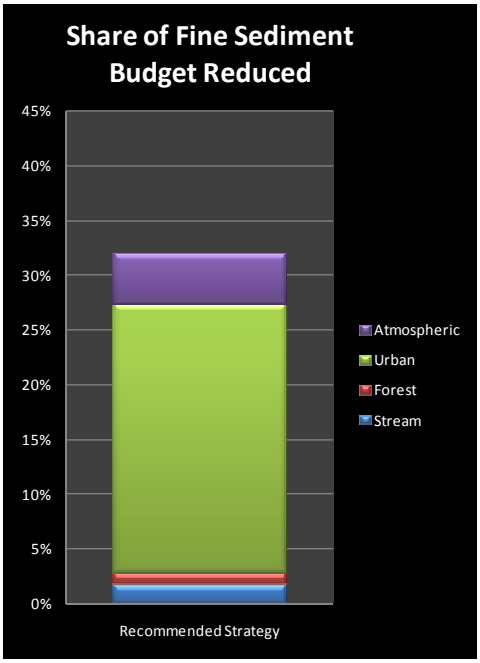

Figure 2-1. Analytic results for total percent reduction of the entire Lake Tahoe fine sediment budget for the Recommended Strategy.

Implementation of the Recommended Strategy controls is projected to achieve fine sediment particle load reductions from all the source categories; however, only a small minority of fine particles is from the

forest or stream categories. Urban stormwater pollutant controls account for the large majority of these reductions, providing approximately 25 percent of the Basin-wide total fine sediment particle budget. Atmospheric controls focused on nonmobile sources are estimated to account for 5 percent of the Basin-wide total fine sediment particle budget. Forested upland and stream channel source controls are estimated to produce 1 percent and 2 percent of the Basin-wide load reduction, respectively.

These results are not intended to discount the importance of forested upland treatments or stream channel restoration as approaches for improving the environment of Lake Tahoe. The PRO Report v2.0 shows that the load reduction available from stream channel erosion is the second most cost-effective way to control fine sediment (Lahontan and NDEP 2007b, p. 272). In addition, stream channel reductions do not include the potential of streams and associated wetlands to capture and control sediment from urban or other upland sources. The 1 percent forested runoff estimate reflects that a relatively low fine sediment particle yield (per acre) and forested lands are generally difficult to access for cost-effective treatments. The fine sediment particle producing land uses within forested areas, such as unpaved roads, ski runs and burn areas provide important opportunities to achieve cost-effective load reductions. For these reasons, the Recommended Strategy includes continued treatment of forest and stream channel sources according to the plans laid out by management and funding agencies such as the Lake Tahoe Basin Management Unit (LTBMU), the California Tahoe Conservancy (CTC) and Nevada Division of State Lands (NDSL).

Lake Clarity Effects

The pollutant load reductions resulting from implementation of the Recommended Strategy are predicted to bring Secchi depth measurements of lake clarity to approximately 78 feet, achieving the Clarity Challenge laid out in chapter one. Figure 2-2 illustrates results obtained using a liner-regression of the Clarity Model results assuming fine sediment particle reductions only. These results demonstrate arrested clarity loss and a 13-foot improvement over the 2006 average Secchi depth of 67.7 feet (TERC 2007, p. 10.2). Achievement of this milestone would be a significant waypoint on the path to eventual attainment of the long-term clarity goal of 97.4 feet (Lahontan and NDEP 2007a, p. 2-8).

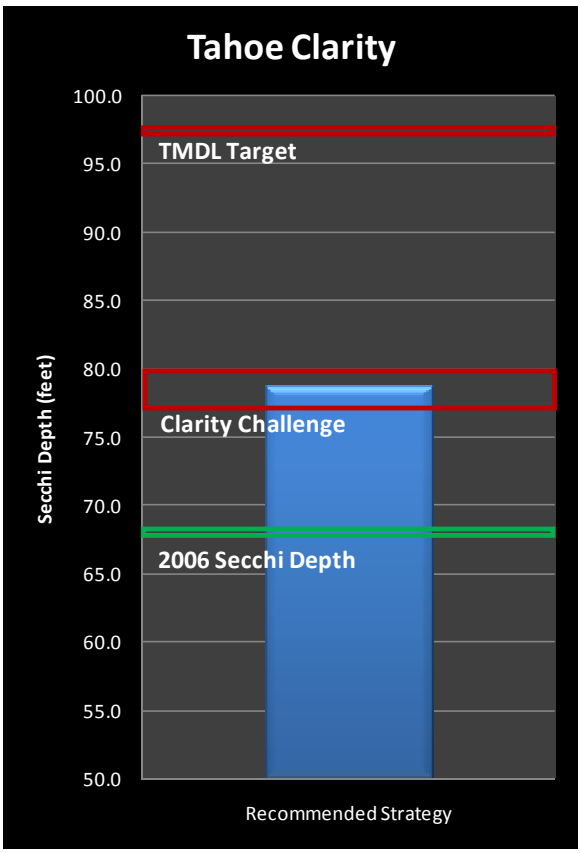

Figure 2-2. The Clarity Model predicts that implementing the Recommended Strategy will achieve the Clarity Challenge of 77-80 feet of Secchi depth as Lake Tahoe's clarity measurement moves from the 2006 value toward the overarching TMDL Target.

This result is calculated using a linear regression of outputs from the Clarity Model as reported in the TMDL Technical Report. The resulting Secchi depths are considered to be a conservative estimate because they do not include the benefits of reducing nutrients that would be associated with any pollutant controls that reduce fine sediment particles. Key sources of uncertainty in this estimate result from assumptions necessary for the Clarity Model and potential non-linearity in lake response to fine sediment inputs.

Costs

The 20-year capital and annual operations and maintenance (O&M) costs of implementing the Recommended Strategy are estimated by groups of experts on a control-by-control basis and then aggregated into totals for each major source category. Capital costs include all implementation costs such as planning, design, acquisition and replacement costs when the useful life of the controls is shorter than 20 years. More detailed analysis is necessary for budgeting and project level planning; these estimates are provided only as rough approximations.

Implementing the entire Recommended Strategy as analyzed would involve an estimated capital investment of approximately $1.5 billion. Figure 2-3 shows a breakdown of the costs associated with each of the major source categories in addition to the total amount. All values are in 2007/2008 equivalent dollars. The majority of costs, $1.3 billion, are for urban runoff pollutant controls. Pollutant controls for other sources estimated are $120 million, $48 million and $40 million for forest runoff, atmospheric and stream channel pollutant controls, respectively. The relatively high investment in urban runoff controls is

reflective of the importance of this source category in reducing fine sediment particle loads. Both types of costs are important because state and federal funding has historically been available for capital investments, while local jurisdictions have been responsible for O&M costs.

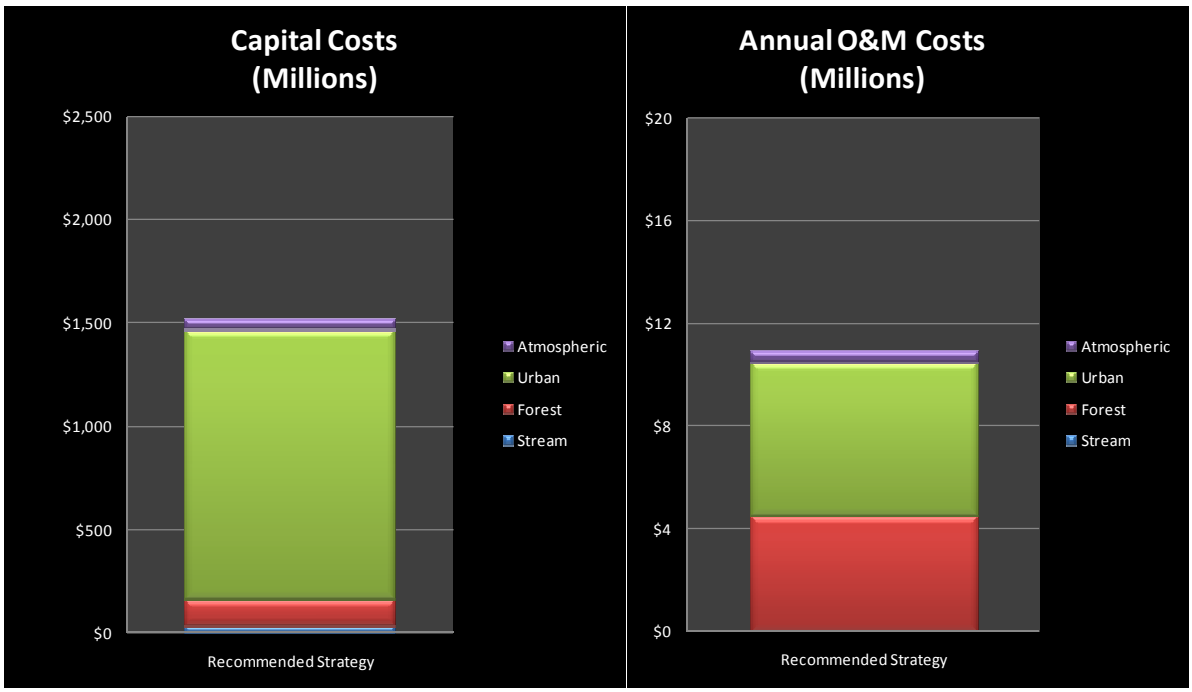

Figure 2-3. An estimated $1.5 billion in capital costs and $11 million in annual O&M costs would be needed to initiate and maintain effectiveness of the Recommended Strategy.

Figure 2-3 above, shows estimates of funding needed annually to operate and maintain recommended pollutant controls including a breakdown of the cost by major source category. These costs are reasonably evenly divided between urban runoff controls and forested runoff controls at $6.0 million and $4.5 million, respectively. Atmospheric controls are estimated to cost approximately half a million dollars annually, while stream channel controls are estimated to be self-sustaining for the life of the project. The average annual O&M costs include all requirements to maintain effectiveness of the pollutant controls at the efficiency used in load-reduction estimates for the expected life of the project.

2.3. Milestone Analysis

The Lake Tahoe TMDL must establish *milestones* along the path toward achieving the Clarity Challenge and, eventually, the Lake Tahoe TMDL's overarching numeric target for Secchi depth. The Recommended Strategy's pollutant controls and application levels define one of the milestones. The current best available science finds that achievement of the load reductions associated with the Recommended Strategy are possible by the third milestone and will accomplish the Clarity Challenge. *Implementation periods* (periods) are the intervals between milestones in which a level of effort (represented by $500 million dollars) is focused on effectively implementing the recommended pollutant controls. Specific application levels of pollutant controls and resulting costs and benefits are calculated

using the Packaging and Analysis Tool[2]. The milestones may be used to guide allocations and permitting decisions as the Lake Tahoe TMDL moves forward.

Pollutant Controls Included

The pollutant controls included in the milestone analysis are based on the Recommended Strategy and include the same selection of pollutant controls. At each milestone, application levels for the treatment tiers are adjusted. Thus, the pollutant control table for this analysis includes values for each source category's settings and treatment tiers at each milestone. The table is included for reference as Table C-2 in Appendix C.

General trends within the table show increasing pollutant control application levels until the third milestone. During the fourth period, many of the current best practices (Tier 1 controls) are projected to be retrofitted or replaced with advanced practices or innovative technologies (Tier 2 and 3 controls). The advanced and innovative technologies are not widely applied during the first two periods because they are assumed to be under development. However, they are assumed to be widely applied during the third and fourth periods, when they are expected to be available for broad application.

Overview Milestone Results

The milestones incorporate load reductions and costs from each of the source categories, but an overview should provide the clearest picture of the important trends that result from the milestone analysis before looking at source category specifics. Figure 2-4 depicts the capital costs and percent of the entire Basin-wide pollutant budget for fine sediment at each of the milestone periods. The center of each bubble is at the potential percent reduction of the overall Basin-wide fine sediment budget at each milestone. The size of the bubble represents the estimated capital cost (in millions) of implementing controls and is rounded to two significant figures. These costs are estimates of the cumulative total needed to reach each milestone.

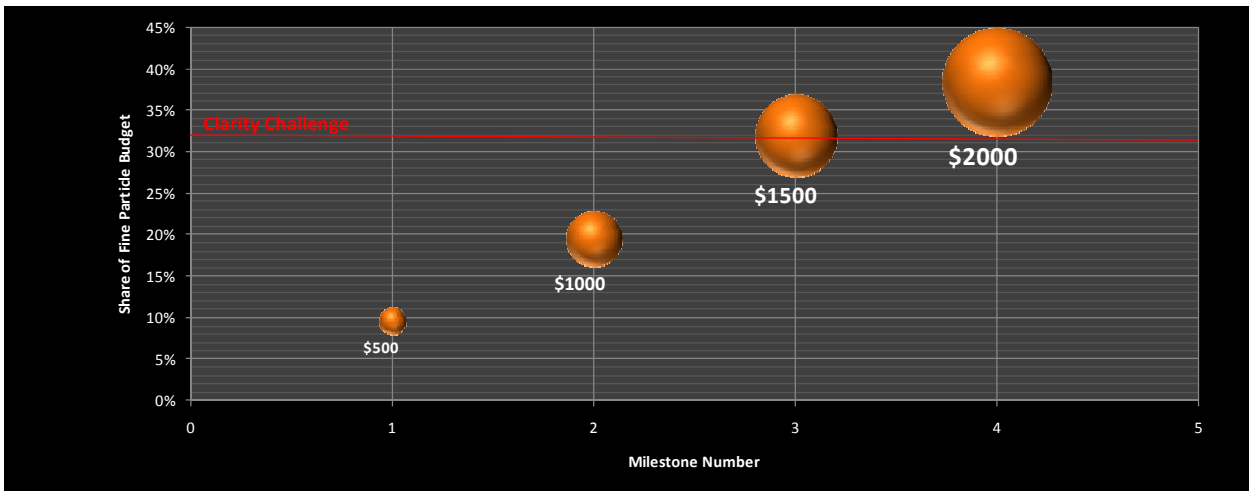

Figure 2-4. Milestones showing estimated fine particle load reductions and cumulative costs (millions) surrounding the Recommended Strategy. Milestone number three is the Recommended Strategy.

One of several important features of the milestone analysis is the ability to achieve the estimated load reductions needed for Clarity Challenge by the end of the third period. This analysis also shows potential

[2] For an additional description of the PAT and its use during creation of the Recommended Strategy, see Section 3-2 and Appendix A.

to move beyond the Clarity Challenge by achieving a 38 percent reduction of fine sediment particle loads by the fourth milestone. The results also show different load reduction rates during each period.

> ***First Period –*** Initial load reductions are 10 percent because the implementers are focused on employing current best practices as the only available pollutant controls.
>
> ***Second Period –*** Marginal[3] load reductions of 9 percent reflect growing implementation capacity with development of new and advanced technologies for fine sediment particle treatment.
>
> ***Third Period –*** Marginal load reductions of 13 percent reflect acceleration from applying advanced fine sediment control technologies and increased implementation capacity.
>
> ***Fourth Period –*** Marginal load reduction of 6 percent because of a slowing rate of reduction as load reduction opportunities become limited and retrofitting Tier 1 projects is necessary.

The overview results show that the Clarity Challenge can be met and exceeded, but additional planning and strategy adjustments will be necessary before the overarching TMDL target of 97.4 feet can be reached. This planning should be performed before the fourth milestone is reached so that implementers can fill their project pipelines with well-targeted projects before the current planning horizon ends.

Source Category Results

At each milestone, expenditures and load reductions are contributed by each source category. Table 2-4 provides load reduction and costs for each of the source categories. The information provided is the cumulative total at each milestone.

This analysis assumes that all reductions for atmospheric, forest and stream channel sources are complete by the third milestone. Additional work on urban sources would continue through the fourth period, but the area available for applying pollutant controls becomes so constrained during this period that load reduction decelerates. In addition, O&M of most pollutant controls would have to be carried beyond this planning horizon to maintain the load reductions.

[3] Marginal change is defined as the incremental change from the previous milestone.

Table 2-4. Estimated Pollutant Reduction and Costs by Source Category for Four Milestones[4,5]

Source category	Milestone #1			Milestone #2			Milestone #3[6]			Milestone #4		
	% Fine particle reduction[7]	Capital costs (millions)	O&M costs (millions)	% Fine particle reduction	Capital costs (millions)	O&M costs (millions)	% Fine particle reduction	Capital costs (millions)	O&M costs (millions)	% Fine particle reduction	Capital costs (millions)	O&M costs (millions)
Atmospheric	1%	$12	$0.12	2%	$23	$0.24	5%	$46	$0.48	5%	$50	$0.49
Forest Upland	0%	$42	$2.6	1%	$77	$3.9	1%	$120	$4.5	1%	$120	$4.6
Stream Chan.	0%	$10	$0.0	1%	$20	$0.00	2%	$40	$0.00	2%	$40	$0.00
Urban Upland	7%	$440	$1.7	15%	$910	$3.7	25%	$1,300	$6.0	31%	$1,700	$11
Total	10%	$500	$4.5	19%	$1,000	$7.8	32%	$1,500	$11	38%	$2,000	$16

[4] **Rounding:** Displayed values have been rounded to two significant figures. Totals were calculated using all available decimal places, then rounded. This causes the apparent errors in column totals.
[5] **Milestone Totals:** The numeric results presented in this table are cumulative totals for each milestone.
[6] **Milestone #3:** The third milestone corresponds to the Recommended Strategy. Load reductions associated with the Recommended Strategy (and thus the third milestone) are expected to achieve the Clarity Challenge.
[7] **Percent of Total Load:** Fine sediment particle reductions are shown as a percent of the entire Basin-wide pollutant budget

Assumptions

The results of the milestone analysis depend on challenging assumptions about funding availability, pollutant control implementation rates and availability of new technologies. The primary assumptions are captured below.

1. The minimum application level for current best practices (Tier 1) controls on urban areas in the third period is 20 percent. This assumption is necessary because implementers have already completed or are planning projects that will achieve this level before innovative practices (Tier 2) or new technologies (Tier 3) are available.
2. The maximum application level for pollutant controls to any given area is 80 percent. This reflects the understanding that implementation issues occur that cannot be determined at a Basin-wide planning scale. In particular, some areas might not be accessible, or pollutant reductions might not be achievable at certain sites. Site-specific challenges such as high groundwater, utility line interference, or bedrock intrusions could also make projects excessively costly in some areas.
3. For the purposes of quantitative analysis, the periods were assumed to be 5 years. This assumption allows the load reductions necessary to reach the Clarity Challenge to be achieved in 15 years. However, the Recommended Strategy and the milestones do not need to be tied to any particular number of years.
4. Funding in the amount of $500 million is available and expendable in each 5-year period. This assumption is considered challenging but reasonable because committed funding was reported as $1.123 billion during the first 8 years of the Lake Tahoe Environmental Improvement Program (EIP) (TRPA 2006, p. 2). Approximately 50 percent of this funding was expended on projects and research for water quality purposes (TRPA 2006, p. 7). Although the EIP's 8-year period is longer than the 5 years assumed for this analysis, the assumption is plausible given the implementation capacity that the Basin has gained during the first round of the EIP. This is the extent of the feasibility analysis that was considered for this assumption. The Recommended Strategy's cost estimates are above and beyond the previous funding of the EIP.
5. Advancements in atmospheric pollutant control technology can be implemented more quickly than advancements in urban pollutant controls. Urban control advancements necessitate new technology that must be researched, demonstrated and pilot tested. Higher technology controls for atmospheric sources, such as fine sediment-effective sweepers used in concrete manufacturing plants, are currently available.
6. The lag between the achievement of necessary load reductions and lake clarity response is assumed to be 10 years. The TMDL Technical Report includes an analysis using the Clarity Model that shows lake clarity achieving the clarity target within 15 years if all urban pollutant loads are reduced at a rate of 4.5 percent per year (Lahontan and NDEP 2007a, p. 5-56). At the outer limit, this implies that lake clarity lag could not be longer than 15 years. Another study of precipitation rates and their effect on Secchi depth measurements showed that the majority of clarity effects were noted within 2 years of precipitation extremes. Thus, it is reasonable to assume that the lake's clarity lag will be between 2 and 15 years.
7. Technology limitations determine early ability to produce advanced practices and new technology (Tiers 2 and 3, respectively) projects in the urban source category. This understanding results in three assumptions for the milestone analysis.
    - **First Period:** Research into new technology and general applicability of advanced practices

- **Second Period:** Limited application of advanced practices and pilot implementation of new technologies
- **Third Period:** Widespread availability of advanced practices and innovative technology

These assumptions are reflected in the milestone analysis constraints that allow only 10 percent of urban areas to be treated with new technology by the third milestone. Cost and opportunity constraints determine the ability to implement projects in later time periods.

3. Development of the Recommended Strategy

The Recommended Strategy was developed through a cyclic process of design and adjustment in which scientists and engineers, stakeholders, and TMDL staff and consultants participated. There were three cycles in the process. The cycles are referred to in terms of their objectives:

- Identify, screen and analyze pollutant controls
- Formulate integrated strategies
- Develop and refine the Recommended Strategy

In each cycle of the process, four activities took place:

- An interim product was developed to engage people in substantive discussion and review.
- Stakeholders commented on the interim product.
- The product was adjusted to address comments—resulting in a new interim product.
- Additional stakeholder questions were answered

The product more closely resembled the Recommended Strategy with each cycle, and the product of the third cycle *is* the Recommended Strategy.

Using the Content of This Chapter

Chapter 3 is an overview of the process of development of the Recommended Water Quality Management Strategy (Recommended Strategy). Because this is a record of process, the tables, graphs and information contained herein are not final products. These are draft materials that were subsequently refined or outmoded as the Recommended Strategy came into form. For final versions of tables, charts and information, see Chapter 2: Recommended Water Quality
Management Strategy and the PRO Report v2.0. Content of this chapter should not be cited except as it pertains to the *process* of developing the Recommended Strategy.

Contributors

Stakeholder participation informed development of the Recommended Strategy. The stakeholders included the Pathway Forum (Forum), the Focus team and Implementers (staff of Basin agencies).[8] Stakeholder contributions to the Integrated Strategies project included consideration, discussion and evaluation of options and strategies at strategic decision points in the process.

Source category groups provided evaluation and technical review of pollutant control options. The source category groups were composed of scientists and engineers independent of the TMDL team and agencies.[9] The source category groups screened pollutant controls and then provided estimates of potential load reductions and costs for the selected pollutant controls. These estimates are the building blocks of the Recommended Strategy.

[8] See Appendix B/Rosters/Stakeholder Roster
[9] See Appendix B/Rosters/Source Category Group Roster

TMDL team participation informed development of the Recommended Strategy. The TMDL team was composed of TMDL staff and consultants.[10] TMDL team contributions to development of the Recommended Strategy included analysis, discussion, design, evaluation and decisionmaking regarding options and strategies throughout the process.

Overview

The Recommended Strategy was developed through iterative interaction of stakeholders, source category groups, and TMDL team contributions in a cyclic process. These interactions are described in terms of cycles to facilitate comprehension of the progression and results of the project. While each cycle involved interim product development, stakeholder comment and product adjustment, any of these activities could have taken place in multiple venues and in varying sequence during one cycle. Table 3-1 is provided to assist project participants identify which stakeholder meetings contributed to realizing each cycle's objective.

Table 3-1. Project Development Cycles and Associated Meetings

Cycle objective	Meeting date/period	Participants
Cycle 1: Identify, screen and analyze pollutant controls	▪ July 27, 2006 ▪ September 28–29, 2006 ▪ September 10–11, 2007 ▪ September 27, 2007	▪ Forum ▪ Forum ▪ Focus team ▪ Forum
Cycle 2: Formulate integrated strategies	▪ October 11, 2007 ▪ October 25, 2007 ▪ November 14, 2007	▪ Focus team ▪ Forum and Focus team ▪ Implementers
Cycle 3: Develop and refine the Recommended Strategy	▪ December 6, 2007 ▪ January 29, 2008	▪ Forum ▪ Implementers

[10] See Appendix B/Rosters/TMDL Team Roster

3.2. Cycle 1: Identify, Screen and Analyze Pollutant Controls

Pollutant controls are the means for reducing pollutant inputs to Lake Tahoe. At the outset of the Integrated Strategies project, the stakeholders, source category groups and the TMDL team all contributed to identifying pollutant control concepts through a series of discussions in which suggested pollutant controls were noted and a broad list of potential options was compiled. Next, the TMDL team and source category groups created screening criteria. Pollutant controls that met these criteria were designated for further analysis. Finally, the source category groups analyzed the pollutant controls to quantitatively estimate their potential for reducing pollutant input to Lake Tahoe. Analysis was done at both site and Basin scales.

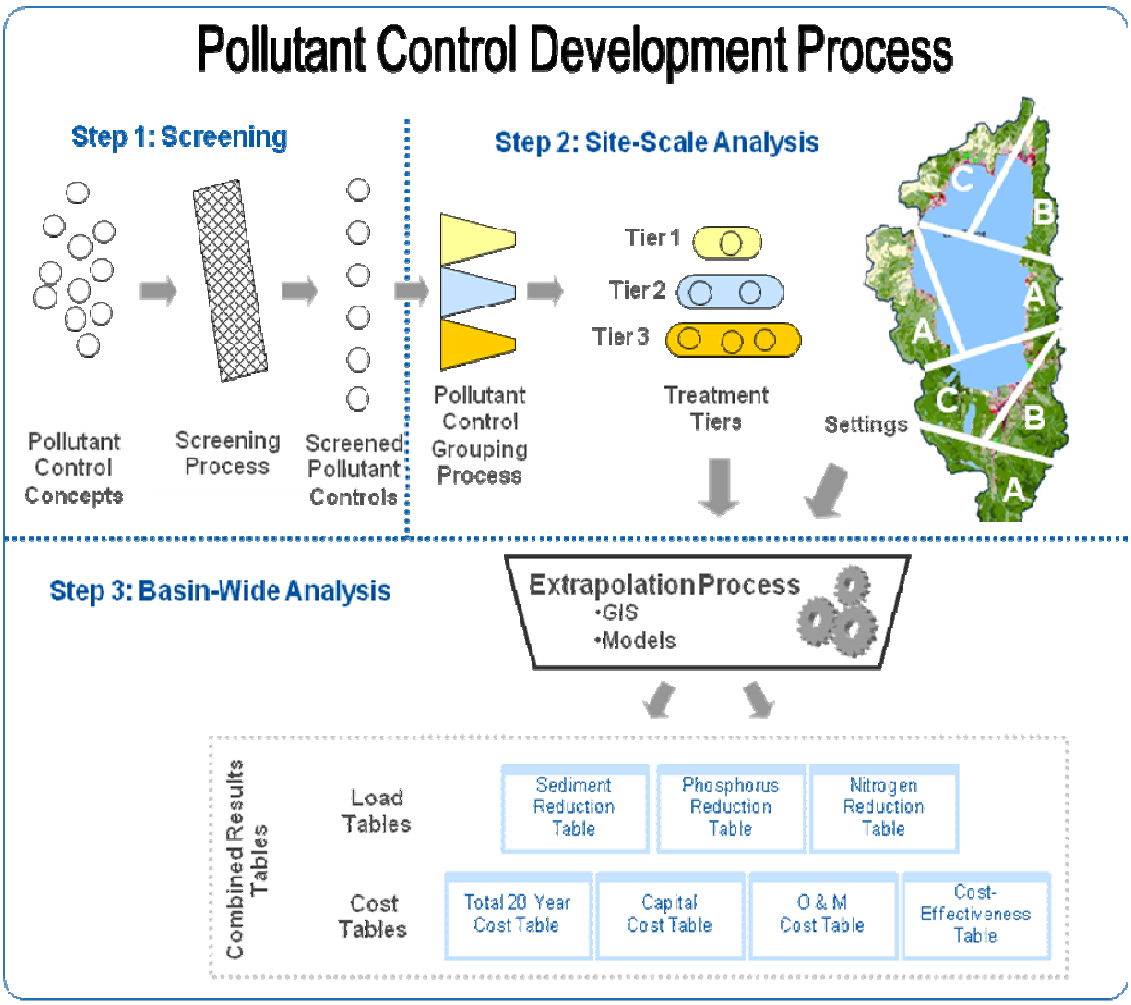

Figure 3-1. After identifying an initial set of pollutant control concepts, the analysis involved (1) Screening—Selecting pollutant controls that are widely applicable at Lake Tahoe and most likely to produce quantifiable load reductions. (2) Analyzing at the site scale—Grouping pollutant controls into Treatment Tiers that can be applied to Settings representative of landscape characteristics. (3) Analyzing at the Basin-wide scale—Extrapolating site-scale results Basin-wide using GIS and predictive models.[11]

[11] Additional background on the scope and objectives of this effort is available in the *PRO Report v2.0* (Lahontan and NDEP 2007b).

Highlights from Cycle 1: Identify, Screen and Analyze Pollutant Controls

Interim product: Viable pollutant controls with analyses of load reduction potential and associated costs (*PRO Report v2.0*)

Review & input venues:

Meeting date/period	Participants
July 27, 2006	Forum and water quality group
September 28–29, 2006	Forum and water quality group
Winter, 2007	Implementers
September 10–11, 2007	Focus team
September 27, 2007	Forum

Adjustments of note:

- Urban Tier 3
- Integrated PRO results chart & tables
- Separate atmospheric mobile and non-mobile pollutant controls
- Recommendations to focus on fine sediment, focus on urban opportunities, implement forest and stream projects as planned
- Progress toward integrated strategies

Identifying Pollutant Controls

Responses to, **"What are the options for reducing pollutant inputs to Lake Tahoe?"** were collected in a series of interactions with the stakeholders, the source category groups and the TMDL team in the period from July 2006 through February 2007. Participants were asked to suggest pollutant controls in terms of the pollutant source categories that the TMDL uses in the Watershed Model. These source categories are urban[12], forest, stream channel, and atmospheric. Highlights of stakeholder input into identifying pollutant controls are summarized in the following table.[13]

[12] The phase "urban" and "urban source category" is used in this document to refer to urban uplands runoff and its effects on groundwater. This is an adjustment from the terminology used in the PRO Report v2.0 in which the phrase "urban & groundwater" was used.

[13] See Appendix B/Identify, Screen and Analyze Pollutant Controls/Stakeholder Contribution to Identification of Pollutant Controls, 2006 (Inputs from the source category groups and TMDL team are not called out in a stand-alone table as these are reflected in the PRO Report v2.0.)

Table 3-2. Highlights from Stakeholder Pollutant Control Identification

Stakeholder-Suggested Pollutant Controls
Urban
▪ Focus on urban area creeks and meadows
▪ Use stormwater utilities for urban areas
▪ Create regional stormwater treatment sites
▪ Use porous parking surfaces
▪ Use vegetated roofs
▪ Research gray water use application and roof runoff collection for Tahoe-specific application
▪ Increase incentives for ecosystem improvements
▪ Use public urban lots for recreation and water quality
Atmospheric
▪ Use parking fees (to offset vehicle use and encourage public transit)
Forest
▪ Reduce forest fuels while improving water clarity
▪ Use recreation improvement opportunities to make water clarity improvements
Stream Channel
▪ Restore stream channels
▪ Restore meander to Upper Truckee River
▪ Restabilize banks
▪ Reduce nutrient flow
General Comment
▪ Use a watershed-based approach
▪ Reduce sediment and nutrient inputs to the Lake
▪ Focus on urban areas
▪ Shift to a macro-results oriented system (and away from micro-regulation)
▪ Address these while reducing pollutant inputs: social and economic benefits, wildlife benefits, soil, defensible space, public access
▪ Formalize education programs in all management efforts
Funding Comment
▪ Consolidate programs across the Basin
▪ Create a stormwater utility tax
▪ Fund research and development
▪ Create private sector incentives
▪ Encourage public–private partnerships
▪ Use mitigation projects
▪ Implement downstream water user surcharges

Source: Stakeholder meetings, July and September 2006

Screening Pollutant Controls

Screening of pollutant controls involved screening and evaluating pollutant controls against set criteria.

The source category groups and TMDL team together finalized the set of pollutant controls for analysis. The screening process is described in full in the PRO Report v2.0. Controls were selected for analysis on the basis of two criteria: (1) ability to demonstrate quantifiable reductions in pollutant inputs, and (2) broad applicability in the Tahoe Basin. The pollutant controls were screened on the basis of existing data whenever possible and best professional judgment of experts from the source category groups, when necessary.

Analyzing Pollutant Controls

Analysis of pollutant controls involved the following:

- Analyzing at site scale
- Extrapolating to Basin-wide scale

The source category groups analyzed pollutant controls at a site scale estimating (1) expected pollutant reduction, and (2) cost of application on a representative site scale. This involved defining representative site areas called *Settings* and groups of pollutant controls representing different approaches to reducing pollutants called *Treatment Tiers*. Subsequently, they extrapolated to a Basin-wide scale estimating (1) pollutant input reduction potential (using models), and (2) cost of application of each Treatment Tier to each applicable Setting. The result of the extrapolation is a Basin-wide estimate of potential pollutant load reductions and associated costs. The analysis process is described in full in the PRO Report v2.0.[14]

Findings of the Pollutant Control Analysis

Scientists and engineers of the source category groups articulated their answers to, **"What are the options for reducing pollutant inputs to Lake Tahoe?"** in the PRO Report v1.01 published in September 2007. This report indicates the following:

- Urban uplands are the source of pollutant inputs that have the greatest and most cost-effective potential to reduce pollutant inputs to Lake Tahoe.
- Stream channel erosion is the source with the least potential for reducing fine sediment particles, but the potential that is available is at relatively low cost and floodplain reconnection has great potential to offer additional ecosystem benefits.
- Forest uplands are the source of pollutant inputs with a small potential to reduce fine sediment particles. Opportunities are cost-effective in some areas, but sediment reductions greater than a few percent of the Basin-wide pollutant budget become very expensive.
- Atmospheric deposition is the source of pollutant inputs showing the best potential to reduce nitrogen and showing good potential to reduce fine sediment particles.

Following is a table providing example pollutant controls used by the source category groups in calculating pollutant input reductions and cost estimates. These pollutant controls are grouped into *Treatment Tiers*—groups of pollutant controls representing different approaches to reducing pollutants.

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[14] See Appendix B/Tables __: Pollutant Controls on which Screening and Analysis were to be Performed
- Assessment of Pollutant Controls for Atmospheric Sources of Fine Sediments and Nutrients
- Initial Evaluation of Pollutant Controls for Urban Uplands and Groundwater
- Initial Pollutant Controls Assessment for Forested Uplands Settings
- Assessment of Pollutant Controls for Stream Erosion Sources of Fine Sediments and Nutrients

Table 3-3. Summary of Options for Reducing Pollutant Inputs to Lake Tahoe, TMDL Treatment Tiers and Example Pollutant Controls

Tier name	Summary definition	Example Controls
Atmospheric		
Tier 2* Transportation Infrastructure & Stationary	A set of PCOs for stationary sources of fine sediment and phosphorous that effectively removes pollutants, deemed cost effective. Numeric estimates based on average literature values.	• Vacuum sweep streets (bi-weekly, fine-sediment-effective) • Pave dirt roads at access points • Limit speed on unpaved roads • Gravel 50% of unpaved roads, including forest roads • Require adequate soil moisture during earth moving operations • Suppress dust on road building projects • Reduce residential wood burning emissions by 20%
Tier 2* Vehicle Emissions	A set of PCOs for mobile sources of nitrogen that effectively removes pollutants and is considered cost effective. Numeric estimates based on average literature values.	• Reduce Vehicle Miles Traveled (VMT) by 10% through incentives/disincentives • Comprehensive transit service
Tier 3 Transportation Infrastructure & Stationary	A set of PCOs for stationary sources of fine sediment and phosphorous, deemed highly effective in removing pollutants and may be more costly than Tier 2. Numeric estimates based on high literature values.	Tier 2 controls plus: • Vacuum sweep streets (weekly, fine-sediment-effective) • Pave all unpaved roads • Suppress dust on construction projects • Reduce residential wood burning emissions by 50%
Tier 3 Vehicle Emissions	A set of PCOs for mobile sources of nitrogen, deemed highly effective in removing pollutants and may be more costly than Tier 2. Numeric estimates based on high literature values.	• Reduce VMT by 25% through incentives/disincentives • Comprehensive transit service
Urban & Groundwater		Note: each tier is defined differently for each setting. These descriptions are representative of controls used.
Tier 1*	An upper-end use of existing practices and technologies. Spatial application within the treatment area considers typical site and funding constraints.	• Stabilize and re-vegetate road shoulders • Vacuum sweep streets (in heavily sanded areas) • Upgrade fertilizer / turf management to reduce nutrient application and provide optional education • Remove impervious and soft coverage (increase infiltration) • Re-route runoff for additional treatment • Install and maintain infiltration trenches • Install and maintain prefabricated infiltration systems • Install and maintain detention basins • Install and maintain prefabricated stormwater vaults
Tier 2	A significantly more intense application of advanced, gravity-driven treatment technologies applied aggressively within the treatment area. Traditional limitations on property acquisition and maintenance rates are relaxed in this Tier.	• Apply advanced deicing strategies (possibly eliminate sand) • Upgrade infrastructure operation and maintenance • Further enhance fertilizer / turf management to reduce nutrient application and require education for turf managers • Control retail fertilizer sales within the Basin • Recommend landscaping practices that reduce nutrient mobilization • Install and maintain wet basins / infiltration basins • Install and maintain constructed wetland • Install and maintain media filters in stormwater vaults
Tier 3	A collection, pumping, and centralized treatment system (Pump & Treat) in concentrated settings with large contiguous areas. Tier 2 controls in dispersed settings.	• Install and maintain stormwater collection and conveyance infrastructure and apply advanced stormwater treatment technologies to address the concentrated impervious area (60% of the urban watersheds) • Apply Tier 2 controls on the remaining 40% of dispersed impervious urban areas

Tier name	Summary definition	Example Controls
Forested Uplands		Note: each tier is defined somewhat differently for each Forested Setting (e.g. unpaved roads, ski runs, and "undisturbed" forested areas). These describe representative activities.
Tier 1*	Includes standard treatments used or required by management agencies in current practice.	• Install and maintain (annually) full unpaved roadway BMPs (e.g. waterbars, armored ditches, rut stabilization) • Hydro-seed and tackify ski runs • Implement forest treatments with ground-based equipment and required BMPs
Tier 2	A middle level of treatment that includes state-of-the-art practices designed to achieve functional rehabilitation of hydrologic properties.	Tier 1 controls plus: • Capture on-site, unpaved roadway sediment • Mulch and revegetate with seedlings on ski runs • Install and maintain "full BMPs" (to increase infiltration and reduce runoff on landings, trails and roads) in forested areas
Tier 3	Treatments designed to develop site conditions that will mimic undisturbed, natural conditions after a period of time. This Tier represents the maximum load reduction possible in the setting and assumes runoff volume and quality similar to natural background conditions.	• Decommission and re-contour existing roads (plus tilling, organic soil amendments, mulch, and functional revegetation) • Fully restore legacy roads and trails • Results in return to native forest conditions with natural hydrologic function
Stream Channel		
Tier 1	**Unconstrained Restoration.** A set of treatments that increases length and sinuosity, connects floodplain, and decreases slope such that a restored condition is eventually reached. Designed to achieve load reductions as well as other ecosystem objectives such as riparian habitat, flood control, and recreation value. Assumes ideal construction access and sequencing. Traditional limitations on property ownership and acquisition are relaxed in this Tier.	• Lower stream channel banks and reduce angle to accommodate more frequent over-bank flow and reduce erosion / slumping of channel banks • Increase channel length and sinuosity which will over-time decrease channel bed slope • Restore riparian vegetation • Reconnect floodplains (remove infrastructure) • Remove any infrastructure (e.g. bridges) that restrict stream channel flow
Tier 2*	**Rehabilitation.** A combination of channel restoration (Tier 1) and simple bank protection (Tier 3) that focuses on cost-effective treatments. Property ownership is considered a factor.	• Apply channel restoration techniques where feasible to mitigate identified channel erosion problems • Protect stream banks and apply grade control where restoration is constrained • The result is a rehabilitated condition of mixed treatments
Tier 3	**Bank protection.** A basic set of channel armoring and minor bank slope reductions that increase hydraulic resistance and reduce bank failure. Does not achieve multiple ecosystem objectives.	• Install rip rap on channel banks • Install grade controls • Remove overhanging banks • (No additional floodplain connection)

* These Treatment Tiers represent current best practices most closely.
Source: Reproduced from October 25, 2007 handout

Focus Team Comments on Pollutant Controls

The source category groups presented pollutant controls to the Focus team on September 10 and 11, 2007.[15] On this occasion, groups of members with expertise in each of the four source categories met with a focus on only one source category (urban, forest, atmospheric or stream channel). In subsequent meetings, all source category topics were discussed together. Topics introduced and discussed included:

Information presented to the Focus team, September 10 and 11, 2007

Primary question: What are the options for reducing pollutant inputs to Lake Tahoe?

Focus of discussion: Pollutant controls (highlights of the PRO Report v1.01)

Discussion topics:

- The approach to screening and analysis of pollutant controls
- The pollutant controls from each of the four source category analyses (see Table 3-3 above)
- Pollutant reduction estimates associated with pollutant controls in each source category
- Cost estimates associated with pollutant controls in each source category
- The planned approach to creating the strategy to reduce pollutant inputs to Lake Tahoe

Citable versions of the information presented are in the PRO Report v2.0.

The materials for the first Focus team meeting presented each source category group's results separately. Focus team responses to this information helped refine the pollutant controls and their presentation. This feedback, summarized in the following table, informed the TMDL team's subsequent refinement and combining of the pollutant controls. [16]

Table 3-4. Focus Team Feedback Regarding the Pollutant Controls

Urban
▪ Further understanding of the ramifications of Pump & Treat are needed
▪ Benefits of existing BMPs and projects implemented need to be quantified and acknowledged
Atmospheric
▪ Atmospheric sources of phosphorus are associated with atmospheric sources of fine particles
▪ Do not assume that a mass transit system would produce fewer pollutant inputs than the cars it would replace
▪ Frame the pollutant controls in terms of *reducing car use* rather than expanding mass transit or visitor fees
Forest
▪ *Legacy road* definition and level of effort to be applied toward these needs to be coordinated between U.S. Forest Service (USFS) and the Lake Tahoe TMDL
▪ USFS and TMDL estimations of cost need to be better-integrated so that the agencies share mutual understanding of level of effort required to achieve desired results
▪ Model analysis has difficulty accommodating *unpredictable* events such as wildfire; therefore, this topic needs to be incorporated into considerations using a different approach.

[15] See Appendix B/Identify Screen and Analyze Pollutant Controls/Focus Team September 10 &11, 2007, Meeting Materials.
[16] See Appendix B/Identify Screen and Analyze Pollutant Controls/Focus Team Meeting Notes September 11, 2007.

Stream Channel

- Be very clear that this analysis is limited to stream channel work as opposed to full stream system restoration
- Address limitations to understanding of flood plain connection benefits for water quality as comprehensively and as soon as possible

General Comment

- Focus effort in areas that will realize benefits to diverse resources
- Align cost-benefit numbers to facilitate comparison among source category groups
- Seek to achieve water quality benefit in several source categories at once wherever possible
- Basin agencies should agree on a standard definition of *cost-effective* for pollution reduction opportunities

Source: Focus Team Notes, September 10 and 11, 2007

Table 3-5. Focus Team Suggested Future Studies

Suggested Future Studies/Efforts

General

- Study the short- and long-term cost tradeoffs of the various approaches to resource management including analysis of O&M versus Capital costs
- Study ways to integrate water quality improvement efforts with efforts benefiting other resource areas
- Establish a long-term plan for housing/staffing the Watershed/Loading Stimulation Program C++ (LSPC) model at the end of the Tetra Tech contract

Urban

- Conduct a Pump & Treat feasibility study
- Expand consideration of Pump & Treat to include decentralized treatment
- Use the Clarity Model to determine the impact of the integrated strategies
- Assess the implications of increased defensible space and other fire risk reduction measures
- Further consider climate change impacts
- Determine how to assess and consider the *non-quantifiable* pollutant controls
- Verify/support the conclusion that groundwater loads will decrease even with increased hydrologic loading (due to an emphasis on infiltration)
- Follow through on/invest further in the Storm Water Quality Improvement Committee (SWQIC) assessment of effectiveness of existing BMPs

Atmospheric

- Research other locations (i.e., Yosemite) regarding visitor fee revenue/vehicle reduction programs and ramifications
- Research legalities regarding visitor fee revenue/vehicle reduction programs
- Analyze break-even point of nitrogen and resuspended road dust from increased number of buses of a mass transit system and the subsequent reduction in number of cars
- Study socioeconomic potential for reducing visitor and resident car usage in the Basin
- Analyze underlying assumptions in TRPA/California Air Resources Board (CARB) boat emissions inventory
- Analyze potential increase in boat emissions related to proposed changes in shore zone ordinance
- Analyze potential ramifications of increasing forest fuels management
- Analyze potential ramifications of future growth/build out

Suggested Future Studies/Efforts
▪ Assess what percentage of phosphorous is associated with atmospheric sources of fine sediment
Forest
▪ Account for economies of scale of combined landscape management practices (fuels/water quality)
▪ Research further how pollutant inputs will be affected by increases in mechanical removal of fuels in stream zones
▪ Research further how pollutant inputs will be affected by increases in forest fuels reduction in general
▪ Use the Lake Tahoe TMDL model to help inform future forest management by the USFS
▪ Develop a fuels reduction/water quality working group to examine trade-offs associated with increased forest management related to wildfire
▪ Incorporate the potential impacts of increased fuels reduction activities and catastrophic wildfire, as feasible, into the Watershed Model to address decreased risk of pollutants resulting from catastrophic events
▪ Study the short- and long-term cost trade-offs of varying approaches to forest management including analysis of O&M versus Capital costs
▪ Use the Angora fire as an opportunity for study. (Incorporate the impacts of catastrophic wildfire into model and calculations, as feasible. Incorporate findings of the USFS study.)
▪ Develop consistent interagency information/understanding regarding legacy roads; agree on how many legacy roads currently affect soil hydrology
▪ Develop criteria for erosion control project implementation—splitting forest and upland
▪ Develop/clarify proximity to waterbody analysis
▪ Determine where/how wildfire prevention enters into an all-agency management equation; specify the role of the Lake Tahoe TMDL in this process; identify factors that need to be considered using models; determine whether a related working group should be established
Stream Channel
▪ Ensure that potential reductions of pollutants—originating from upland sources and eliminated by stream channel work—are captured in the Lake Tahoe TMDL analysis and reporting
▪ Improve stream restoration project monitoring
▪ Include *non-water quality* benefits in estimating *value* of stream environment restoration
▪ Expand evaluation to include stream environment restoration as opposed to only stream channel restoration
▪ Apply Southern Nevada Public Land Management Act (SNPLMA) funding to further evaluate benefits of increased connectivity to the floodplain

Source: Focus Team Notes, September 10 and 11, 2007

Adjustments of Note from Focus Team Communication about Pollutant Controls

In response to concerns over marginalization of the importance of stream restoration and forest health treatments, the TMDL team adjusted the approach to these source categories. These projects are important and should be managed under multi-objective plans. The Lake Tahoe TMDL agencies support the approaches promoted by the appropriate management agencies and recognizes that the fine sediment and nutrient reductions available from these projects will contribute to achieving water quality goals. TMDL staff plan to work with management agencies to synchronize plans and proceed with appropriate assumptions.

Several Focus team members noted that the Pump & Treat Tier defined for urban sources was not comparable to the other urban tiers, so the TMDL team defined an additional tier for urban sources. Tier 3 is a composite of the Pump & Treat Tier for all concentrated impervious subwatersheds, supplemented by

advanced practices (Tier 2) on subwatersheds that have dispersed impervious coverage. This adjustment allows innovative and advanced pollutant controls for the entire urban area of the Basin, making this tier comparable to Tier 1 and Tier 2. The TMDL team also expanded the scope of thinking about the meaning of Tier 3 to include additional forms of centralized treatment through advanced methods. Although previous estimates were based on filtration technology, the TMDL team felt that the numeric estimates would provide a reasonable first-order estimate of costs and effectiveness of other advanced treatments such as cultured ecologies, flocculation and electrostatic treatment.

Focus team members also asked that atmospheric treatments for mobile sources not be limited to a park and ride transit system as the sole approach to achieving the goals of the Tier 1 pollutant controls. They suggested that paid parking and other incentive/disincentive programs could also be effective for achieving reductions in VMT. This shifted the thinking among TMDL team members and is a consideration for further planning development.

The TMDL team also converted atmospheric results provided as inorganic nitrogen to total nitrogen using a factor of 1.5. This conversion allowed atmospheric results to be compared to nitrogen reduction results from other source categories and is consistent with this species conversion in the Lake Tahoe TMDL pollutant budget (Lahontan and NDEP 2007b, Section 2.8).

Forum Comments on Pollutant Controls

The TMDL team presented to the Forum on September 27, 2007, the findings of the pollutant controls analysis and source category combinations.[17] Context for the information provided was essential because it had been a year since there had been communication with the Forum on this topic. Also, the Clarity Challenge put the new information in the context of the next 20-year planning horizon. Main points of the September 27 communication are bulleted below. The full record of the meeting is in Appendix B.

Information presented to the Forum, September 27, 2007

Primary question: How are we going to restore Lake Tahoe's famed clarity?

Focus of discussion: Pollutant controls (highlights of the PRO Report v1.01)

Documents distributed: PRO Report v1.01, *Charting a Course to Clarity* and the Technical Report

Discussion topics:

- Pollutants causing Lake Tahoe's clarity loss
- How much of each pollutant is reaching Lake Tahoe
- How much of each pollutant Lake Tahoe can accept and still achieve the clarity goal
- Introduction to options for reducing pollutant inputs to Lake Tahoe
    - Overview of pollutant control reduction and cost estimates
- The Clarity Challenge—an interim milestone to assist in managing toward Lake clarity for 20 years
- The planned approach to creating the strategy to reduce pollutant inputs to Lake Tahoe

Citable versions of the information presented are in the PRO Report v2.0.

[17] See Appendix B/Identify Screen and Analyze Pollutant Controls/Forum September 27, 2007, Meeting Materials.

Pathway Forum responses to this information helped to refine thinking about ways to combine the pollutant controls and their presentation as the project advanced.[18]

Table 3-6. Forum Feedback Regarding the Pollutant Controls

Forum Feedback Regarding the Pollutant Controls
Urban
▪ In subsequent TMDL analysis differentiate between levels of urban development
▪ Investigate alternative pavement materials as a means to alleviate the need to sand roads
▪ Emphasize pervious pavement (especially on low traffic surfaces like bike lanes, paths, sidewalks, small commercial parking lots, residential driveways, and the like)
▪ Use monitored demonstration projects as a means to improve knowledge about road design, infiltration design, sweepers, and such.
Atmospheric
▪ Incorporate into calculations the future development and resulting VMT (and/or second homeowners converting to full-time homeowners) over the baseline
▪ Adjust the cost analysis for the atmospheric category so that the results read consistently with the others
Forest
▪ In subsequent TMDL analysis separate the trail system from roads (separate issues and uses)
▪ The way in which the trails system is accounted for has implications for future trails improvement funding
Stream Channel
▪ Explain stream channel erosion better: appears from the description of Tiers 1 and 3 that they should be the same percent load (based on treatments)
▪ If (as believed) stream zone restoration has significant, non-quantifiable benefits at low cost ,it seems we must have at least a ballpark estimate of load reduction. (Otherwise we could spend a lot for small benefit just to meet the Clarity Challenge.) For example, Forest Upland Runoff has a very high unit cost—floodplain restoration could make that unnecessary.
Other Comment
▪ Clarify whether there is a *point of diminishing return* with regard to the Clarity Challenge. How do benefits change when you are considering an improvement of 28–29 meters as opposed to 25–26 meters of clarity?
▪ Estimate the cost of reduction that achieves the best environmental results
▪ Identify potential funding sources to inform the feasibility discussion
▪ Expand consideration of Pump & Treat to include decentralized treatment
▪ Consider incorporating *ecosystem services* into the approach for funding the new EIP (state and national)
▪ Include control of development as a pollutant control opportunity for investigation

Source: Forum Notes, September 27, 2007

[18] See Appendix B/Identify Screen and Analyze Pollutant Controls/ Forum Pollutant Controls September 27, 2007 Meeting Notes.

Table 3-7. Forum Suggested Future Studies

Forum Suggested Future Studies/Efforts
General
▪ Clarify the pollutant loading difference between urban development with BMPs versus those without
▪ Clarify the pollutant loading difference anticipated from better street sweepers
▪ Investigate the contribution to nitrogen from goose droppings: Is it enough to be considered a source?
▪ Investigate fire effects on fine sediments and nutrients. (Increase monitoring to assess the effects of wildfire, pile burning, controlled burns; smoke from distant fires; and pollen)

Source: Forum Notes, September 27, 2007

Adjustments of Note from Forum Communication about Pollutant Controls

In response to comments about the atmospheric source category results, the TMDL team separated revenues and costs that could be generated from public transport incentives and divided the pollutant controls into mobile and non-mobile sources. Separating revenues from the costs associated with using incentives to reduce VMT by 10 percent made costs for this source category comparable to the others. It also significantly reduced the cost-effectiveness of mobile source controls. It became clear that non-mobile sources needed to be divided out of the total atmospheric controls because the extreme costs associated with the VMT reduction were not shared by the non-mobile pollutant controls. Non-mobile pollutant controls for fine sediment particles became much more economically attractive after the division was made.

In response to stakeholder suggestions to analyze behavior-changing or social strategies that could result in pollutant reductions, the TMDL team considered available data on VMT and private-property BMPs. These two pollutant controls were the best available proxies of changeable behavior. This analysis was complicated by private property BMPs being quantified separately from other pollutant controls within the urban Treatment Tiers. The effects of VMT changes were available, but they were focused on nitrogen instead of fine sediment. (Later in the project, additional estimates of VMT reductions revealed small effect on fine sediment particle loads.) The analysis did not show that behavior change could achieve the Clarity Challenge without large projects reducing impacts from existing infrastructure.

3.3. Cycle 2: Formulate Integrated Strategies

Integrated strategies are combinations of pollutant controls from each of the source categories, employed at varying application levels throughout the Basin to reduce pollutants. Pollutant controls from each source category were combined in varying ways in the effort to find the combination that maximizes pollutant reduction, with cost effectiveness considered.

The TMDL team formulated integrated strategies through a two-step process. The first step resulted in draft integrated strategies known as *integrated packages*. The second step resulted in a second draft set of integrated strategies known as *Scenarios* that replaced the integrated packages. These intermediate steps allowed stakeholders to comment during the formulation process of a Recommended Strategy.

Highlights from Cycle 2: Formulate Integrated Strategies

Interim products: Integrated packages (of pollutant controls) and scenarios

Review & input venues:

Meeting date/period	Participants
▪ October 11, 2007 ▪ October 25, 2007 ▪ November 14, 2007	▪ Focus team ▪ Forum and Focus team ▪ Implementers

Adjustments of note:

- Packaging and Analysis Tool becomes available
- Adjust forest treatments
- Create four Integrated Packages including *Extension of Current Practice*
- Recommendations to focus on non-mobile atmospheric sources

TMDL Team Drafts Integrated Packages

Using results of the pollutant controls analysis, the TMDL team and stakeholders undertook to answer the question, "**What strategy should we implement to reduce pollutant inputs to Lake Tahoe?**" This involved analyzing integrated strategies and comparing them to one another for effectiveness in maximizing pollutant reduction in an efficient and acceptable manner.

New Materials

During this cycle, the TMDL team produced a spreadsheet tool to facilitate aggregation of pollutant controls, load reductions and costs, and used it to formulate three integrated packages based on pollutant reduction themes. The spreadsheet tool allows a user to scale back the *application level*[19] of each Treatment Tier. The spreadsheet tool was built using Microsoft Excel and uses a lookup table and linear scaling to calculate the estimated load reduction and cost of each tier for each source category. The spreadsheet tool does not allow the user to consider spatial or land use considerations (Settings—as defined by the source category groups) except in the special case of the forest source category. Additional resolution is necessary for the forest source because small areas (e.g., unpaved roads, ski runs) produce higher yields of fine sediment, and pollutant controls are much more cost effective in these areas. Additional explanation of the forest source category is provided in the Integrated Packages Overview section below. Table 3-8 shows a sample of the spreadsheet tool. Adjustable inputs are shown as blue numbers, and net results of package are totaled on the bottom line.[20]

[19] *Application level* is expressed as a percent of total possible application. For instance, a 75 percent application level of an urban Treatment Tier would mean that three-quarters of the Tahoe Basin's urban areas would be treated with that group of pollutant controls and one-quarter would remain untreated.

[20] The underlying load reduction to the version of the spreadsheet tool used to create the integrated packages were subsequently changes to address technical issues discovered during the initial review. This resulted from the desire to engage stakeholders in discussion before a full technical review could be completed. These adjustments were made before developing the scenarios that the Forum reviewed on October 26th.

Table 3-8. Example of Spreadsheet Tool Used to Create Integrated Packages

[redacted]

Integrated Packages Overview

The integrated packages are composed of pollutant controls from all four source categories. Urban and atmospheric components of the integrated packages were adjusted significantly according to the theme of the package. Forest and stream channel source contributions did not vary across the three integrated packages that were presented. This is because of the narrow band of pollutant reduction opportunity and existing multi-objective management plans that are in place for these source categories. For these reasons, the forest and stream channel contributions to the integrated packages presented were known as *base packages*.

The stream channel base package is relatively straightforward, while the forest base package requires some understanding. The stream channel base package is modeled after current and planned stream restoration projects within the Basin. These typically involve a mix of complete restoration and bank armoring. The stream channel base package includes applying this mix to 80 percent of the stream channels of Blackwood Creek, the Upper Truckee River and Ward Creek. The forest base package includes a 70 percent application level of required BMPs (Tier 1), and 10 percent application of complete restoration (Tier 3) to unpaved roads, trails, ski runs, campgrounds and bare slopes. This package would also include 10 percent application of hydrologic restoration (Tier 2) and 10 percent application of complete restoration (Tier 3) to typical Tahoe forests. (It is important to note that this base package evolved slightly before it became part of the Recommended Strategy.)

The integrated package themes and a few of their differentiating features are as follows:

> ***Extension of Current Best Practice –*** Implementing an aggressive version of existing best practices focused on wide application of controls for urban stormwater and atmospheric fine particles. This integrated package would result in 18 percent reduction in fine sediment particles and require capital investment of $1.69 billion.
>
> ***Focus on Innovation –*** Investing in development and implementing innovative practices and new technology such as conveying and treating stormwater with mechanical or chemical systems. This

scenario would reduce fine sediment particle loads by 21 percent and require capital investment of $1.86 billion.

All Out Push – Developing new technologies that would be more effective in removing pollutants and applying these pollutant controls to the greatest area possible given certain constraints. This scenario would achieve 31 percent fine sediment particle load reduction and require capital investment of $2.65 billion.

The integrated packages were presented as handouts to stakeholders. These handouts described the integrated packages using four elements. These elements are described below and are followed by a series of three figures that replicate the handouts for each integrated package.

Package Theme – A general description of the unifying quality of the pollutant controls included and the objectives of the integrated package. This element was in the upper-left corner of the handout.

Spreadsheet Tool Inputs/Outputs – The application levels, pollutant reductions and costs of each integrated package. This element was in the upper-right corner of the handout.

Results Charts – A graphic depiction of the fine sediment reductions, capital costs, annual O&M costs and estimated resulting clarity measurement. These charts are colored black and use stacked, colored bars to depict the contribution of each source category to the total.

Example Pollutant Controls – A set of bullets that note many of the major pollutant controls that are included in the integrated package. These lists do not include the complete set of pollutant controls that could be used within the package but are provided to facilitate understanding of the types of pollutant controls contributing to load reductions.

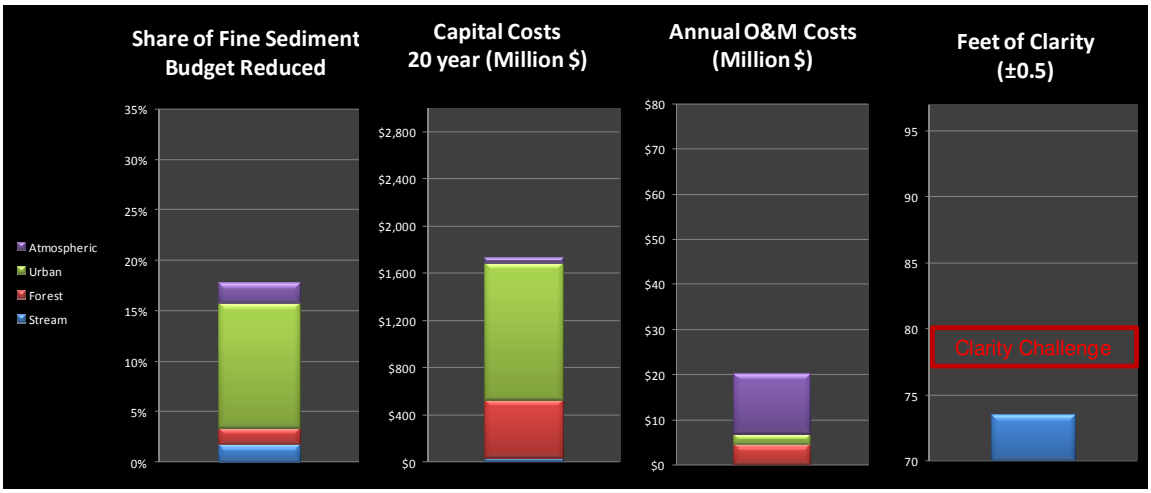
Integrated Package: Extension of Current Practice

Integrated Package Description

This package is an aggressive implementation of current best practices, emphasizing broad implementation of pollutant controls for reducing atmospheric fine sediment and treating urban runoff. Controls focus on treating stationary atmospheric sources of fine sediment and phosphorus, extension of current residential and forest BMPs, and a combination of stream channel rehabilitation and restoration.

	Percent Application (%)	< 20 micron sediment particle reductions	Phosphorus reductions	Nitrogen reductions	Capital cost 20 year (Million $)	Annual O&M cost (Million $)	Total 20 year cost (Million $)
Atmospheric							
Tier 2 FS&P/Stationary	**70%**	2%	2%	0%	$20	$0	$25
Tier 2 Mobile	**10%**	0%	0%	0%	$28	$13	$290
Tier 3 FS&P/Stationary	**0%**	0%	0%	0%	$0	$0	$0
Tier 3 Mobile	**0%**	0%	0%	0%	$0	$0	$0
Total	*OK*	*2%*	*2%*	*1%*	*$48*	*$13*	*$315*
Urban & Groundwater							
Tier 1	**80%**	12%	5%	2%	$1,120	$2	$1,200
Tier 2	**0%**	0%	0%	0%	$0	$0	$0
Tier 3	**0%**	0%	0%	0%	$0	$0	$0
Total	*80%*	*12%*	*5%*	*2%*	*$1,120*	*$2*	*$1,200*
Forested Uplands							
Base Package		*2%*	*0%*	*0%*	*$482*	*$4*	*$549*
Stream Channel							
Tier 1	**0%**	0%	0%	N/A	$0	$0	$0
Tier 2	**80%**	2%	1%	N/A	$40	$0	$40
Tier 3	**0%**	0%	0%	N/A	$0	$0	$0
Total	*80%*	*2%*	*1%*	*0%*	*$40*	*$0*	*$40*
Scenario Total		**18%**	**9%**	**3%**	**$1,690**	**$20**	**$2,103**

Results



Example Pollutant Controls

- Bi-weekly PM-effective street sweeping
- Pave dirt roads at access points
- Gravel 50% of unpaved roads
- Sweeping in intensive traction abrasive areas
- 50% completion of residential best management practices
- Detention & retention basins
- Coverage removal
- Forest treatments done with ground-based equipment and required BMPs focusing on unpaved roads, disturbed areas and fuels treatment areas
- Stream channel restoration and bank protection

TMDL Focus Team Meeting #2 Thursday, October 11, 2007

Figure 3-2. A reproduction of the handout describing the *Extension of Current Practice* integrated package from October 11, 2007.

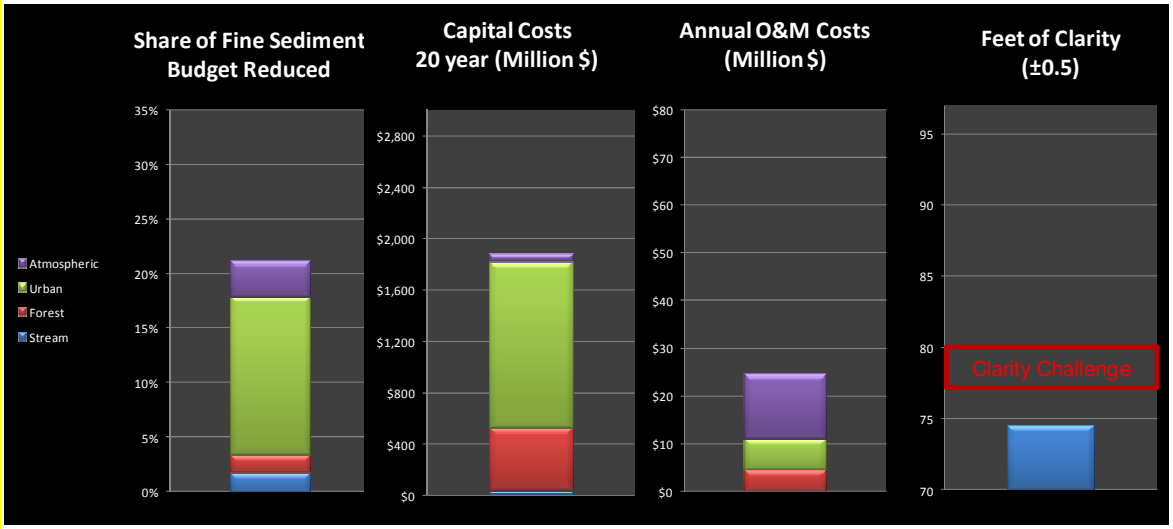
Integrated Package: Focus on Innovation

Integrated Package Description

This integrated package involves an investment of time and resources in developing new technologies to more effectively reduce pollutants, and implementation of these new technologies to the degree possible once they have been developed. Efforts include significant deployment of pollutant controls to reduce stationary sources of atmospheric pollutants, development and application of urban stormwater pump and treat technologies, extension of current forest BMPs, and a combination of stream channel rehabilitation and restoration.

	Percent Application (%)	< 20 micron sediment particle reductions	Phosphorus reductions	Nitrogen reductions	20 year capital cost (Million $)	Annual O&M cost (Million $)	Total 20 year cost (Million $)
Atmospheric							
Tier 2 FS&P/Stationary	**10%**	0%	0%	0%	$3	$0	$4
Tier 2 Mobile	**10%**	0%	0%	0%	$28	$13	$290
Tier 3 FS&P/Stationary	**40%**	3%	3%	0%	$30	$0	$35
Tier 3 Mobile	**0%**	0%	0%	0%	$0	$0	$0
Total	*OK*	*3%*	*4%*	*1%*	*$60*	*$13*	*$329*
Urban & Groundwater							
Tier 1	**20%**	3%	1%	1%	$280	$1	$300
Tier 2	**0%**	0%	0%	0%	$0	$0	$0
Tier 3	**40%**	11%	5%	2%	$1,000	$6	$1,120
Total	*60%*	*14%*	*6%*	*3%*	*$1,280*	*$7*	*$1,420*
Forested Uplands							
Base Package		*2%*	*0%*	*0%*	*$482*	*$4*	*$549*
Stream Channel							
Tier 1	**0%**	0%	0%	N/A	$0	$0	$0
Tier 2	**80%**	2%	1%	N/A	$40	$0	$40
Tier 3	**0%**	0%	0%	N/A	$0	$0	$0
Total	*80%*	*2%*	*1%*	*0%*	*$40*	*$0*	*$40*
Scenario Total		**21%**	**11%**	**4%**	**$1,862**	**$24**	**$2,337**

Results



Example Pollutant Controls

- Weekly street sweeping
- Aggressively reduce residential wood burning emissions
- Collection and conveyance infrastructure for private property and public impervious areas
- Control or retail fertilizer sales
- Media filters in stormwater vaults
- Forest treatments done with ground-based equipment and required BMPs focusing on unpaved roads, disturbed areas and fuels treatment areas
- Stream channel restoration and bank protection

TMDL Focus Team Meeting #2 Thursday, October 11, 2007

Figure 3-3. A reproduction of the handout describing the *Focus on Innovation* integrated package from October 11, 2007.

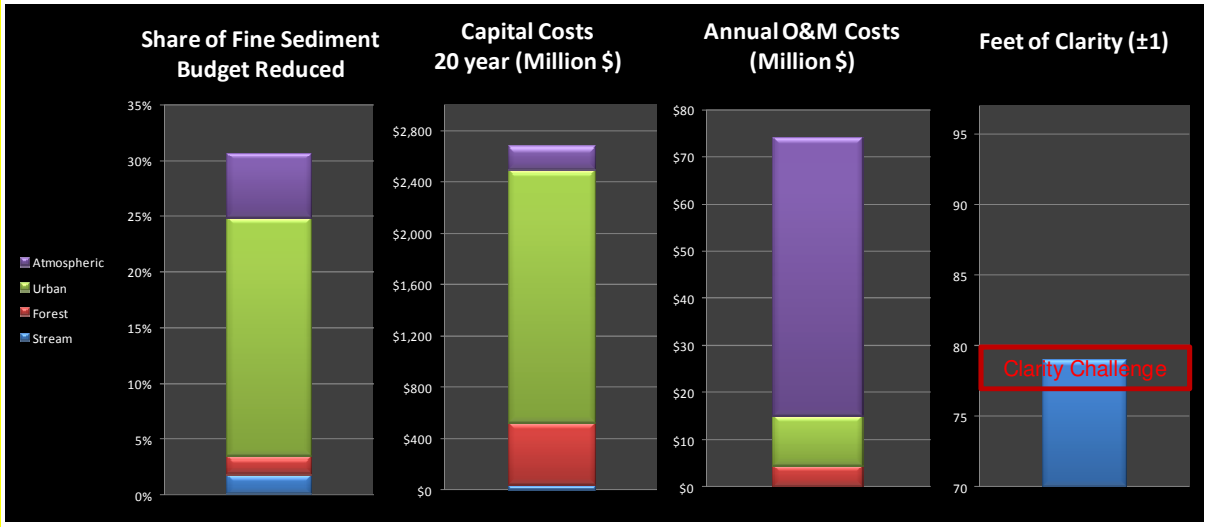
Integrated Package: All Out Push

Integrated Package Description

This integrated package includes development of new technologies to more effectively reduce pollutants and implementation of these new approaches over the greatest area possible. Efforts include maximum implementation of pollutant controls to reduce stationary sources of atmospheric pollutants, development and application of urban stormwater pump and treat technologies, extension of current forest BMPs, and a combination of stream channel rehabilitation and restoration.

	Percent Application (%)	< 20 micron sediment particle reductions	Phosphorus reductions	Nitrogen reductions	Capital cost 20 year (Million $)	Annual O&M cost (Million $)	Total 20 year cost (Million $)
Atmospheric							
Tier 2 FS&P/Stationary	**20%**	1%	1%	0%	$6	$0	$7
Tier 2 Mobile	**20%**	0%	0%	1%	$56	$26	$580
Tier 3 FS&P/Stationary	**70%**	5%	6%	1%	$52	$0	$62
Tier 3 Mobile	**10%**	0%	0%	1%	$69	$33	$720
Total	*OK*	*6%*	*6%*	*3%*	*$182*	*$60*	*$1,369*
Urban & Groundwater							
Tier 1	**30%**	5%	2%	1%	$420	$1	$450
Tier 2	**10%**	3%	1%	1%	$280	$2	$320
Tier 3	**50%**	14%	6%	3%	$1,250	$8	$1,400
Total	*90%*	*21%*	*9%*	*4%*	*$1,950*	*$11*	*$2,170*
Forested Uplands							
Base Package		*2%*	*0%*	*0%*	*$482*	*$4*	*$549*
Stream Channel							
Tier 1	**0%**	0%	0%	N/A	$0	$0	$0
Tier 2	**80%**	2%	1%	N/A	$40	$0	$40
Tier 3	**0%**	0%	0%	N/A	$0	$0	$0
Total	*80%*	*2%*	*1%*	*0%*	*$40*	*$0*	*$40*
Scenario Total		**31%**	**16%**	**7%**	**$2,654**	**$75**	**$4,127**

Results



Example Pollutant Controls

- Weekly street sweeping
- Collection and conveyance infrastructure for private property and public impervious areas
- Control of retail fertilizer sales
- Media filters in stormwater vaults
- Reduce vehicular emissions and travel
- Forest treatments done with ground-based equipment and required BMPs focusing on unpaved roads, disturbed areas and fuels treatment areas
- Stream channel restoration and bank protection

TMDL Focus Team Meeting #2 Thursday, October 11, 2007

Figure 3-4. A reproduction of the handout describing the *All Out Push* integrated package from October 11, 2007.

Focus Team Comments on Integrated Packages

The TMDL team presented the integrated packages (above) to the Focus team on October 11, 2007.[21] The TMDL team informed the Focus team of the intent to set interim clarity goals and articulated the goal of this session as "discussing strategies which integrate controls from all sources at once." Additional highlights of the information presented are as follows:

Information presented to the Focus Team October 11, 2007

Focus of discussion: Integrated packages (see the preceding three pages):
- Extension of Current Practice
- Focus on Innovation
- All out Push

Discussion topics:
- Focus on fine sediment particle reductions
- Focus on the largest opportunity for pollutant reductions—urban runoff
- Implement forest and stream restoration programs for multiple benefits as planned

Citable versions of this information are in Chapter 2: Recommended Water Quality Management Strategy

The recommendation to focus on fine sediment particle reductions sprung from three pieces of key information: (1) fine sediment is responsible for the majority of clarity loss; (2) the difference in clarity benefits between fine sediment and nutrient load reductions versus fine sediment reductions alone is very similar within the percent reductions that appear possible (Lahontan and NDEP 2007a p. 5-55), and (3) while the current focus for implementation will be fine sediment particles, phosphorus and nitrogen are also removed by fine sediment particles controls. The Lake Tahoe TMDL will continue to track nutrient reductions and the responsible agencies recognize the importance of nutrients in restoring Lake Tahoe's clarity.

The recommendation to focus on the largest opportunity for pollutant reductions—urban sources—was made because of the following (1) it produces the largest load of fine sediment particles, (2) it has more than four times the potential for load reductions than the next-best source category, and (3) it is cost-competitive with other source categories for fine sediment particle reduction.

The recommendation to implement forest programs as planned by the management and funding agencies that are leading these efforts evolved for several reasons. Forests are currently managed for multiple objectives (e.g., fuels reduction, recreation, habitat) which could take priority over the goals of Lake Tahoe TMDL's water quality objective. In addition, the source category group analysis showed that these projects, when completed using current best practices, provide a net benefit to water quality by reducing fine sediment particle loads.

Multi-objective stream channel erosion programs are well established, and existing conditions do not offer wide latitude in treatment options. The Lake Tahoe TMDL analysis focuses only on fine sediment

[21] See Appendix B/Formulate Integrated Strategies/Focus Team October 11, 2007 Meeting Materials.

particles released from stream banks and does not consider the other potential ecosystem benefits available from stream restoration or potential water quality benefits of reconnecting floodplains.

The Focus team asked questions and provided comment during the meeting. These comments are captured and synthesized in Table 3-9.

Table 3-9. Focus Team Feedback Regarding the Integrated Packages

Urban
▪ Evaluation of road projects will be easier with the TMDL methodology as it reflects "reasoned prioritization"
▪ Gut check the assumption that 60% of urban areas (as opposed to 80%) can be treated
▪ Look at Tier 2 as much as possible; focus on advanced BMPs other than Pump & Treat
▪ Continue to expand the Pump & Treat inquiry and research further the cost effectiveness of different approaches. Is there a certain approach that would be more effective given local conditions?
▪ Consider moving snow and then treating it elsewhere
▪ Funding could be more of an issue than human capacity
Atmospheric
▪ Maintain a focus on addressing mobile as well as stationary sources because VMT affects multiple sources—not only nitrogen emissions in the air, but also the amount of fine sediment and phosphorus that gets resuspended or ends up as runoff from the roads
▪ Package the recommendations in a way that encourages behavioral change
▪ Traction materials and de-icers are important to study further
▪ Try Tier 2 over Tier 3 in urban areas
Forest and Stream Channel
Meeting participants supported the TMDL team's approach to ▪ Pursue a strategy for forest sources that builds on existing practices ▪ Pursue a strategy for stream channels that builds on existing practices ▪ Using this consistent strategy for both forests and streams under all 3 packages ▪ Focusing more intense efforts on atmospheric deposition and urban runoff (bigger load reduction potentials)
New Ideas from the Focus Team
▪ Include actions focused on sociological fixes/behavior change to complement the technological fixes
▪ Improve quantification of benefits; quantify benefits of collaboration; for instance project permitting and business interests; SWQIC process a good example of this
▪ Credit source control measures including those that cannot be easily quantified; this would increase source control efforts
▪ Attempt to develop some packages that disaggregate settings in urban and other source categories
▪ Include some trade-off analysis
▪ Identify a certain amount of money and then run the Clarity Model to optimize actions
Future Research Suggestions from Focus Team
▪ Pursue a system for central tracking and quantification of existing clarity achievements that link to specific projects
▪ Conduct Pump & Treat feasibility study
▪ Connect strategy/packages with the Clarity Model
▪ Consider the impacts of greater implementation of defensible space practices

- Consider the impacts of future growth (U.S. Geological Survey)
- Consider the impacts of climate change
- Study further the time over which lake clarity change is expected (using the Clarity Model)
- Study the long-term impacts of the existing sewage system
- Incorporate the benefits of stream channel restoration into other sources
- Characterize and include other non-water quality benefits of stream channel restoration
- Include fine sediment reduction benefits of overbanking and increasing floodplain connectivity of streams
- Quantify the benefits of a water quality project
- Conduct a natural resource economic analysis
- Spatial and temporal challenges make funding this data collection difficult
- Quantify nutrient cycling on the floodplain
- More stream data is needed in general

Source: Focus Team Notes, October 11, 2007

Adjustments of Note from Focus Team Input on Integrated Strategies—Scenarios

The TMDL team synthesized feedback from the Focus team and developed scenarios—refinements of the integrated packages.[22]

Forest

Interest from the LTBMU and a new analysis tool encouraged the TMDL team to make adjustments to the forest pollutant controls. The new analysis tool (explained in the following paragraphs) allowed for better cost/benefit analysis that made it apparent that more cost-effective pollutant reductions were available with modified pollutant controls and application levels. The adjustment resulted in several changes in the results pertaining to the forest strategy:

- Fine sediment particle reductions decreased somewhat, from 2 percent to 1 percent
- 20-year capital costs decreased significantly, from $482 million to $120 million
- Annual O&M costs rose slightly, from $4 million to $4.5 million

Stream Channel

Some stakeholders identified that the stream channels could provide treatment of upland sources and that this potential was not analyzed in the pollutant control analysis. The TMDL team attempted to gain an understanding of this potential by using design reports from the Upper Truckee River Marsh Restoration project in combination with average particle fluxes from general research done by University of California Davis (UCD). The analysis did show some potential for the restoration to increase fine sediment particle capture during flooding on the order of the reductions from stream channel erosion overall. This calculation was very preliminary and additional analysis will be necessary before these load reduction estimates can be included in the Lake Tahoe TMDL.

Atmospheric

The TMDL team did additional analysis into mobile sources of fine sediment. The initial analysis of mobile sources did not include VMT reductions as a pollutant control for fine sediment particles. A rough quantitative estimate revealed that VMT reductions up to 25 percent resulted in fine sediment particle

[22] See Appendix B/Formulate Integrated Strategies/Focus Team Integrated Strategies Meeting Notes October 11, 2007.

load reductions less than half of one percent. This result supported the initial assumption that VMT reductions do not provide a significant opportunity for significant fine sediment particle load reductions. However it is important to note that current scientific understanding of the linkage between VMT and fine sediment loading to Lake Tahoe is not well characterized and additional research is included within the Tahoe Science Consortium's research plan.

Scaling

The TMDL team determined that scaling factors were necessary to match the source category groups' results with the Basin-wide pollutant budget. This scaling allowed each source category group to use the best available information and methodologies from its source category while they performed their estimates. Once these estimates were complete, they were scaled to the baseline pollutant budget used by the Lake Tahoe TMDL. The scaling factors needed were different for each source category and ranged from 1.561 to 1. Atmospheric source category results were not scaled because this source category group rectified the California Air Resources Board emission inventory with the TMDL pollutant budget. Appendix C provides a table with all the scaling factors used. The most notable change in the values was an increase in the estimated load reduction potential from the urban source category.

New Discussion Materials

A new tool designed to enhance the TMDL team's ability to create and analyze integrated packages of pollutant controls became operational at this point in the project. The Packaging and Analysis Tool (PAT) allowed the TMDL team to delve more deeply into the integrated packages by allowing them to apply application levels to specific settings, as opposed to aggregated source categories. PAT also included features to minimize costs within given constraints and seek goals for pollutant reduction or costs. The PAT was built using Visual Basic for Applications (VBA) on a Microsoft Excel platform. It incorporates a scatter search version of a genetic algorithm to find *best solutions* subject to user-defined constraints. In this case, best solutions are defined by the product of cost and pollutant reduction. Appendix A further describes the functions and technology used in PAT.

The PAT was used to explore the most efficient ways that a given budget could be invested in pollution control. This analysis resulted in a curve describing the best clarity that could be reached for a given investment, subject only to the constraint that no more than 80 percent of a given setting can be treated with pollutant controls and the predetermined forest and stream pollutant controls. Figure 3-5 is the slide that was discussed with stakeholders. It shows that $1.1-$1.5 billion dollars are needed to achieve the Clarity Challenge under these idealized conditions. It should be noted that all integrated packages and scenarios were subject to some additional constraints and were always somewhat less optimal than this curve.

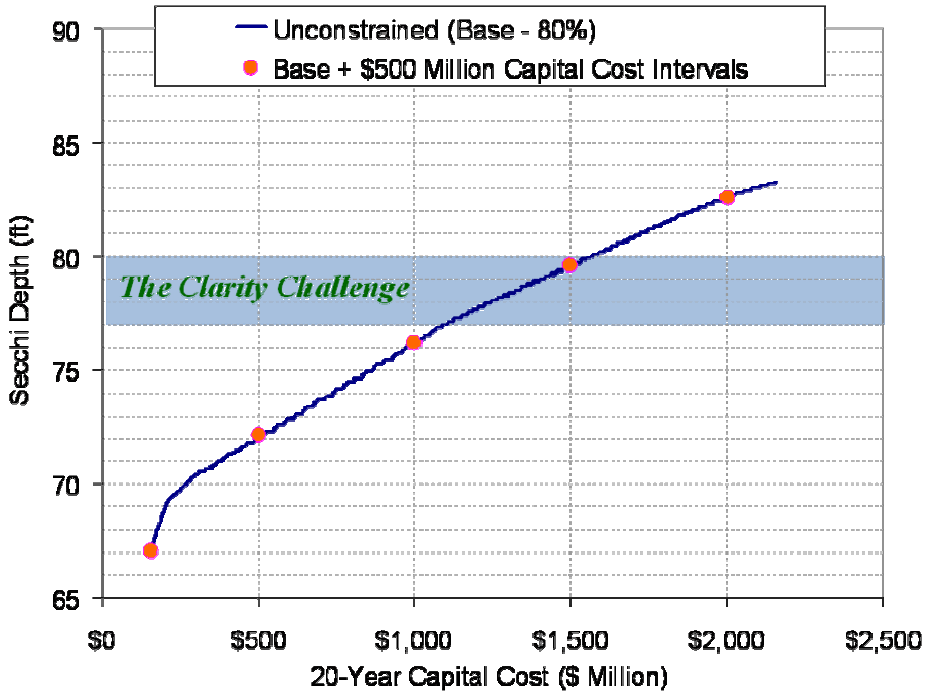


Figure 3-5. An optimal cost curve relating investment to Secchi depth.

Scenarios

The PAT was also used to enhance the integrated packages by analyzing more cost-effective ways of applying pollutant controls to particular Settings. The advancements made through this analysis and comments by the Forum Planning Committee prompted the TMDL team to rename the integrated packages to scenarios. This was particularly important because the new scenarios were built on the same themes as their integrated package predecessors. Although their names are usually similar, they have slightly different application levels for many of the pollutant controls. In some cases, significant changes in cost and pollutant removal resulted from the new analysis.

Three scenarios and an analysis of current best practices were presented to stakeholders with a series of handouts like the integrated packages handouts. This handout series included similar categories of information as the integrated package handout, except the PAT equivalent of the "Spreadsheet Tool Inputs/Outputs" was much more extensive and was summarized via a narrative. The handouts for each of the four scenarios are reproduced in the following figures. The extensive PAT Inputs/Outputs page for each scenario is in Appendix B.[23]

The scenarios and a few of their differentiating features are as follows:

> ***Scenario A: Retrofit & Enhanced Best Practices –*** Implementing existing best practices augmented with more advanced and intensive treatment of urban stormwater and atmospheric fine particles. This scenario would meet the Clarity Challenge and require capital investment of $1.8 billion.
>
> ***Scenario B: Focus on Innovation & Advanced Practices –*** Developing and implementing innovative practices such as conveying and treating stormwater with mechanical or chemical

[23] See Appendix B/Formulate Integrated Strategies/Forum & Focus Team October 25, 2007 Meeting Materials.

systems. This scenario would meet the Clarity Challenge and require capital investment of $1.5 billion.

Scenario C: All Out Push – The maximum, potentially practical load reduction, given applicability constraints of the proposed pollutant controls. This scenario would exceed the Clarity Challenge and require capital investment of $2.0 billion.

Scenario A: Retrofit & Enhanced Best Practices

Meets Clarity Challenge

Theme

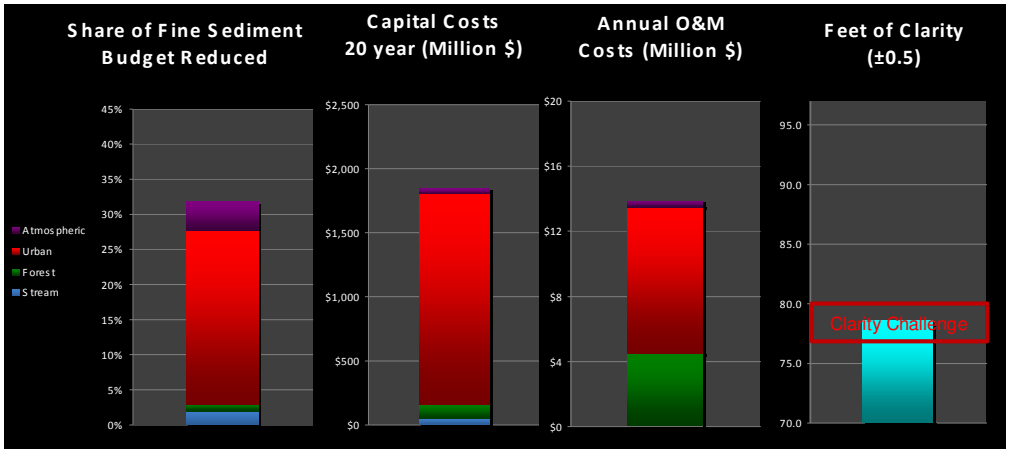
This scenario focuses on continuing to implement existing best practices -- augmenting these with more-advanced and intensive treatment of urban stormwater and atmospheric fine sediment -- to meet the Clarity Challenge. A maximum of 80% of the land area for any particular setting is treated.

Atmospheric: Focus on reducing fine sediment and phosphorus from roadways by: sweeping streets weekly or bi-weekly (using fine-particle-effective technologies); paving dirt roads at access points; graveling or paving portions of 80% of the unpaved roadways in the Basin; and reducing use of woodburning stoves.

Urban and Groundwater: Extending **current practice** for residential, commercial and roadway areas on approximately 40% of the urban area; employing advanced passive treatment technologies on an additional 40% of the urban area; and achieving implementation of a majority of private property BMPs.

Forest: Treating 60% of unpaved roads, ski runs, campgrounds and other disturbed forested areas, using current best practices; employing intensive treatments such as on-site sediment capture on 10% of the area; and restoring an additional 10% of unpaved roads and disturbed areas. Assumes treating 15% of the forest to reduce fuels loads (2/3 of which will receive standard pollutant controls and the other 1/3 treated using more intensive treatment approaches).

Streams: Combining stream channel rehabilitation and restoration on 80% of the potential project areas on each of the Upper Truckee River, Ward Creek and Blackwood Creek.



Example Pollutant Controls

• Bi-weekly augmented by some weekly fine particle-effective street sweeping • Gravel or pave unpaved roads • Reroute runoff for additional treatment • Road shoulder stabilization & revegetation • Additional operations & maintenance of infrastructure • Fertilizer management	• Wet basin and constructed wetlands • Extensive implementation of private property BMPs • Impervious and soft coverage removal • Forest treatments done with ground-based equipment and required BMPs focusing on unpaved roads, disturbed areas and fuels treatment areas • Stream channel restoration and bank protection

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Figure 3-6. A reproduction of the handout describing *Scenario A - Retrofit & Enhanced Best Practices from October 25, 2007.*[24]

[24] See Appendix B/Formulate Integrated Strategies/Retrofit & Enhanced Best Practices (details).

Scenario B: Focus on Innovation & Advanced Practices

Meets Clarity Challenge

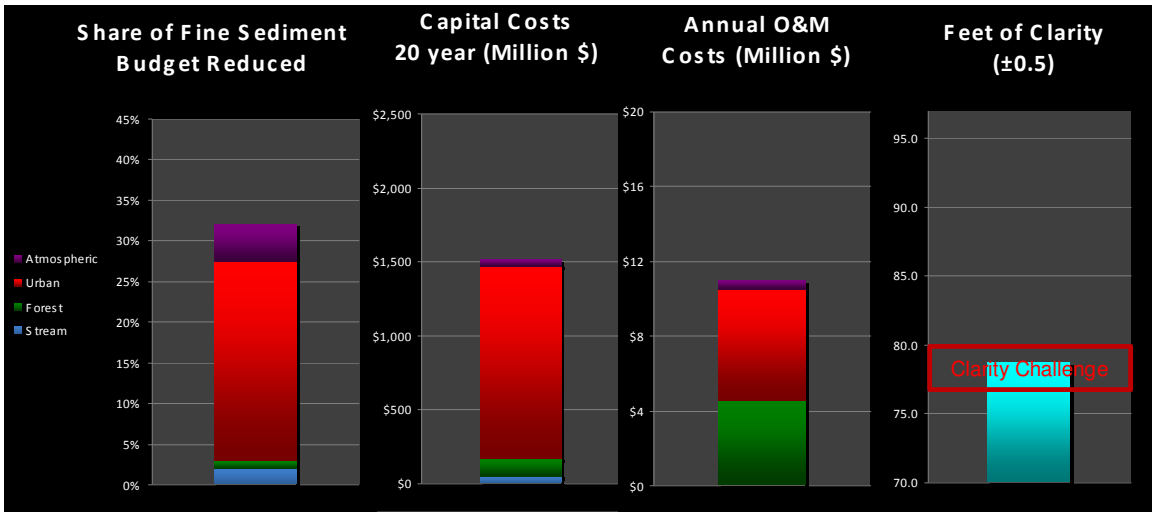
This scenario focuses on implementing innovative practices to meet the Clarity Challenge. In this scenario, less land area is treated than in the "Retrofit & Enhanced Best Practice scenario". This scenario assumes urban stormwater collection and treatment and intensive effort to control atmospheric fine sediment. A maximum of 80% of the land area for any particular setting is treated.

Atmospheric: Intensive effort to reduce fine sediment and phosphorus from roadways by: sweeping streets weekly or bi-weekly (using fine-particle-effective technologies); paving dirt roads at access points; paving and graveling significant portions of 80% of the unpaved roadways in the Basin; and reducing use of woodburning stoves.

Urban and Groundwater: Implementing **advanced controls** including: conveying and treating stormwater on approximately 50% of areas with concentrated impervious surfaces, in combination with using current best-practices on approximately 30% of all urban areas, and advanced passive controls in select areas; and achieving a moderate-level of implementation of private property BMPs.

Forest: Treating 60% of unpaved roads, ski runs, campgrounds and other disturbed forested areas using current best practices; employing intensive treatments such as on-site sediment capture on 10% of the area; and restoring an additional 10% of unpaved roads and disturbed areas. Assumes treating 15% of the forest to reduce fuels loads (2/3 receiving standard pollutant controls and the other 1/3 treated using more intensive treatment approaches).

Streams: Combining stream channel rehabilitation and restoration on 80% of the potential project areas on each of the Upper Truckee River, Ward Creek and Blackwood Creek.



Example Pollutant Controls

• Weekly or bi-weekly fine-particle-effective street sweeping • Pave dirt roads at access points • Pave or gravel significant portions of unpaved roads • Collect and treat urban stormwater with advanced mechanical or chemical treatments	• Detention & retention basins • Increased implementation of private property BMPs • Forest treatments done with ground-based equipment and required BMPs focusing on unpaved roads, disturbed areas and fuels treatment areas • Stream channel restoration and bank protection

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Figure 3-7. A reproduction of the handout describing *Scenario B - Focus on Innovation & Advanced Practices from October 25, 2007*.[25]

[25] See Appendix B/Formulate Integrated Strategies/Focus on Innovation & Advanced Practices (details).

Scenario C: All Out Push

Exceeds Clarity Challenge

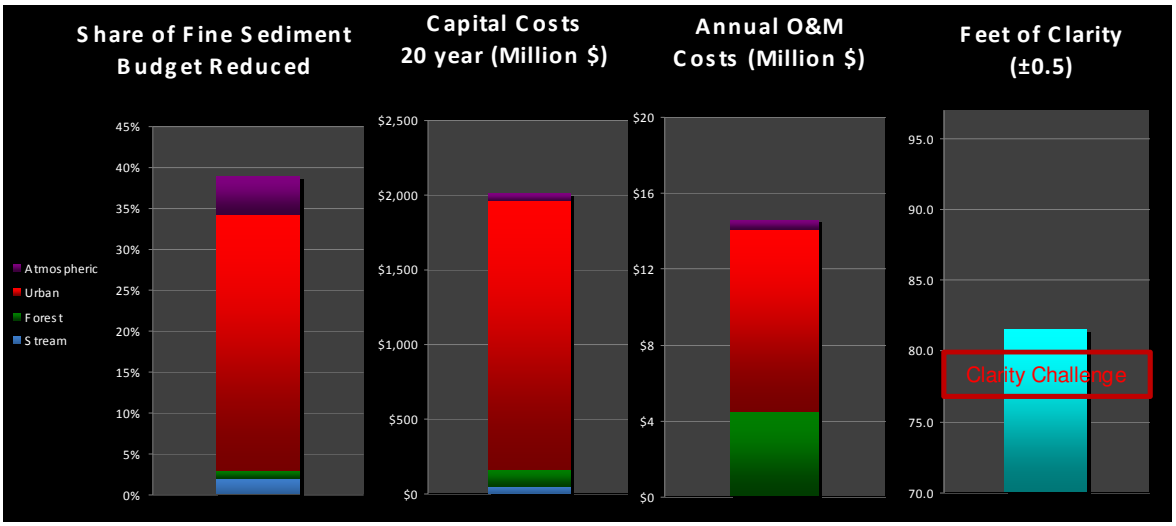
This scenario represents the maximum potentially practical load reduction that can be achieved considering the set of pollutant reduction opportunities analyzed. Treatment areas are restricted to a maximum implementation of 80% of the land area for any particular setting and 20% of the treated urban area will use current best-practices rather than advanced treatment. This scenario exceeds the Clarity Challenge.

Atmospheric: Intensive effort to reduce fine sediment and phosphorus from roadways through: weekly fine-sediment-effective street sweeping of a majority of roads; paving 80% of dirt roads at access points; paving or graveling significant portions of unpaved roads; and reducing use of woodburning stoves.

Urban and Groundwater: Implementing **advanced controls** including: conveying and treating stormwater from 60% of the dense urban areas, and using advanced passive treatment controls on dispersed urban areas. Employing current practices on a 20% of urban areas. Achieving a high level of private property BMP implementation.

Forest: Treating 60% of unpaved roads, ski runs, campgrounds and other disturbed forested areas using current best practices; employing intensive treatments such as on-site sediment capture on 10% the area; restoring an additional 10% of unpaved roads and disturbed areas. Assumes 15% of the forest will be treated to reduce fuels loads (2/3 of which will receive standard pollutant controls and the other 1/3 will be treated using more intensive treatment approaches).

Streams: Combining stream channel rehabilitation and restoration on 80% of the potential project areas on each of the Upper Truckee River, Ward Creek and Blackwood Creek.



Example Pollutant Controls

- Weekly fine particle-effective street sweeping
- Pave dirt roads at access points
- Gravel unpaved roads
- Collect and treat urban stormwater with advanced mechanical or chemical treatments
- Advance deicing and reduced use of road sands
- Fertilizer management & sales restrictions

- High degree of implementation of private property BMPs in dispersed urban areas
- Impervious and soft coverage removal
- Forest treatments done with ground-based equipment and required BMPs focusing on unpaved roads, disturbed areas and fuels treatment areas
- Stream channel restoration and bank protection

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Figure 3-8. A reproduction of the handout describing *Scenario C - All Out Push from October 25, 2007.*[26]

[26] See Appendix B/Formulate Integrated Strategies/All Out Push (details).

Forum and Focus Team Comment on Scenarios

The scenarios were presented to the Focus team and the Forum together on October 25, 2007.[27] Highlights of the information presented are as follows:

Information presented to the Focus Team and Forum October 25, 2007

Focus of discussion: Three scenarios (see preceding pages)
- Scenario A - Retrofit and Enhanced Best Practices
- Scenario B - Focus on Innovation and Advanced Practices
- Scenario C - All Out Push

Discussion topics:
- Reiteration of recommendation to focus on fine sediment removal
- Recommendation to focus effort in the atmospheric category on non-mobile sources
- Finding that continuation of current practice would not achieve the Clarity Challenge

Citable versions of this information are in Chapter 2: Recommended Water Quality Management Strategy.

The TMDL team recommended that the strategy for reducing pollutant inputs to Lake Tahoe emphasize fine sediment removal because it is responsible for the majority of the clarity condition, and the Clarity Model shows that lake response from fine sediment particle reduction alone is similar to reductions available from a combination of fine sediment particles, nitrogen and phosphorus.

Splitting non-mobile and mobile sources of atmospheric pollutants and the advanced PAT analysis led the TMDL team to recommend focusing efforts exclusively on non-mobile sources of atmospheric pollutants. Non-mobile sources such as roads produce 88 percent of the fine sediment particles from this source category (Lahontan and NDEP 2007b, p. 52) and available pollutant controls such as fine particle street sweepers are cost effective. The recommendation particularly noted street sweeping, using advanced traction compounds, and restoring or surface treatment of unpaved surfaces as focus areas. This recommendation was further supported by accepting the earlier recommendation to focus on fine sediment particle reductions and continue to track nutrient reductions.

The TMDL team completed an analysis showing that continuing current practices would not achieve the Clarity Challenge. The PAT provided a venue to input assumed application levels from each source category and produce estimates of total costs and benefits. The assumed application levels for each source category were as follows:

- Urban Tier 1: 70%
- Stream Channel Tier 2: 80%
- Forest Tier 1: 80%
- Atmospheric non-mobile sources Tier 2: 70%

This analysis estimated capital investment at $1.1 billion, annual O&M at $7.4 million. The benefit of implementing these practices was estimated at 22 percent fine sediment particle reductions and 75 feet of clarity.

[27] See Appendix B/Formulate Integrated Strategies/Forum & Focus Team October 25, 2007, Meeting Materials.

The TMDL team presented forest management pollutant reduction recommendations. On the basis of the pollutant's total percentage of input to Lake Tahoe, forest sources account for significantly less impact than do atmospheric deposition and urban runoff sources. Therefore, the TMDL team recommended that the current multi-objective approach to forest management continue; including aggressive implementation of BMPs wherever forest fuels treatments could cause an impact and mitigation of impacts from highly disturbed areas such as unpaved roads, ski runs and campgrounds.

The TMDL team recommended continuing current and planned stream restoration activities and supported monitoring and research in this source category. Stream restoration is highly cost-effective and provides water quality and ecosystem benefits beyond what just stream channel work would achieve. However, the quantifiable fine sediment particle load reductions are not as large as load reductions from other source categories such as urban and atmospheric. More information and additional studies will be available in the near future, and crediting and tracking for stream restoration projects will be updated accordingly.

The TMDL team presented urban runoff pollutant reduction recommendations. Urban upland runoff accounts for 72 percent of the pollutant input to Lake Tahoe. The TMDL team recommended that to meet the Clarity Challenge (1) consider Tier 1 applications for dispersed coverage areas; (2) apply substantially more Tier 2 treatments (filtration and O&M); and (3) consider and research Pump & Treat applications for some areas.

As the Forum and Focus team were combined for this interaction, their feedback was gathered from combined small groups in discussion about the topics presented. The feedback received subsequently helped inform development of the Recommended Strategy.[28] This feedback is presented in Table 3-10.

[28] See Appendix B/Formulate Integrated Strategies/Forum & Focus Team Scenarios Meeting Notes October 25, 2007.

Table 3-10. Forum and Focus Team Feedback Regarding Scenarios

Feedback on Scenarios

Scenario A - Retrofit Enhanced Best Practice

- Like scenario B as a means to get to scenario C
- Like scenario A as a means to get to C (go with what we can do before try to run)—make sure progress is being made while innovation is being pursued
- Some skepticism of A as a scenario

Scenario B - Innovation & Enhanced Best Practice

- Scenario B is good because of value and applicability for achieving 100-foot clarity
- Combine Scenario A and B
- Scenario B—Issues of return relative to expectation
- Be realistic about the time it will take to get Pump & Treat pollutant controls underway
- Lean toward innovation, history shows it will be to good end; account for *creative breakthroughs* in the time frame of the project
- Use scenario B and ask for the full amount required – say "Here is what we need to make the Clarity Challenge"
- Develop a scenario using maximum implementation of all current best practices. Then apply a realistic filter to work backward from there.

Scenario C - All Out Push

- Pursue the All out push
- Like scenario C
- Go with C, okay to pull in some aspects of B
- What is the incentive to exceed the clarity challenge (why would anyone want to go to scenario C?)
- Aim high—all out push—do whatever it takes to save the Lake
- Momentum is there for A to B to C
- Make sure not to make us stop the progress
- May be better off to do as much work early as possible—because it will be cheaper overall
- Consumer action seems least likely to make a difference in this scenario

New Scenario Ideas Proposed

- High-confidence scenario
- Incentive-based scenario
- Un-development scenario
- Sustainability scenario (sustainable clarity over time)
- Stormwater export out of Basin scenario
- Compliance with everything already on the books scenario

Transportation

- Transportation-focus scenario
- Need a scenario that covers transportation—take things that are in other scenarios but craft in terms of transportation—calculate emissions per person, per mile. A transportation scenario is more compelling when it comes to raising funds than other scenarios might be.

Cost

- Distribute cost equitably
- Prioritize by cost-benefit before bundling at source category level; use most effective and least costly pollutant controls
- Target best bang for the buck from each source
- Emphasize least cost that will get to Clarity Challenge

Feedback on Pollutant Controls within the Scenarios

Private property BMPs

- Caution on ever including 100% private property BMP implementation
- Pull back on reliance on private property BMP
- Combine defensible space and erosion control efforts
- Enforcement an agency issue
- Question residential BMP effectiveness
- Do not drop residential BMPs—tie to incentives like defensible space and insurance credits
- People would rather pay long term into public system than put down a bunch of cash for private BMPs
- Remove impervious coverage (purchase for-sale lots with homes on them to retire coverage)

Sweeping

- Fine as a pollutant control
- Make sure frequency and effort are fine-tuned for maximum effectiveness, least nuisance
- Needs regional effectiveness measuring/adjusting

Residential wood combustion

- Not a good pollutant control
- Too little gain for the trouble
- A health and safety issue
- Just focus on incentives (rebates and EPA-compliant stoves)
- Use education as a pollutant control for raising awareness about good/bad times for wood stove use
- Don't mess with woodstoves—too little gain for the price you will pay with the public
- De-emphasize residential wood burning reduction—complement with incentives (especially for low-income households)

Pump & Treat

- Fine as a pollutant control
- Test further before putting too much emphasis here
- Use existing infrastructure
- Look into localizing efforts over regionalizing efforts
- Pump & Treat—early stage, introduce it, but don't rely on it…introduce slowly
- Pump & Treat scenic and noise issues—can publicly fund
- Stormwater fees as a way to pay for Pump &Treat
- Fine as pollutant control to consider… need to know more
- Pump & Treat—if you've got to do it, you've got to do it.
- Is there any redundancy between private property BMPs and the Pump & Treat controls?

Focus on transportation

- Keep VMT and look at ecosystem benefits
- RE: VMT—Don't let it drop because the benefits would be so great
- VMT is out-dated way of looking at transportation
- Don't de-emphasize transportation efforts, fine to let VMT specifically go
- Use less salt, sand, looking into alternatives favorable
- Maintain safety but look to alternatives to road sanding

Themes

Pursue a course in which you have a high degree of certainty

- Certainty and ability to reach expectation that you are setting out to achieve needs to be an explicit part of the equation
- If we are going to put our faith in these things, let's make sure we have confidence they will work
- Invest in effectiveness and best chance of success

Pursue incentives

- Incentives a good way to redistribute burden
- Are there ways to switch to incentivizing?
- Move from stick to carrot…If we are going to ask folks to change behavior, make it more incentive based and focus on education

Set up a system that is accountable

- Demonstrate progress
- Make sure monitoring is factored into any future scenario
- Emphasize the public visibility of progress in each source category
- Emphasize accountability and follow through
- Require payment into public program for those who do not do private BMPs—that takes the burden for them
- Document costs and benefits, including social

Pursue benefits to water clarity mutual with other ecosystem benefits

- Highlight collateral benefit to the other thresholds
- Emphasize those that benefit other thresholds
- Social: To get buy-in on TMDL need to put it in context of Regional Plan and don't neglect other thresholds
- Keep an eye out for synergistic effects with other thresholds

Pursue public solutions (as opposed to private)

- Increase emphasis on government action (as opposed to individual action)
- Look to opportunities that don't involve social change (more expeditious)
- Try to keep away from putting burden on the individual
- Must have a plan for a local source of revenue
- Pursue centralized authority and aggregated funding (CA/NV, joint-funding authority and so on.)
- Use a large public works approach "like a sewage treatment plant" if lake clarity is the agreed upon priority
- Public borrowing much cheaper than private borrowing
- Create organizational infrastructure that supports investment in new technology. Designate that certain amount of total funds will go to innovation, improving technology and such

Public Sentiment

- We'll do what makes sense
- We trust Lahontan and NDEP to give us their best judgment regarding what makes sense
- Emphasize incentives over regulation
- Emphasize effectiveness

Messaging

- Use patience and good humor
- Put messages in positive light to fuel energy and innovation
- Message positively for most public support and progress
- Acknowledge (or better, account for) what has already been done
- Market the concept and the target—sell the general public on this
- Be honest
- Do not try to convey that there is consensus
- The *big* conversation is about a package that we can sell
- Provide context—relate the 2030 ask to the 1990–2010 amount actually spent
- Be careful with messaging—Don't give impression "we don't care about anything but water clarity"
- At an individual level, people need to buy in to the need for these controls

Other

- Concern with unpaved road numbers (too high), costs for forest source control seems high
- Focus on Upper Truckee River area—set up incremental goals
- Streams—have a good public image, keep highly visible
- Is the Lake Tahoe TMDL Is the target even attainable?
- Make sure cost distribution is equitable and can be handled

Adjustments of Note from Focus Team and Forum Communication about Scenarios

In response to comments, the TMDL team adjusted the estimate of the forest fuels treatments planned and reevaluated the recommendation not to focus on VMT reductions until science can more adequately quantify the linkage between VMT and particle deposition to Lake Tahoe. During the meeting with the LTBMU and other land managers, the planned treatment of forested lands was lowered from 20 percent to 15 percent. Although not confirmed in current official plans, this estimate is considered a conservative estimate on the basis of projected resource availability. The TMDL team also reevaluated its initial recommendation on the importance of VMT reductions. Current estimates of the fine sediment particle load reductions available might be too rough to use as a basis for significant management decisions. The team performed additional analysis, as described in the next section, and acknowledges that VMT reductions are extremely important for achieving objectives in other resource areas such as air quality, as well as contributing to fine sediment load reductions.

3.4. Cycle 3: Develop and Refine the Recommended Strategy

The Recommended Strategy is the final product of the development process—the combination of pollutant controls combined into a strategy for reducing pollutant inputs into Lake Tahoe to achieve the maximum feasible clarity at an acceptable cost. The Recommended Strategy is explained in Chapter 2 of this report.

Highlights from Cycle 3: Develop and Refine the Recommended Strategy

Products: Responses to stakeholder questions, Recommended Strategy, Refined Recommended Strategy

Review & input venues:

Meeting date/period	Participants
▪ December 6, 2007 ▪ January 29, 2008	▪ Forum ▪ Implementers

Adjustments of note:

- Responses to stakeholder questions sought and presented
- Time-series created
- The effects of the timing of innovation are analyzed and compared
- Fuels treatment assumptions are adjusted
- Terminology adjusted

Forum and Focus Team Hear Responses to Questions Posed and Comment on the Recommended Strategy

The TMDL team presented the Recommended Strategy and responses to specific hypothetical questions to the Forum on December 6, 2007.[29] Following are highlights of the information presented.

Information presented to the Forum December 6, 2007

Focus of discussion: Responses to stakeholder questions
The Recommended Strategy

Discussion topics:

- High-confidence pollutant controls
- Effects of increased impervious cover
- Effects of lowering VMTs
- Technology and the Clarity Challenge
- Pollutant controls' potential effect on other resource areas

Citable versions of this information are in Chapter 2: Recommended Water Quality Management Strategy.

Responses to Stakeholder Questions

Stakeholders posed several hypothetical questions earlier in the development process. The TMDL team used all available tools and data to provide quantitative answers whenever possible. In many cases, the answers were specific and quantitative, while in other cases, data limitations allowed only qualitative answers. In a few cases, the tools and data were not adequate to provide a specific response. Questions that were analyzed but not answered in public meetings are included for reference here. Questions that were answered are summarized here and explanatory slides are included in Appendix B.

Can we focus on high-confidence pollutant controls? – The TMDL team considered two kinds of confidence in this analysis: *analytic confidence* was provided by the source category groups, while *implementation feasibility* was judged by members of the TMDL team. Pollutant controls that did not score high in these ratings were eliminated from Scenario B. These criteria eliminated all atmospheric controls, eliminated Tier 3 urban controls, and reduced the application of Tier 2 urban controls.

Results: High-confidence pollutant controls do not achieve the Clarity Challenge. They reduce fine sediment particle loads by 27 percent instead of the necessary 32 percent. These include capital costs of $1.7 billion.

What are the effects of increased impervious cover? How much will fine sediment particle loads increase at full build out? – The TMDL team used the Watershed Model and a series of development simulations to estimate the additional fine sediment particle load that would result under existing development rules. In a separate trial, the Watershed Model was tested for sensitivity to 10 percent increase and a 10 percent decrease in impervious cover after full build out. The 10 percent change in impervious cover was achieved by increasing coverage equally in

[29] See Appendix B/Develop and Refine the Recommended Strategy/Forum December 6, 2007, Meeting Materials.

all subwatersheds.

Results: Fine sediment particle loads are estimated to increase by just over 2 percent at full build out. A 10 percent change in coverage is estimated to change fine sediment particle loads by 8 percent.

What are the effects of investing in pollutant controls on mobile atmospheric sources (lowering VMT)? – The TMDL team created an additional scenario that supplemented Scenario B with maximum effectiveness mobile controls applied at the maximum intensity (80 percent, Tier 3).

Results: When lowering VMT, nitrogen reductions increase from four to 15 percent, fine sediment particle reductions increase less than 1 percent, capital costs increase from $1.5 billion to $2.1 billion, and annual O&M costs increase from $11 million to $271 million. Note that the atmospheric source category group estimated offsetting O&M revenues from mobile source controls.

How far could a maximum technology scenario take us beyond the Clarity Challenge? – The TMDL team created another hypothetical scenario that maximized the application level of the most advanced pollutant controls. This maximization was still subject to the constraint that only 80 percent of a setting could be treated. Stream channel and forest pollutant controls were not changed from their Scenario B values. The maximum technology scenario was compared to Scenario B.

Results: In a maximum technology scenario, fine sediment particle reductions increase from 32 percent to 44 percent, capital costs rise from $1.5 billion to $2.2 billion, and annual O&M costs rise from $11 million to $17 million.

How will the pollutant controls affect other resource areas? – It is expected that any significant implementation of the pollutant controls will affect other resource areas. For instance, the stream channel erosion pollutant controls would be expected to enhance fish spawning habitat and atmospheric dust controls would increase air quality by decreasing particulate matter and increasing visibility. In another example, it is conceivable that centralized treatment pumps for urban stormwater could create noise that may affect sound levels in their vicinity. There was insufficient data to provide quantitative results to this question. Table 3-11 was presented to indicate expected interactions. Overall, pollutant controls are generally believed to have predominantly beneficial effects on other resource areas and their implementation is consistent with attainment of TRPA thresholds for these resource areas.

Table 3-11. Expected Positive (blue) and Negative (red "X") Effects of Pollutant Controls, Expected Magnitude of Effect is Depicted by Symbol Size

Scenario B	Wild/ Fish	Soil	AQ	Veg	Noise	Scenic	Rec
Urban & GW	•	•	●	•	x		
Atmospheric	•		●	•	•	●	
Streams	●	●		●		●	•
Forest	●	●		●		•	

What are the effects of climate change on the Lake Tahoe TMDL? – The Lake Tahoe TMDL includes a targeted study of 84 climate change simulations. This generated 11 precipitation and temperature scenarios that were considered a reasonable estimate of the possibilities for the future Tahoe Basin climate. These scenarios were used as inputs to the Watershed Model, and new hydrology results were generated. Resource limitations have not permitted application of the new hydrology results to pollutant transport subroutines.

Results: The hydrology results vary, but central tendencies point to more precipitation as rain, 9 inches less peak snow pack, 10-day later snowpack, and a 73-day reduction in presence of the snowpack.

Time-Series Analysis

The Lake Tahoe TMDL must consider the path to achieve the Clarity Challenge and the overarching numeric target. The time-series analysis was built using a series of PAT runs based on Scenario B, stakeholder input, and a series of assumptions about funding availability, pollutant control implementation rates and lake response lag. The analysis resulted in four sets of data that defined estimated potential load reductions and costs for four milestones. Each milestone was based on a uniform level of effort measured by a capital cost of $500 million invested between each milestone. Milestones were expected to be achieved every fifth year during stakeholder discussions. The specific timing may vary and does not affect the analysis. This analysis is more completely described in Section 2.3: Milestone Analysis.

Innovation Timing Analysis

Stakeholders raised questions about the need to invest scarce funds in innovation that prompted an analysis of the effects of a 10-year delay in implementation of innovative pollutant controls. To answer this question, the TMDL team made adjustments to technology assumptions and compared the numeric results to the Recommended Strategy milestones.

Delayed innovation was represented by limiting the application level for advanced practice and new technology (Tier2 and Tier 3) pollutant controls for the first two milestones. During the later time periods, application levels were controlled by funding available. These assumptions are represented in Table 3-12. These assumptions should be compared to the baseline Recommended Strategy assumptions presented at the end of Section 2.3: Milestone Analysis. In particular, assumption number 7 is related.

The complete set of PAT inputs used for this analysis is provided in Table C-1 of Appendix C.

Table 3-12. Assumptions Limiting Innovation*

Pollutant controls	Milestone #1	Milestone #2	Milestone #3	Milestone #4
Advanced Practices (Tier 2)	10%	20%	$	$
New Technology (Tier 3)	0%	10%	$	$

*Percentages are maxima; dollars represent limitations based only on resource availability

The results of delayed innovation are considerable and graphically depicted in Figure 3-9. The center of each bubble is located at the potential percent reduction of the overall Basin-wide fine sediment budget for each time step. The size of the bubble represents estimated capital cost (in millions) of implementing controls and is rounded to two significant figures. The Clarity Challenge is shown by the horizontal red line.

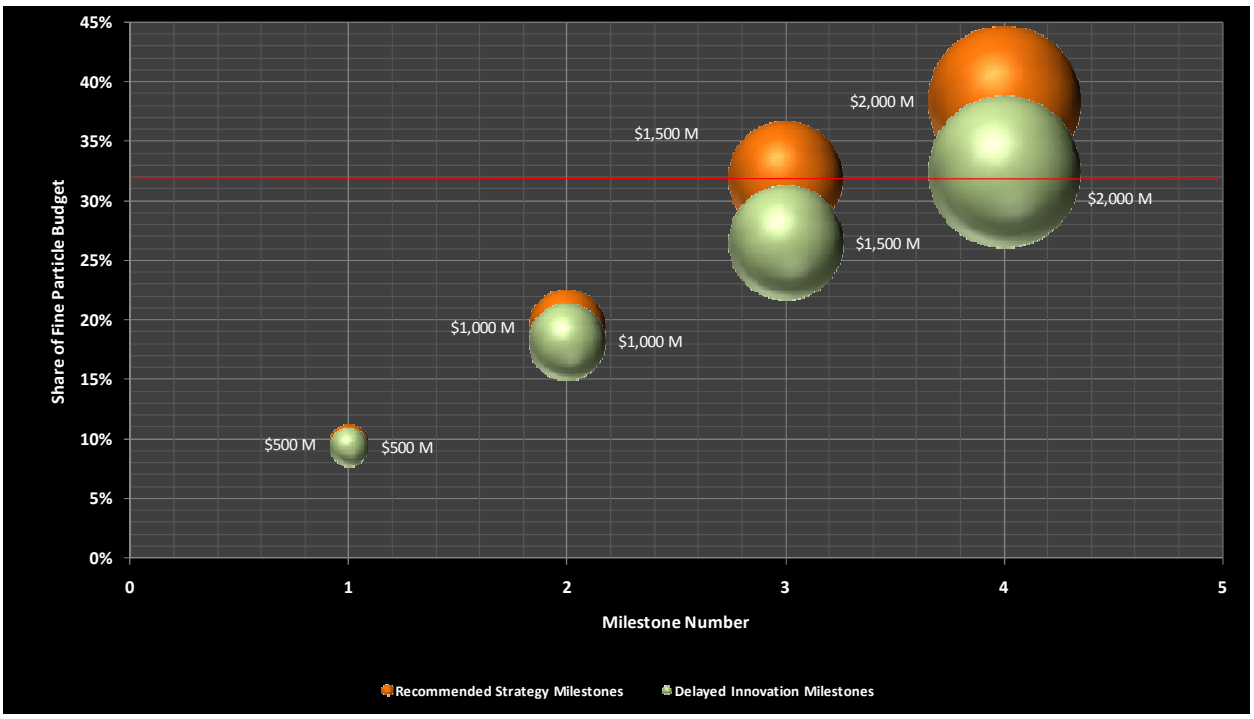

Figure 3-9. A comparison of the Recommended Strategy milestone analysis (orange bubbles) versus a delayed innovation analysis representing a 10-year delay in innovative pollutant controls (green bubbles).

Although capital investment is identical, the delayed innovation results in fine sediment reductions of only 27 percent by the third milestone and 32 percent by the fourth milestone. These fine sediment particle load reductions begin to lose pace with the Recommended Strategy by the second milestone. The overall finding is that achieving the Clarity Challenge is delayed by one milestone and that the maximum potential for fine sediment particle reductions are 6 percent less at the fourth milestone.

Forum and Implementers Feedback Regarding the Recommended Strategy

The December 6, 2007, Forum meeting[30] was structured to encourage open discussion about anything that forum members wanted to address. Themes of the day's discussion echoed those heard throughout the series of communications with the Forum in the year of the project. Where applicable, these themes had already influenced the Recommended Strategy. Those themes that do not directly influence the Recommended Strategy are noted that they could inform implementation efforts for the Lake Tahoe TMDL.

Table 3-13. Forum Feedback Regarding the Recommended Strategy and Other Topics

Feedback on Funding
▪ Competition for funds at the state and federal levels is increasing—set goals accordingly

▪ Increase organizational capacity for securing funding for the Tahoe Basin including
  ▪ Regional revenue source
  ▪ Private, local, county, regional, state and federal coordination
  ▪ Strategize and coordinate communications with funding sources—convey confidence in ability to achieve goals

▪ Apply similar rigor for creating a funding strategy as has been applied to defining the Lake clarity problem
Feedback on Innovation
▪ Innovate with regard to the way regulation plays out in the Tahoe Basin
▪ Increase organizational capacity and effectiveness for monitoring at a Basin-wide level ▪ Monitor effects of innovation to ensure best-possible performance and quality
▪ Market Tahoe as a national center for research and demonstration for innovation to encourage private investment in innovative techniques on-the-ground
▪ Incentivize innovation
▪ Evaluate regulations to remove those that inhibit innovation
Feedback on Pollutant Controls
▪ Look for opportunities to maximize benefit to ecosystem functions beyond water clarity
▪ Emphasize transportation strategies (VMT and infrastructure)
Feedback on Other Topics
▪ Tie clarity improvements to other thresholds
▪ Focus on activities at the subwatershed level, eliminating coverage model

[30] See Appendix B/Develop and Refine the Recommended Strategy/Forum Recommended Strategy Meeting Notes December 6, 2007.

3.5. Refine the Recommended Strategy

To complete the project, the TMDL team made minor changes to application levels, adjusted the terminology used and provided additional data that could be used for load allocations in the *Final Lake Tahoe TMDL* document. Application levels for atmospheric and urban tiers of Scenario B were adjusted slightly to better incorporate stakeholder feedback. During the December Forum meeting, the TMDL team presented the "time-series analysis" of "Scenario B". Subsequent discussions resulted in realization that the results of this analysis would be more appropriately called the "Recommended Strategy" and "milestone analysis." This terminology change will be useful when the Lake Tahoe TMDL agencies produce the *Final Lake Tahoe TMDL* document.

The TMDL team did additional GIS analysis of the Recommended Strategy to provide data that could be used in load allocations. The analysis applied the estimated potential load reductions from the Recommended Strategy in several ways;

- Designating jurisdictions as either forest or urban, then applying the relevant percent load reduction to the jurisdiction's baseline load
- Categorizing land uses as either forest or urban, then applying the relevant percent load reduction and aggregating the land uses by jurisdiction
- Representing all the urban and forest pollutant controls in the Watershed Model and then aggregating the outputs by jurisdiction

The analysis also explored an approach to establishing allocations through equal reduction of the anthropogenic loads of each jurisdiction. A description of this analysis and the resulting data are available in Chapter 4: Analyses Supporting Load Allocations.

4. Analyses Supporting Load Allocations

This chapter presents an estimate of baseline annual pollutant loads by jurisdiction and five approaches to establishing allowable loads for upland sources. Results for each of the methods are provided along with discussion about the potential implications for load allocation associated with each of the approaches. The Lake Tahoe TMDL agencies may use this information to inform discussions with the implementing community and determine the approach that will be included in the Final Lake Tahoe TMDL document.

This chapter focuses on upland pollutant sources and does not present information about potential load allocations to atmospheric or stream channel sources. The urban and forest upland sources will be covered by permits, memoranda of understanding or other regulatory requirements that will directly relate to upland loads and load reductions. The Recommended Strategy does include stream channel load reductions, which will be achieved through other programmatic efforts.

This chapter also describes an analysis of how to appropriately express loads in the TMDL and presents *load duration curves* that can be used to express the *annual* allowable load allocations as *daily* loads. The load duration curves are based on evaluation of EPA guidance document *Options for Expressing Daily Loads in TMDLs* (EPA 2007).

4.1. Distributing Baseline Loads to Jurisdictions

Establishing estimates of how much of the baseline load is attributable to each of the management jurisdictions is a two-step process that involves (1) spatially referencing jurisdictional boundaries in a GIS relative to subwatershed and land use locations, and (2) database aggregation of the original Watershed Model results according to the referenced jurisdictional boundaries.

Methods

Four data sets were used to develop the baseline load estimates by jurisdiction: (1) the results of the Watershed Model baseline run; (2) an aggregated GIS layer of jurisdictions; (3) the Watershed Model land use grid; and (4) the Watershed Model subbasin boundaries. The starting point for the analysis was the Watershed Model baseline loading outputs.

As described in the Technical Report, the Watershed Model results for the baseline run were based on a calibration period from 1995 to 2004. The upland areas results were summarized in a master table of annual average surface and subsurface loads for each pollutant of concern for each subbasin and land use combination. This master table contains results for the 223 modeled subbasins, 20 land uses, and 5 pollutants of concern (Surface TSS, Surface Fines, Surface Particles, Total Nitrogen, and Total Phosphorus), for a total of 22,300 records. The format of this table is presented in Table 4-1. This master table, however, does not include information regarding the jurisdictional boundaries. The table is too large to be included as an appendix of this report, but it is stored within the Lake Tahoe TMDL project records at the Lahontan Water Board and NDEP.

Table 4-1. Example Table Format of Watershed Model Baseline Results

Pollutant	Subbasin ID	Land use ID	Baseline load
Surface Fines (tonne)	1001	1	…
Surface Fines (tonne)	1001	2	…
…	…	…	…
Surface Particles (count)	1001	1	…
Surface Particles (count)	1001	2	…
…	…	…	…
Surface TSS (tonne)	1001	1	…
Surface TSS (tonne)	1001	2	…
…	…	…	…
Total TN (kg)	1001	1	…
Total TN (kg)	1001	2	…
…	…	…	…
Total TP (kg)	1001	1	…
Total TP (kg)	1001	2	…
…	…	…	…

Spatially Referencing Jurisdictional Boundaries in a GIS

The following GIS layers were collected and compiled for this effort. Data sources are listed in parentheses.

1. City of South Lake Tahoe limits (TRPA)
2. USDA Forest Service Lands (TRPA)
3. California Tahoe Conservancy (CTC, TRPA)
4. Nevada State Lands (TRPA)
5. California State Parks (TRPA)
6. Counties (TRPA)
7. General Improvement Districts for Douglas County (Douglas County, NDEP)

An aggregated jurisdiction GIS layer was created by merging the various component layers and dissolving features within within unique jurisdictional boundaries. In those instances where an area was shared by two or more jurisdictions, the order of precedence for jurisdiction assignment was as follows: (1) USDA Forest Service, (2) California Tahoe Conservancy, (3) State Parks, (4) State Lands, (5) Cities, and (6) Counties. Douglas County is further subdivided into General Improvement Districts. Since the all-inclusive county boundaries was last in the order of precedence, any area not previously assigned to one of the preceding jurisdictions was automatically included as general county land. Because primary roads were already distinguished within the TMDL land use layer, CALTRANS and NDOT jurisdiction areas were assigned directly from this land use category by state.

The aggregated jurisdictional layer was intersected with the subbasin layer to obtain a composite layer containing both subbasin and jurisdictional information, as illustrated in Figure 4-1. This new layer was overlaid upon the Watershed Model land use grid, and the attributes tabulated according to the new jurisdiction and subbasin combinations. The result was a table of subbasins, jurisdictions, and land use areas.

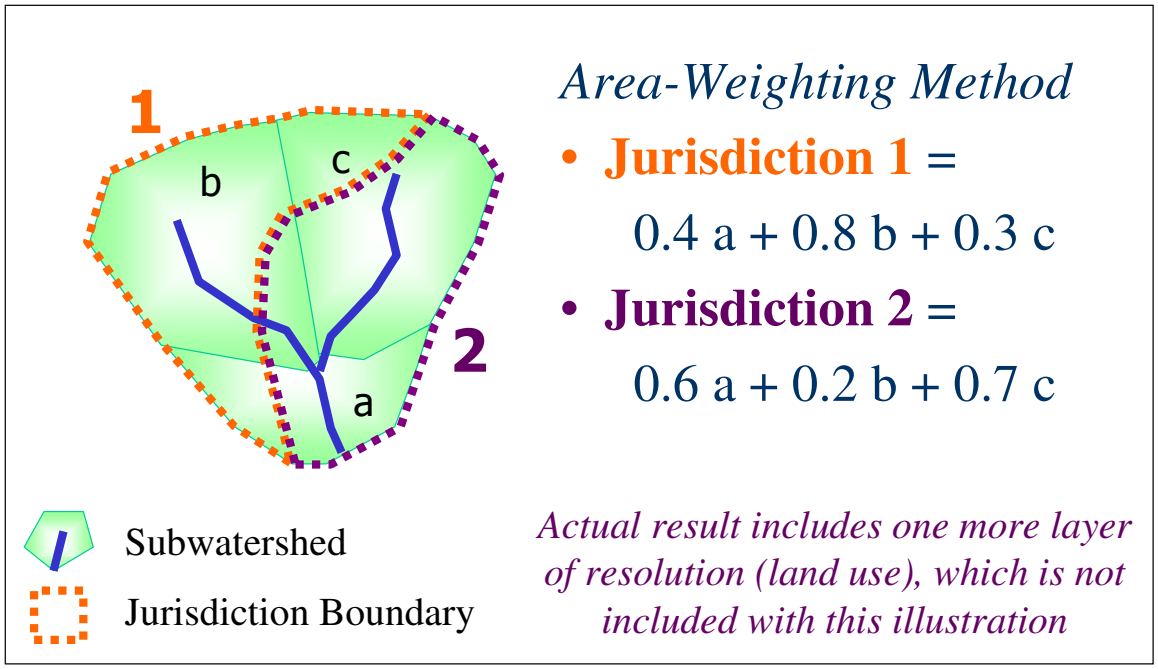

Figure 4-1. Area-weighting method used to build a composite subbasin-jurisdiction layer

Figure 4-2 presents a summary of the land uses by jurisdiction as a percent of its area obtained from the process described here. To simplify presentation, two jurisdictional consolidations have been made. First, the Douglas County General Improvement Districts (GIDs) have been grouped as Douglas County, NV. The second consolidation includes the forested jurisdictions: CTC; USFS; Nevada State Lands; California and Nevada State Parks; and Carson City, Nevada. Detailed summaries for each of the individual jurisdictions are presented in Appendix C.

The composite jurisdiction-and-subwatershed layer was used to resample the numerical results. For each jurisdiction, the percent area of each subbasin and land use combination served as a weighting factor for the jurisdictional roll-up. An example excerpt of this table is shown in Table 4-2. In this case, 25 percent of the Veg_EP3 land use (Vegetated Erosion Potential 3) of subbasin 1001 falls within the US Forest Service jurisdiction, while 10 percent is part of the Nevada State Lands, and the remaining 65 percent is part of Washoe County.

Table 4-2. Example Table of Percent of Area by Jurisdiction

Subbasin	Land use ID	Land use description	Jurisdiction	State	Percent of area
1001	7	Veg_EP3	US Forest Service	NV	24.71%
1001	7	Veg_EP3	NV State Lands	NV	9.92%
1001	7	Veg_EP3	Washoe County	NV	65.36%

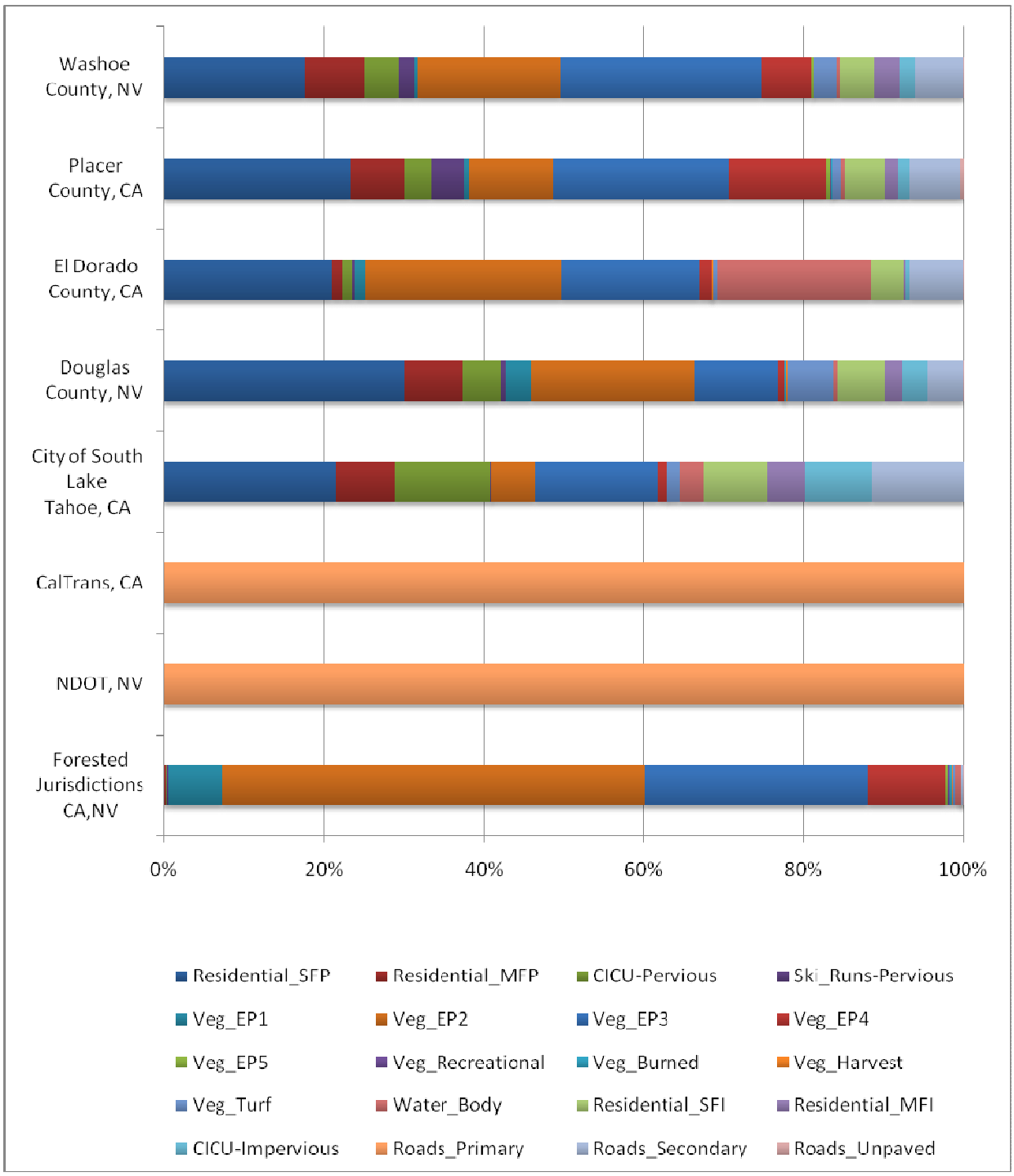

Figure 4-2. A comparison of land use composition among aggregated jurisdictions.

Database Aggregation of Results Based on Jurisdictional Boundaries

The table of subbasin, land use, and percent area by jurisdiction was combined with the model results in the master baseline table. Loads for each jurisdiction were calculated by distributing the land use load for each subbasin according to the resampled jurisdiction percent areas previously described.

In the example started above, the average annual total particles load for the Veg_EP3 land use of subbasin 1001 is approximately 10.37 x 10^{15}. Table 4-3shows how this amount is split among the three jurisdictions according to their percent distribution. Table 4-4 is an example of how the estimated load by subbasin, land use, *and* jurisdiction are summarized. This exercise was performed for all subbasins, land uses, jurisdictions, and pollutants of concern.

Table 4-3. Example Table of Subbasin Loads Split by Jurisdiction

Subbasin	Land use ID	Land use name	Jurisdiction	State	Fine sediment load (particle #)
1001	7	Veg_EP4	US Forest Service	NV	2.56 x 10^{14}
1001	7	Veg_EP4	NV State Lands	NV	1.03 x 10^{14}
1001	7	Veg_EP4	Washoe County	NV	6.78 x 10^{14}

Table 4-4. Final Baseline Master Table Including Jurisdictions

Pollutant	Subbasin ID	Land use ID	Jurisdiction	Baseline load
Surface Particles (count)	1001	1	Jurisdiction A	…
Surface Particles (count)	1001	1	Jurisdiction B	…
Surface Particles (count)	1001	…	…	…
Surface Particles (count)	1001	2	Jurisdicton A	…
Surface Particles (count)	1001	2	Jurisdicton B	…
Surface Particles (count)	1001	2	Jurisdicton C	…
Surface Particles (count)	…	…	…	…
…	…	…	…	…

Jurisdictional baseline loads were summed for each pollutant from the new table of pollutant, subbasin, land use, and jurisdictions.

Results

Table 4-5 presents the baseline annual average loads of fine sediment particles by jurisdiction along with the associated percentage relative to the basin-wide total. The jurisdictions with the largest total surface fine sediment particles loads are CalTrans and the City of South Lake Tahoe.

Table 4-5. Baseline Fine Sediment Particle Loads by Jurisdiction

Jurisdiction	Baseline (particles x 10^{18})	% of total urban baseline load
Forest Jurisdictions	51.7	13%
CalTrans, CA	76.4	20%
City of South Lake Tahoe, CA	74.6	19%
Douglas County, NV	10.2	3%
El Dorado County, CA	37.6	10%
NDOT, NV	32.8	8%
Placer County, CA	56.9	15%
Washoe County, NV	48.8	13%

4.2. Load Allocation Approaches

The TMDL Team explored five approaches for determining load allocations. The first two approaches applied the Recommended Strategy's source category load reductions directly to each jurisdiction's baseline loads, the third approach applied the Recommended Strategy's load reductions by setting before summarizing by jurisdiction, the fourth approach explicitly represented Recommended Strategy controls within the watershed model to spatially distribute associated level of application relative to the baseline run, and the fifth approach directly applied the required load reduction to a watershed model estimate of anthropogenic loading.

Table 4-6 presents a summary of the allocation approaches. The *Basic map unit* column is the starting point for the analysis. The *Basis for assigning load reduction* column explains how the reductions are calculated. The *Load reduction aggregation to* column shows that all load reductions are summed by jurisdictions for all approaches. The methods and results for each approach are described in the following sections.

Table 4-6. Summary of Allocation Approaches

	Basic map unit	Basis for assigning load reduction	Load reduction aggregated to
Approach I: Predominant Load Source	26 Jurisdictions	Baseline loading reduced by the source category % reductions from the Recommended Strategy	26 Jurisdictions
Approach II: Load Source Weighted	20 TMDL Land Uses Aggregated to Forest or Urban	Baseline loading reduced by the source category weighted % reductions from the Recommended Strategy by land use	26 Jurisdictions
Approach III: Setting Specific	4 Urban Settings plus 3 Forested Settings (Groupings of the 20 Land Uses)	Baseline loading reduced by the setting-specific % reductions from the Recommended Strategy by setting	26 Jurisdictions
Approach IV: Watershed Model	Watershed Models' subbasins and land uses	Watershed model's estimates of HSC, PSC, and SWT effects. Application levels from the Recommended Strategy by setting and tier are modeled	26 Jurisdictions
Approach IV: Anthropogenic Loading	Basin-wide	Uniform % reduction of anthropogenic load	26 Jurisdictions

Load Reduction Milestones and the Load Target

The milestone analysis, described in Chapter 2: Recommended Water Quality Management Strategy was the basis for setting load reduction milestones. The four milestones provide a path to reaching the Clarity Challenge. An additional, *Lake Tahoe TMDL final load target* (load target) is necessary to estimate the additional load reductions to achieve the *Lake Tahoe TMDL numeric target* of 97.4 feet of clarity (Lahontan and NDEP 2007a, pp.2–8). The pollutant load reductions for the load target were calculated by linearly extrapolating the average load reduction rates through the fourth milestone to achieve the numeric target defined by using the Lake Clarity Model.

Approach I: Predominant Load Source

Approach I: Predominant Load Source categorized each *jurisdiction* as urban or forested based on the type of land use, urban or forest, which causes the predominant load from the jurisdiction. The corresponding percent load reduction for the predominant source category determined by the Recommended Strategy milestones analysis was then applied to the jurisdiction's baseline load. For instance, if 20 percent of a county's load comes from forest land uses and 80 percent comes from urban land uses, the county would be expected to achieve a 34 percent reduction from baseline loading to meet the third (Clarity Challenge) milestone. The 34 percent reduction corresponds to the load reduction expected from all urban uplands.

Methods

Table 4-7 shows the Basin-wide average load reductions corresponding to each of the milestones and the load target for forest and urban sources. The percent reductions are from the source category specific baseline pollutant budget. They were calculated using Equation #1 with the necessary percent reduction at each milestone taken from the Basin-wide load reduction milestones presented in Chapter 2: Recommended Water Quality Management Strategy.

Equation #1:

$$\%\ Reduction\ from\ Source\ Category\ Baseline = 100 \times \frac{Necessary\ \%\ Reduction\ at\ Milestone}{Source\ Category\ \%\ of\ Baseline\ Load}$$

Table 4-7. Average Fine Sediment Percent Reductions at Each Milestone for Forest and Urban Source Categories

Pollutant	Milestone	Forest reduction*	Urban reduction*
Fine Sediment Particles	#1	6%	10%
	#2	9%	21%
	#3	12%	34%
	#4	12%	42%
	Load Target	20%	71%

*All values provided are percentages of the forest or urban specific source category baseline pollutant budget.

The resulting designations for each jurisdiction are presented in Table 4-8, with the loading source shown in Figure 4-3. Even though the area for some counties was a majority forested, the predominant load source for all counties, primary road jurisdictions and the City of South Lake Tahoe was urban.

Table 4-8. Predominant Load Source of Jurisdictions (Approach I)

Jurisdiction	Forest/Urban category
California Tahoe Conservancy, CA	Forest
CalTrans, CA	Urban
Carson City (Rural Area), NV	Forest
City of South Lake Tahoe, CA	Urban
Douglas County, NV	Urban
El Dorado County, CA	Urban
USFS, CA	Forest
USFS, NV	Forest
NDOT, NV	Urban
Placer County, CA	Urban
State Lands, NV	Forest
State Parks, CA	Forest
State Parks, NV	Forest
Washoe County, NV	Urban

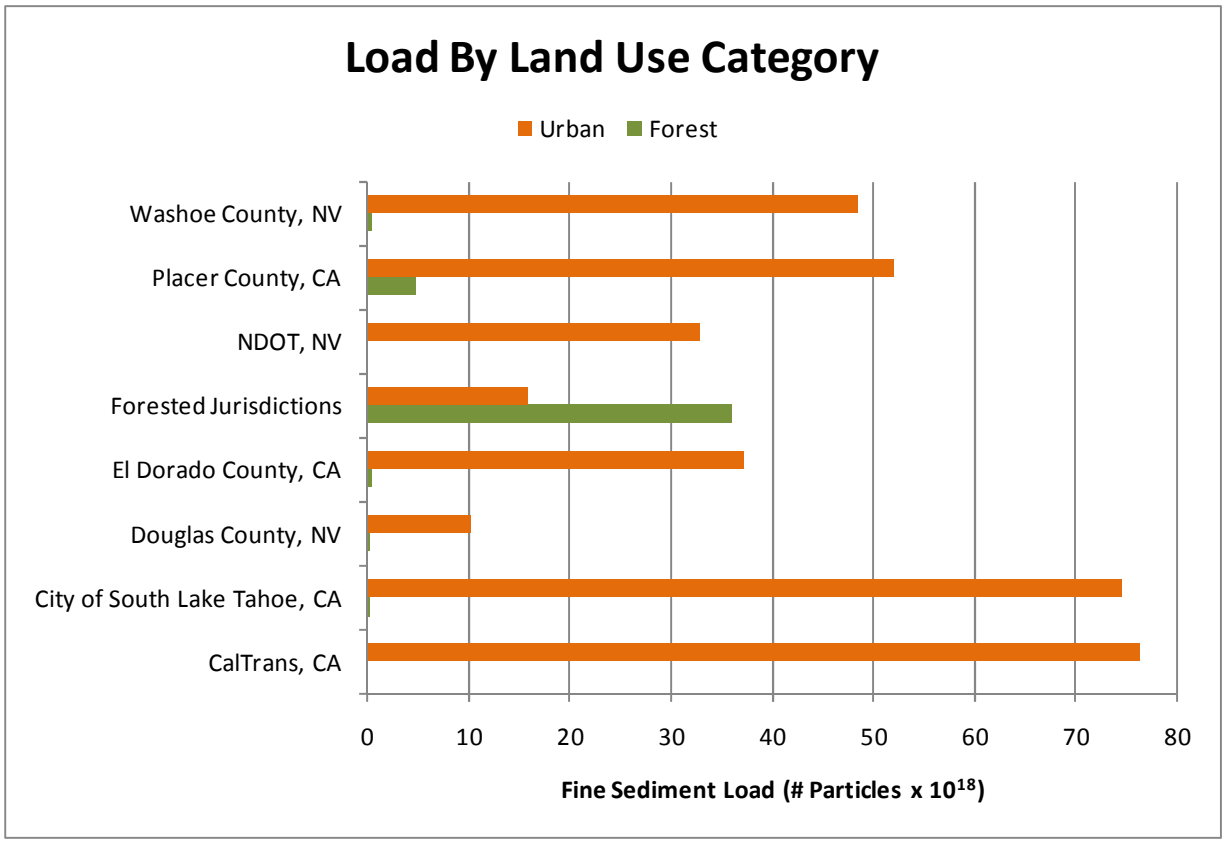

Figure 4-3. The portion of each major jurisdiction's fine sediment particle load categorized as forested or urban.

Analysis Assumptions

This analysis assumes that load reduction capability is primarily determined by the dominant loading source and that other loading sources within a jurisdiction will not significantly change the jurisdiction's ability to reduce overall loads. This assumption is valid in cases where forested land uses make up a small proportion of loading within a predominantly urban area. This assumption is less valid when urban land uses make up a small part of a forested area because there is a larger potential for urban areas to reduce fine sediment particles.

Results

The results of the Predominant Load Source approach are presented in Table 4-9. Allowable loads were calculated using Equation #2. Urban jurisdictions had higher load reduction percentages than forested jurisdictions, and all urban percent reductions were the same.

Equation #2:

$$Allowable\ Load = Baseline\ Load\ -\ Baseline\ Load\ \times\ \frac{\%\ Reduction}{100}$$

Table 4-9. Fine Sediment Particle Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach I: Predominant Load Source Approach[31]

Jurisdiction	% Reduction from jurisdiction baseline[32]					Allowable load (particles x10[18])					
	Milestone #1	Milestone #2	Milestone[33] #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
Forested Jurisdictions[34]	6%	9%	12%	12%	20%	51.7	48.8	47.2	45.7	45.6	41.4
CalTrans, CA	10%	21%	34%	42%	71%	76.4	68.5	60.2	50.5	44.2	22.0
City of South Lake Tahoe, CA	10%	21%	34%	42%	71%	74.6	66.9	58.8	49.3	43.2	21.5
Douglas County, NV	10%	21%	34%	42%	71%	10.2	9.2	8.0	6.7	5.9	2.9
El Dorado County, CA	10%	21%	34%	42%	71%	37.6	33.7	29.6	24.9	21.8	10.8
NDOT, NV	10%	21%	34%	42%	71%	32.8	29.4	25.9	21.7	19.0	9.4
Placer County, CA	10%	21%	34%	42%	71%	56.9	51.0	44.8	37.6	32.9	16.4
Washoe County, NV	10%	21%	34%	42%	71%	48.8	43.8	38.5	32.3	28.3	14.1

[31] Similar tables for total nitrogen and total phosphorus are included in Appendix C.
[32] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.
[33] The third milestone corresponds to the Recommended Strategy. Load reductions associated with the Recommended Strategy (and thus the third milestone) are expected to achieve the Clarity Challenge.
[34] Forested jurisdictions include CTC; USFS; State Lands, Nevada; California and Nevada State Parks; Carson City, Nevada. For the results of each of these individual jurisdictions, see Appendix C.

Approach II: Load Source Weighted

Approach II: Load Source Weighted categorized each of the 20 TMDL *land uses* as either urban or forested and determined the amount of pollutant load coming from each category of each jurisdiction. The corresponding source category percent load reduction from the Recommended Strategy was applied to the urban and forested loads independently and summed to determine the total jurisdictional load reduction. For example, if 20 percent of a county's load comes from forest land uses and 80 percent comes from urban land uses, the county would be expected to achieve a 12 percent load reduction from the forest load and a 34 percent load reduction from the urban load to meet the Clarity Challenge milestone. This corresponds to an overall jurisdictional weighted load reduction of 30 percent.

Methods

This approach used the baseline loads distributed to jurisdictions and the relative source category load reductions resulting from the milestone analysis. Table 4-10 shows which land uses were categorized as urban versus forest, and Figure 4-4 summarizes the distribution of urban and forested land use classifications for each jurisdiction. Figure 4-3 above, shows the fine sediment particle loads, summarized by forest and urban land use categories, for each jurisdiction.

Table 4-10. Categorization of Land Uses as Urban or Forest

Land use ID	Land use name	Land use category
1	Residential_SFP	Urban
2	Residential_MFP	Urban
3	CICU-Pervious	Urban
4	Ski_Runs-Pervious	Urban
5	Veg_EP1	Forest
6	Veg_EP2	Forest
7	Veg_EP3	Forest
8	Veg_EP4	Forest
9	Veg_EP5	Forest
10	Veg_Recreational	Forest
11	Veg_Burned	Forest
12	Veg_Harvest	Forest
13	Veg_Turf	Urban
14	Water_Body	Waterbody
15	Residential_SFI	Urban
16	Residential_MFI	Urban
17	CICU-Impervious	Urban
18	Roads_Primary	Urban
19	Roads_Secondary	Urban
20	Roads_Unpaved	Forest

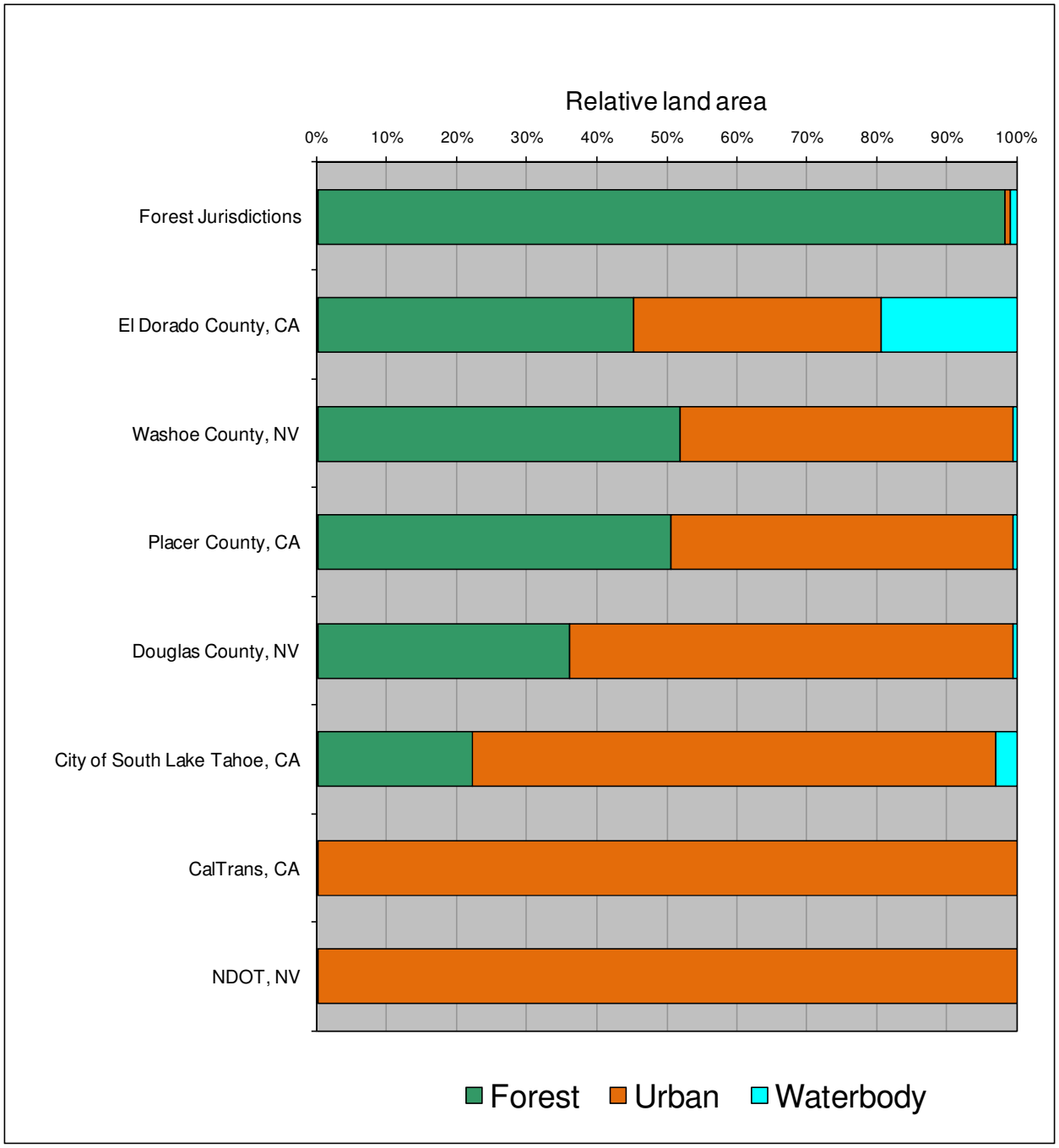

Figure 4-4. The relative portion of each major jurisdiction's land use, categorized as forest, urban, and waterbody.

Analysis Assumptions

This analysis assumes that load reductions at the jurisdictional scale can be achieved in urban and forested land uses similar to the average reductions for urban and forest land uses developed in the Recommended Strategy. It does not differentiate between load reduction potential among the various urban and forest land use categories. It also does not consider any spatially variability in load patterns associated with climate and hydrologic variability around the basin.

Results

The results of the Load Source Weighted approach are presented in Table 4-11. Allowable loads were calculated using Equation #2. Percent load reductions from urban jurisdictions are somewhat similar to each other despite differences in the percent area of urban and forested land uses. This is because the dominance of the urban load (see Figure 4-3). The impact of the urban load allocation is evident even when the fraction of urban land area is less than 50 percent.

Placer County's forested land is considerably higher than the other counties as a result of a greater area of highly erosive forested land uses and the high level of precipitation and runoff in the northwest portion of the Basin. Placer County is the only urban jurisdiction where the forest load notably reduces the load reduction requirement compared to a purely urban area.

Table 4-11. Fine Sediment Particle Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach II: Load Source Weighted Approach[35]

Jurisdiction	% Reduction from jurisdiction baseline[36]					Allowable load (particles x 10^{18})					
	Milestone #1	Milestone #2	Milestone[37] #3	Milestone #4	Load Target	Baseline Load	Milestone #1	Milestone #2	Clarity Challenge #3	Milestone #4	Load Target
Forested Jurisdictions[38]	7%	13%	18%	21%	36%	51.7	48.1	45.2	42.2	40.8	33.3
CalTrans, CA	10%	21%	34%	42%	71%	76.4	68.5	60.2	50.5	44.2	22.0
City of South Lake Tahoe, CA	10%	21%	34%	42%	71%	74.6	66.9	58.8	49.3	43.2	21.5
Douglas County, NV	10%	21%	34%	42%	71%	10.2	9.2	8.0	6.8	5.9	3.0
El Dorado County, CA	10%	21%	34%	42%	71%	37.6	33.7	29.7	24.9	21.9	11.0
NDOT, NV	10%	21%	34%	42%	71%	32.8	29.4	25.9	21.7	19.0	9.4
Placer County, CA	10%	20%	32%	40%	67%	56.9	51.2	45.4	38.7	34.4	18.8
Washoe County, NV	10%	21%	34%	42%	71%	48.8	43.8	38.5	32.4	28.4	14.3

[35] Similar tables for total nitrogen and total phosphorus are included in Appendix C.
[36] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.
[37] The third milestone corresponds to the Recommended Strategy. Load reductions associated with the Recommended Strategy (and thus the third milestone) are expected to achieve the Clarity Challenge.
[38] Forested jurisdictions include CTC; USFS; State Lands, Nevada; California and Nevada State Parks; Carson City, Nevada. For the results of each of these individual jurisdictions, see Appendix C.

Approach III: Setting Specific

Approach III: Setting Specific used the individual percent reductions by setting from the Recommended Strategy, and applied them to the baseline loads of each setting.

Methods

For this approach, urban upland areas throughout the basin were categorized into 4 settings (either Concentrated Moderate, Concentrated Steep, Dispersed Moderate, or Dispersed Steep). Forest upland areas were split between 3 settings (Setting A, Setting B, and Setting C). The baseline loads from each one of these settings received the average percent reduction by setting from the Recommended Strategy shown in Table 4-12. Finally, the reduced loads were summed by jurisdiction, and the overall jurisdiction percent reduction from baseline was calculated.

Table 4-12. Fine Sediment Particles Percent Reduction by Setting

Pollutant	SCG	Setting	Reduction %
Fine Sediment Particles	Forest	Setting A	75%
		Setting B	66%
		Setting C	2%
	Urban	Conc.-Moderate	42%
		Conc.-Steep	36%
		Disp.-Moderate	43%
		Disp.-Steep	7%

Assumptions

This analysis assumes that load reductions at the jurisdictional scale can be achieved in urban and forested settings similar to the average reductions for those settings developed in the Recommended Strategy. It does not differentiate between load reduction potential *within* settings; however, it begins to factor in differences in load reduction potential *between* settings. Because similar settings are fairly well distributed around the basin, Approach III also does not explicitly consider any spatial variability in load patterns associated with climate and hydrologic variability around the basin.

Results

The results of the Setting Specific approach are presented in Table 4-13. Allowable loads were calculated using Equation #2, and the percent reductions for each setting from Table 4-12. This analysis was completed for the third milestone only.

Table 4-13. Fine Sediment Particle Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach III: Setting Specific[39]

Jurisdiction	% Reduction from jurisdiction baseline[40]					Allowable load (particles x 10^{18})					
	Milestone #1	Milestone #2	Milestone[41] #3	Milestone #4	Load Target	Baseline Load	Milestone #1	Milestone #2	Clarity Challenge #3	Milestone #4	Load Target
Forested Jurisdictions[42]			18%			51.7			42.7		
CalTrans, CA			31%			76.4			52.9		
City of South Lake Tahoe, CA			42%			74.6			43.0		
Douglas County, NV			29%			10.2			7.2		
El Dorado County, CA			32%			37.6			25.7		
NDOT, NV			24%			32.8			24.8		
Placer County, CA			34%			56.9			37.4		
Washoe County, NV			35%			48.8			32.0		

[39] Similar tables for total nitrogen and total phosphorus are included in Appendix C.
[40] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.
[41] The third milestone corresponds to the Recommended Strategy. Load reductions associated with the Recommended Strategy (and thus the third milestone) are expected to achieve the Clarity Challenge.
[42] Forested jurisdictions include CTC; USFS; State Lands, Nevada; California and Nevada State Parks; Carson City, Nevada. For the results of each of these individual jurisdictions, see Appendix C.

Approach IV: Watershed Model

Approach IV: Watershed Model used the Watershed Model to simulate the effects of proposed pollutant controls in reducing upland source loads. This approach required a unique run of the Watershed Model and incorporated the hydrologic effects of pollutant controls. It can be thought of as a spatially relevant disaggregation of the Recommended Strategy. In contrast to approaches I, II, and similar to approach III, this approach explicitly accounts for the level of application for the different settings determined in the Recommended Strategy. While approach III averages the model response by setting, the Watershed Model approach reveals different responses for areas of the same setting, but in different locations of the basin. For this reason, the associated allocations by jurisdiction are reflective of spatially variable loading patterns in the watershed.

Methods

For this approach, the Watershed Model was configured to simulate the hydrologic and water quality effects of the application of pollutant controls for the different settings and tiers selected as part of the Recommended Strategy.

The application level of each tier of pollutant control determined in the Recommended Strategy was applied to each watershed according to the appropriate urban setting for urban watersheds or the mix of settings for forest watersheds. The Watershed Model results provided pollutant loads associated with Recommended Strategy application level by subbasin, which are then summed to jurisdictions similarly to the method described in Section 4.1 for distributing baseline loads.

Assumptions

This analysis assumes that pollutant controls will be implemented in every subbasin according to the Recommended Strategy application levels for Tiers 1, 2, and 3. While actual pollutant controls are likely to be implemented more intensively in certain subbasins and others will receive less treatment, this analysis approximates the load reductions possible from implementing pollutant controls throughout the watershed.

Results

The results of the Watershed Model approach are presented in Table 4-14. Allowable loads were provided directly from the Watershed Model outputs, and percent reductions were calculated using Equation #3.

Equation #3:

$$\%\ Reduction\ from\ Jurisdiction\ Baseline = 100 \times \frac{Baseline\ Load - Allowable\ Load}{Baseline\ Load}$$

This analysis was completed for the third milestone load reductions only.

Table 4-14. Fine Sediment Particle Allowable Loads and Jurisdictional Percent Reductions at Each Milestone for Approach IV: Watershed Model[43]

Jurisdiction	% Reduction from jurisdiction baseline[44]					Allowable load (particles x10[18])					
	Milestone #1	Milestone #2	Milestone[45] #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
Forested Jurisdictions[46]			17%			51.7			43.1		
CalTrans, CA			36%			76.4			48.6		
City of South Lake Tahoe, CA			38%			74.6			45.9		
Douglas County, NV			21%			10.2			8.1		
El Dorado County, CA			38%			37.6			23.5		
NDOT, NV			28%			32.8			23.7		
Placer County, CA			34%			56.9			37.5		
Washoe County, NV			33%			48.8			32.5		

[43] Similar tables for total nitrogen and total phosphorus are included in Appendix C.
[44] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.
[45] The third milestone corresponds to the Recommended Strategy. Load reductions associated with the Recommended Strategy (and thus the third milestone) are expected to achieve the Clarity Challenge.
[46] Forested jurisdictions include CTC; USFS; State Lands, Nevada; California and Nevada State Parks; Carson City, Nevada. For the results of each of these individual jurisdictions, see Appendix C.

Approach V: Anthropogenic Loading

Approach V: Anthropogenic Loading first calculated the *difference* in pollutant loading between the *baseline loads* on the basis of current land uses and *background loads* determined by Watershed Model estimates of pollutant loading from a completely forested watershed. A uniform percent reduction sufficient to meet Basin-wide load reduction milestones was applied to the resulting anthropogenic load. Total allowable loads were determined for each jurisdiction by adding the background load and allowable anthropogenic load at each milestone according to Equations #4.

Equation #4:

$$Total\ Allowable\ Load = Background\ Load + Allowable\ Anthropogenic\ Load$$

Where

$$Allowable\ Antropogenic\ Load = Antropogenic\ Load - Antropogenic\ Load \times \frac{\%\ Reduction}{100}$$

The following discussion and Figure 4-5 illustrate this approach with the actual values further described below.

- The sum of forest and urban Basin-wide *baseline* load is 389 x 10^{18} particles.
- The sum of forest and urban Basin-wide *background* load is 35 x 10^{18} particles.
- The sum of forest and urban Basin-wide *anthropogenic* load is 354 x 10^{18} particles.
- The sum of forest and urban loading at the third milestone is 266 x 10^{18}. Thus, the allowable anthropogenic load is 231 x 10^{18} (266 x 10^{18} less the background load of 35 x 10^{18}). This corresponds to a 35 *percent anthropogenic load reduction*.

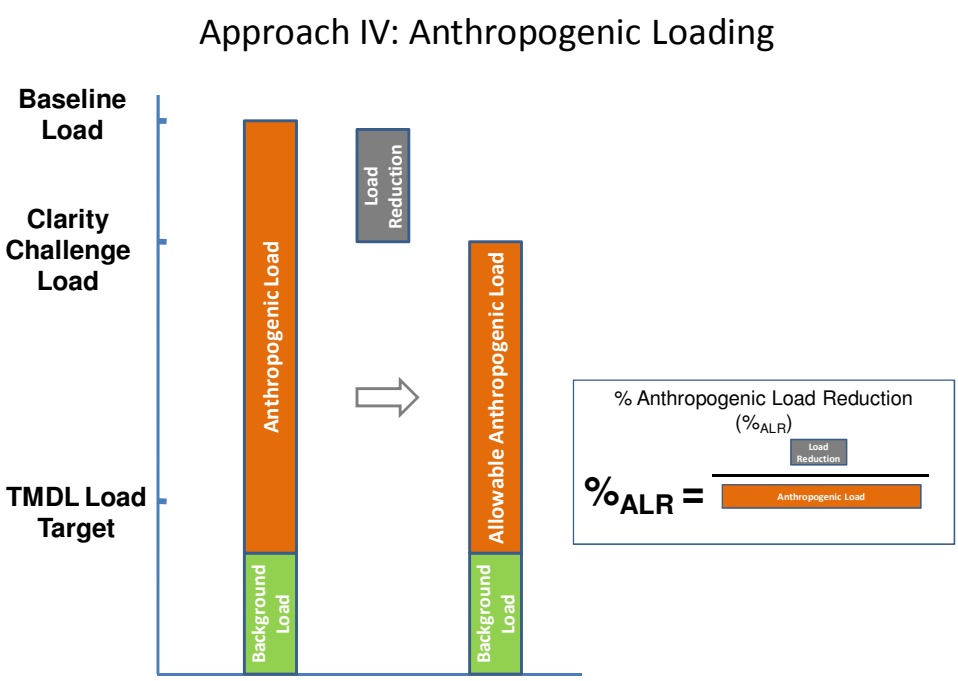

Figure 4-5. A diagram of the key concepts used in Approach IV: Anthropogenic Loading for establishing allowable loads.

This 35 percent reduction was applied to each jurisdiction's anthropogenic load, giving an allowable anthropogenic load at the third milestone. [47] A jurisdiction's total allowable load is the sum of the allowable anthropogenic load and the background load as shown in Equation #5.

Methods

Background loads were determined by running the Watershed Model with all developed land uses replaced by forested land uses: Vegetated EP1 through EP5. The forested land use areas were determined from the erosion potential GIS coverage intersected with the subbasin coverage. Table 4-15 shows the Basin-wide allowable upland load at each milestone, which corresponds to the sum of forest and urban particles at each milestone. The corresponding Basin-wide allowable anthropogenic load was computed by subtracting the background load from the allowable load. The percent anthropogenic load reduction was computed by dividing the allowable anthropogenic load by the total anthropogenic load.

Table 4-15. Basin-wide Allowable Loads and Anthropogenic Load Reductions at Each Milestone

Pollutant	Milestone	Basin-wide allowable upland load (particles x10^{18})	Background load (particles x10^{18})	Allowable anthropogenic load (particles x10^{18})	Anthropogenic load reduction
	Baseline	389	35	354	0%
Fine Sediment Particles	#1	351	35	315	11%
	#2	312	35	276	22%
	#3	266	35	231	35%
	#4	238	35	202	43%
	Load target	162	35	97.5	72%

*All values provided are percentages of the forest and urban upland specific source category baseline pollutant budget.

The jurisdiction specific background loads were determined using the same method described in Section 4.1 above for summing baseline loads by jurisdiction. Jurisdiction specific anthropogenic loads are computed as the difference between the background load and the baseline load. The jurisdiction specific allowable loads were calculated using Equation #4 with the jurisdiction specific baseline and background loads and the percent anthropogenic load reduction from Table 4-16. Results are presented in Table 4-17.

Assumptions

This approach assumes that the undeveloped load can be approximated in the watershed model by converting all areas to Vegetated, according to the five established erosion potential groups. This approach is also based on the assumption that anthropogenic loads of pollutants are controllable for all sources with the same effectiveness regardless of their spatial location in the watershed.

Results

The jurisdiction-specific baseline, background and anthropogenic loads are presented in Table 4-16. Allowable loads and percent reductions at each milestone for the Anthropogenic Loading approach are presented in Table 4-17. The results show that a vast majority of anthropogenic loading comes from urban jurisdictions, and the commensurate majority of the load reductions are expected from the urban jurisdictions. Results also show that 40 percent of the load from the forest jurisdictions is anthropogenic from urban or other developed land uses within the forest jurisdictions.

[47] The third milestone is established by the Recommended Strategy and is estimated to achieve the Clarity Challenge.

Table 4-16. Fine Sediment Particle Loads by Jurisdiction[48]

Jurisdiction	Fine sediment particle load (particles x10[18])			
	Baseline load	Background load	Anthropogenic load	Anthropogenic load % of baseline[49]
Forested Jurisdictions[50]	51.7	30.9	20.9	40.4%
CalTrans, CA	76.4	0.02	76.3	100%
City of South Lake Tahoe, CA	74.6	0.12	74.5	99.8%
Douglas County, NV	10.2	0.05	10.2	99.5%
El Dorado County, CA	37.6	0.29	37.3	99.2%
NDOT, NV	32.8	0.01	32.8	100%
Placer County, CA	56.9	3.6	53.2	93.6%
Washoe County, NV	48.8	0.42	48.4	99.1%

[48] Similar tables for total nitrogen and total phosphorus are included in Appendix C.
[49] All values have been rounded to three significant figures.
[50] Forested jurisdictions include CTC; USFS; State Lands, Nevada; California and Nevada State Parks; Carson City, Nevada. For the results of each of these individual jurisdictions, see Appendix C.

Table 4-17. Fine Sediment Particle Allowable Loads and Jurisdictional Percent Reductions From Baseline Load at Each Milestone for Approach V: Anthropogenic Loading[51]

Jurisdiction	% Reduction from jurisdiction baseline[52]					Allowable load (particles x10[18])				
	Milestone #1	Milestone #2	Milestone[53] #3	Milestone #4	Load target	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
Forested Jurisdictions[54]	4%	9%	14%	17%	29%	49.5	47.2	44.5	42.8	36.6
CalTrans, CA	11%	22%	35%	43%	72%	68.1	59.6	49.9	43.7	21.1
City of South Lake Tahoe, CA	11%	22%	35%	43%	72%	66.6	58.3	48.8	42.7	20.7
Douglas County, NV	11%	22%	35%	43%	72%	9.1	8.0	6.7	5.9	2.9
El Dorado County, CA	11%	22%	34%	42%	72%	33.6	29.4	24.6	21.6	10.6
NDOT, NV	11%	22%	35%	43%	72%	29.3	25.6	21.4	18.8	9.1
Placer County, CA	10%	20%	32%	40%	68%	51.1	45.2	38.4	34.1	18.3
Washoe County, NV	11%	22%	34%	42%	72%	43.6	38.2	32.0	28.1	13.8

[51] Similar tables for total nitrogen and total phosphorus are included in Appendix C.
[52] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.
[53] The third milestone corresponds to the Recommended Strategy. Load reductions associated with the Recommended Strategy (and thus the third milestone) are expected to achieve the Clarity Challenge.
[54] Forested jurisdictions include CTC; USFS; State Lands, Nevada; California and Nevada State Parks; Carson City, Nevada. For the results of each of these individual jurisdictions, see Appendix C.

Approach Comparison

Each of the approaches provides load reductions from the baseline load. Figure 4-6 shows the baseline load and the allowable loads at the third (Clarity Challenge) milestone for each jurisdiction using the five different load reduction approaches. Figure 4-7 shows the percent reduction from the jurisdiction's baseline load to the Clarity Challenge milestone for each jurisdiction using the five different load reduction approaches.

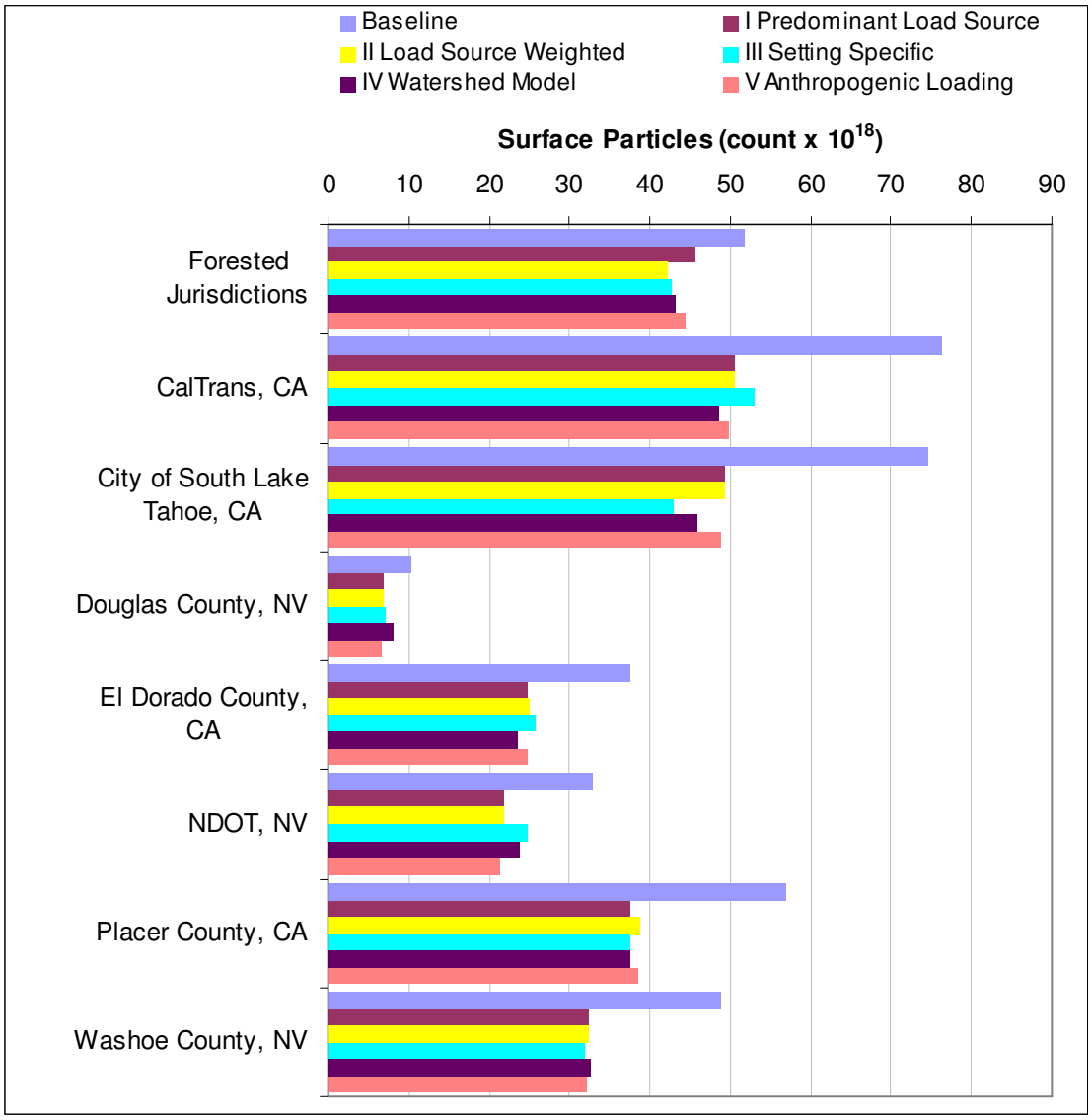

Figure 4-6. Fine sediment particle load by jurisdiction for baseline and at the Clarity Challenge Milestone for five allocation approaches

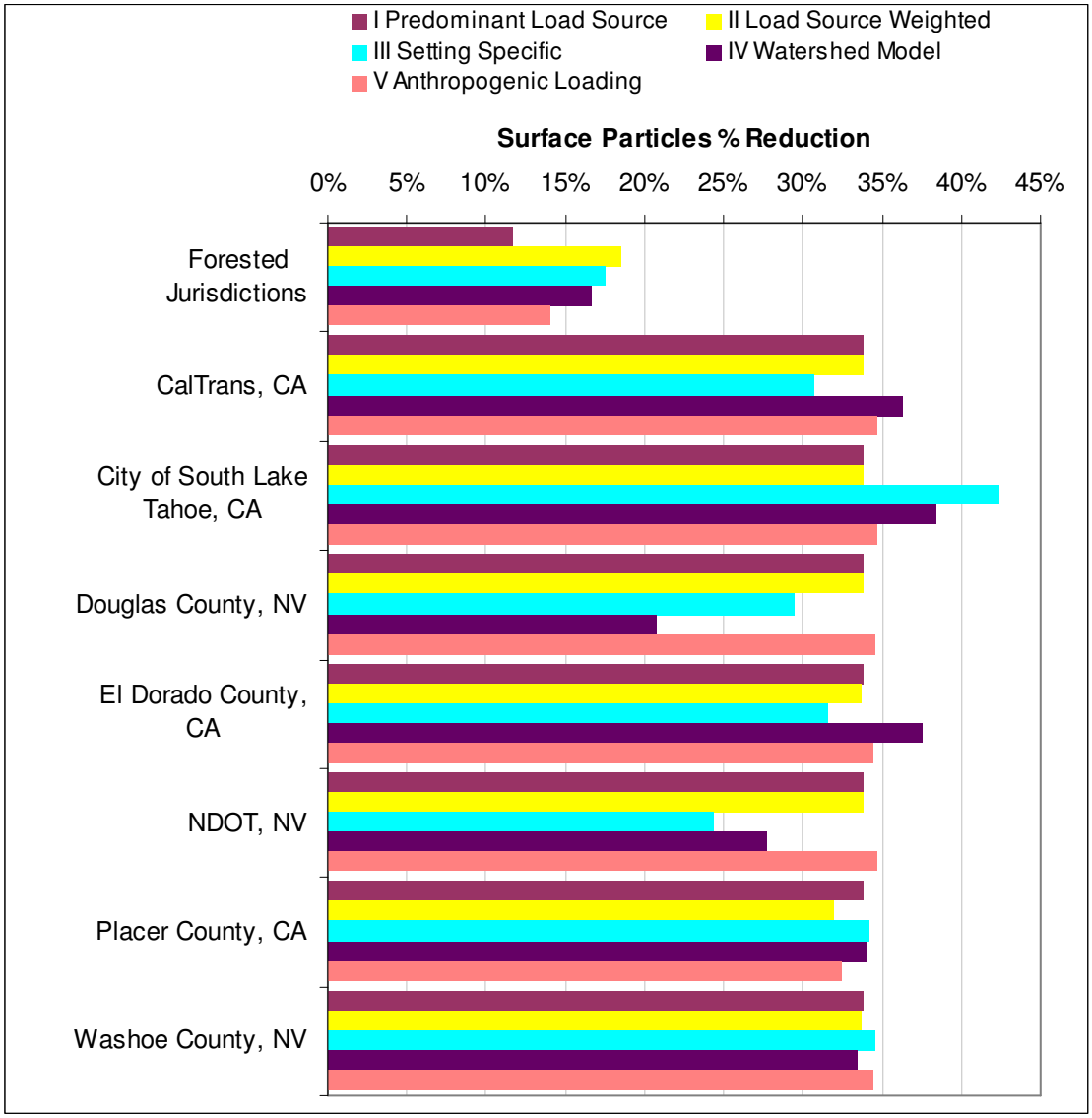

Figure 4-7. Percent reductions of fine sediment particles at the Clarity Challenge Milestone for five allocation approaches

Approach I: Predominant Load Source & Approach II: Load Source Weighted

Approaches I and II provide very similar results for all urban jurisdictions but a notable difference for the forested jurisdictions. This is a result of the dominance of urban loading sources within urban areas, even when a significant proportion of the area is forest uplands. Likewise, the relative strength of urban over forest pollutant loading results in the small proportional urban land area in the forested jurisdictions having a noticeable impact of loading, and associated load reduction, in Approach II.

Approach III: Setting Specific

Approach III takes the analysis a step further in that it differentiates between source category settings. The Recommended Strategy development focused on overall cost and relative contributions from each source category. Within a source category a constrained optimization approach lead to the selection of different levels of application for different settings based on relative cost effectiveness. The influence of cost optimization shows that the load reductions from individual jurisdictions vary as a result of different

proportions of specific settings between jurisdictions. The following discussion illustrates this point using the Recommended Strategy application levels for urban pollutant controls presented in Table 2-1.

Treating dispersed impervious coverage areas on *steep* slopes is estimated to be relatively less cost effective than treating other settings. As a result:

- Only a 30 percent application level of best current practices (Tier 1) is defined for dispersed impervious coverage areas on *steep* slopes. The result is approximately 7 percent load reduction from dispersed impervious coverage areas on steep slopes.
- A 40 percent application level of best current practices (Tier 1) and an additional 40 percent application level of advanced, intensive practices (Tier 2) are defined for dispersed impervious coverage areas on *moderate* slopes. The result is approximately a 43 percent load reduction from dispersed impervious coverage areas on moderate slopes.

Therefore, a county with a low proportion of dispersed impervious coverage areas on *steep* slopes and a high proportion of dispersed impervious coverage areas on *moderate* slopes is expected to reduce more pollutant load than a county with a high proportion of the dispersed impervious coverage areas on *steep* slopes. This influence can be seen by the City of South Lake Tahoe's higher load reduction and Douglas County's lower load reduction from this approach when compared to Approach II.

Approach IV: Watershed Model

Approach IV takes the analysis one step further than Approach III, in that it differentiates watershed response within areas of the same type setting that are located in different parts of the basin. It uses the Recommended Strategy application levels and controls as direct inputs to the watershed model. The Recommended Strategy was developed using Basin-wide average cost effectiveness figures with no distinction made between east and west during the optimization exercise. Because of a West to East rain shadow effect and other physical features, greater loading, load reduction potential and cost effectiveness is found on the western side of the Basin. As a result, had a spatial distinction been made during the optimization exercise, the selected application levels for the Recommended Strategy would have been heavily biased towards controls in California over Nevada.

Approach IV highlights the difference in the opportunities and limitations for load reductions in different jurisdictions depending on their location and land characteristics. Weather patterns, hydrology, and soils can change the effectiveness of pollutant controls. The Watershed Model is necessary to account for all of these effects.

Approach V: Anthropogenic Loading

Approach V uses the same percent reduction from the estimated anthropogenic load to achieve the overall load reduction required. This approach does not differentiate among sources or reduction potential for different locations and land characteristics.

Sensitivity Analysis

It is also useful to quantify the spatial influence of a selected application level among the various pollutant controls. A sensitivity analysis was performed based on using 80% application level for urban areas as the maximum theoretical treatable area. Forest areas were maintained at the application levels specified in the Recommended Strategy. The goal of the analysis was to estimate the effects of treating at 80% application level using the most potent urban Tiers for all locations. This represents a "theoretical maximum" scenario. Using the Watershed Model allows us to assess the performance of this scenario under natural spatial climate and hydrologic variability.

Methods

For this approach, the Watershed Model is configured to simulate the hydrologic and water quality effects of the application of pollutant controls for the different settings and tiers using 80% application level as the maximum theoretical treatable area.

An 80% application level for the most potent urban Tiers was used for all settings. The Watershed Model results provide pollutant loads by subbasin and land use, which are then summed to jurisdictions similarly to the method described in Section 4.1 for distributing baseline loads.

Results

The results of the sensitivity analysis compared with the 5 allocation approaches are presented in Table 4-18. The analysis shows that even when the same application level is applied uniformly around the Basin, the model shows spatial variability in the potential for load reduction. Spatially variable influences of climate and hydrology around the watershed may be significant to consider in definition of load allocations.

State Comparison

Another interesting observation is the difference in overall percent reduction for the urban jurisdictions in California and Nevada.

Table 4-19 shows the total loads and percent reductions in three groups: urban jurisdictions in California, urban jurisdictions in Nevada and forested jurisdictions. For approach II, urban jurisdictions in the state of California receive a 33% reduction, while the urban jurisdictions in Nevada receive 34%. The reductions for the urban jurisdictions in California increase for Approach III, while they decrease in Nevada. Furthermore, the percent reductions for Approach IV show a greater difference between states by increasing to 37% reduction in California while remaining at 30% in Nevada.

Table 4-18. Sensitivity Analysis for Fine Sediment Particle Allowable Loads and Jurisdictional Percent Reductions From Baseline Load at the Third Milestone for All Five Allocation Approaches

Jurisdiction	% Reduction from jurisdiction baseline[55]						Allowable load (particles x10^{18})						
	I	II	III	IV	V	80% Max. LOA[56]	Baseline	I	II	III	IV	V	80% Max. LOA
Forested Jurisdictions[57]	12%	18%	18%	17%	14%	**24%**	51.7	45.7	42.2	42.7	43.1	44.5	**39.4**
CalTrans, CA	34%	34%	31%	36%	35%	**83%**	76.4	50.5	50.5	52.9	48.6	49.9	**13.0**
City of South Lake Tahoe, CA	34%	34%	42%	38%	35%	**66%**	74.6	49.3	49.3	43.0	45.9	48.8	**25.5**
Douglas County, NV	34%	34%	29%	21%	35%	**58%**	10.2	6.7	6.8	7.2	8.1	6.7	**4.3**
El Dorado County, CA	34%	34%	32%	38%	34%	**85%**	37.6	24.9	24.9	25.7	23.5	24.6	**5.7**
NDOT, NV	34%	34%	24%	28%	35%	**80%**	32.8	21.7	21.7	24.8	23.7	21.4	**6.5**
Placer County, CA	34%	32%	34%	34%	32%	**63%**	56.9	37.6	38.7	37.4	37.5	38.4	**20.9**
Washoe County, NV	34%	34%	35%	33%	34%	**66%**	48.8	32.3	32.4	32.0	32.5	32.0	**16.5**

[55] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.
[56] LOA is an abbreviation for application level.
[57] Forested jurisdictions include CTC; USFS; State Lands, Nevada; California and Nevada State Parks; Carson City, Nevada. For the results of each of these individual jurisdictions, see Appendix C.

Table 4-19. State Comparison of Fine Sediment Particle Allowable Loads and Summarized Jurisdictional Percent Reductions From Baseline Load at Each Milestone for All Five Allocation Approaches

Jurisdiction	% Reduction from jurisdiction baseline[58]						Allowable load (particles x10^{18})						
	I	II	III	IV	V	80% Max. LOA	Baseline	I	II	III	IV	V	80% Max. LOA
Forested Jurisdictions[59]	12%	18%	18%	17%	14%	24%	51.7	45.7	42.2	42.7	43.1	44.5	39.4
Urban Jurisdictions, CA	34%	33%	35%	37%	34%	73%	245.4	162.3	163.5	159.0	155.5	161.7	65.0
Urban Jurisdictions, NV	34%	34%	30%	30%	35%	70%	91.9	60.8	60.9	64.0	64.4	60.2	27.3

[58] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.
[59] Forested jurisdictions include CTC; USFS; State Lands, Nevada; California and Nevada State Parks; Carson City, Nevada. Urban Jurisdictions in California include CalTrans, City of South Lake Tahoe, El Dorado County and Placer County. Urban Jurisdictions in Nevada include Douglas County, NDOT and Washoe County.

4.3. Expressing Allowable Pollutant Loads

Throughout the TMDL analysis and this report, loads have been expressed as annual loads. In the *Final Lake Tahoe TMDL* document, allowable load allocations must be expressed as *daily* loads. This section describes options that EPA recommends for expressing jurisdictional loads in this form.

The EPA document *Options for Expressing Daily Loads in TMDLs* (EPA 2007) recommends guidelines for expressing daily loads in TMDLs from the following assumptions:

1. Methods and information used to develop the daily load should be consistent with the approach used to develop the loading analysis.
2. The analysis should avoid added analytical burden without providing added benefit.
3. The daily load expression should incorporate terms that address acceptable variability in loading under the long-term loading allocation. Because many TMDLs are developed for precipitation driven parameters, one number will often not represent an adequate daily load value. Rather, a range of values might need to be presented to account for allowable differences in loading due to seasonal or flow-related conditions (e.g., daily maximum and daily median).
4. The specific application (e.g., data used, values selected) should be based on knowledge and consideration of site-specific characteristics and priorities.
5. The TMDL analysis on which the daily load expression is based fully meets the EPA requirements for approval, is appropriate for the specific pollutant and waterbody type, and results in attainment of water quality criteria.

When making the decision of how to express allowable loads as daily loads, the practitioner should maintain consistency with assumptions from the non-daily TMDL analysis and consider (1) pollutant source types, (2) critical loading conditions, (3) pollutant source behavior, and (4) waterbody type. Tables 4-20 to 4-23(taken from EPA 2007) show recommended options for daily load expressions based on these considerations and highlight the most appropriate option for the Lake Tahoe TMDL. The three daily load expression options described in the tables include the following:

- **Static** – one load applicable to all times and flow conditions
- **Flow range variable** – defining acceptable loads related to corresponding flows
- **Temporally variable** – defining acceptable loads for different seasons or critical periods during the year

Table 4-20. Target Option and Pollutant Source Type Considerations

Pollutant source types	Daily load expression option		
	Static	Flow range variable	Temporally variable
Point source-dominated ▪ Water quality problems often related to discharge that overwhelms receiving stream's dilution capacity ▪ Critical conditions generally occur during low flows	**High**—Could be appropriate for steady state analysis TMDLs or when dynamic modeling output is used in conjunction with the TSD approach for identifying the maximum daily load (e.g., nutrient loads from a wastewater treatment plant)	**Medium**—Consider when discharges are related to precipitation and critical conditions occur at a particular flow range (e.g., municipal separate storm sewer systems [MS4s], stormwater, combined sewer overflows [CSOs], surface mines)	**Low**—Might be appropriate if discharges are seasonal in nature (e.g., power plants, wastewater treatment plants [WWTPs] in a summer vacation area where population increases)
Nonpoint source-dominated ▪ Water quality problems often related to precipitation/runoff events ▪ Critical conditions generally occur during high flows	**Medium**—Could be appropriate to apply TSD approach to long-term average load to develop corresponding maximum daily value. Consider if parameters are relatively constant but from nonpoint sources (e.g., septics, abandoned mine land seeps, sediment oxygen demand, sediment as in-stream source of metals)	**High—**Might be appropriate when problem conditions occur with varying intensity across different flow ranges (e.g., streambank erosion)	**Medium**—Could be appropriate when sources are seasonal in nature (e.g., agricultural, summer season campground package plants)
Mixed point source and nonpoint source ▪ Water quality problems associated with precipitation/runoff events (nonpoint source) and dry-weather point source discharges ▪ Different sources impact stream at different flow ranges	**Medium**—Could be appropriate to apply TSD approach to long-term average load to develop corresponding maximum daily value	**High**—Could be appropriate for problem conditions that occur with varying intensity across different flow ranges	**Medium**—Could be appropriate when sources are seasonal in nature (e.g., agricultural, summer season campground package plants)

Source: EPA 2007.

Lake Tahoe is nonpoint source-dominated. The highest recommended option for the daily expression of the TMDL is the flow range variable. Temporally variable expressions could also be used, given the seasonal pattern of flows and loadings.

Table 4-21. Target Option and Critical Condition Considerations

Critical condition	Daily load expression option		
	Static	Flow range variable	Temporally variable
Low flow	**High**—Consider when steady-state analysis was used for non-daily TMDL; point source dominated with little nonpoint source influence; critical conditions occur at multiple flow ranges	**Low**	**Medium**—Consider when problem conditions occur seasonally (e.g., nuisance algal growth in-stream due to summer low flows, slow flow rate, lack of shading)
High flow	**Low**	**High—**Consider when critical conditions are associated with precipitation/runoff events and sources include multiple source types	**Medium**—Consider when critical conditions are associated with precipitation/runoff events and occur seasonally
Seasonal	**Low**	**Low**	**High**—Consider when critical conditions are driven by seasonal factors (e.g., seasonal water quality criteria)

Source: EPA 2007.

Lake Tahoe's critical condition is high flow. The highest recommended option for the daily expression of the TMDL is the flow range variable. Temporally variable expressions could also be used, given the seasonal pattern of flows and loadings.

Table 4-22. Target Option and Source Behavior Considerations

Source behavior	Daily load expression option		
	Static	Flow range variable	Temporally variable
Seasonal (e.g., agricultural nonpoint loading)	**Low**	**Medium**—Might be appropriate if seasonal source is also associated with specific flow regimes	**High—**Could be appropriate when seasonal sources dominate the waterbody response
Constant (e.g., atmospheric mercury)	**High**—May be appropriate to consider when source is fairly constant in nature or when the TMDL approach assumes a constant loading rate	**Medium**—Might be appropriate if impact of constant source is more critical during certain flow regimes (e.g., low flows) than others	**Low**
Precipitation driven	**Medium**—Might be appropriate to apply the TSD approach to develop single maximum associated with long-term average derived by dynamic or general watershed model	**High—**Might be appropriate when major sources are precipitation driven	**Medium**—Consider using if seasonal considerations are significant

Source: EPA 2007.

Lake Tahoe is both seasonal and precipitation driven. The highest recommended options for the daily expression of the TMDLs are the temporally variable and the flow range variable.

Table 4-23. Target Options and Waterbody Considerations

Waterbody type	Daily load expression option		
	Static	Flow range variable	Temporally variable
Lake/Impoundment	**Medium**—Consider when major sources are point sources or with dynamic model output and the TSD approach	**High—Consider when loads are driven by surface washoff in the watershed**	**Medium**—Consider for situations where long-term and seasonal control of nutrients/sediment is important for meeting lake targets
Free-flowing river/stream	**Medium**—Consider for point sources; dynamic model output/TSD	**High**—Consider when loads are driven by surface washoff in the watershed.	**Medium**—Consider when major sources are seasonal in nature or if critical conditions occur seasonally
Tidal/estuarine	**Medium**	**Medium**—Consider when loads are driven by surface washoff in the watershed	**High**—Consider when major sources are seasonal in nature or if critical conditions occur seasonally

Source: EPA 2007.

Finally, the highest recommended option for the daily expression of the TMDL for lakes is the flow range variable.

Following the guidelines, it is apparent that the most appropriate daily load expression for the Lake Tahoe TMDL is the flow range variable. The temporally variable option is also appropriate. The Watershed Model analysis already provides daily output of simulated daily loads, supplying the needed daily data set.

To establish the dependency of the daily loading on flow and seasons, the daily load expression for Lake Tahoe's TMDL can be established with flow-variable targets. Modeled daily loads can be arranged with increasing flows, and grouped in percentiles of flow. In the figures presented here, the flows are arranged into 10-percentile increments, and the min, max and average loads for those percentile ranges shown. In addition, the same exercise is performed grouping the flows and loads by month of the year, instead of percentile of flow, to show the seasonal variability of the daily loads.

Flow-Associated Assessment

Lake Tahoe Baseline
Flow: Sum of Inputs to Lake Tahoe (L/s)
Pollutant: Particles
Data from: 1/1/1990 to 12/31/2004

Flow Range	Associated Flow			Conc. (count/L)		Load (count/day)	
Percentile	Mean	Min	Max	Mean	Max	Mean	Max
0-10	1,375	1,013	1,587	1.1E+08	9.4E+08	1.4E+16	1.1E+17
10-20	1,754	1,587	1,936	1.6E+08	1.2E+09	2.4E+16	1.8E+17
20-30	2,195	1,937	2,504	3.2E+08	1.6E+09	6.0E+16	3.1E+17
30-40	2,842	2,505	3,240	4.6E+08	2.1E+09	1.1E+17	5.1E+17
40-50	3,848	3,243	4,593	5.8E+08	3.2E+09	1.9E+17	1.1E+18
50-60	5,546	4,594	6,706	7.4E+08	3.2E+09	3.6E+17	1.5E+18
60-70	8,642	6,707	10,977	8.9E+08	5.7E+09	6.7E+17	4.3E+18
70-80	14,274	10,999	18,158	9.2E+08	3.5E+09	1.1E+18	4.4E+18
80-90	24,386	18,160	34,477	9.3E+08	3.3E+09	2.0E+18	7.0E+18
90-100	60,450	34,613	167,090	1.1E+09	4.5E+09	6.0E+18	2.3E+19

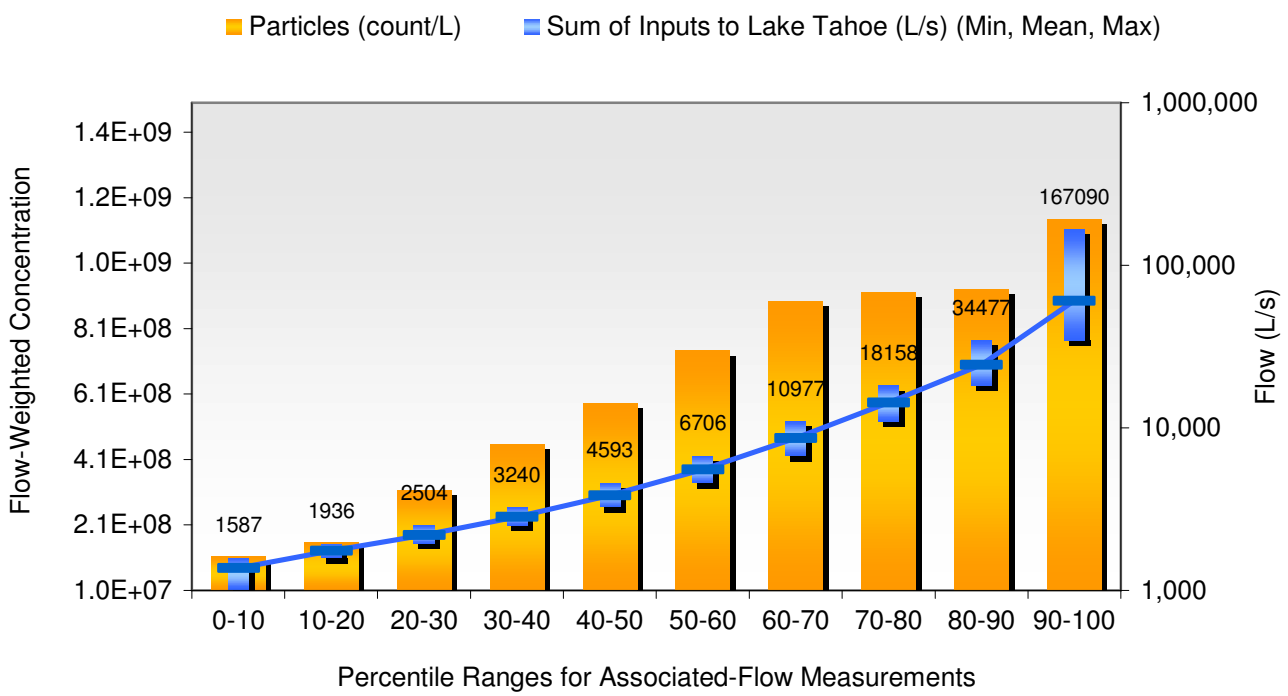

Figure 4-8. Analysis of daily maximum and average particle loads (displayed as flow-weighted concentrations) for baseline conditions.

Seasonal Assessment

Lake Tahoe Baseline
Flow: Sum of Inputs to Lake Tahoe (L/s)
Pollutant: Particles
Data from: 1/1/1990 to 12/31/2004

Time Period	Associated Flow			Conc. (count/L)		Load (count/day)	
Month	Mean	Min	Max	Mean	Max	Mean	Max
Jan	7,433	1,165	351,220	1.4E+09	3.8E+09	8.9E+17	2.4E+18
Feb	8,488	1,202	111,944	1.1E+09	3.6E+09	8.1E+17	2.6E+18
Mar	17,566	3,252	160,296	1.2E+09	5.7E+09	1.8E+18	8.7E+18
Apr	28,637	7,044	113,921	9.9E+08	3.1E+09	2.4E+18	7.6E+18
May	37,196	3,590	167,090	9.9E+08	2.7E+09	3.2E+18	8.7E+18
Jun	26,726	2,701	164,164	9.0E+08	2.1E+09	2.1E+18	4.7E+18
Jul	9,229	1,825	72,088	5.4E+08	1.3E+09	4.3E+17	1.0E+18
Aug	3,241	1,407	12,789	1.8E+08	2.4E+09	5.1E+16	6.6E+17
Sep	2,165	1,213	14,509	2.5E+08	2.2E+09	4.7E+16	4.1E+17
Oct	2,117	1,117	16,401	5.7E+08	3.5E+09	1.1E+17	6.4E+17
Nov	3,383	1,064	76,312	1.3E+09	3.4E+09	3.7E+17	9.9E+17
Dec	4,829	1,013	137,458	1.4E+09	4.1E+09	5.9E+17	1.7E+18

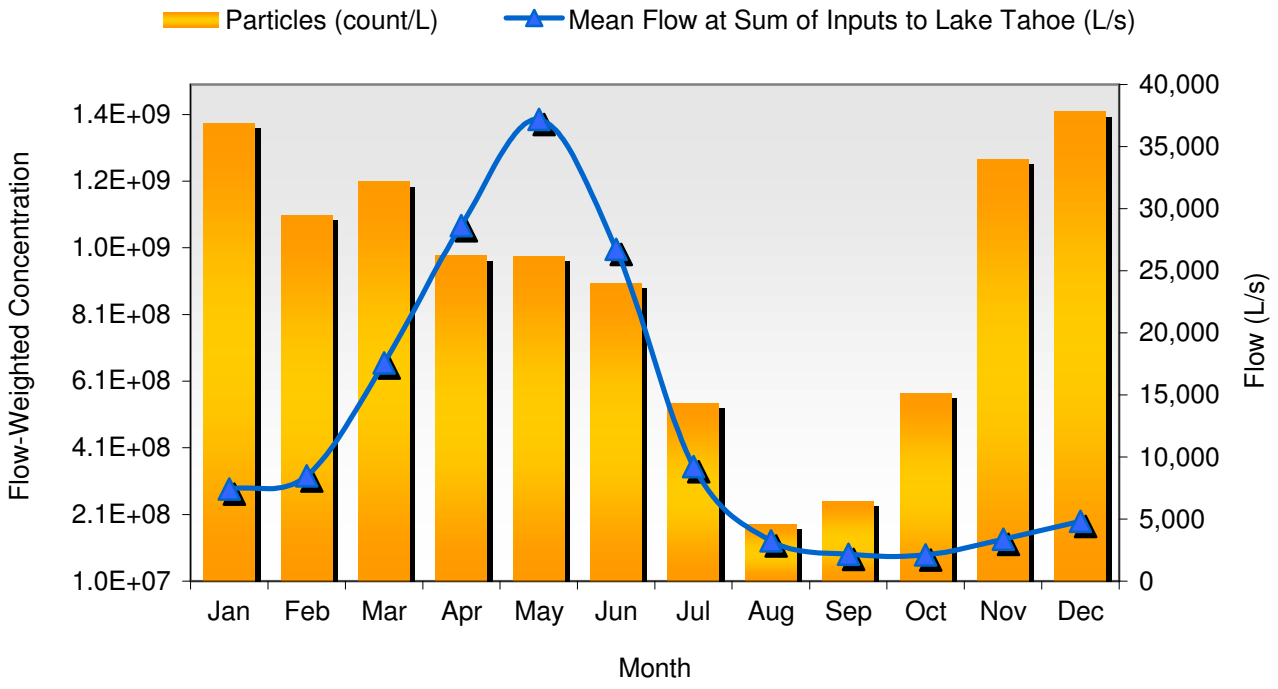

Figure 4-9. Analysis of daily maximum and average particle loads (displayed as flow-weighted concentrations) for baseline conditions.

Glossary

Advanced treatments (Tier 2). A forested source category treatment tier that includes pollutant controls designed to achieve restoration close to natural conditions over time. These include Standard BMP Treatments as well as revegetation, sediment capture BMPs, trail restoration, and the like.

Advanced, Intensive Practices (Tier 2). An urban treatment tier that includes wetland and passive filtration basins, media filters in stormwater vaults, deicing compounds or advanced abrasive (sand) recovery, intensive maintenance of stormwater infrastructure, 100 percent completion of private property BMPs. This treatment tier was named Tier 2 in the PRO Report v2.0.

Analytic Confidence. Numeric confidence ratings provided by each source category group for each of their treatment tiers. These ratings were based on guidance criteria provided by the TMDL team and used a 1 to 5 scale. These ratings were used in an analysis of high-confidence controls.

Application Level. The portion of the potential opportunities that a treatment tier is applied to; expressed as a percent. For instance, a 75 percent application level of a particular urban treatment tier would mean that three-quarters of the Tahoe Basin's urban areas would be treated with that group of pollutant controls and one- quarter would remain untreated. The treatment tiers can be applied at various application levels to several different *Settings* that are representative land uses based on Basin-wide physical characteristics.

Bank Protection. A treatment tier from the stream source category that established one end of a spectrum of potential treatments. This treatment tier represents stream restoration that retains the original course of the stream but reduces bank failure through channel armoring and bank slope reduction.

Base Package. Pollutant controls and application levels of the integrated packages that represent current multi-objective management strategies and are consistent across all the integrated strategies. Only the stream channel and forest upland source categories included base packages.

Basin. An abbreviation of Lake Tahoe Basin. This concept includes Lake Tahoe's watershed and airshed.

Best Current Practice (Tier 1). A treatment tier established for the urban source category that includes a set of techniques or pollutant controls that have been applied to areas of Lake Tahoe in recent, high-quality restoration projects. Pollutant controls include detention and retention basins, stormwater vaults, road shoulder stabilization, vacuum sweeping on heavily sanded roads, limited impervious coverage removal and 50 percent completion of private property best management practices (BMPs).

Best Solutions. The solutions found using PAT that achieve the highest quality of cost and pollutant reduction.

Capital Costs. Capital costs provided for pollutant controls include all implementation costs such as planning, design, acquisition and replacement costs when the useful life of the controls is shorter than 20 years.

Clarity Challenge. A water quality milestone established by the Lahontan Water Board and NDEP to focus planning efforts on achieving a meaningful load reduction that is projected to result in a measurable

improvement of lake clarity. The Clarity Challenge is proposed as a Basin-wide 32 percent fine sediment (of less than 20 microns in diameter) load reduction and is expected to result in 77 to 80 feet of clarity.

Cost-effectiveness. A treatment tier's cost divided by the mass of emissions reduced (most typically expressed in terms of *dollars per ton* or *dollars per particle*).

Final Lake Tahoe TMDL. The legal document required by the Clean Water Act that is produced by the Lake Tahoe TMDL for the EPA and state government approval. This document will contain the required TMDL elements including allowable load allocations. The Final Lake Tahoe TMDL will be peer reviewed.

High Intensity (Tier 3). A group of the highest level of atmospheric pollutant controls. This treatment tier includes vacuum sweeping, unpaved road treatments, dust suppressants on construction areas and wood burning controls. These controls are applied more intensively and pollutant load reduction effectiveness is higher than increased intensity controls. This treatment tier was called Tier 3 in the PRO Report v2.0.

Innovative Technology (Tier 3). An urban treatment tier that includes active pumping and filtration systems for stormwater applied to urban areas with concentrated impervious coverage (such as *downtown* areas) and Advanced, Intensive Practices (Tier 2) pollutant controls applied to urban areas with dispersed impervious coverage (such as many residential areas).

Integrated packages. Thematically generated packages of pollutant controls and associated application levels from all four source categories. Each integrated package included Basin-wide estimates of pollutant load reduction and cost. Three integrated packages were initially created and then adjusted based on stakeholder comment to become three scenarios. One of the scenarios formed the basis for the Recommended Strategy.

Urban and atmospheric components of the integrated packages were adjusted significantly according to the theme of the package. Forest and stream channel source contributions did not vary across the three integrated packages that were presented.

Integrated Water Quality Management Strategy (Integrated Strategy). A plan to help stakeholders understand ways in which the necessary TMDL load reductions could be achieved using pollutant controls from all four major pollutant source categories.

Implementation Periods (Periods). The intervals between milestones in which a level of effort (represented by $500 million dollars) is focused on effectively implementing the recommended pollutant controls.

Increased Intensity (Tier 2). This atmospheric treatment tier includes a set of pollutant controls that is generally applied more intensively or extensively than current efforts but less intensively than the high intensity treatment tier. Pollutant controls are similar to high intensity treatment tier and include: vacuum sweeping, unpaved road treatments, dust suppressants on construction areas and wood burning controls.

Milestones. The Lake Tahoe TMDL must establish *milestones* along the path toward achieving the Clarity Challenge and, eventually, the Lake Tahoe TMDL's overarching numeric target for Secchi depth. The milestones may be used to guide allocations and permitting decisions as the Lake Tahoe TMDL moves forward. The Recommended Strategy's pollutant controls and application levels establish the third milestone. A pollutant reduction, cost and lake clarity result have been estimated for each milestone.

Mixed Approach (Tier 2). A stream source category treatment tier that includes unconstrained restoration where possible and simple bank protection on constrained stream reaches. This treatment tier best represents the current and planned future projects under consideration in the Tahoe Basin. The mixed approach was used to formulate the Recommended Strategy and all integrated packages.

Moderate to highly disturbed. Forested areas that have compacted soils, minimal vegetation and poor soil hydrology.

Operating and Maintenance Costs (O&M). Expenses associated with personnel, materials, consumables, equipment repair and other types of continuing expenses that would allow a pollutant controls to maintain load reductions as estimated.

Packaging and Analysis Tool (PAT). A spreadsheet model used to application pollutant controls to specific settings, and calculate resulting load reductions and costs. The PAT was built using Visual Basic for Applications (VBA) on a Microsoft Excel platform. It incorporates a scatter search version of a genetic algorithm to find *best solutions* subject to user-defined constraints. The PAT was used to explore the most efficient ways that a given budget could be invested in pollution control.

Pollutant Control. A general term to describe the physical and nonphysical methods that can reduce pollutant loads to Lake Tahoe. Examples could include residential BMPs, a commuter shuttle system or a fertilizer education program.

PRO Report. The *Lake Tahoe TMDL Pollutant Reduction Opportunity Report v2.0* that provides the underlying analysis of the cost and pollutant loading effects of pollutant controls. The results in the PRO Report v2.0 were produced by groups of experts called source category groups.

Recommended Strategy. The Recommended Strategy incorporates the best available science and extensive stakeholder input to describe a Basin-wide, non-prescriptive strategy to inform the TMDL load allocations and implementation plans. The Recommended Strategy is intended to guide implementing agencies in their efforts to achieve necessary load reductions. The Recommended Strategy does not directly translate to recommendations for project-scale application, and implementing agencies are not required to implement the specific pollutant controls contained within the Recommended Strategy.

Restored. Defined in the Forest Source Category Group as treatment to an area that eventually will replicate natural conditions. This not only achieves load reductions, it achieves other ecosystem objectives.

Scenario. A thematically generated set of pollutant controls and associated application levels from all four source categories. Each scenario included Basin-wide estimates of pollutant load reduction and cost. Three scenarios were created from stakeholder input and the Packaging Analysis Tool analysis of the integrated packages. One of the scenarios formed the basis for the Recommended Strategy.

Urban and atmospheric components of the scenarios were adjusted significantly according to the theme of the package. Forest and stream channel source contributions did not vary across the three scenarios that were presented.

Scenario B. A set of pollutant controls and associated application levels from all four source categories based on the theme "Focus on Innovation & Advanced Practices." This scenario focuses on developing and implementing innovative practices such as conveying and treating stormwater with mechanical or chemical systems and high intensity atmospheric treatments such as weekly vacuum sweeping of roadways. This scenario is estimated to meet the Clarity Challenge and require capital investment of $1.5

billion. The Recommended Strategy evolved from Scenario B but the two are substantially different and these terms should not be used interchangeably.

Setting. Representative areas of the Lake Tahoe Basin that could include similar physical characteristics, pollution controls applicability or loading effects. In general, settings strongly influence the planning, design and construction of pollutant controls in the Lake Tahoe Basin.

Source Category Groups (SCGs). Groups of technical experts that screened pollutant controls and then provided estimates of potential load reductions and costs for the selected pollutant controls. These estimates are the building blocks of the Recommended Strategy.

Source Category. A set of sources that provide a significant portion of the pollutant loads to Lake Tahoe. The Lake Tahoe TMDL has established five source categories including urban uplands, forested uplands, atmospheric deposition, stream channel erosion and groundwater.

Standard BMP Treatments. A forest treatment tier that includes pollutant controls planned by federal and state land management agencies for their roads, trails and fuels reduction projects. Examples of these controls include waterbars, culverts, road grading, hydroseeding and planting.

Stream. As used in this study, it refers to the mainstem channel of tributary watersheds to Lake Tahoe.

Technical Report. The *Draft Lake Tahoe Total Maximum Daily Load Technical Report* that provides details of the scientific research underlying the Lake Tahoe TMDL. See Lahontan and NDEP 2007a for full citation.

TMDL Team. The TMDL agency staff and supporting consultants from private companies and educational institutions who contributed to the Lake Tahoe TMDL. TMDL team contributions to development of the Recommended Strategy included analysis, discussion, design, evaluation and decisionmaking regarding options and strategies throughout the process.

Transportable Fraction (TF). Fraction of a source's mass emissions that remain airborne and available for transport away from the source after localized removal has occurred.

Treatment Tier. A group of pollutant controls that can be applied to each setting and demonstrate the broad spectrum of potential load reduction effectiveness and effort possible. Pollutant reductions and costs were estimated for each combination of treatment tier and setting. Application level refers to the portion of the potential Basin-wide area on which treatment tiers are applied.

Typical Tahoe forested. Forested areas that have healthy vegetation and/of thick layers of duff. These areas have good soil hydrology and appear undisturbed to most observers.

Unconstrained Restoration. A stream treatment tier that includes treatments to modify planform, increase length and sinuosity, connect floodplains and decrease slope such that a restored condition is eventually reached. These treatments are designed to achieve load reductions as well as other ecosystem objectives such as riparian habitat enhancement, flood control and recreation value. Load reduction and cost estimates for these treatments assumed ideal construction access and project sequencing.

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Appendix Contents

Appendix A:

Packaging and Assessment Tool Description

Appendix B: Information Supporting Discussion of the Development of the Recommended Water Quality Management Strategy

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- Source Category Groups
- TMDL Team

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Tables Supporting Chapter 2 and 3

Tables and Figures Supporting Chapter 4

Appendix A: Packaging and Assessment Tool

Overview and Description

With more than $1 billion in funding from the federal government pouring in to the watershed to improve the Lake Tahoe environment, a premium had been placed on developing a suite of state-of-the-science analysis to quantify loads and pollutant sources, assess management activities, and identify and develop innovative management solutions. To facilitate this process, the Lahontan Water Quality Control Board and the Nevada Department of Environmental Protection identified and assembled regional experts into four Source Category Groups (SCGs) to investigate potential Pollutant Control Opportunities for each major source of pollutants entering Lake Tahoe. They were (1) Urban Uplands and Groundwater, (2) Forest Uplands, (3) Atmospheric Deposition, and (4) Stream Channel Erosion SCGs.

Each SCG identified three or four physical settings that represented typical features governing the selection and implementation of specific PCOs, and influencing pollutant fate and transport to the lake. An example of an Urban Upland setting is a concentrated-impervious-steep subbasin, whereas an Atmospheric Deposition setting is a concentric perimeter of uniform distance to the Lake. Each SCG also defined two or three tiers representing different combinations of PCOs, and estimated annualized load reductions from applying each tier to each setting. Table A1 below describes the settings and tiers for each SCG, as established for the IWQMS project.

Table A1. Description of IWQMS Settings and Tiers by Source Category Group

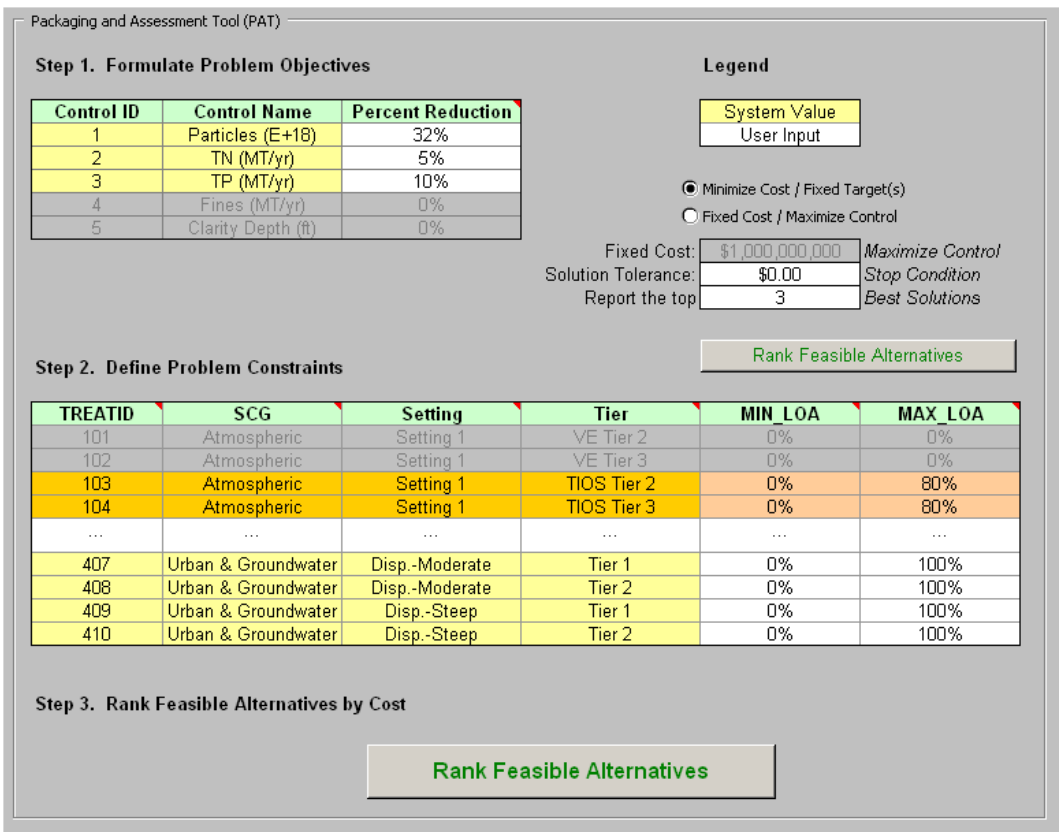
Atmospheric Deposition	
Settings	Four spatially based settings, measured by concentric rings of distance from the lake
Tiers	Four tiers per setting were applied, based on two different treatment levels from two different groups of pollutant sources. The first group was vehicle emisions, and the second group included transportation infrastructure or structural controls
Forest Uplands	
Settings	Three source based settings, including (A) unpaved roads, (B) highly erodible forest and recreational areas, (C) burned, plus harvested, plus relatively undisturbed forest areas
Tiers	Three tiers per setting with increasing degree of treatment: low, medium, and high
Stream Channel	
Settings	Three treatable segments along the top three most sediment-productive streams in the Basin: (1) Blackwood Ck, (2) Upper Truckee, and (3) Ward Creek
Tiers	Three levels of treatment with varying intensities and stabilization activities
Urban Upland	
Settings	Four settings based on the different combinations of slope (moderate or steep) and impervious configuration (concentrated or dispersed).
Tiers	Two tiers of differing intensity and sophistication of treatment activities, plus a third "Pump and Treat" stormwater tier for concentrated impervious areas only

For each tier of controls, associated capital, maintenance, and life-cycle costs were researched, compiled, and normalized for cross-comparison. Cost constraints were not imposed on any tier during the selection of PCOs at this stage in the process. A database of cost and Level of Adoption (LOA) was derived by scaling between the existing baseline loading budget (0 percent LOA) and the maximum load reduction estimated from applying each tier to all areas within applicable settings (100 percent LOA). Different LOA combinations result in different marginal costs for pollutant load reductions.

Faced with such a large search domain of potential alternatives with multiple control objectives and potentially non-linear cost-benefit relationships, a meta-heuristic optimization technique was applied to evaluate the costs-benefits and selection trade-offs among basin-wide pollutant sources. This technique was applied in a Microsoft Excel environment, and was called the Packaging and Assessment Tool (PAT). Output from the various SCG models, methods, and techniques were compiled and applied within PAT to assess and prioritize a wide range of management options, and evaluate potential economic benefits from water quality trading. This methodology was the platform upon which the recommended strategy was derived. The following sections will highlight (1) problem formulation using PAT, (2) describe the underlying computational algorithm, and (3) conclude with a discussion of uncertainty associated with PAT predicted results.

Problem Formulation using PAT

Problem formulation using PAT follows a three step process, as illustrated in Figure A1 below.



Control ID	Control Name	Percent Reduction
1	Particles (E+18)	32%
2	TN (MT/yr)	5%
3	TP (MT/yr)	10%
4	Fines (MT/yr)	0%
5	Clarity Depth (ft)	0%

TREATID	SCG	Setting	Tier	MIN_LOA	MAX_LOA
101	Atmospheric	Setting 1	VE Tier 2	0%	0%
102	Atmospheric	Setting 1	VE Tier 3	0%	0%
103	Atmospheric	Setting 1	TIOS Tier 2	0%	80%
104	Atmospheric	Setting 1	TIOS Tier 3	0%	80%
...	...	...	...	...	...
407	Urban & Groundwater	Disp.-Moderate	Tier 1	0%	100%
408	Urban & Groundwater	Disp.-Moderate	Tier 2	0%	100%
409	Urban & Groundwater	Disp.-Steep	Tier 1	0%	100%
410	Urban & Groundwater	Disp.-Steep	Tier 2	0%	100%

Figure A1. PAT user interface showing the three steps associated with problem formulation

Step 1 – Formulation Problem Objectives

The first step is to formulate the problem objectives. An optimization problem can be formulated to either (1) minimize costs to achieve a set of fixed pollutant targets, or (2) maximize potential reduction of pollutants, given a fixed cost. Since three pollutants (fine sediment, nitrogen, and phosphorus) were all thought to be potentially subjected to management controls, the technique was designed to accommodate

multiple pollutant control objectives. For example, the problem could be framed such that an optimum solution must simultaneously meet prescribed fine sediment, nitrogen, and phosphorus targets. Figure A1 shows simultaneous control targets for Particles, TN, and TP (32 percent, 5 percent, and 10 percent, respectively) for the minimize cost for a fixed target option. If the maximize benefit for a fixed cost option is selected, the interpretation of the control targets shifts from percent reduction to control priority (a rank from 0, meaning not controlled, to 10 meaning maximum control at any cost). The other user entries under step 1 include the stop tolerance (which was always set to zero for PAT operation), and the number of best solutions to display. Stop tolerance will be further explained with the description of the underlying algorithm.

Step 2 – Define Problem Constraints

The second step in the process is where problem constraints are introduced into the formulation. Each SCG-Setting-Tier combination represents a controllable entry. Constraints can be placed on each of these entries by adjusting either the minimum or maximum LOA, or both. The number of entries in Figure A1 has been condensed for illustrative purposes. In the Figure A1 example, Atmospheric-Setting 1-VE Tiers 2 and 3 have are not considered in the formulation because the maximum LOA is set to zero. The Atmospheric Transportation Infrastructure or Structural (TIOS) tiers have a maximum LOA of 80 percent, while the Urban and groundwater tiers are not unconstrained (0 percent-100 percent). These constraints are for illustrative purposes only. Rationale and assumptions for some of the actual problem formulations are listed in the Assumptions and Rationale section.

Step 3 – Rank Feasible Alternatives by Cost

Once problem formulation is completed, pressing the "Rank Feasible Alternatives" button launches the optimization process. A progress bar is displayed while the optimizer iterates through the search domain to find a set of optimum solutions. Once the search process is completed, the results are summarized in a series of tables in subsequent tabs, as described below:

BestLoad – In addition to the baseline pollutant load budget, this table presents the pollutant load budgets associated with each of the best solutions in by SCG and setting. Cost information (20-year capital, annual operations and maintenance, and 20-year total) are also summarized and presented with the load budget

BestLOA – Each solution has LOA selections for all SCG-setting-tier combinations. This table presents the selected LOA levels for each of the best solutions

BestTiers – This report presents the load reductions associated with each SCG and tier combination. The results are aggregated for all settings within the SCG and rolled up by tier. In addition to the cost and pollutant reduction information, a weighted aggregate LOA is shown for each SCG and tier combination for each solution, to highlight which tier strategies were preferred during optimization.

SettingsTiers – This report includes the most detailed breakdown of the optimization results. It presents the selected LOA for each SCG-setting-tier combination, the associated load reductions, associated cost information, and a SCG rollup summary.

Handout – Similar to the SettingTiers report, the Handout presents the load reductions as a percentage relative to the original untreated pollutant load budget. Another computed data point included in this report is a cost effectiveness estimate computed as an annual total cost per percent particles removed. Cost effectiveness is a normalized quantity for comparing performance between SCG-setting-tier controls.

Description of the Underlying Algorithm

Scatter search is meta-heuristic search technique that has been explored and used in optimizing complex systems (Glover et al. 2000). Scatter search has some commonalties with traditional Genetic Algorithms (GAs); however, there are also a number of quite distinct features. Both scatter search and GAs are *population-based* approaches which search for best solutions by combining existing elements. An individual in the population is one combination of decision variables (LOA) that all fall within the defined constraints. A population is a group of individuals. The objective of both GA and scatter search is to search among the characteristics (LOA) of individuals in the population to find which ones result in the highest quality. Quality is measured as a computed byproduct of cost and percent reduction. If the objective of the problem is to maximize pollutant reduction and minimize cost, populations and individuals in the population which best achieve this objective are considered of better quality.

GA approaches are predicated on the idea of choosing parents (individuals) randomly to produce offspring (other individuals with slightly different characteristics or LOAs), and further on introducing randomization to determine which characteristics (LOA) of the parents should be combined. By contrast, the scatter search approach does not emphasize randomization because it is indifferent to choices among alternatives. Instead, the approach incorporates strategic responses, both deterministic and probabilistic, that take into account the evaluation history. Scatter search focuses on generating relevant outcomes without losing the ability to produce diverse solutions (Laguna and Marti, 2002). In other words, it initially searches across a wide spectrum of populations with the objective function in mind, and uses the evaluation history to hone in on elements in the population which exhibit the highest quality. The *scatter* process helps to reduce the likelihood of finding a local best solution that is not the true best solution. Because of this feature of scatter search, it can find the near-optimal solution in a more efficient way, and serve as a better optimization engine for the type of goal-seeking required for the underlying PAT dataset. The scatter search procedural adaptations that were applied in PAT were developed by Zhen (2002), and have been tested and applied for solving a variety of optimization formulations (Zhen and Yu, 2002, 2004; Riverson et al., 2004; Lai et al., 2006, Lai et al., 2008). The implementation of scatter search processes generally follows the four step approach outlined below:

1. Generate a starting set of diverse points (individuals in a population)

This is accomplished by initially dividing the range of each decision variable (LOA range) into four sub-ranges of equal size. Then, a solution is constructed in two steps. First, a sub-range is randomly selected, and second, a value is randomly chosen from within the selected sub-range. The starting set of solution points also includes all variables at their lower bound (minimum LOA), all variables at their upper bound (maximum LOA), all variables at their midpoints, and any other solution points or constraints imposed by the user. This represents the widest possible search domain, and sets the stage for further refinement of the search.

2. Choosing a subset of diverse points (individuals) as a reference set (population)

A reference set (reference population) is group of individuals with diverse characteristics (LOA). An individual's characteristics all fall within the user-specified set of constraints; however, the algorithm tries to make the characteristics as diverse as possible. With each successive iteration, a new population is created and compared against the reference set. For PAT, the number of individuals in the population is computed as 4 times the number of decision variables (LOA) ranges. So for the initial configuration, the number of LOA ranges was 43, representing all the different combinations of SCG, settings, and tiers;

therefore, the number of individuals in the unconstrained reference set was 43 times 4 or 172. The higher the number, the more diverse the search domain, the greater the likelihood of finding a near optimum solution; however, the sacrifice is an increase in computational intensity. The PAT underlying database was designed to significantly minimize computation time because (1) LOA increases in 10 percent intervals, and (2) all associated pollutant reductions were pre-computed as rating curve elements in the underlying database; therefore, a set of 172 reference set individual solutions was not computationally prohibitive.

A designed objective of the search approach is to seek individuals within a reference set with diverse characteristics. This is done to reduce the likelihood that the solution technique blindly converges upon a local best solution and ignores other potentially better solutions. Population "diversity" is measured by the Euclidean distance of individuals within the reference set. Euclidean distance is the straight line distance between two points. With respect to the PAT dataset, two points exist in a multi-dimensional space with as many dimensions as there are decision variables (LOA), which would be in 43-dimensional space. An example of Euclidean distance in a two-dimensional plane with point 1 at (x_1, y_1) and point 2 at (x_2, y_2), it is computed as:

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

3. Generating new points to update the reference set

While searching for the optimum solution, Scatter Search uses a linear combination method to construct new solution points (individuals) from the reference solution points. This combination is based on the three types of formulations, in which x' and x'' are reference solution points, and x_1 through x_3 are the newly generated solution points:

$$x_1 = x' - d$$
$$x_2 = x'' - d$$
$$x_3 = x' + d$$

Where $d = r\dfrac{x'' - x'}{2}$ and r is a random number in the range (0, 1).

The number of solution points created from the linear combination of two reference solution points depends on the quality of the solutions being combined.

In the course of searching for a global optimum, the reference set is continuously updated. The solutions having better quality, while preserving or refining the diversity of the reference set, are chosen as replacements for old points in the reference set. A diversification step is performed to repopulate the reference set. To preserve quality, a small set of the best solutions (or elite set) from the current reference set is used to seed the new reference set. The diversification method is used to repopulate the reference set with solutions that are diverse relative to the elite set. If higher quality elements are found among the new diverse set, they become part of the elite set in successive reference sets. This step continues until no solutions or higher quality are available, or until a user specified stopping criteria is achieved.

4. Stop the search if the stopping criteria are met

The stopping criteria can be defined, as the maximum number of iteration runs, or the minimum improvement between updates of the reference set, or both. If both criteria are specified, then the search will be stopped when either of the criteria is met. In the case of PAT, the minimum improvement was set at zero, so that iterations would stop when absolutely no better solution could be found. After multiple sensitivity runs using the PAT dataset, the maximum number of iterations was empirically computed as:

$$MaxRuns = n^2 \times 4$$

Where n = the number of decision variables.

For the initial PAT configuration, the maximum number of runs was 118,336. While this number seems like a large number, the number of possible solutions for an unconstrained simulation is several orders of magnitude higher. Given 43 decision variables, if all setting-tier and LOA constraints removed, and each decision variable has the option to vary between 0 percent and 100 percent (at 10 percent LOA intervals), there would be 11 possible solutions for each of the 43 variables. The unconstrained number of possible solutions is 11 raised to the 43rd power, or roughly 602,400,691,612,422,000,000,000,000,000,000,000,000,000,000 combinations. The number drops a few orders of magnitude as various combinational constraints are introduced. Nonetheless, it punctuates the potential efficiencies to be gained with the application of meta-heuristic solution techniques like scatter search.

Assumptions and Rationale

There were a few key assumptions that have been made regarding the nature and usage of the underlying database derived from the SCG work products. These assumptions are listed below in bullet form, with associated narrative explanations.

- The SCG products for each setting and tier combination represent maximum application of the associated controls. These controls were quantity based, such that depending on the SCG and setting, controls are expressed in terms of amount of area treated, number of objects controled, or length of segment treated. For this reason, it was both possible and appropriate to scale the LOA for these controls according to the applicable quantity. For each SCG, LOA was scaled linearly from 0 percent (baseline condition with no controls) to 100 percent (maximum application) for a given Tier and setting combination. Pollutant reduction was linearly scaled between baseline loads to reduced loads associated with each setting and tier combination. Associated management costs were scaled from zero cost for the baseline to 100 percent of the cost for full application to a given setting and tier combination.

- The setting is the smallest unit for management, for which there is a fixed manageable quantity. For example, given a specific Urban Upland setting, the fixed manageable quantity is area. Therefore, a 50 percent application level of Tier 1 means that the suite of controls associated with Tier 1 are applied to 50 percent of the total available area. If during the solution search routine, additional controls are found to be required for that specific setting in order to meet the defined objectives, it can be achieved by either (1) increasing the LOA for that particular Tier, (2) applying a different LOA of another Tier (i.e. Tier 2) which has a higher treatment potential, or applying combinations of LOA for more than one Tier (i.e. 50 percent Tier 1, and 20 percent Tier 2, for a total of 70 percent of the total area being treated).

- The maximum LOA for any given setting was assumed to be 80 percent. For practical reasons, it was thought unlikely that any given combination of tiers could be applied so as to treat 100 percent of a given setting. There will always be urban areas which cannot be treated due to restricted access or impracticability, remote forest settings which are naturally erodible and/or are not accessible by conventional means, private property air pollutant sources or vehicle emissions that cannot be managed for various reasons, or stream segments which cannot be easily stabilized and restored.

- There were certain assumptions associated with LOA constraints for the various packages. These include definition of the base package as well as selected minimum/maximum LOA constraints for some of the exploratory packages. These were introduced to limit the selection of some of the more sophisticated, but untested technologies. For example, lets assume that Tier 1 of a given SCG and setting is composed of common conventional practices, while Tier 2 includes some sophisticated and innovative practices. A scenario that focuses on traditional control technologies may restrict the selection of Tier 2 practices, in favor of Tier 1; whereas a scenario that focuses on innovative practices might constrain the selection of Tier 1, and allow more selection of Tier 2 practices. Assumptions associated with scenarios are described in detail in Chapter 3: Development of the Recommended Strategy.

Uncertainty associated with methods and results

All calculations and estimates include uncertainty because of the current limits of scientific understanding. There is uncertainty associated with (1) the data developed in the underlying database, as well as uncertainty associated with (2) the optimization searching processs.

Underlying Database Uncertainty

Since the SCG products all represent the ultimate pollutant delivery to Lake Tahoe associated with the SCG settings and tiers, the predicted confidence of an individual solution can be computed as a weighted average of the confidence associated with the components. A uniform confidence rating convention was developed to help quantify uncertainty associated with the diverse set of SCG products. Each of the SCGs noted uncertainties throughout their analyses and assigned an overall confidence rating to each set of results provided. The assigned confidence values were rated on a one to five scale according to a system designed for the SCG's use. The rating was based on the SCGs own answers to 16 questions about the data sources used, the calculation results and modeling parameters.

SCGs used the following guidance:

A rating of "1" generally indicates:

- Data sources were from a dissimilar area, were unreviewed and not supported by other research
- Calculation results were not similar to other investigations, used mostly professional judgment, had high calculation error, and required unlikely assumptions
- Models were not widely accepted, were poorly calibrated, or were not validated

A rating of "3" generally indicates:

- Data sources were from a similar, cold climate; were reviewed as agency drafts; or were partially supported by other research

- Calculation results were somewhat similar to other investigations, used some professional judgment; had intermediate calculation error or required reasonable assumptions
- Models had been used before, were reasonably calibrated but might not have been well validated

A rating of "5" generally indicates:

- Data sources were from Tahoe, published, and supported by other research
- Calculation results were similar to independent investigations, used little professional judgment, had low calculation error, and were based on conservative assumptions
- Models were widely accepted, well calibrated, and validated on non-calibration data

Overall, ratings of 1 and 2 were used when future values were considered likely to change significantly, and the SCG was not comfortable using them for significant management decisions. Ratings of 3, 4, and 5 were used when future values are not expected to change significantly, and the information is considered appropriate for management decisions. Further detail about confidence ratings for each of the individual SCG components is provided in the Lake Tahoe TMDL PRO Report (Lahontan and NDEP 2007b).

Optimization Uncertainty

Meta-heuristic optimization approaches are based on random number search techniques. Uncertainty increases with the prevalence of local minimums to which the solution technique might become trapped, and miss potentially better solutions within its search vicinity. Specialized approaches like scatter search include considerations for diversity during the searching process, which minimizes the likelihood of falling into a less than optimal local minimum. If the resolution around other potential solutions within the general vicinity of the near-optimum solution is amplified, one can better illustrate and quantify the nature of uncertainty associated with the PAT optimization technique. In optimization space, all points which are said to be optimal will fall along a region called the Pareto optimal frontier.

Pareto optimality is a concept commonly applied in economics and engineering. The underlying premise for PAT optimization involves the allocation of monetary resources to reduce pollutant loads such that the lowest cost alternative is achieved. Additional constraints imposed upon the solution can bend the search space to ensure that the allocation of resources involves all stake holders involved. During the search operation, reallocation of resources is done in such a way that marginally more benefit is achieved with each additional cost incurred. Cost effectiveness is measured by benefit achieved per dollar allocated. To remain Pareto optimal, the solution technique selects the more cost effective solutions first before considering others. A solution is said to be Pareto optimal when no further improvements can be made.

A second optimization formulation was tested against the Scatter Search formulation in PAT to help amplify the resolution of solutions in the general vicinity of the selected near-optimum solution. The primary objective of this formulation is to identify the Pareto optimum frontier. This formulation is a called the Non-dominant Sorting Genetic Algorithm (NSGA-II), developed by Deb et al. (2000). While scatter search refines a scatter pattern around the targeted objectives by replacing members of a reference population, NSGA-II defines a population as individual solutions along a cost-benefit frontier and refines the entire population with better and better solutions until the final solution approaches the true Pareto frontier. Figure A2 is a conceptual representation of the two search routines.

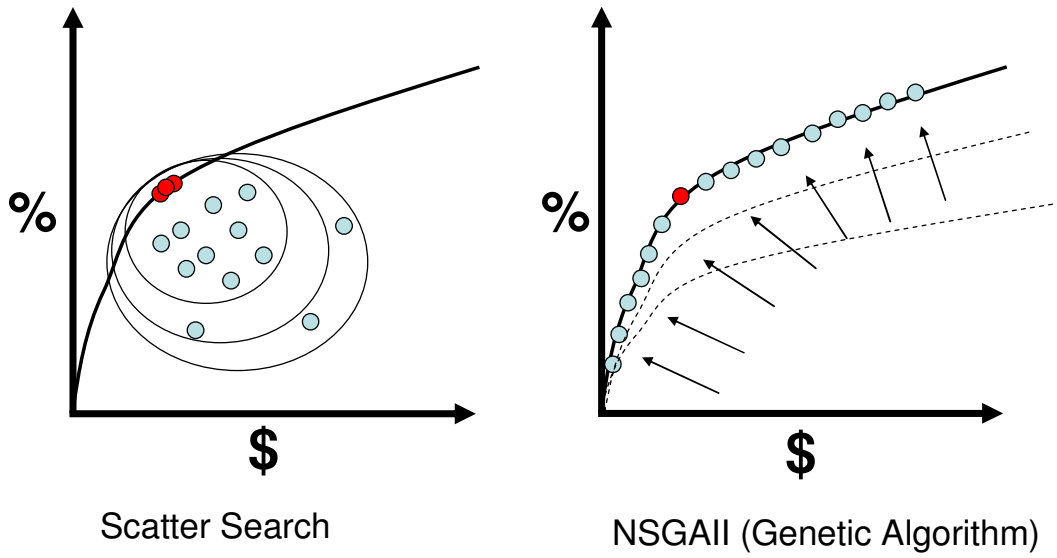


Figure A2. Conceptual representation of the searching techniques for Scatter Search and the Non-dominant Sorting Genetic Algorithm-II

In both graphs, the Pareto Optimum frontier is represented as the solid cost-benefit arc. It conceptually represents the true collection of optimum solutions for every cost ($) and benefit (percent) combination. The concentric circles in the scatter search graph illustrate progressively better (narrower) reference populations, until the final set of best solutions are found clustered around the point along the Pareto frontier. The dashed lines in the NSGA-II graph illustrate progressively improving cost-benefit relationships with each new generation of solutions, until the true Pareto frontier is approximated in the last generation. The red dot on the NSGA-II graph shows how a near-optimum solution for a given objective target might be inferred from the Pareto frontier. The distance between points along the trade-off curve for both methods shows that scatter search clusters solutions around the defined objective on the Pareto frontier, while NSGA-II distributes the solutions along the entire trade-off frontier. Increasing the resolution for NSGA-II means increasing the number of individuals in the population, which exponentially increases the number of generations required to approach the near optimum Pareto frontier.

The scatter search predicted PAT results were compared against results generated by the NSGA-II using the same underlying database and constraints. The NSGA-II population size was set to 1,376, which equals the number of decision variables (43) times 2^5 or 32. The population size must be increased in increments of 2 times the number of decision variables in accordance with requirements associated with parent-offspring Genetic Algorithm formulations. The resulting Pareto frontier is a high resolution rendering based on 1,376 individual solutions along the frontier. Due to the increased complexity of the problem and the high-resolution population size, each NSGA-II simulation required roughly 20 minutes of runtime to complete the simulation to generate the Pareto optimum frontier.

After the simulation, an empirical relationship derived from on sensitivity runs of the Lake Tahoe Clarity Model was used to translate the results from total fines reduction to resultant lake clarity (represented as Secchi Depth). Secchi depth versus 20-year capital cost Pareto Frontiers are presented for some of the

exploratory scenarios in Figure A3. These exploratory scenarios are described in greater detail in Chapter 3: Development of the Recommended Strategy.

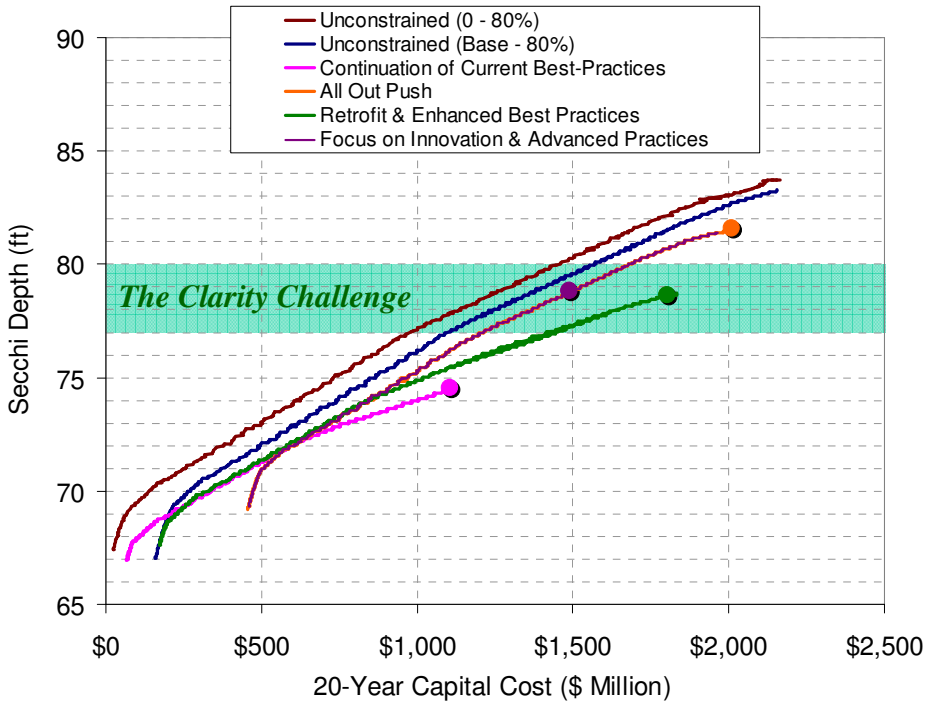


Figure A3. Pareto optimum frontiers for IWQMS exploratory scenarios.

The solid color-coded dots represent the "best" PAT-predicted scatter search solutions plotted along the Pareto Frontier associated with the corresponding scenario. In addition to the individual scenario Pareto frontiers, the unconstrained simulation frontier and a base-package-constrained simulation frontier were also generated for comparison. These illustrate the impact of the LOA constraints on the predicted optimal solution at each cost interval.

Further investigation of the LOA characteristics for the solutions in and around the PAT predicted optimum solutions yields insight into the factors that influence the selected solution at different intervals. Consider the hypothetical unconstrained (0-80 percent) simulation. Each of the 1,376 points along the Pareto optimal frontier includes characteristic information about the selected LOA for every setting and tier combination. If the predicted cost at each percent reduction interval is broken down and summarized by SCG-and-Setting combination, it is possible to see the order in which the optimizer tends to select cost-effective solutions at each cost interval along the Pareto frontier. Figure A4 is a graph of Pareto-optimal cost distribution for SCG-and-settings combinations, normalized at each percent reduction interval along the frontier. Likewise, if cost is broken down and summarized by SCG-and-Tier combination, it is possible to see the order in which the optimizer tends to select cost-effective solutions at each cost interval along the Pareto Frontier. Figure A5 is a graph of Pareto-optimal cost distribution for SCG-and-tier combinations, normalized at each percent reduction interval along the frontier.

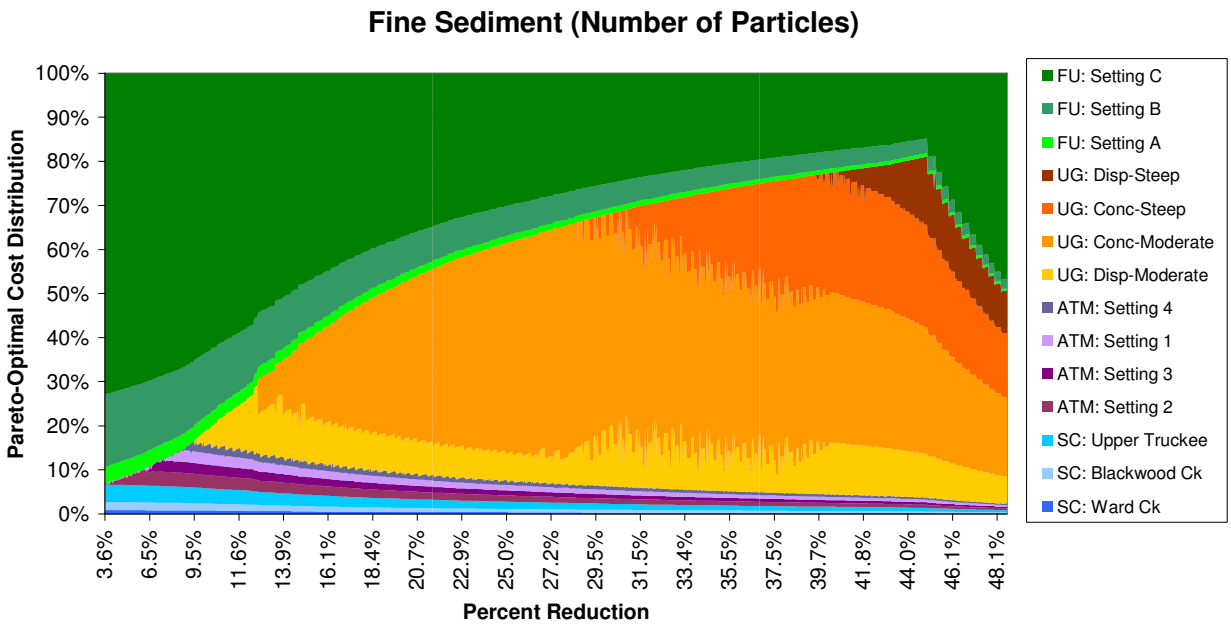


Figure A4. Pareto-optimal cost distribution versus percent fines reduction by setting

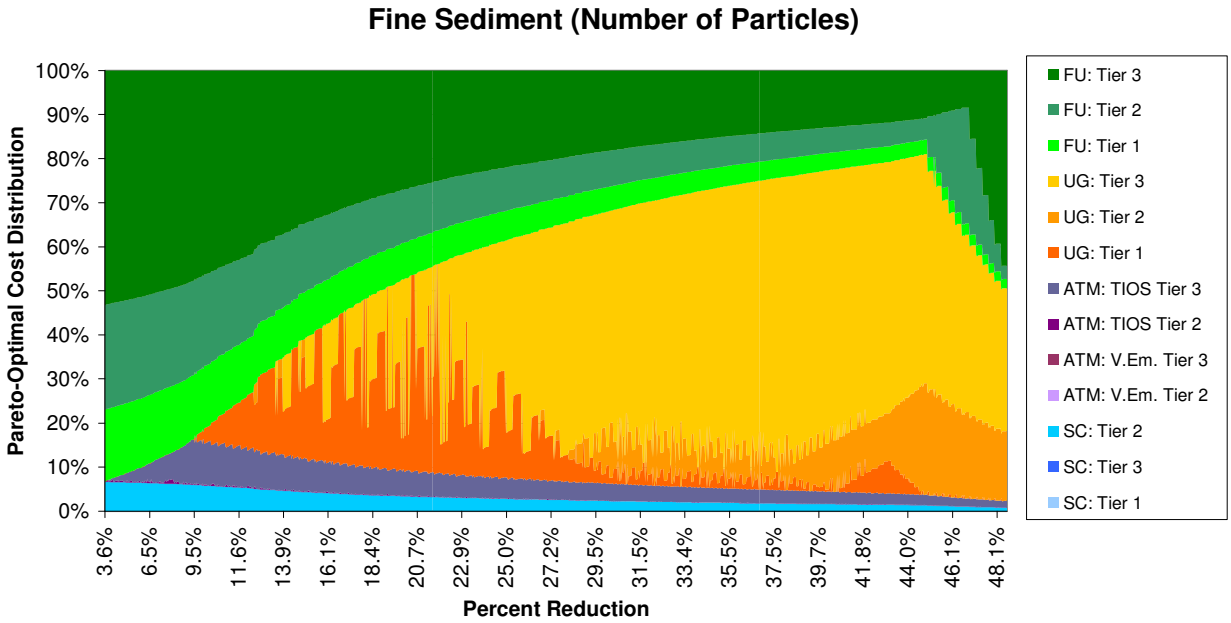


Figure A5. Pareto-optimal cost distribution versus percent fines reduction by tier

At certain intervals, these graphs show a systematic pattern of "noise" in the cost distributions. This occurs when the aggregated cost-effectiveness for different combinations of LOA among settings and tiers are comparable. This pattern is especially prevalent among the urban SCG settings and tiers. There are a number of factors which contribute to this noise in the results. Climate variability around the watershed influences the effectiveness of stormwater controls. Since setting and tier results are aggregated across multiple spatial locations, there are sometimes overlaps in aggregated reduction per dollar invested. When searches target percent reduction criteria that are in relatively stable sections of the

Pareto frontier, scatter-search will tend to find the same solution consistently in consecutive runs. However, when scatter-search explores regions along the Pareto frontier where there is a lot of "noise" generated by the interplay of similar aggregated cost-effectiveness values among individual solutions, it increases the likelihood of finding a local best solution which may actually have slightly better solutions nearby. Figure A6 is a conceptual representation of what a scatter search solution might look like while operating in a noisy region along the Pareto frontier. The dips in the figure are deliberately exaggerated to highlight how a local minimum might be chosen as the solution in lieu of a slightly better one nearby.

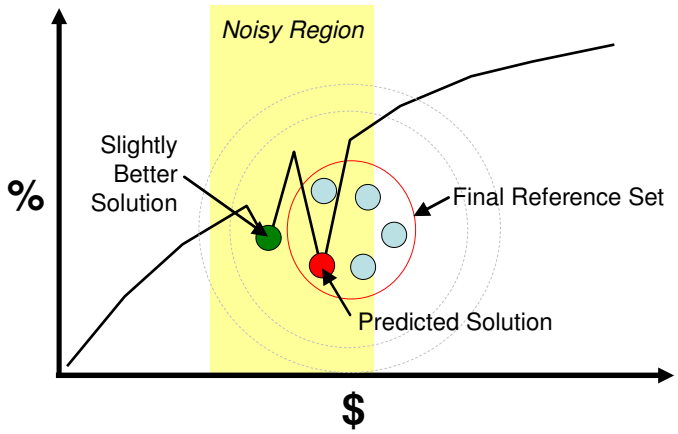


Figure A6. Conceptual representation of scatter search in a noisy region along the Pareto frontier

To validate the predictive performance of scatter search and NSGA-II, Lai et al. (2008) tested both of these search techniques against a known hypothetical linear solution, where no noise existed in the underlying dataset. The objectives were twofold: (1) to evaluate Scatter Search ability to pick a known linear solution for a single BMP given multiple pollutant performance functions and multiple pollutant reduction objective criteria, and (2) to evaluate NSGA-II ability to generate a trade-off curve for a known linear solution for a single BMP. Both the Scatter Search and NSGAII optimization techniques were able to solve a known linear solution with 100 percent accuracy. In addition, the optimization techniques were both able to select an optimum solution given multiple control objectives for controlling sediment and nitrogen simultaneously. The NSGA-II technique was also able to predict a known linear trade-off curve, as shown in Figure A7.

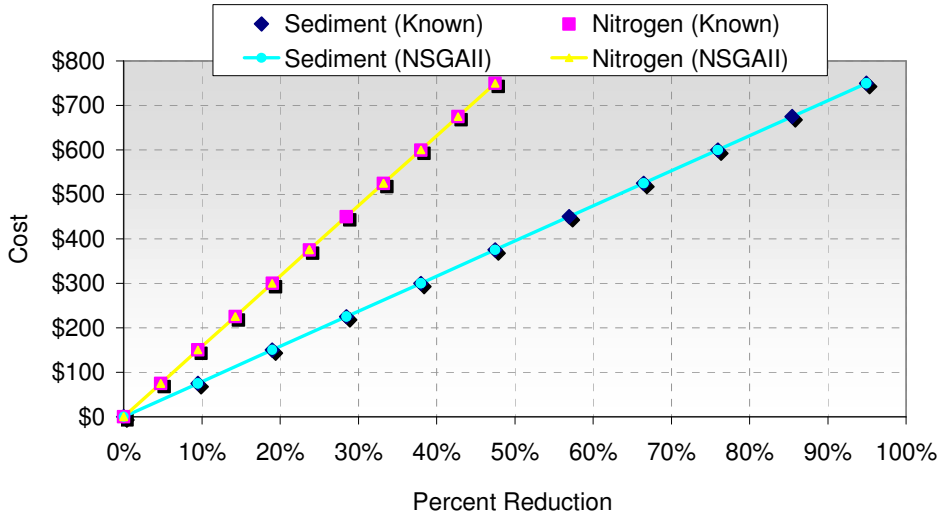


Figure A7. Validation of NSGA-II against a known linear solution (Source: Lai et al., 2008)

In conclusion, it is important to note that the results of meta-heuristic search techniques are usually referred to as near-optimal solutions. Uncertainty of a scatter search solution heavily depends on the amount of "noise" in the region along the Pareto frontier which is being searched. Just as the entire Pareto frontier shifts when LOA constraints are added to given problem formulation, the noise associated with the interplay of cost-effectiveness also varies as constraints are imposed upon the search formulation. In the absence of noise, both scatter search and NSGA-II have been shown to consistently predict results with 100 percent accuracy. The predictive efficiency for scatter search given the nature of the underlying database is probably on the order of 98 percent to 99.9 percent efficient in terms of accuracy. However, further trade-off analysis of this manner is needed to better quantify uncertainty associated with specific scenario results.

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Zhen, X. J. and S. L. Yu, (2002). "Optimization of Best Management Practices (BMPs) Placement for Non-Point Source Pollution Control at the Watershed Scale." Conference on Water Resources Planning and Management, ASCE-EWRI and Virginia Tech, Roanoke, VA.

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Appendix B: Information Supporting Chapter 3: Development of the Recommended Strategy

Appendix B Contents

Part 1: Rosters

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Implementers

Source Category Group Roster

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TMDL Agency Staff
Consultants

Part 2: Identify, Screen and Analyze Pollutant Controls

Stakeholder Contribution to Identification of Pollutant Controls, 2006
Pollutant Controls for Screening and Analysis by Source Category

- **Assessment of Pollutant Controls for Atmospheric Sources of Fine Sediments and Nutrients**
- **Initial Evaluation of Pollutant Controls for Urban Uplands and Groundwater**
- **Initial Pollutant Controls Assessment for Forested Uplands Settings**
- **Assessment of Pollutant Controls for Stream Erosion Sources of Fine Sediments and Nutrients**

Focus Team September 10 & 11, 2007 Meeting Materials
Focus Team Pollutant Controls Meeting Notes September 11, 2007
Forum September 27, 2007 Meeting Materials
Forum Pollutant Controls September 27, 2007 Meeting Notes

Part 3: Formulate Integrated Strategies

Focus Team October 11, 2007 Meeting Materials
Focus Team Integrated Strategies Meeting Notes October 11, 2007
Scenario A: Retrofit & Enhanced Best Practices (details)
Scenario B: Focus on Innovation & Advanced Practices (details)
Scenario C: All Out Push (details)
Forum and Focus Team October 25, 2007 Meeting Materials
Forum & Focus Team Scenarios Meeting Notes October 25, 2007

Part 4: Develop and Refine the Recommended Strategy

Forum December 6, 2007 Meeting Materials
Forum Recommended Strategy Meeting Notes December 6, 2007

Appendix B
Part 1

Rosters

Stakeholder Roster

Pathway Forum

Local Interests

Defined as those interest groups or constituencies located fully or partially within the Lake Tahoe Basin

Transportation/Transit

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Real Estate Interests

Primary Residence Owners

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Real Estate Interests

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Community Business

e.g., service providers, professional businesses, local retail

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Local Interests

Defined as those interest groups or constituencies located fully or partially within the Lake Tahoe Basin

Tourism Business

e.g., gaming, recreation providers/ski industry, lodging

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Community Sustainability

e.g., community planning and development/quality of life issues

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Community Recreationalists

e.g., sports leagues, organized teams

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Local Interests

Defined as those interest groups or constituencies located fully or partially within the Lake Tahoe Basin

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Non-Governmental Social Services

e.g., food banks, shelters, housing advocates

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those who recreate on land and water-- non-motorized

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those who recreate on land and water--motorized

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Local Interests

Defined as those interest groups or constituencies located fully or partially within the Lake Tahoe Basin

North Tahoe Basin--*Specific Interests*

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Local Interests

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South Tahoe Basin--*Specific Interests*

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Local Interests

Defined as those interest groups or constituencies located fully or partially within the Lake Tahoe Basin

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Local Interests

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Stakeholder Roster

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Theresa	Jones	Focus Team	NDOT
Rich	Williams	Focus Team	CalTrans
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Cliff	Lawson	Focus Team	NDEP stormwater
Liz	Harrison	Focus Team	NDSL, WQ, SWQIC
Jon-Paul	Harries	Focus Team	TRPA, EIP
Ron	Roman	Focus Team	DOUG Cty, SWQIC
Kimble	Corbidge	Focus Team	WASH Cty, SWQIC
Peter	Kraatz	Focus Team	Placer Co., SWQIC
Groundwater			
Russ	Land	Focus Team	NDEP GWTR
Forest			
Joe	Barron	Focus Team	NDSL
Roland	Shaw	Focus Team	NDSL
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Martin	Goldberg	Focus Team	Lake Valley Fire
Jerry	Dion	Focus Team	Tallac
Zach	Hymanson	Focus Team	TSC
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Cyndi	Walck	Focus Team	CA Parks, UTRWAG
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Jennifer	Carr	Focus Team	NDEP BAQP
Jennifer	Quickel	Focus Team	CSLT, UTRWAG
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Stream Channel			
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Jennifer	Quickel	Focus Team	CSLT, UTRWAG
Liz	Harrison	Focus Team	NDSL, SOILS
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Phil	Scoles	Focus Team	TRPA

Implementers

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Kris Klein	Washoe County
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John McCall	Lakeridge GID
Charlie Donohue	NDSL
Liz Harrison	NDSL
Joyce Brenner	CalTrans
Mitch Mysliwiec	CalTrans (Larry Walker & Associates
Vanessa Gallo	NDOT
Paul Frost	NDOT
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Dr. Rob	Odell	SCG Contributor	nhc
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Dr. Peter	Mangarella	SCG Contributor	Geosyntech
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Theresa	Loupe	SCG Contributor	LTBMU
Jim	Haris	SCG Contributor	LTBMU
David	Fournier	SCG Contributor	LTBMU
Bob	Coats	SCG Contributor	UC Davis
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Peter	Mulholland	Tech. Reviewer	NDSL
Woody	Loftis	Tech. Reviewer	NRCS

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Susan	Countess	SCG Contributor	Geosyntech
Will	Anderson	SCG Contributor	nhc
Dr. Tom	Cahil	SCG Contributor	UC Davis
Charles	Emmet	Tech. Reviewer	CTC
Karen	Fink	Tech. Reviewer	TRPA, TRANS
Mel	Zelden	Tech. Reviewer	invited

Stream Channel

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Dr. Eddy	Langendoen	SCG Contributor	USDA Sed. Lab
Mike	Rudd, P.E.	SCG Contributor	Entrix
Michell	Swanson	SCG Contributor	Swanson Hydrology
Craig	Oehrli	Tech. Reviewer	LTBMU

TMDL Team Roster

TMDL Agency Staff

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Robert Larsen	Lahontan Water Board
Jason Kuchnicki	Nevada Division of Environmental Protection
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Hannah Schembri	Lahontan Water Board

Consultants to Integrated Strategy Project

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Appendix B
Part 2

Identify, Screen and Analyze Pollutant Controls

Identify, Screen and Analyze Pollutant Controls

Stakeholder Contribution to Identification of Pollutant Controls, 2006

Pathway Forum Input to the Lake Tahoe TMDL

The Pathway 2007 Forum has provided suggestions regarding strategies to control pollutants entering Lake Tahoe as well as more general policy recommendations. Many of the suggestions and issues raised will be explored as part of the Lake Tahoe Clarity Total Maximum Daily Load (TMDL) Phase 2 investigations to analyze pollutant control strategies and develop an Integrated Water Quality Management Strategy.

The following table was developed to assist the TMDL Source Category Integration Committee to ensure that all pertinent suggestions raised by the Forum are considered in TMDL Phase 2 investigations in 2007, subsequent Phase 3 efforts or through other efforts such as the Pathway 2007 planning process. The comments and suggestions in the table are a compilation of all of the water-related input found in the meeting notes produced from the July and September 2006 Forum meetings. Comments and suggestions have been paraphrased and in some instances similar comments were combined. The document and page number for each item are provided in the Source column. More complete citation information is provided at the end of this document. The final column indicates what group or effort will consider the suggestion given.

The primary groups indicated include:

- Urban Upland Source Category Group (SCG) – investigating pollutant control options for urban areas including groundwater loading of pollutants to the lake
- Forest Uplands SCG – investigating pollutant control options for forested areas
- Stream Channel Erosion SCG – investigating pollutant control options related to stream restoration and stream related processes
- Atmospheric Deposition SCG – investigating pollutant control options related to preventing direct deposition of pollutant to the lake surface
- Source Category Integration Committee – TMDL coordinating committee
- TMDL Phase 3 Implementation – analyses that will be conducted during the implementation phase of the TMDL following 2007
- Pathway – the overall planning effort
- Soils/Stream Environment Zones and Transportation Resource Groups – Pathway Core Groups and Technical Working Groups focusing on soils, stream zones and transportations

Forum Input Related to TMDL from July & September 2006 Meetings

Comment/Suggestion	*Source*	*How Being Considered*
Urban Stormwater		
How do you treat stormwater?	September Forum Meeting Summary, Pg 4	Urban Upland Source Category Group (SCG)
How can we reduce pollutant loadings from the urban areas?	September Forum Meeting Materials, Pg 7	Urban Upland SCG
What is the significance of connectivity between impervious surfaces and runoff, loading, and stream bank erosion?	July Forum Meeting Notes, Pg 6	Source Category Integration Committee (SCIC), Urban Upland SCG, Stream Channel Erosion SCG
Use treated wastewater flumes to carry biomass out of basin.	September Forum Output Public Lands, Pg 3	Urban Upland SCG
We should have regional stormwater treatment sites.	September Forum Output Urban Lands, Pg 3	Urban Upland SCG
Research is needed on water quality improvement technology for urban areas.	September Forum Output Urban Lands, Pg 4	Urban Upland SCG
Basin-wide stormwater treatment should consider impacts at the sub-basin scale.	September Forum Output Urban Lands, Pg 3,4	Urban Upland SCG and SCIC
We should use porous parking surfaces vegetated roofs, and gray water systems.	September Forum Output Urban Lands, Pg 3,4	Urban Upland SCG
We should encourage creative use of gray water and roof runoff.	September Forum Output Urban Lands, Pg 5	Urban Upland SCG
Stormwater assessments are needed.	September Revenue Report, Pg 1	Pathway & TMDL Phase 3 Implementation
How do we restore stream and soils functions in urban areas?	September Forum Meeting Materials, Pg 7	Urban Upland SCG & Soils/Stream Environment Zones (SEZ) Resource Group
Publicly owned urban lots should be used for recreation and water quality.	September Forum Output Urban Lands, Pg 5	Pathway & Urban Upland SCG
Streams and Forests		
Stream restoration and bank restabilization are win-win because they help water quality and recreation.	July Forum Meeting Notes, Pg 6	Stream Channel Erosion SCG
Restore the meander to the Upper Truckee River.	July Forum Meeting Notes, Pg 6, September Forum Output Urban Lands, Pg 4	Stream Channel Erosion SCG
Restore stream channels.	September Forum Output Public Lands, Pg 2	Stream Channel Erosion SCG

Comment/Suggestion	Source	How Being Considered
Reduce nutrient flow from creeks and rivers.	September Forum Output Public Lands, Pg 3	Stream Channel Erosion SCG
How do we improve lake clarity while also reducing forest fuels (thin trees, remove dead wood, etc.)?	September Forum Meeting Materials, Pg 5	Forest Upland SCG
Public lands and water management need to include formalized education programs.	September Forum Output Public Lands, Pg 3	Pathway
Recreation promotes water quality by managing lands, applying BMPs, and reducing erosion.	September Forum Output Public Lands, Pg 3	Forest Upland SCG
Restore wetlands and stream meadows that have been overused.	September Forum Output Public Lands, Pg 3	Urban Upland SCG
General		
We should reduce sediment and nutrient runoff.	September Forum Output Public Lands, Pg 2	All SCGs
Creeks and meadows in urban areas should be restored.	September Forum Output Urban Lands, Pg 8	Stream Channel Erosion SCG & Soils/Stream Environment Zone Resource Group
Design watershed restoration to improve neighborhoods by considering wildlife and defensible space.	July Forum Meeting Notes, Pg 6	Pathway & TMDL Phase 3 Implementation
The public message needs to clearly address: how our efforts help the lake, what the benefits are, and how individuals and the community will be better for it.	July Forum Meeting Notes, Pg 7	Pathway
We should design restoration projects to provide social and economic benefits.	September Forum Output Public Lands, Pg 3	Pathway
How is soil addressed for water quality?	July Forum Meeting Notes, Pg 9	Pathway & Source Category Integration Committee
Park City has had success with wetland restoration.	September Forum Meeting Summary, Pg 6	Urban Upland SCG
Water quality monitoring should be used as a tool to measure restoration success.	September Forum Output Public Lands, Pg 9	TMDL monitoring planning, EIP
Ecosystem restoration projects should be required to demonstrate results.	September Forum Output Urban Lands, Pg 3	TMDL overall related to water quality improvement, EIP
We should try to achieve an 80 percent reduction in Nitrogen & Phosphorous entering the lake to protect clarity.	September Forum Output Public Lands, Pg 9	TMDL IWQMS development process
We should measure the percentage of sites with BMPs in place and maintained to reduce sediment and fines.	September Forum Output Public Lands, Pg 9	TMDL overall

Comment/Suggestion	Source	How Being Considered
We need a watershed-based planning approach with social benefits and flexibility.	September Forum Output Urban Lands, Pg 1	Pathway & TMDL Phase 3 Implementation
Ecosystem restoration should be watershed-based and restoration coverage should be distributed across watersheds.	September Forum Output Urban Lands, Pg 3	TMDL IWQMS development process, Pathway & EIP
Decreased sedimentation into the lake (TMDL) should be a success indicator.	September Forum Output Urban Lands, Pg 8	TMDL overall
Measure sediments and nutrients for standardized thresholds.	September Pathway Output Urban Lands, Pg 8	TMDL monitoring planning

Comment/Suggestion	Source	How Being Considered
Policy		
We should shift to macro results oriented system TMDL and away from micro regulation.	September Forum Output Public Lands, Pg 14	Pathway & TMDL Phase 3 Implementation
A stormwater utility tax could be a source of revenue.	September Revenue Report, Pg 1	Pathway & TMDL Phase 3 Implementation
We need new ways to fund water quality infrastructure.	September Revenue Report, Pg 2	Pathway & TMDL Phase 3 Implementation
A tax increment could fund water quality improvements.	September Forum Output Urban Lands, Pg 3,4	Pathway & TMDL Phase 3 Implementation
We could use downstream water use surcharges for funding.	September Forum Output Public Lands, Pg 12	Pathway & TMDL Phase 3 Implementation
More consolidation of regional water programs is needed.	September Forum Output Revenue Report, Pg 1	Pathway & TMDL Phase 3 Implementation
A way to take credit for environmental improvements targeting stream restoration is to create conservation easements and/or mitigation banking.	September Forum Revenue Report, Pg 3	Pathway & Water Quality Trading Project
How do we create incentives for ecosystem restoration improvements in urban areas?	September Forum Meeting Materials, Pg 7	Urban Upland SCG, Water Quality Trading Project
Consider stormwater treatment utilities for urban areas.	July Forum Meeting Notes, Pg 6	Pathway & TMDL Phase 3 Implementation
Parking fees could be based upon the impact level of the recreation type.	September Forum Output Public Lands, Pg 5	Transportation and Recreation Resource Groups, Atmospheric Deposition SCG, Urban Upland SCG
Parking fees can be used to encourage use of public transit.	September Forum Output Public Lands, Pg 5	Transportation Resource Group, Atmospheric Deposition SCG, Urban Upland SCG
We should eliminate coverage percentages for ecosystem restoration assessment.	September Forum Output Urban Lands, Pg 3	Urban Upland SCG & Soils/Stream Environment Zone Resource Group
Scope and scale of restoration projects should be flexible regarding future development within the same watershed.	September Forum Output Urban Lands, Pg 3	Pathway & Urban SCG
We must ensure that mitigation will be implemented before development projects are allowed to begin.	September Forum Output Urban Lands, Pg 3	Pathway, Phase 3 TMDL Implementation
We need to invest in research and development of mitigation strategies using a mitigate-first approach and private incentives.	September Forum Output Urban Lands, Pg 4	Pathway, Phase 3 TMDL Implementation, Water Quality Trading Project

Comment/Suggestion	***Source***	***How Being Considered***
For urban sustainability, we need a catalogue of incentives for the private sector, and to encourage private-public partnerships.	September Forum Output Urban Lands, Pg 5	Pathway & Water Quality Trading Project

References

July Pathway Forum Meeting Summary - Pathway 2007 Meeting Summary. July 27, 2006. Kings Beach, CA.

September Pathway Forum Meeting Materials - Pathway 2007 Proposed Approach for September 28-29 Management Strategies/Management Approaches Forum Workshop. Incline Village, NV.

September Pathway Forum Meeting Summary - Pathway 2007 Meeting Summary. September 28-29, 2006. Incline Village, NV

September Pathway Forum Meeting Output Public Lands - Pathway 2007 Forum Workshop Draft Output from Urban Lands Groups. September 28-29, 2006. Incline Village, NV.

September Pathway Forum Meeting Output Urban Lands - Pathway 2007 Forum Workshop Draft Output from Public Lands Groups. September 28-29, 2006. Incline Village, NV.

September Pathway Forum Meeting Revenue Report - Regional Revenue Report Out. September 28, 2006 Forum Workshop Product. Incline Village, NV.

Identify, Screen and Analyze Pollutant Controls

Pollutant Controls for Screening and Analysis by Source Category

Assessment of PCOs for Atmospheric Sources of Fine Sediments and Nutrients

Source Category	*Potential Control Option*	*Quantifiable Load Reduction*	*Viability*
Paved Roads	1a. Deicers instead of cinders and sand	Yes	High
	1b. Designated sites for snow removed from road	Maybe	High
	1c. Vegetation/barriers	Maybe	High
	1d. Pave shoulders	Yes	Medium
	1e. Clean gutters and curbs	Maybe	High
	1f. Move traffic to roads further inland from lake	Maybe	Low
	1g. Tarps for haul trucks	Maybe	High
	1h. PM10-efficient vacuum units	Yes	High
	1i. Replace sweepers with PM10-efficient vacuum units	Yes	High
	1j. Cleanup erosion deposits/spills within 24 hours of discovery	Maybe	High
	1k. Remove abrasive material from road ASAP	Maybe	High
Unpaved Roads	2a. Maximum speed limit of 25 mph	Maybe	High
	2b. Limit weight and/or number of vehicles	Maybe	High
	2c. Pave unpaved roads/parking lots	Yes	High
	2d. Apply gravel or slag	Yes	High
	2e. Pipe-grid system or gravel bed to control trackout	Yes	High
	2f. Plant a vegetative cover	Maybe	High
	2g. Road closures	Yes	High
	2h. Water industrial unpaved roads	Yes	High
	2i. Chemical dust suppressant	Yes	High
	2j. Vegetation/Barriers	Maybe	High
	2k. Prohibit new roads where soil instability is an issue	Maybe	High
	2l. Move traffic to roads further inland from lake	Maybe	Low
Construction/Demo	3a. Water disturbed surfaces at regular intervals	Yes	High
	3b. Chemical dust suppressants	Yes	High
	3c. Barriers around the site for soil dust sequestration	Maybe	High
	3d. Ban demolition/grading activities if wind >25 mph	Maybe	High
	3e. Require minimum soil moisture of 12% for earthmoving	Maybe	High
	3f. Limit on-site vehicle speeds to 15 mph	Maybe	High
	3g. Prohibit new roads where soil instability is an issue	Maybe	High
	3h. Pipe-grid system or gravel bed to control trackout)	Yes	High
	3i. Pave construction access road	Yes	High
	3j. Clean access roads frequently	Maybe	High
Farming Ops	4a. Equipment modifications	Maybe	Medium

	4b. Process modifications	Maybe	High
	4c. Limited activity during high winds	Maybe	High
RWC	5a. Ban new wood burning stoves/fireplaces	Yes	Medium
	5b. Replace non-approved stoves	Maybe	Medium
	5c. Ban RWC during periods with poor atmospheric dispersion	Maybe	High
	5d. Limit wood to hardwoods or pellets with low moisture	Maybe	High
	5e. Weatherize residences heated by wood stoves	Maybe	Medium
Managed Waste Burning	6a. Limit burning to periods with high atmospheric dispersion	Maybe	High
	6b. Ban all open burning	Yes	High
Mobile	7a. Trolley or elevated tram service	Maybe	Low
	7b. Ski shuttle services	Maybe	Medium
	7c. Inter-city bus services for casino guests	Maybe	Medium
	7d. Facilitate non-motorized transportation	Maybe	Medium
	7e. Incentives for the use of bike lanes	Maybe	Medium
	7f. Create a pedestrian friendly environment	Maybe	Medium
	7g. Incentives for alternative fuel use	Maybe	Low
	7h. Mass transit incentives	Maybe	Medium
	7i. Employer-based trip reduction incentives	Maybe	Medium
	7j. Incentives for alternate driving days	Maybe	Low
	7k. Incentives for vanpools for commuters	Maybe	Medium
	7l. Incentives for ferry travel to reduce road travel	Maybe	Low
	7m. Synchronize traffic signals to minimize idling time	Maybe	Medium
	7n. Ban boating during late evening/early morning hours	Maybe	Low
	7o. Annual Smog Check for cars >4 years with no exemptions	Maybe	Medium
	7p. Reduce commercial shipping activities	Maybe	Low
	7q. Limit travel during late evening/early morning hours	Maybe	Low
	7r. Particulate filters for diesel trucks and buses	Maybe	Low
	7s. Particulate filters/ oxidation catalysts for diesel boats	Maybe	Low
	7t. Retrofit vehicles/boats with cleaner engines	Maybe	Low
	7u. Inspection program for off-road equipment	Maybe	Medium
	7v. Road-side inspection of heavy duty diesel trucks/buses	Maybe	Medium
	7w. Incentives to retire older vehicles	Maybe	Medium
	7x. Incentives for all Basin residents to purchase CA fuel	Maybe	Low

Source: Table 3-1. Assessment of PCOs for Atmospheric Sources of Fine Sediments and Nutrients from Lake Tahoe TMDL SCG Work Plan

Initial Evaluation of PCOs for Urban Uplands and Groundwater

Source Category/ Treatment Option	Potential Control Option	BMP	Quantifiable Load Reduction	Viability
Hydrologic Source Controls	1. Redirection or separation of runoff	a. Berms	Maybe	Low
		b. Piping		
	2. Decrease amount of runoff generated	a. Hard coverage removal	Yes	High
		b. Soft coverage removal		
		d. Pervious pavement		
		e. Soil restoration		
	3. Decrease amount of runoff reaching catchment outlet	a. Routing impervious runoff to pervious area	Yes	High
		b. Perforated piping		
		c. Infiltration trenches		
	4. Private BMP implementation to detain and infiltrate runoff	a. Percolation trench	Yes	High
		b. Slotted drain		
		c. Drywell		
		d. Pervious pavement		
		e. Pre-fabricated infiltration system		
Pollutant Source Controls	1. O&M	a. Road abrasive application management	Maybe	Medium
		b. Street sweeping		
		c. Recovery of detained pollutants		
	2. Road shoulder stabilization	a. Curb and gutter	Maybe	High
		b. AC berm or AC swale		
		c. Vegetated or rock-lined channel		
	3. Drainage system stabilization	a. Vegetated Rock-lined channel	Maybe	High
		b. Piping		
	4. Disturbed area or slope stabilization	a. Retaining wall	Maybe	High
		b. Soil restoration		
		c. Revegetation		
		d. Soft coverage to pavement		
		e. Rock slope protection		
		f. Parking protection or enforcement		
	5. Distributed collection of pollutants	a. Sediment traps or drop inlets with sumps	Maybe	High
	6. Land use change	a. Redevelopment	Maybe	Low
		b. Conservation		

Source Category/ Treatment Option	Potential Control Option	BMP	Quantifiable Load Reduction	Viability
	7. Gully stabilization	a. Armoring	Maybe	High
	8. Private BMP implementation to reduce mobilization of pollutants	a. Slope stabilization	Yes	High
		b. Driveway paving		
		c. Vegetation and mulch		
		d. Parking protection		
		e. Gravel armor		
	9. Reduce Road Abrasives	a. Alternative deicing strategies	Yes	High
		b. Increased recovery from sweeping		
	10. Reduce Fertilizer Applications (recreational and residential)	a. Alternative fertilizer applications, conversion of turf to synthetics, etc.	Yes	High
		b. Change in fertilizer brand availability, educational efforts, management efforts	Yes	High
	11. Sewer Exfiltration and Septic System Management	a. Increased sewer system monitoring and maintenance	Maybe	High
		b. Point source removal and treatment	Maybe	Medium
	12. Animal Waste Management	a. Bird waste management, bird management, etc.	Yes	Medium
		b. Pet waste management, owner education	Yes	High
Stormwater Treatment	1. Volume and sed based treatment via pervious BMP	a. Detention basin	Yes	Medium
		b. Wetland basin		
		c. Retention basin		
		d. Infiltration basin		
	2. Volume and sed based treatment via impervious BMP	a. Pre-fabricated vault	Yes	Medium
		b. Hydrodynamic device		
	3. Flow based treatment via fabricated structural BMP	a. Media filter	Yes	Medium
		b. Regional treatment plant		
		c. Electrocoagulation		
	4. Flow based treatment via vegetated filtration BMP	a. Grass swale - biofilter	Yes	Medium
	5. Advanced treatment prior to infiltration to groundwater (applies as add-on to PCO 1-3)	a. Chemical dosing	Yes	Medium
		b. Adsorptive media	Yes	High
		c. Vegetation management and maintenance	Maybe	High

Source Category/ Treatment Option	Potential Control Option	BMP	Quantifiable Load Reduction	Viability
		d. Vertical treatment strategies in dry wells	Yes	High
Groundwater Treatment	1. In-situ groundwater	a. Pump and treat	Yes	Medium
		b. Reactive walls	Maybe	Medium

Source: Table 4-1. Initial Evaluation of PCOs for Urban Uplands and Groundwater, from Lake Tahoe TMDL SCG Work Plan

Initial PCO Assessment for Forested Uplands Settings

Setting	PCO	Measured Locally	Measurement Methodologies	Viability
Forestry and Watershed Management	Limit # of trips	No	3,7	High
	Broadcast burn	?	1,2,3,4,5	Med-High
	Chip and remove	No	1,2,3,4,5	High
	Chip and scatter	No	1,3,4,5	Med-High
	Mastication	Yes	1,3,4,5	Med-High
	Over-the snow work	No	1,3,4,5,6	High
	Pile and burn	?	1,2,3,4,5	High
	Forwarding	No	1,3,4,5	Med-High
	Grapple (tong-toss) skidding	No	1,3,4,5	High
	Skidding	?	1,3,4,5	High
	Skyline	No	1,3,4,5	Med-High
	Helicopter logging	No	1,3,4,5	Med-High
	Yarding	No	1,3,4,5	Med-High
	Fire suppression activities	No	1,3,4,5,6	High
	Post-fire treatment activities	Yes	1,3,4,5,6	High
	Mulching (& type)	Yes	1,2,4,5	Med-High
	Ripping-sub-soiling (& depth)	Yes	1,3	High
	Road removal	Yes	1,3,4,5,6	Med-High
	Road surface restoration	Yes	1,3,4,5,6	High
Roads, Trails and Other Impervious Surfaces	Insloping	No	8	High
	Outsloping	No	5,8	High
	Paving	?	2,8	Med-High
	Rock surface	No	2,8	High
	Water bars	No	2,8	High
	Watering	?	2,8	Med-High
	Curb and gutter	?	2,8	Med-High
	Filter berms-pine needle	Yes	2,8	High
	Flow path check dams	No	2,8,9	High

Setting	PCO	Measured Locally	Measurement Methodologies	Viability
	Infiltration ditch	Yes	2,3,8,9	High
	Infiltration gallery	Yes	9	Med-High
	Infiltration swale	Yes	1,2,3,4,5,6	Med-High
	Other (see Urban Uplands)		Various	
	Rock line ditch	No	2,8	Med-High
	Settling pond	No	2,8	Med-High
	Treatment swale	Yes	1,2,3,4,5,6	Med-High
	Vegetated swale	Yes	1,2,3,4,5	Med-High
	Vegetated filter strips (VFS)	No	2,8	Med-High
	Traffic exclusion	Yes	1,2,3,4,5	Med-High
Ski Slopes	Full treatment (suite x)	Yes	1,2,3,4,5,6	High
	Hydroseeding	Yes	1,2,3,4,5,6	Low-High
	Irrigation	Yes	1,3,4,5	Med-High
	Mulch (& type)	Yes	1,2,4,5	Med-High
	Mycorhizzae	?	10,11	Med
	Organic matter amendment	Yes	1,2,3,4,5,6	Med-High
	Other amendments	No	Various	
	Planting (& type)	Yes	12,13	Low-Med
	Ripping (& depth)	Yes	1,3	High
	Seeding (& type)	Yes	1,3,4,5	High
	Soil roughness	Yes	1,2,3,4	High
	Tilling (& depth)	Yes	1,2,3,4,5	High
	Track walking	Yes	1,2,3,4,5	Low-High
	Clearing and plucking	Yes	1,3,4,5	Med-High
	Mastication	Yes	1,3,4,5	Med-High
	Smooth grading	Yes	1,2,3,4,5	Low-High
Road Cut and Fill Slopes	Drilling (& depth)	Yes	1,3,4,5	Med-high
	Engineering	No	2,5,8	Low-High
	Hydroseeding	Yes	1,2,3,4,5,6	Low-High
	Irrigation	Yes	1,3,4,5	Med-High
	Mulch	Yes	1,2,4,5	Med-high
	Mycorhizzae	?	10,11	Med
	Organic matter amendment	Yes	1,2,3,4,5,6	Med-High
	Other amendments	No	Various	
	Planting (& type)	Yes	12,13	Low-Med
	Retaining structures	No	2,3,5	Low-High
	Ripping (& depth)	Yes	1,3	High

Setting	PCO	Measured Locally	Measurement Methodologies	Viability
	Seeding (& type)	Yes	1,3,4,5,6	High
	Soil roughness	Yes	1,2,3,4	High
	Tilling (& depth)	Yes	1,2,3,4,5	High
	Track walking	Yes	1,2,3,4,5	Med
	Traffic exclusion	No	1,2,3,4,5	Med-High

Source: Table 5-1. Initial PCO Assessment for Forested Uplands Settings, from Lake Tahoe TMDL SCG Work Plan

Assessment of PCOs for Stream Erosion Sources of Fine Sediments and Nutrients

Identified PCO[1]	Specific PCOs/Strategies[1]	Load Reduction Quantification	Degree of Viability
Peak flow and duration management	▪ Manage flows (with on- or off- channel storage and releases) ▪ Restore in-stream hydrologic characteristics ▪ Constructed wetlands ▪ Various land management practices to preserve hydrology	▪ Empirical ▪ Modeling	Moderate
Tributary/outfall treatments	▪ Modify local hydraulics to reduce shear stress	▪ Standards	Moderate
Streamside land use buffers	▪ Prevent vegetation removal and/or soil compaction along streambanks ▪ Alleviate compacted soils ▪ Increase SEZ setbacks ▪ Remove recreation activities ▪ Designate riparian conservation areas ▪ Transfer development from SEZs ▪ Buyout coverage and relocate SEZ properties;	▪ Empirical	High
Floodplain constriction / fill removal	▪ Restore floodplain area ▪ Transfer development from SEZs ▪ Buyout and relocation of SEZ properties ▪ Impervious coverage removal in SEZs and setbacks ▪ Remove earthfill and other structures confining flow in channel	▪ Empirical ▪ Modeling	High
Channel constriction removal	▪ Replace outdated, under-sized culverts and/or bridges	▪ Empirical ▪ Modeling	High
Bank Protection-stone	▪ Streambank stabilization (rigid)	▪ Standards ▪ Empirical ▪ Modeling	High
Bank Protection-flexible geotech mattresses	▪ Streambank stabilization (flexible)	▪ Standards ▪ Empirical ▪ Modeling	High

Identified PCO[1]	***Specific PCOs/Strategies[1]***	***Load Reduction Quantification***	***Degree of Viability***
Bank Protection-LWD / rootwad revetment	▪ Streambank stabilization (Anchored LWD) ▪ Restore woody debris assemblages	▪ Empirical	Moderate
Bank Protection-anchored shrub/brush revetment	▪ Streambank stabilization (Anchored shrub)	▪ Empirical	Moderate
Bank Protection-stacked sod revetment	▪ Streambank stabilization (Anchored sod)	▪ Empirical	Low
Bank Strengthening-wet meadow vegetation	▪ Restore streambank vegetation herbaceous (via soil improvements, soil moisture increases) wet meadow 'sod' growing on banks	▪ Empirical ▪ Modeling	Low
Bank Strengthening-woody riparian vegetation	▪ Restore streambank vegetation woody (via soil improvements, soil moisture or stream dynamics-seed beds)	▪ Empirical ▪ Modeling	Low
Grade Control Structure-non porous material	▪ Keyed sheet pile/concrete sills, etc.	▪ Standards ▪ Empirical ▪ Modeling	Moderate
Grade Control Structure-porous rock material	▪ Keyed boulder/cobble wiers, riffles, etc.	▪ Standards ▪ Empirical ▪ Modeling	Moderate
Grade Control Structure-porous rock and LWD	▪ Keyed boulder/LWD jams ▪ Restore woody debris assemblages	▪ Empirical ▪ Modeling	Low
Channel fill with bank toe stabilization	▪ Maintain hydrologic connectivity in streams, meadows, and wetlands ▪ Raise streambed elevation within incised channel	▪ Empirical ▪ Modeling	Low
Bank lowering +floodplain excavation	▪ Maintain hydrologic connectivity in streams, meadows, and wetlands ▪ Excavate bank to create connected active floodplain	▪ Empirical ▪ Modeling	Moderate
Bank lowering +angle reduction	▪ Maintain hydrologic connectivity in streams, meadows, and wetlands ▪ Excavate and contour bank to reduce angle and/or improve bank vegetation	▪ Empirical ▪ Modeling	Moderate
Channel reconstruction	▪ Restore natural geomorphic characteristics through construction ▪ Restore sinuosity to channelized streams ▪ Maintain hydrologic connectivity in streams, meadows, and wetlands	▪ Standards ▪ Empirical ▪ Modeling	High
Channel restoration	▪ Restore natural geomorphic characteristics through construction and restored processes ▪ Restore sinuosity to channelized streams ▪ Maintain hydrologic connectivity in streams, meadows, and wetlands	▪ Empirical ▪ Modeling	Low

[1]PCOs identified by SCG Lead, Contributors, and/or Pathway Forum

Source: Table 6-3. Assessment of PCOs for Stream Erosion Sources of Fine Sediments and Nutrients, from Lake Tahoe TMDL SCG Work Plan

Lake Tahoe Total Maximum Daily Load Atmospheric Deposition Focus Team Agenda

September 10, 2007, 1 - 4 p.m.

Session 1 objective:

Discuss potential options for reducing atmospheric sources of fine particles, nitrogen and phosphorus to Lake Tahoe

Location: Embassy Suites Hotel, South Lake Tahoe, ground floor

Thank you for sharing your expertise and insight by participating on the Lake Tahoe TMDL Focus Team for Atmospheric Deposition. How are we going to restore Lake Tahoe's clarity? This is the central question of the Lake Tahoe TMDL. In the session on Monday, September 10 you will participate in discussion about the latest findings of TMDL research and how to chart a course to restoring clarity.

1:00 Focus team role and objectives

Central questions of the TMDL

Opportunities & Boundaries

1:10 Questions addressed

What pollutants are causing Lake Tahoe clarity loss?

How much of each pollutant is reaching Lake Tahoe?

How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?

1:30 Most-recent findings

What are the options for reducing pollutant inputs to Lake Tahoe?

Findings from atmospheric deposition research

Methods and approach discussion

Next-level refinement and continual improvement discussion

3:30 Introduction to focus question for fall - winter discussion

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Next Focus Team discussion and steps through the fall - winter season

4:00 Adjourn

Lake Tahoe TMDL Phase Two

Fall 2007 Public Participation Series

Source Category Group Focus Team Meetings

TMDL Program Overview

A science-based plan to restore Lake Tahoe's clarity

Central TMDL Questions

Questions Addressed

1. What pollutants are causing Lake Tahoe's clarity loss?
2. How much of each pollutant is reaching Lake Tahoe?
3. How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?

Current Questions

1. What are the options for reducing pollutant inputs to Lake Tahoe?
2. What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Source Category Group Analysis Opportunities

- Basin-Wide load reduction estimates
- Relative load reduction opportunity among source categories
- Consistent methods to evaluate future pollutant control options

Source Category Group Analysis Boundaries

- Not suited to project scale
- Evaluated pollutant control options chosen for data availability
- Limited time, resources, and effectiveness data

Continuous Improvement

- Adaptive management process
- SNPLMA science funding opportunities
- Each group identified "next steps" and data needs

Focus Team Role

- Gain technical understanding of SCG approach
- Act as a liaison to your agency
- Provide input on preferred pollutant control options
- Suggestions for future work

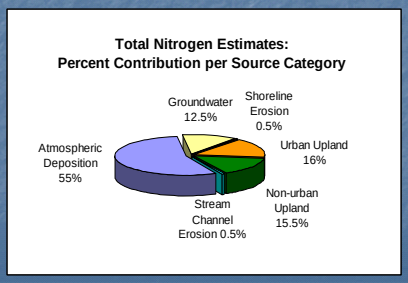
Questions?

Questions Addressed

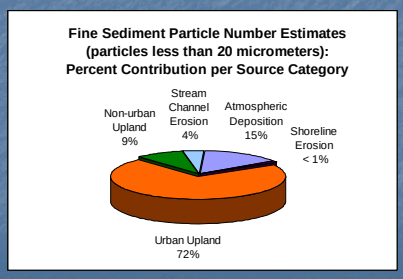
What is causing Lake Tahoe's clarity loss?

- Suspended fine sediment
- Floating algae – fed by nutrients
- Very fine sediment (<20 microns) accounts for ~2/3 of the clarity conditions

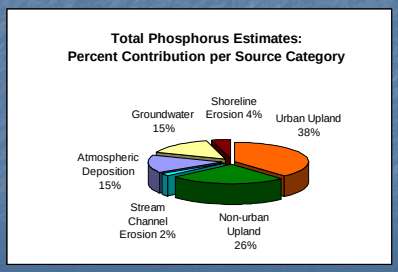
How much of each pollutant is reaching Lake Tahoe?



How much of each pollutant is reaching Lake Tahoe?



How much of each pollutant is reaching Lake Tahoe?



How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?

- The Lake Clarity Model provides estimates of clarity response to load reductions
- Reducing fines has a greater potential to improve clarity
- Model output indicates significant reductions will be needed

What are the options for reducing pollutant inputs to Lake Tahoe?

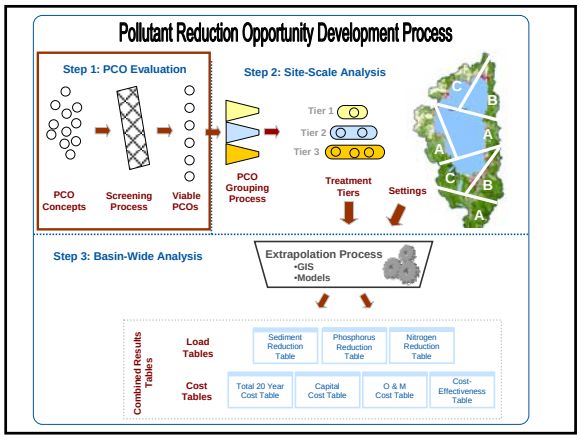
Good Question!

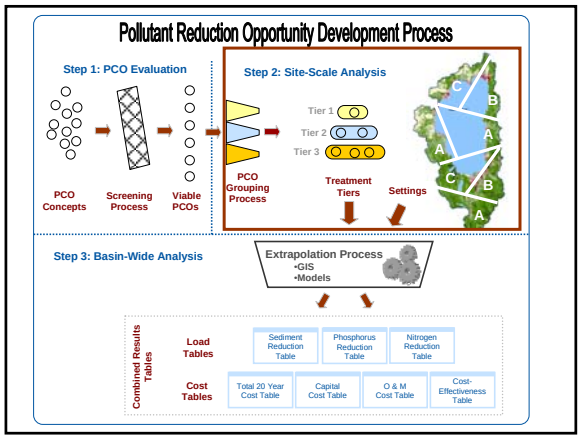
Approach to Answering Current Questions

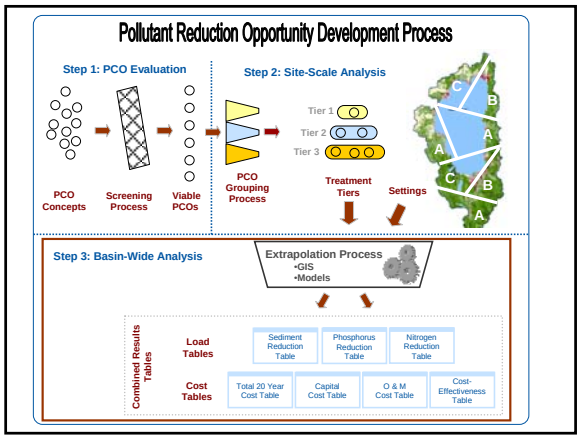
- Identify load reduction options
- Quantify load reduction options
- Prepare Integrated Strategies
- Gather stakeholder input

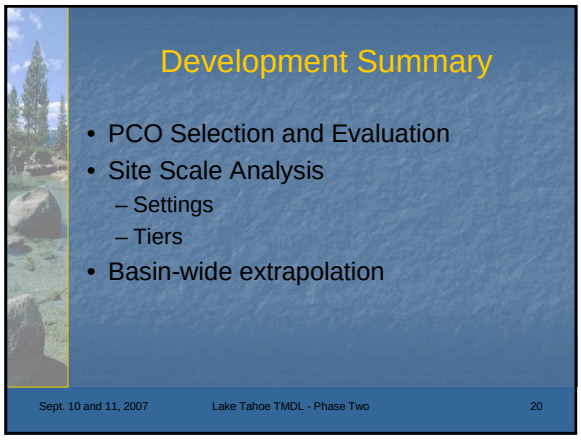
Pollutant Load Reduction Opportunity Project - People

- Source Category Groups
- Technical Reviewers
- Source Category Integration Committee
- Project Team
- Focus Teams






Pollutant Reduction Opportunity Development Process
Step 1: PCO Evaluation
PCO Concepts
Screening Process
Viable PCOs
Step 2: Site-Scale Analysis
PCO Grouping Process
Tier 1
Tier 2
Tier 3
Treatment Tiers
Settings
C
B
A
A
C
B
A
Step 3: Basin-Wide Analysis
Extrapolation Process
•GIS
•Models
Combined Results Tables
Load Tables
Sediment Reduction Table
Phosphorus Reduction Table
Nitrogen Reduction Table
Cost Tables
Total 20 Year Cost Table
Capital Cost Table
O & M Cost Table
Cost-Effectiveness Table


Development Summary
• PCO Selection and Evaluation
• Site Scale Analysis
– Settings
– Tiers
• Basin-wide extrapolation
Sept. 10 and 11, 2007
Lake Tahoe TMDL - Phase Two
20

Purpose and Background

- Inform pollutant load reduction estimates for urban storm water runoff, including infiltration to groundwater
- Watershed Model simulations use UGSCG input to estimate pollutant load reductions for surface water
- Groundwater estimates conducted independent of Watershed Model simulations

Key Steps in Approach (Surface Runoff)

Step 1: PCO Evaluation

Step 2: Site-Scale Analysis
- Define Urban Upland Settings
- Develop Treatment Tiers by Setting

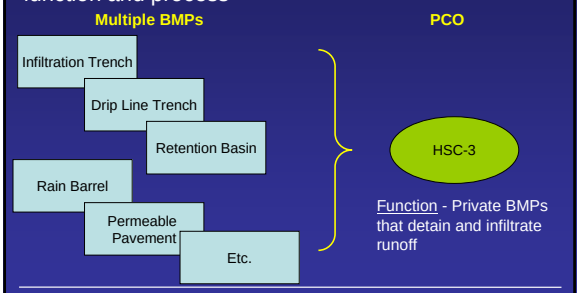
Step 3: Basin-Wide Analysis
- Provide input to Watershed Model
- Watershed Model simulations estimate pollutant load reductions

PCO Considerations

- Large number of BMPs are applicable to urban uplands and groundwater
- BMPs are typically applied in various combinations, configurations, and sizes depending on site conditions
- Potentially creates an unmanageable number of alternatives

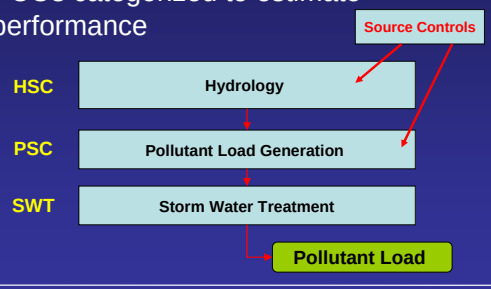
PCO Development

A single PCO represents multiple BMPs having similar function and process



PCO Performance Estimates

- PCOs categorized to estimate performance



PCO Performance Estimates (cont.)

- Pollutant Source Controls
  - Represented by adjustments to existing condition EMCs by land use
  - Tahoe Basin storm water data and other applicable data applied
  - Aggregation of multiple BMPs improves land use condition
  - Best professional judgment applied

PCO Performance Estimates (cont.)

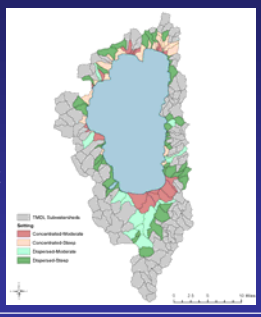
- Hydrologic Source Control
  - Specified storage volume and infiltration rate
  - Capture ratios computed
- Storm Water Treatment
  - Median effluent quality from Tahoe storm water monitoring data and ASCE database
  - Capture ratios computed

Urban Upland Settings

- Settings classify subwatersheds to guide potential PCO applications
- Settings based on two key physiographic characteristics
  - Impervious area configuration
  - Average slope of urban area
- Many other performance factors captured by Watershed Model (e.g., meteorology, land use, soils, etc.)

Urban Upland Settings

- 4 Settings defined
  - Concentrated-Steep
  - Concentrated-Moderate
  - Dispersed-Steep
  - Dispersed-Moderate
- Settings recognized to not represent project implementation scale



Treatment Tiers

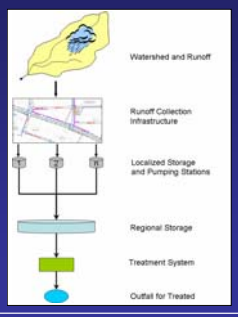
- Conceptual combinations of PCOs applicable to a particular Setting
- Two standard Treatment Tiers defined
- Represent steps or levels in expected water quality performance and cost
  - Tier 1: Similar to existing practice
  - Tier 2: Tier 1 plus increased spatial scale of PCO implementation and more advanced PCOs applied

Treatment Tier Example

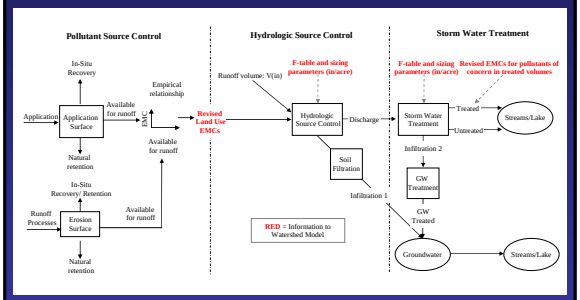
PCO	Description of PCO Function	Spatial Scale of Application		Rationale for Spatial Scale of PCO Application and Key Assumptions	
		Tier 1	Tier 2	Tier 1	Teir 2
PSC-1A	Road drainage system stabilization; distributed collection of pollutants; Road abrasives application reductions, maintenance and operations	50%	0%	Road shoulders parallel to slope stabilized; road shoulders perpendicular to slope not stabilized	Not applied
PSC-1B	PSC1A plus increased maintenance and operations; Use of alternative deicers; Use of advanced road abrasive collection technology	0%	100%	Not applied	Standard assumption for Tier 2 treatment tier
HSC-2	Decrease runoff reaching outlet in steep sloped catchments	15%	30%	Select opportunities to disperse runoff while considering physical constraints	Tier 1 plus additional drainage infrastructure to disconnect and disperse runoff
HSC-3	Private BMP implementation to detain and infiltrate runoff	50%	100%	Standard assumption for Tier 1	Standard assumption for Tier 2
SWT-2A	Mechanical separation	40%	0%	Slopes limit opportunities for runoff capture	Not applied
SWT-2B	Mechanical separation with media filtration	0%	100%	Not applied	Extensive subsurface construction for treatment

Pump and Treat Tier

- Developed specialized treatment tier
- Collection and pumping of storm water to a regional treatment plant
- Applied in concentrated settings



PCO Performance Informing Watershed Model Simulations



Preliminary Results (Surface Water)

Estimated Average Annual Load Reduction (Metric Tons)

Setting	Pollutant of Concern	Tier 1	Tier 2	Pump & treat
Concentrated-moderate	Fines < 63 µm	520	1,200	1,100
	Total Nitrogen	5.6	13	6.9
	Total Phosphorus	1.3	2.1	2
Concentrated-steep	Fines < 63 µm	310	760	670
	Total Nitrogen	2.3	6.2	3.7
	Total Phosphorus	0.8	0.7	1.2
Dispersed-moderate	Fines < 63 µm	160	400	n/a
	Total Nitrogen	1.6	5.2	n/a
	Total Phosphorus	0.4	1	n/a
Dispersed-steep	Fines < 63 µm	200	520	n/a
	Total Nitrogen	1.2	4.8	n/a
	Total Phosphorus	0.5	1.1	n/a

Groundwater Background

- Key question:
  - What is the impact of urban storm water infiltration on groundwater nutrient loading to the Lake?
- Estimated changes to groundwater loads independent of Watershed Model
- Baseline conditions assumed from Groundwater Framework Study for Lake Tahoe (ACOE 2003)
- Mass balance approach used

Key Steps in Approach (Groundwater)

1. SWMM used to quantify infiltrated volumes
2. Compared and related SWMM results to ACOE (2003) for baseline conditions
3. Used SWMM to estimate changes in infiltrated volumes for Tier 1 and Tier 2 implementation
4. Applied estimates of Tier 1 and Tier 2 characteristic runoff quality infiltrated
5. Developed estimates of pollutant loads to groundwater

Preliminary Results (Groundwater)

2007 Nutrient Budget	DN (MT/yr)	DP (MT/yr)
Groundwater contribution	35.7	4.9
% of total annual load to Lake Tahoe	17%	36%
Treatment tier	**DN load reduction (MT/yr)**	**DP load reduction (MT/yr)**
Urban Upland Storm Water PCOs		
Tier 1	(0.1)	0.2
Tier 2	2	0.87
Sewage System Maintenance		
Tier 1	0.3	0.03
Tier 2	0.6	0.06
In-situ Groundwater Treatment		
Tier 2	not evaluated	0.28

Text in parenthesis indicates an estimated increase in annual load

Overview of Load Reduction Estimates for Atmospheric Sources of Pollutants

Richard Countess
Atmospheric Deposition SCG Lead
September 10, 2007

Outline of Presentation

- Atmospheric Deposition Pollutant Budget
- Technical Approach
- Pollutant Control Option Evaluation
- Site-Scale Analysis (settings, treatment tiers)
- PCOs Chosen for Atmospheric Pollutants
- Assumptions
- Load Reduction Estimates
- Conclusions

2

Atmospheric Deposition Pollutant Budget

- Nitrogen: 218 MT/year (55% of N budget)
- Phosphorus: 7 MT/year (15% of P budget)
- Fine Sediment
  - 750 MT/year (5% of FS budget)
  - 75 x 10^{18} particles/year (16% of FS budget)

3

Technical Approach

- Developed emission inventory to identify major atmospheric sources of pollutants in basin.
  - Extrapolated CARB's 2005 PM, NOx and NH_3 emission inventories for the CA portion of basin to the entire basin based on population & VMT.
  - Modified CARB's estimates based on basin specific source activity data & emission factors.
  - Used basin specific source profile test data to estimate emissions for TP and EC.

4

Nitrogen Sub-sources (based on updated EI)

- On-road vehicles: 48%
- Off-road equipment: 27% (97% diesel)
- Boating: 7%
- Area Sources: 7%
- Stationary Sources: 5%
- Residential Wood Combustion: 3%
- Aircraft: 2%

5

FS and P Sub-sources (based on updated EI)

- Unpaved roads: 46%
- Paved roads: 43%
- Construction: 8%
- Residential wood combustion: 2%
- Mobile sources: 1%
- Other sources: 1%

6

Technical Approach (continued)

- Calculated “transportable fraction” for resuspended soil to account for loss between source and lake.
- Calculated emission reductions using published control measure efficiency values for PCOs for different treatment scenarios.
- Calculated load reductions by multiplying emissions reductions by “transportable fraction” to account for loss of resuspended soil between source and lake.

7

Pollutant Control Option Evaluation

- Compile list of PCOs for major pollutant sources based on updated emission inventory
  - Pathway Transportation Technical Working Group
  - Pathway Forum
  - California Air Resources Board
  - Western Regional Air Partnership
- Selection of PCOs
  - Effectiveness
  - Viability
  - Applicability

8

Selection Process for Control Measures

- Identify control measures applicable for the basin
- Mobile source control measures reviewed by
  - Gordon Shaw (Transportation Working Group)
  - Earl Withycombe (CARB)
- Eliminate control measures for minor sources
- Eliminate control measures adopted since 2003 CARB Deposition Study which is the basis for the FS budget
- Eliminate control measures only enforceable at the state or federal level

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Site-Scale Analysis: Importance of Settings

- Pollutant sources closer to the lake have a higher probability of reaching the lake compared to distant sources.
- Allows regulatory agencies to implement a step-wise approach for controlling pollutants by focusing on sources most likely to impact the lake.
- Settings based on spatial distribution of on-road mobile source emissions since these emissions account for largest portion of atmospheric sources of TN.

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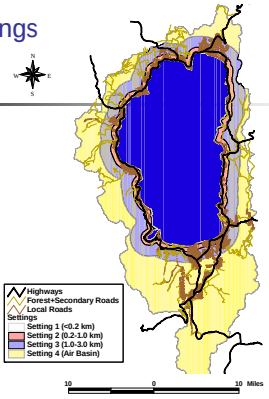
Settings



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Treatment Tiers

- Tier 3
  - Implement measures with highest control efficiencies
  - 100% penetration throughout basin
- Tier 2
  - Realistic measures in terms of costs and acceptability
  - Less than 100% penetration throughout basin
- Tier 1 (Baseline)
  - No additional new control measures

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PCOs Chosen for Paved Roads

- Use of PM efficient vacuum sweepers
  - 45% reduction for weekly sweeping (Tier 3)
  - 23% reduction for biweekly sweeping (Tier 2)
- Switch from sand/cinders to deicers for snow/ice covered roads (Tiers 2 and 3)
- Pave 100' section of unpaved road at each access point to paved road to decrease track-out (Tiers 2 and 3)

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PCOs Chosen for Unpaved Roads

- Tier 3
  - Pave roads (99% reduction)
- Tier 2
  - Apply gravel for 50% of roads (46% reduction)
  - Impose 20 mph speed limit for other 50% of roads (12 % reduction)

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PCOs Chosen for Bare Disturbed Areas

- Chemical dust suppressant with 84% reduction
  - Road construction (Tiers 2 & 3)
  - Building construction (Tier 3)
- 15 mph speed limit with 19% reduction (Tier 2)
- Minimum 12% soil moisture for earthmoving activities will provide 68% reduction for this phase of construction activities (Tiers 2 &3)

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PCOs Chosen for On-Road Mobile Sources

- Charge daily fee for visitors driving into basin to encourage use of Park-and-Ride transit system
- Establish an extensive clean emissions mass transit system for residents and visitors

Note: EPA's 2004 regulations for non-road diesel vehicles and equipment are projected to reduce emissions from these sources by >90%

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Assumptions

- Local sources account for most of the decline in lake clarity.
- Fine sediment is due to resuspended soil and elemental carbon.
- Total nitrogen load reduction equals inorganic nitrogen load reduction estimate multiplied by TN/IN ratio from deposition budget (i.e., 1.47).
- New PCOs for on-road vehicles plus EPA's non-road diesel regulations will achieve nitrogen load reduction goals for each treatment tier.

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Load Reduction Estimates for Basin as Percentage of Atmospheric Dep. Budget

Pollutant	Tier 3	Tier 2
Inorganic Nitrogen	23%	9%
Fine Sediment	65%	26%
Phosphorus	61%	24%

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Basin-Wide Costs and Cost Effectiveness of PCOs

Pollutant	IN		FS	
	Tier 3	Tier 2	Tier 3	Tier 2
Annual Cost ($)	368M	147M	5.7M	2.1M
Cost Effectiveness ($/MT/yr)	18M	18M	12K	10K

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Visitor Fees will Offset Cost of New Transit System and Park-n-Ride Lots

- Visitor fees based on $20/day
  - Tier 3: $312M/year
  - Tier 2: $374/year
- Cost of new transit system & park-n-ride lots
  - Tier 3: $368M/year
  - Tier 2: $147M/year
- Net cost of new transit system & park-n-ride lots
  - Tier 3: $56M/year
  - Tier 2: -$227M/year

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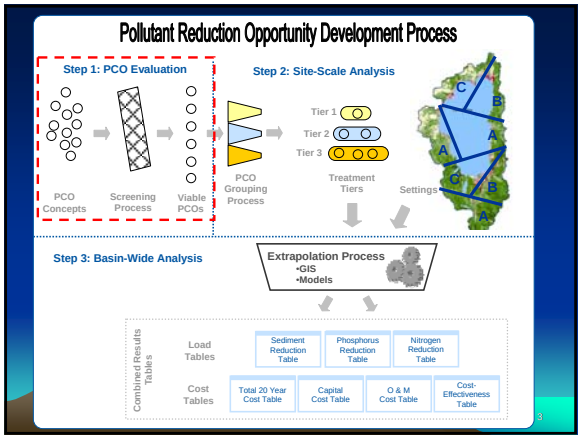
Lake Tahoe TMDL
Forested Upland Source Category Group Load Reduction Analysis

Dr. Mark Grismer, UC Davis
Michael Hogan & Kevin Drake, Integrated Environmental

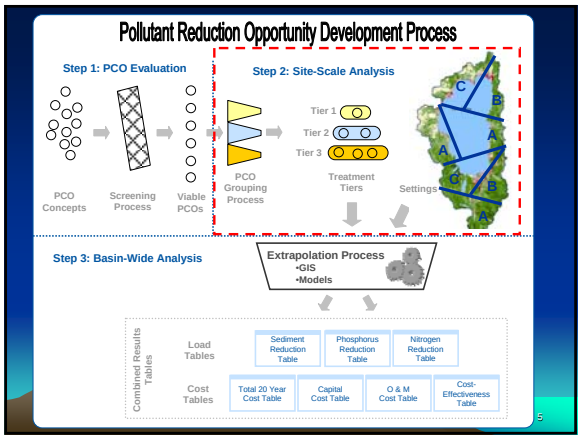
Introduction to Forested Uplands in the Lake Tahoe Basin

- Represents ~80% of land area in Tahoe Basin
- Diverse array of habitat types, soil types and landscape features
- Many land-uses and activities including ski resorts, unpaved roads, “undisturbed” forest, campgrounds, thinning and fuel reduction activities, hiking, biking, wilderness areas, roadless areas, etc.



Pollutant Control Options (PCOs)

Organic matter amendments	Traffic exclusion
Ripping-subsoiling	Pine needle filter berms
Tilling	Flow path check dams
Soil surface roughening	Hydroseeding
Seeding	Infiltration ditches
Mulching	Infiltration swales
Irrigation	Rock-lined ditches
Functional soil restoration	Settling ponds
Road obliteration	Water bars/rolling dips

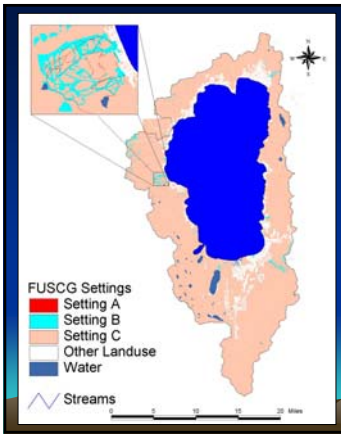


Developing Settings

- Used LSPC model land-use categories as building blocks
- Coordinated with UGSCG to delineate “forested” from “urban” land-uses
- Grouped land-use categories into settings based on functional condition and PCO application

Forested Upland Settings

Setting	Soil Functional Condition	LSPC Land Use Category
A	Bare, highly compacted	Roads_Unpaved
B	Disturbed, surface treatment, no functional mulch cover	Veg_unimpacted EP5
		Ski_Runs-Pervious
		Veg_Recreational
C	Relatively undisturbed, managed forest	Veg_Burned
		Veg_Harvest
		Veg_unimpacted EP4
		Veg_unimpacted EP3
		Veg_unimpacted EP2
		Veg_unimpacted EP1



Total Land Areas of FUSCG Settings

	Area (acres)	% of Forested Uplands
Setting A	311	0.2%
Setting B	1,878	1.1%
Setting C	162,639	98.7%
Total	164,828	

Developing Treatment Tiers

- Tiers represent incremental improvements in soil cover and functional condition
- **Tier 1**—*Standard* treatments used in current practice.
- **Tier 2**—*State-of-the-art* practices designed to achieve *functional* rehabilitation of hydrologic properties.
- **Tier 3**—Treatments designed to develop site conditions that will eventually mimic undisturbed, *natural* conditions.

Setting A Treatment Tiers

Setting	Baseline Functional Condition	LSPC Land-use Category	Treatment Tier 1	Treatment Tier 2	Treatment Tier 3
A	Bare, highly compacted	Roads_Unpaved	Full BMP retrofit (waterbars, rolling dips, armored drainage ditches, stabilize ruts) + annual maintenance	Full BMP retrofit + on-site sediment capture + annual maintenance	Full obliteration/ functional restoration (recontouring, soil restoration, seed, functional mulch, block vehicle access)

Setting B Treatment Tiers

Setting	Baseline Functional Condition	LSPC Land-use Category	Treatment Tier 1	Treatment Tier 2	Treatment Tier 3*
B	Disturbed; surface treatment; no functional mulch cover	Veg_unimpacted EP5	Surface treatment (e.g. hydroseeding, straw mulch or erosion control fabric, straw wattles)	Surface treatment with functional mulch cover (pine needles, tub grindings)	Full recontouring, functional restoration (tilling, organic amendments, organic fertilizer, seed, functional mulch cover), establishment of native hydrology and vegetation
		Ski_Runs-Pervious			
		Veg_Recreational			

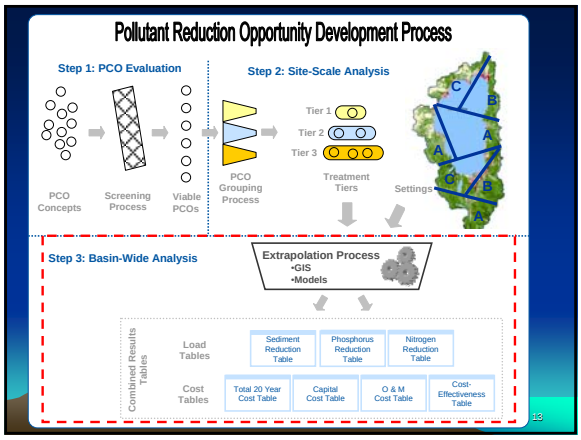
** Treatment Tier 3 is not achievable for the Veg_unimpacted EP5 land-use category*

Setting C Treatment Tiers

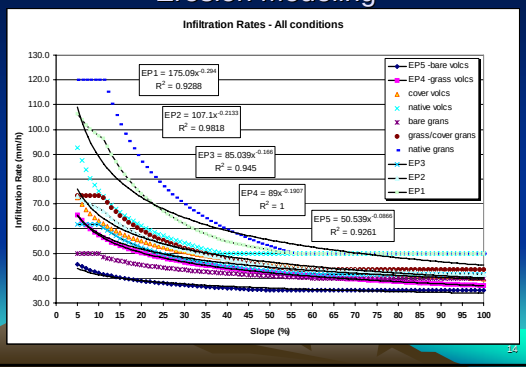
Setting	Baseline Functional Condition	LSPC Land-use Category	Treatment Tier 1	Treatment Tier 2	Treatment Tier 3
C	Relatively undisturbed, managed forest	Veg_unimpacted EP4	Ground-based equipment + req'd BMPs	Ground-based equipment + full BMPs	Ground-based equipment + full BMPs + restore legacy roads/trails
		Veg_Burned			
		Veg_Harvest			
		Veg_unimpacted EP3			
		Veg_unimpacted EP2			
		Veg_unimpacted EP1			

Required BMPs – waterbar/mulch skid trails, landings and temporary roads; close temporary roads.

Full BMPs – till, mulch and construct water bars on all skid trails; obliterate/recontour (i.e. full functional restoration) all landings and temporary roads.



Integrating Field Measurement and Erosion Modeling



Functional Condition Classes

Functional Condition Class	Description
A	Fully functional forest soils – limited erodibility, high infiltration rates and sustainable soil nutrient conditions.
B+	Approaching functional soil conditions as per class A; may not yet be sustainable, or are limited by available soils and slope.
B	Functional surface soil protection and initiation towards hydrologic functionality; long-term condition uncertain.
C	Disturbed sites with surface treatment that provide temporary cover but little functional erosion control.
D	No protective surface cover and limited infiltration capacity
F	Compacted bare soil conditions; highly erodible.

Merging Settings, Treatment Tiers and Functional Condition Classes

Setting	Soil Functional Condition	Land Use Category	Base-line	Tier 1	Tier 2	Tier 3
A	Bare, highly compacted	Roads_Unpaved	F	C	B	A
B	Disturbed, surface treatment, no functional mulch cover	Veg_unimpact EP5	D	C	B	B
		Ski_Runs-Pervious	C	C	B	A
		Veg_Recreational	C	C	B	A
C	Relatively undisturbed, managed forest	Veg_Burned	C	C	B	A
		Veg_Harvest	C	C	B	A
		Veg_unimpact EP4	C	C	B	B+
		Veg_unimpact EP3	B	B	B	B+
		Veg_unimpact EP2	B+	B+	A	A
		Veg_unimpact EP1	A	A	A	A

Basin-wide Loading Analysis Process

1. Get LSPC model data for all 184 sub-watersheds. *Assume basic hydrologic processes are in effect*
2. Determine baseline loading for each sub-watershed from FUSCG regression equations.
3. Estimate and optimize scaling factor for each sub-watershed such that predicted sub-WS sediment loading is equivalent to that from LSPC.
4. Calculate loading for each setting – treatment tier combination based on soil functional condition classes and corresponding regression equations.
5. Sum loading for each setting across each sub-watershed then sum results from each sub-watershed across the Basin.

Basin-wide Cost Analysis Process

- Obtain cost information from field practitioners, Basin agencies, forestry contractors, ski resort operations managers and FUSCG's contracting experience.
- Assume full treatment costs best reflected by private contractor rates
- Estimate functional life expectancy of each treatment based on observed and measured performance in the field, local agency estimates, FUSCG experience and best professional judgment.
- Estimate costs for each setting-treatment tier combo then sum for the total area (acres) of each setting across Basin to derive Basin-wide total cost and cost per acre estimates.

Basin-wide Load Reduction Matrix

Setting A – Unpaved Roads – 310.8 acres

	LSPC/Base	Tier 1	Tier 2	Tier 3
Sediment (MT/yr)	353.56	313.09	344.65	349.05
Silt (MT/yr)	124.51	113.60	122.55	123.59
Clay (MT/yr)	2.15	2.03	2.14	2.15
TN (MT/yr)	0.47	0.127	0.141	0.222
TP (MT/yr)	0.614	0.157	0.187	0.261
Surface Flow (m^3/yr)	142,079	38,535	42,812	67,570

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Basin-wide Load Reduction Matrix

Setting B – Ski Runs, Recreation Areas – 1877.9 acres

	LSPC/Base	Tier 1	Tier 2	Tier 3
Sediment (MT/yr)	1422.69	1129.50	1197.11	1249.37
Silt (MT/yr)	524.72	421.99	461.49	475.23
Clay (MT/yr)	7.93	6.55	7.33	7.44
TN (MT/yr)	0.633	0.025	0.04	0.162
TP (MT/yr)	0.542	0.021	0.043	0.125
Surface Flow (m^3/yr)	1,137,257	45,136	99,180	262,086

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Basin-wide Load Reduction Matrix

Setting C – Forested Areas – 162,639 acres

	LSPC/Base	Tier 1	Tier 2	Tier 3
Sediment (MT/yr)	9579.28	0	3600.35	7325.55
Silt (MT/yr)	3840.56	0	1719.94	3141.43
Clay (MT/yr)	44.10	0	24.31	38.89
TN (MT/yr)	9.538	0	0.049	1.492
TP (MT/yr)	2.383	0	0.027	0.329
Surface Flow (m^3/yr)	43,205,109	0	202,577	6,969,652

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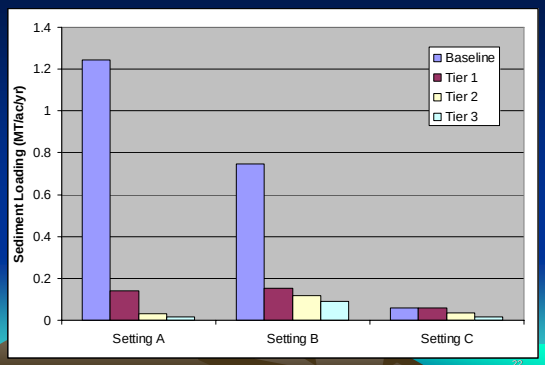
Basin-wide Annual Sediment Loading Per Acre



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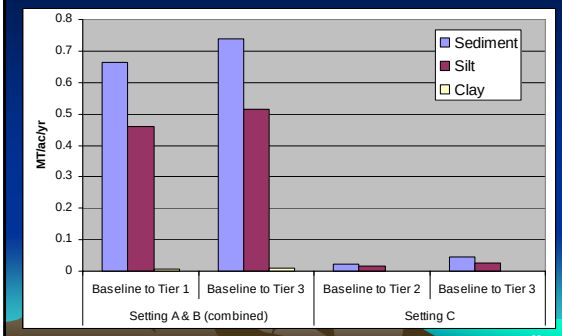
Change in Annual Loading Reduction Per Acre for Different Treatment Tiers



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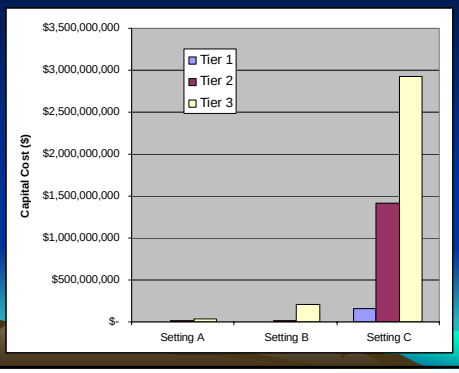
Capital Cost Estimates



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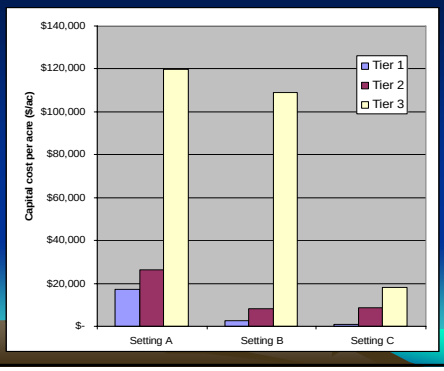
Capital Cost Per Acre Estimates



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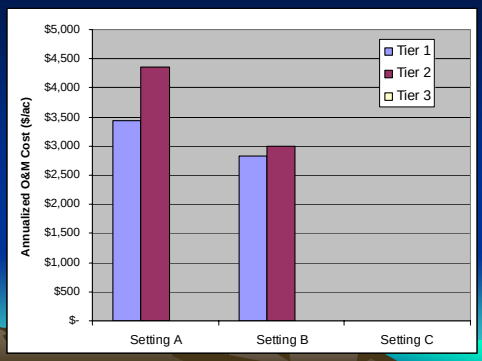
Annualized O&M Cost Per Acre Estimates



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Key Findings

- Greatest load reductions per acre are associated with disturbed volcanic soils on the north and west sides of the Basin, such as unpaved roads, recreational and ski run areas (Settings A and B).
- Per acre load reductions from forested areas are an order of magnitude smaller than per acre reductions from unpaved roads, ski slopes and campgrounds.
- Annual per acre fine sediment loading rates from unpaved roads are roughly double that from ski trails and 20–40 times greater than loading rates from undeveloped forested areas.
- In forested areas, obliteration of legacy areas has the greatest potential to efficiently reduce loading, especially if conducted in combination with planned thinning and fuels reduction treatments.

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Lake Tahoe Stream Channel Load Reduction and Costs

September 2007
Focus Team Workshop

Virginia Mahacek
Valley & Mountain Consulting

Purpose

- Options to reduce basin-wide stream channel erosion pollutants to Lake
  - Stream Banks
  - Stream Bed
    - Sediment
      - Total Sediment
      - Fine Sediment
    - Nutrients
      - Nitrogen
      - Phosphorus

...not 'pollutants conveyed in stream channel, but from other sources'

STEP 1: PCO EVALUATION

STEP 3: BASIN – WIDE ANALYSIS

STEP 2: SITE-SCALE ANALYSIS

STEP 1: PCO EVALUATION

Streambank Erosion PCOs

- Hydraulic Constriction Removal
- Bank Protection
- Bank Strengthening
- Grade Control
- Reduce Bank Height
- Channel / Floodplain modification

Selected PCOs

Bank Protection	Stone toe
	LWD / rootwad revetment
Bank Strengthening	Wet meadow vegetation
	Woody riparian vegetation
Reduce Bank Height	Channel fill with stabilization
	Bank lowering +floodplain excavation
	Bank lowering +angle reduction
Channel/Floodplain Modification	Reconstruction
	Restoration

PCO Effectiveness Data

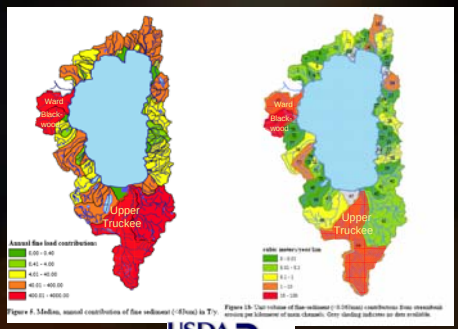
- **Design Standards**
- **Field / Lab Tests**
- **Local Monitoring**
  - Trout Creek
  - Lower Rosewood Creek
  - Upper Truckee Marsh and Trout Creek
- **Modeling**

BSTEM Modeling of PCOs

- **Representative Sites**
  - Actively eroding, 'Moderate and High' fine sediment source areas
- **Selected Hydrologic Period**
  - 1995 Annual hydrograph
  - January 1997 Flood event
- **Validation of Existing Conditions**
- **Parameterized PCOs**

STEP 2: SITE-SCALE ANALYSIS

Stream Fine Sediment Sources



Simon and Others 2003

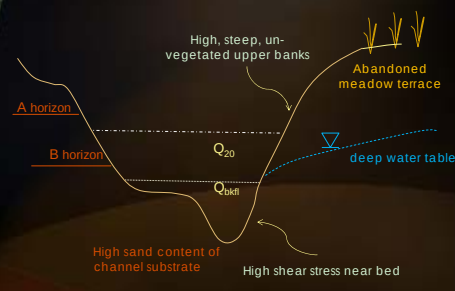
Watershed Settings

Watershed*	Streambank fine sediment load (MT/y)	Percent of streambank fine sediment load (%)
Upper Truckee River	**2,259**	**60.0**
Blackwood Creek	**873**	**23.2**
Ward Creek	**485**	**12.9**
General Creek	48	1.3
Third Creek	23	0.6
Total of all 63 watersheds	3,768	100.0

96.1%

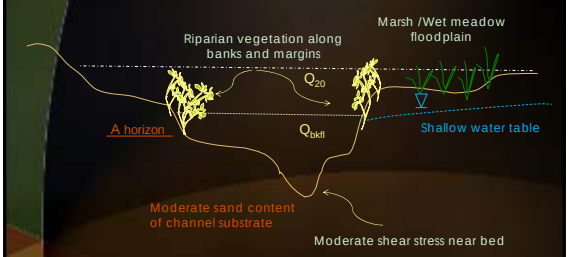
Watersheds with Largest Streambank Fine Sediment (<0.063mm) Loads (MT/y) to Lake Tahoe
Source: Lahontan and NDEP 2007.

Baseline



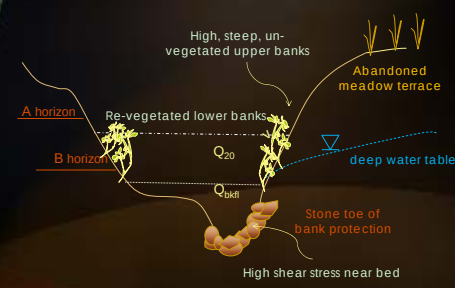
Sketch (not to scale): 2nd Nature, Inc.

Tier 1: Channel Restoration



Sketch (not to scale): 2nd Nature, Inc.

Tier 3: Bank Protection



Sketch (not to scale): 2nd Nature, Inc.

STEP 3: BASIN – WIDE ANALYSIS

Load Estimates

- Key Watersheds
- Pollutant Source Reaches
- PCO Effectiveness Values
- PCOs by Treatment Tier

Spatially-weighted extrapolation from site > reach > stream

Load Reductions (Percent)

Stream	Tier 1-Channel Restoration	Tier 2-Mixed Treatments	Tier 3-Bank Protection
Blackwood Creek	41.5	71.2	83.5
Upper Truckee River	51.7	64.1	81.1
Ward Creek	40.9	68.9	82.2
Top Three Sub Total/Averages	44.7	68.1	82.3
General Creek	42.1	N/A	82.4
Third Creek	44.7	N/A	82.4
Top Five Totals/Averages	44.0	N/A	82.3

PCO Cost Estimates

- Recent construction costs for implemented projects in Tahoe Basin
- Construction + O&M over 20-years
- Cost per 1,000 ft of treated channel
  - Scaling for stream size
  - Assumptions for public lands
- Comparison to planning estimates

Cost Comparisons

- By Tier
  - Total cost and cost per load reduction for Restoration higher; not all benefits valued
  - Total cost and cost per load reduction for Protection lower; may be incomplete

- By Stream
  - Length of treated reaches
  - Varied source magnitudes

Initial Questions?

Identify, Screen & Analyze Pollutant Controls

Focus Team Pollutant Controls Meeting Notes September 10 & 11, 2007

Lake Tahoe Total Maximum Daily Load
Urban and Groundwater Focus Team
Meeting Summary

September 11, 2007, 8am – 10:45 am

Session 1 objective: Discuss potential options for reducing urban and groundwater sources of fine particles, nitrogen and phosphorus to Lake Tahoe

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Meeting Attendees: Scott Cecchi, Nicole Beck, Brent Wolfe, Ed Wallace, Penny Stewart, Sarah Hussong Johnson, Liz Harris, Charlie Donohue, Paul Nielsen, Scott Brown, Audrey McCombs, Marc Grismer, My-Linh Nguyen, Michael Hogen, Russ Wigart, Kevin Drake, Lauri Kemper, Mark Kiesler, Gary Garofalo, Jag Grewal, Kansas McGanhan, Barbara Shanley, John Johnson, Steve Kooyman, Anand Moganti, Rick Robinson, Tim Hogan, Robert Erlich, Steve Looke, Elizabeth Harrison, Hannah Schembri, Kim Gorman, John Reuter, Chad Praul, Bob Larsen, Doug Smith, John Riverson, Larry Benoit, Jeremy Sokulsky, Jack Landy, Michelle Sweeney (facilitator), Dave Roberts, Rebecca Bryson (note-taker)

Overview of the Presentations

Introduction and Opening Statements

The facilitator opened the meeting by explaining that that this was the first meeting of the Urban and Groundwater Focus Team, comprised mainly of agency staff. She noted that there are three other focus teams meeting: Atmospheric Deposition, Forest Uplands, and Stream Channel. The objectives of the meeting were:

1. To update the Focus Team on the latest TMDL-related research and answer any initial questions and clarify the materials presented.
2. To get feedback from the Focus Team on how the information is organized and presented prior to the first public presentation
3. To receive input on potential options for reducing atmospheric sources of fine particles, nitrogen and phosphorus to Lake Tahoe, and
4. To provide recommendations on additional research needed or policy matters raised by proposed pollution controls.

Water Board Presentation:

Bob Larsen, the Project Leader from the Lahontan Regional Water Quality Control Board (Water Board) gave a brief overview of the TMDL process and findings to date. This presentation and the most recent documents produced by the TMDL can be found at: http://www.waterboards.ca.gov/lahontan/TMDL/Tahoe/Tahoe_Index.htm.

Urban Uplands and Groundwater Experts' Presentation

Ed Wallace presented the work of this source category group. Their presentation is available at the URL listed in the previous paragraph. A summary of their analysis can be found in section 3.2

of the Lake Tahoe TMDL Pollutant Reduction Opportunity Report, also available at the URL above.

Question and Comment Period

The Urban Uplands and Groundwater source category group and members of the TMDL team answered a variety of questions during the session.

Pollutant Control Options: Have there been any source reduction strategies that have been taken off the table already because of cost? No, cost was only used as one factor that affected placement of pollutant controls in Tiers. Cost and public acceptability will be considered at later meetings with the Focus Team and Pathway Forum. The information presented today does not represent a prescriptive approach; it is intended to start the discussion of what is possible.

EMCs from BMPs: How were the EMCs (event mean concentrations) from BMPs on the ground measured and calculated? The team reported that they had been measured for two years from 16 specific sites and those numbers were used for the Watershed Model. These values were generally the same ones used for load reduction calculations, but literature values were used when local values were not available.

Hydraulic Calculations: Do hydraulic calculations consider multiple storm events? Yes, the team used a long hydraulic record, which includes calculations on a hourly basis over several years. This method helped the team look at total volume and long-term performance.

Cost Estimates: There were several questions about the cost estimates. It was noted that the cost estimates were not necessarily linear. The team also noted that while Pump and Treat Tier did not assume Tier 2 operations were in place, it did assume a Tier 1 level of conveyance to get the water to the treatment storage/stations. The team also stressed that the cost estimates provided included a 20 year maintenance plan in the estimate that incorporated the personnel needed to run those operations. Ed Wallace explained that the increase in performance often corresponded with increased cost/frequency in O&M. It was also explained that the cost included stormwater collection infrastructure along streets and associated repaving costs.

The team noted that the reason Tier 2 was so expensive (in line with the Pump and Treat Tier) was that it included fairly expensive and extensive operations that would involve more rigorous maintenance than Tier 1 to operate efficiently. For the Pump and Treat option, they would only be applied in concentrated settings and would be more cost effective. The group discussed whether it would be more reasonable to show cost of settings/acre or other performance versus cost metrics.

Clarification of Treatment Tiers: There were several questions about how Tier 1 and Tier 2 were defined and what type of Tier 2 treatment technologies were included. The team explained that each Tier represented a combination of PCOs. Tier 1 consisted of incremental improvements above current EIP projects that they deemed achievable based on existing BMPs. For Tier 2, they assumed greater application of BMPs within project areas, and more advanced treatments such as media filtration. Tier 2 includes both wider geographic coverage of project areas and more intensive application within the projects. For example, Tier 2 includes deicers and more efficient vacuum sweepers. Slide 12 and the table on page 118 in the Pollutant Reduction Opportunity report provide more detail. The team noted that Tier 2 involved increased O&M cost both by amount of existing facilities as well as in terms of increased frequency.

Definition of Urban Upland Area: The team explained that the settings were defined by GIS analysis. Any area that was greater than 1% impervious cover was considered Urban Upland (see page 109 of the report). Most of these subwatersheds include a large proportion of the highways around the Lake.

Numerical Values of Reduction Rates: There was a question about the basis for the numerical values used to derive reductions (was it modeled, field research/measurements and/or expert opinion)? For Pollutant Source Controls (PSCs), the main inputs were revised land use EMCs (event mean concentrations). Thus the Watershed Model for existing conditions uses characteristic EMCs, developed from monitoring in the Lake Tahoe basin. So when PSCs are applied, the land use conditions are improved, so the team needed to account for that in the quality of the runoff.

The effects of hydrologic source controls were primarily estimated by estimating physical parameters such as volume and infiltration rates, so for a particular size of Hydrologic Source Control (HSC), the team used the Watershed Model to estimate performance based upon specified design parameters. Stormwater treatment performance was based primarily on information from the ASCE international BMP database.

The team confirmed that the numbers from the TMDL monitoring a few years back fed into these numbers. The majority of data was Tahoe-specific (for example, from Caltrans). The team stated that they attempted to characterize well-treated, controlled run-off quality based on available data, and to distinguish that from Watershed Model land use (generally untreated) EMC values.

Total Load Reduction Associated with Infiltration: There was a question about how much load reduction is achieved by infiltration (the questioner assumed it was not 100% because some percent of DP and DN make it to the lake) but they wanted clarification on the "treatment efficiency" of groundwater. The team explained that for tier 1, the Watershed Model estimates a 7% reduction in runoff volume, for Tier 2, a 15% reduction, but this runoff would be infiltrated to groundwater. However, the team also stressed that better quality water would be infiltrated thus less pollutants would reach the groundwater.

How Much Reduction is Needed: There were several questions about how much total reduction is needed (from Urban Uplands) according to the clarity model? It seems like the approach here is to estimate the effects of chosen actions rather than to determine pollutant reductions needed first, then choose the PCOs to provide that level of reduction.

The rationale for trying to estimate what reductions could be achieved in each source category at this stage in the process is to help TMDL team and other agencies in the Basin determine what load reduction activities seem most promising. Once the options and the potential reductions of each are clearer, then the Water Board can feed this information back into the model to determine more specific numbers in each source category.

Exclusion of "Non-quantifiable" PCOs: There was a question about how the Water Board plans to acknowledge/encourage those PCOs that are not measurable but that may still provide significant benefit. Water Board staff indicated that they would continue to support the implementation of such actions and that once better tools for quantification are developed, these controls will be brought into the analysis. However, for now non-measurable options are not included in the report. It was noted that source control BMPs, in particular, are typically the most difficult to quantify in the Urban and Groundwater source category.

It was also stressed that the TMDL is currently looking at this data from the 30,000 foot level. The team stressed that the approach they used was not to evaluate the impact of specific source controls per se, but rather evaluate the question of what level of EMCs is achievable with pollution controls.

John Reuter stressed that if one looks at the question from an even higher level, we first need to answer the general question of whether it is even possible to implement enough BMPs to achieve the clarity required. He noted that no one had that information before now. He explained that once the whole spectrum of options is understood/analyzed, we can then focus on the most promising candidates.

Tier 2 and (Pump and Treat Tier): Larry Benoit asked about the relationship between Tier 2 and Pump and Treat Tier. He noted that in the analysis some Tier 2 may be applied to subwatersheds that have functional limitations, such as high groundwater, which would indicate that that PCO combination might not work well there and that a pump and treat option might be more effective there. He suggested that there may be additional potential for load reduction if the analysis included HSC or PSC. He noted that he was involved in a study at Kings Beach that might be able to evaluate some of these issues. The team noted that the Tiers were not intended to be additive because only one could be implemented on the same land area. However, the Pump and Treat Tier was only applicable to a fraction of the urban area and other Tiers could be applied to the complimentary area.

A Placer County representative reported that in the initial estimates of costs for a pump and treat (type of) system at Kings Beach had an estimated 90% efficiency of removal for a cost of $40m, whereas for an overall 76% efficiency, the estimated costs are only $8m.

The team stressed that the pump and treat option <u>does</u> include the cost of the collection system. In terms of performance, however, the team focused on how much was captured and how clean it was at the end and thus it does not include the potential effects of the capture step. Meeting participants noted that because the team did not consider intensive PSCs with the pump and treat option, the cost/benefit numbers may not necessarily reflect all the benefits. The team noted that the additional benefits are still unclear because by adding PSCs at the upper end, it does not necessarily reduce pollutant loads; however, they acknowledged that it might reduce O&M costs.) The report acknowledges that the team had the least confidence in the performance/load reductions estimated related to pump and treat because several assumptions were required to estimate how much stormwater could be captured and pumped.

Bob Larsen acknowledged the good points raised and noted that given time and resource constraints, the pump and treat option will be further analyzed through a feasibility analysis that will provide the type of information necessary to study this option at a finer scale.

There were several follow up questions about the point of discharge. The team noted that they assumed the point of discharge would be directly into the lake. However, the team noted that there were many options/variables related to the pump and treat option that had to be assumed including the size of the infrastructure, how much storage, how much pumping and the location of the outfall which all affect how much is captured, how much is bypassed. These are some of the types of issues that will be addressed in the TRPA study mentioned earlier.

There was a question about discharge limitations and the team reported that the discharge limitations assumed for the effluent concentrations were .5mg/l for FS (which might be too high),

0.09 mg/l for phosphorus, and no decrease for DN. Larry Benoit noted that there are several aspects of how a pump and treat option could affect pollutant loads/effluent concentrations, particularly if a wetland system is employed, and that this would be considered further in the TRPA feasibility study. Larry explained that the TRPA study is, not a demonstration project. The purpose of the study is to take a broader look at what it would take to establish a working pump and treat system, to have it be functional over a 20 year O&M cycle and to develop criteria to evaluate certain concentrated subwatersheds or communities where it would make sense.

Suggested Future Study/Next Steps:

- Conduct more intensive studies on the cost/benefit of a pump and treat option and how to make it more efficient based on information from future TRPA study.
- Combined Tier 2 and Pump and Treat analysis should be conducted in terms of its feasibility to determine the ultimate achievable reduction for urban stormwater.

Effluent Limits: There was a question about the status of effluent limits in the Basin Plan and whether they are enforceable or whether the focus is shifting to load reductions. Water Board staff reported that the effluent limits are still in the Basin Plan (approved in 1980). The deadline for compliance, at which time they will be enforceable, is November 2008. Staff noted that the Water Board is moving to a load-based approach – and the TMDL will provide such a load-based approach. However, until such time that this approach is approved, the effluent limits are the basis for regulation. The Water Board does anticipate having some type of transition plan between November 2008 and 2010 when the TMDL is expected to be adopted, but they have not talked with their authorities yet.

Watershed Burn Area: There was a question about how the wildfire/burned areas affect the numbers. Fire is included as a land use application in the Watershed Model. But it includes primarily historic – prescribed and wildfires. Anticipated burns are not included. It was also asked whether there will be a difference in runoff from urban areas as people start to create greater areas of defensive space. The TMDL team noted that the Watershed Model could be used to analyze anticipated actions such as each property owner creating 30 feet of defensible space around their structure.

Future Build Out/Growth: There was a question about if and how future change/growth has been factored in and if not whether a foreseeable, reasonably conservative future condition—including climate change—might be modeled and used to develop wasteload allocations. The team noted that both urban build out and climate change had been studied in previous Watershed Model analyses.

Use of Clarity Model to-Date: There were several questions about the extent to which any of the numbers provided had been used in the Clarity Model to predict load reductions, and whether the model is a transient or steady state model (it is the former). It was pointed out that the cities/stormwater agencies were most interested in the end goal of what actions they would be required to take as part of the TMDL efforts to restore Lake clarity. It was noted that the Clarity Model had not been used to run the numbers yet, but this work would be available in the reasonably near future.

Effectiveness of BMPs: There was a question about BMPs and whether the Watershed Model could predict their effectiveness. John Reuter noted that while the Clarity Model could not predict the effectiveness of specific BMPs, it did show that if we had a magic wand and could reduce the pollutant load by the prediction 55% today, in 10 or 15 years only, the Lake would return to its

30m of clarity fairly soon. He also pointed out that the number we are aiming for of 30m in clarity was a reality in the Lake only 30 years after the Comstock period, so the Lake can and does respond rapidly to changes.

Groundwater Loading: There was a question to confirm that the groundwater loading was analyzed in combination with the urban runoff tiers and that the net outcome was not adverse if mitigations are implemented and whether other adverse or favorable consequences of these tiers was considered (e.g. benefits to air quality of road sweeping, improved vacuuming).

Additional Questions Not Addressed at the Meeting:

- Was an effort made to specify how much hydrologic control concentrates on biological forms and nutrients?
- Was an effort made to quantify biologically available forms of nitrogen and phosphorus in the different source categories and different treatment options?
- Was there any consideration of construction of in-stream weirs to force backflooding and increase sediment deposition in the upgradient floodplain? In other words, is it possible to model an approach to have a net gain in floodplain sedimentation using in-stream controls?

Issues to Consider and Suggested Future Studies

- Conduct pump and treat feasibility study
- Use Clarity Model to determine impact of various pollutant control strategies
- Assess implications of increased defensible space and other fire risk reduction measures
- Confirm that future growth/development is addressed (e.g. via application of USGS land use model)
- Further consider climate change impacts
- Use Clarity Model to determine time and duration for expected lake response based on: TMDL implementation schedule, climate change
- Determine how to assess and consider non-quantifiable PCOs
- Verify/support conclusion that GW loads will decrease even with increased hydrologic loading due to emphasis on infiltration.
- SWQIC (Storm Water Quality Improvement Committee) should address studies needed to assess effectiveness of existing BMPs

Lake Tahoe Total Maximum Daily Load
Forest Uplands Focus Team
Meeting Summary

September 11, 2007, 11:15 am – 2:00 pm

Session 1 objective: Discuss potential options for reducing forest upland sources of fine particles, nitrogen and phosphorus to Lake Tahoe

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Meeting Attendees: Mark Grismer, Michael Hogan, Kevin Drake, Sue Norman, Cyndi Walck, Theresa Loupe, David Fournier, Dave Roberts, Mike Vollmer, Martin Goldberg, Mike Shophirt, Phil Scoles, Harold Singer, Hannah Schembri, Kim Gorman, John Reuter, Chad Praul, Bob Larsen, Doug Smith, John Riverson, Larry Benoit, Jeremy Sokulsky, Jack Landy, Michelle Sweeney (facilitator), Rebecca Bryson (note-taker)

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6. To get feedback from the Focus Team on how the information is organized and presented prior to the first public presentation
7. To receive input on potential options for reducing atmospheric sources of fine particles, nitrogen and phosphorus to Lake Tahoe, and
8. To provide recommendations on additional research needed or policy matters raised by proposed pollution controls.

Water Board Presentation:

Bob Larsen, the Project Leader from the Lahontan Regional Water Quality Control Board (Water Board) gave a brief overview of the TMDL process and findings to date. This presentation and the most recent documents produced by the TMDL can be found at: http://www.waterboards.ca.gov/lahontan/TMDL/Tahoe/Tahoe_Index.htm.

Forested Uplands Experts' Presentation

Michael Hogan and Kevin Drake from Integrated Environmental along with Dr. Mark Grismer from UC Davis presented. Their presentation is available at the URL listed in the previous paragraph. A summary of their analysis can be found in section 4.2 of the Lake Tahoe TMDL Pollutant Reduction Opportunity Report, also available at the URL above.

Question and Comment Session

The Forested Uplands and Groundwater source category group and members of the TMDL team answered a variety of questions during the session.

Burn Distinction: There was a question about whether there was any distinction in their analysis of those areas that had experienced wildfire versus prescribed burns. The team noted that the LSPC model uses the "equivalent roaded area" (ERA) methodology to account for these differences. The Forest Service staff has done extensive analysis characterizing the relative impacts of harvest and burn events—whether prescribed or wildfires—and has determined ERAs for each area, which are essentially a representation of how much of the impacted area behaves like an unpaved road. ERAs were spatially referenced for every event that occurred during the period of the team's calibrations and were incorporated into/overlaid on the land use layer. The team then clarified that prescribed and managed fire was included in the category of "veg burn".

Prescribed Burns: There was a question about the expected increase in prescribed burns over the next 20 years and whether they were predicted in the analysis. The team noted this was excluded because the analysis is based on existing conditions, as opposed to predictions of future treatment effects. It was noted that there is a literature review of fire effects on water quality in the Forest Uplands Appendix B. Sue Norman noted that there is a very useful report that does predict impacts from wildfire that could be helpful. It is from the Rocky Mountain Research Station and it is under the General Technical Reports section of their website. This excellent resource addresses the impacts of wildfire on air, water quality, flora and fauna in four large volumes.

Phosphorus and Nitrogen Data: Larry Benoit asked whether the source for phosphorus and nitrogen data was from the 2006 Soil Map Unit analysis and how different was their baseline data from Tahoe baseline. Larry pointed out that the reason for a study in 1997 was that there was no phosphorus data on Tahoe soils. So if there are questions on why the load reductions are so low, we need to be clear on the source. It was explained that the team used data from the LSPC model/database to estimate the nitrogen and phosphorus numbers by subwatershed. In terms of the reduction in P and N, the only reductions in loads included in their calculations are those based on increased infiltration and reduced runoff rates. The team noted that this was a conservative estimate because several of the treatments include creation of plant biomass that will also affect these numbers and may affect atmospheric deposition, so the numbers are conservative.

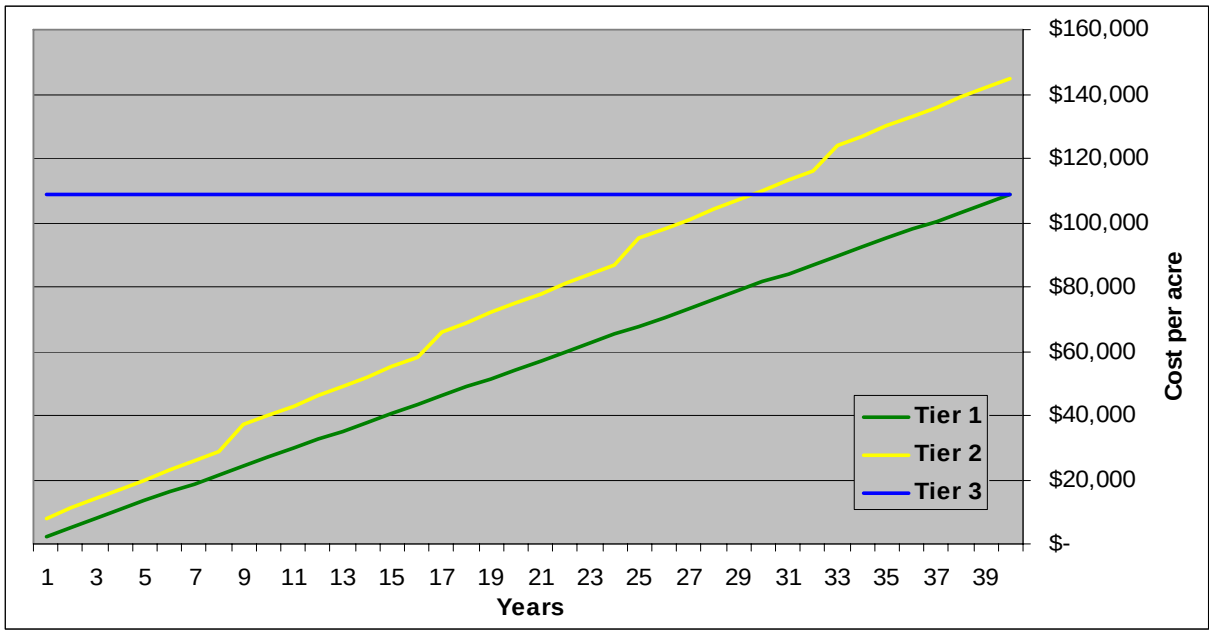
John Riverson noted that the Watershed Model does not use the coefficients from the 2006 Soil Map directly as inputs in the model. The team calibrated the model using EMCs (representing the loadings from land uses) and LTIMP data, which includes 10 major tributary outlets representing 50% of all Tahoe Basin stream flows. Their calibration effort was to get the sediments and nutrient loads at those outlets (in the model) to be consistent with what was observed. For the reductions, they did provide GIS spatial summaries of soil properties that were used to inform the equations that Mark described.

Legacy Road Treatment: Cyndie Walck commented that the graph showed much larger costs for Treatment Tier 3 in Setting A than Tier 2. Is this based on mostly legacy road treatment? If so, she believed that Tier 3 versus Tier 2 cost differential should not be too great? Once you get the equipment to the site, it is not that much more to do a full treatment. She noted that in Setting A, the analysis shows that one can get almost 100% reduction by eliminating the roads, but in Setting C, it is never 100% because there is natural level of erosion. Is the amount of reduction

indicated for Setting C for the whole of the area, or just looking specifically at roads. Because her data shows that almost all erosion is from roads. Therefore are the costs really that high if you just focus on the roads in that setting?

The team explained that the numbers are approximations and the next step is to get more field info on road removal and what are the impacts, for example you need to clean up the gullies created from the old roads. Cyndie responded that Tier 2 may be a one time, lower cost but you haven't necessarily fixed the issue the same as you would have by going to Tier 3. The team also noted that it is important to examine these issues over a 20 year maintenance/life cycle as explained above. For example, hydromulching is cheap but the life cycle is only 1-2 years.

The team noted it was not its charge to go out over 20 years, but it is important to analyze it over this type of scope/timescale. To this end, the team did some analysis to show that at 30 years, the cost of on-going Tier 2 treatment will be equal to and then exceed what would have been spent for a one-time Tier 3 treatment. At 40 years, the cost of on-going Tier 1 treatments, such as mulching, will be equal to and continue exceeding what would have been spent for a one-time Tier 3 treatment. See diagram below.



It was noted that another thing that plays into this, is that as we do more, we find better ways to do the same thing at a lower cost. Or, we find ways to integrate a number of practices. For example, we want to reconstitute organic matter into the soil while a land manager is out there trying to remove biomass and we could use the trees he/she is cutting down. As we integrate different elements of landscape management, we reduce costs across the board, which can help pay for these practices.

Future Studies/Considerations:

- Need to take into account in the calculations the economies of scale of combined landscape management practices.

John Reuter pointed out that even if the cost is the same, the confidence we would have of Tier 3 being effective is much higher than for Tier 1 treatments. It was also noted however, that a good percentage of the unpaved roads are currently in use and cannot be removed/restored.

Infiltration Rates Methodology: Regarding the methodology used for determining the infiltration rates, the team noted that they used rainfall simulations. They assumed steady infiltration near the surface and did not consider subsurface issues. Once the ground is saturated, the modeling automatically adjusts the infiltration rates accordingly. However, the modeling did not account for any hydrophobic soil effects.

Costs regarding the Forested Setting: David Fournier asked for a clarification on the costs. He noted that the costs for PCOs for Setting C were calculated on the basis of restoring/addressing 10% of the acres in the Forested Setting, but it appears - given the cost of $2.9m - as if the team did a cost estimate for all the acres in this setting. The team confirmed that for their cost estimates they assumed that 10% of every acre would need to be treated and then multiplied that by the number of acres.

Cyndie questioned whether the analysis also included the predicted costs of restoring roads that would be built in the future for maintenance or fuels reduction efforts. She noted that if so, this would be inconsistent with the cost projections in the other 2 treatment tiers. The team was also asked to clarify what percentage of the Forested Setting, they considered to be legacy roads and they replied less than 0.5% The team noted that the numbers do account for the cost of using and then restoring the roads necessary to do thinning, but do not account for the cost of the thinning itself.

Assumed Efficiency of BMPs: There were several questions about how the efficacy of certain BMPs were established. The team noted that the model/data were limited so they did not look at individual BMPs, but rather lumped them into Tiers. They did acknowledge that there are different forest practices and different accounts of cost estimates depending on USFS, State Parks, Conservancy or private land treatments. In terms of Tier 3, for example, they only took into account the impacts of full restoration. They noted that treatments in Tier 2 assumed treatment on 5% of the area and the addition of 5% roads to achieve those treatments.

Impacts of More Aggressive Fuels Removal: There was a question about how pollutant loads will be affected by the increase in mechanical removal of fuels in SEZ and more aggressive fuels reduction in general. The team noted that they had not studied that issue and that it would be difficult to predict the impact of future as of yet unquantified activities.

Future Studies/Considerations:

- Research further how pollutant loads will be affected by increases in mechanical removal of fuels in SEZ and more aggressive fuels reduction in general.

Legacy Roads: Sue Norman asked about the basis for the information/assumption regarding legacy roads. She reported that the USFS has done an inventory on legacy roads in the Basin. They identified 100 miles of roads in 7 seven years and have restored almost all of them. She believes that the other unpaved roads the USFS does know about; however are still in use by USFS and are not legacy roads. She noted that as part of that inventory, she had them look for obliterated roads and her teams could never find them as they were all overgrown.

The team responded that in their analysis/judgment, there are still many legacy roads that may have been “grown over” or revegetated but are still affecting the functioning of the soil. They

acknowledged that the legacy roads might have been difficult for USFS staff to find if they did not know where to look, or they might use different criteria to determine that they were restored. Michael Hogan explained that in his prior and ongoing work in the Basin, he has often encountered old roads where manzanita has completely overgrown the road. However, when analyzed, his team found that the level of compaction was just as great as it was 15-20 years prior when first built and it was creating streams/ gullies. The team noted that in its professional judgment, they would estimate that 5% of each area in the Forested Setting contains erosion hot spots (from various historical activities).

Road Connectivity: Sue Norman also asked whether the analyses of yield considered connectivity of roads to water bodies because USFS analysis indicates different results. The team noted that they did not analyze the spatial distribution of roads in relationship to water bodies. They stressed that they would need a new set of tools to do the calculations at that level, however, that coul be important to address in a future stage of analysis.

Sue noted that USFS is developing a synthesis of information about forest thinning and the affects on water quality which should be available in about 2 months. Their WEPP modeling shows that actual delivery of sediment to a water body is considerably less than the erosion generated, depending on the location of the site and the water body. This must be represented in order to prioritize treatment. Sue suggested that TMDL research should correlate LSPC modeling and SCG work with the forthcoming USFS results. Two different models are being used with different resolutions. They should be reconciled in the implementation phase. The TMDL should check with the USFS to determine a realistic level of implementation for future restoration/obliteration.

She noted that if the team has estimated the cost, but do not fully know the benefits, then the numbers would be less accurate. It was noted that the atmospheric deposition team had used a transport fraction to account for the load reductions prior to reaching the Lake and that a similar calculation could be developed for the model here. She questioned spending billions of dollars just to eliminate 350 MT as called for in Setting A.

Temporary Treatment of Roads and Landings: David Fournier noted that there will be long-term needs for access in the Forested Setting. He did stress, however, that in general USFS has not built temporary roads for fuels treatment; they use existing roads. USFS has maps of all Level 1 roads. They know exactly they are there and that they are available to use even if they are vegetated. While some full obliteration of roads is needed, he asked whether some roads and landings could be BMPed and laid to rest for a few decades and then resurrected when needed again. It was noted that this could be specific to a watershed.

Increased Thinning Efforts/SEZs: Sue Norman explained that the next stages of forest management in the Basin include significant thinning efforts. If USFS has to restore and recontour all the roads, they will then just have to recommission them. Since the Angora fire, there has been increased demand for fuels reduction – quicker and cheaper. Sue Norman acknowledged that it was very important to be careful in the SEZs and the report should acknowledge that. She asked if the study had made any recommendations on project design, measures, and tools. She suggested it would be very useful if the TMDL model could tell USFS where it is appropriate to treat more land quicker and cheaper.

Future Studies/Considerations:

- Need more in-depth research on future forest management issues/potential impacts.

- Use TMDL model to help inform USFS's future thinning efforts - where it is appropriate to treat a greater land area quicker and cheaper.

Flow Splitting: Scott Cecchi asked about the potential impacts of flow splitting, or diverting "clean" Forest flows before they enter urban areas and overload water quality improvement facilities. He explained that they are considering this option in Keller Canyon and he wanted to know if there could be modeling to determine when it is appropriate based on the cost/benefit of the necessary infrastructure and the effects on overall hydrologic function. The team noted that they do have information by subwatershed and the model could predict what type of water quality impacts might be expected based on its functional condition. They stressed, however, that it would be more useful to incorporate field monitoring information from this Keller Canyon project into the TMDL model to help analyze the impacts of this type of approach in other areas.

Sources or Sinks: Tim Hagen then asked what role overgrown, forested areas serve within the impervious/built-out urban areas. Are they becoming sources rather than sinks? The team noted that this should be considered from a biogeochemical perspective.

Prescribed Burns/Catastrophic Fires: There was a question about whether future development/change has been accounted for, and whether a reasonably foreseeable future condition – such as increase in prescribed burns – could be incorporated into the model. For example, in the Veg_harvest and Veg_burn categories, can the model anticipate the impacts of the increased burns in the next 20 years, and develop the best management practices and cost information possible to inform the TMDL implementation plan?

John Riverson explained that the model could incorporate these inputs, but it does not do that yet, and it was discussed by the team as a potential next step. For example, one could look at the areas proposed for timber harvesting and incorporate them. The issue is that before the Tetra Tech contract expires, it will be important to find a place to house the running/updating of the model so such factors can continue to be analyzed.

It was noted that in terms of Martin Goldberg's question on incorporating the impacts of catastrophic wildfire; however, it is more difficult to model. Without knowing where, when and how large, it is too speculative. It was acknowledged that at this time there is not a lot of information on fire in the LSPC – except for the Gondola Fire. John Reuter and audience members noted that now is the perfect time to start gathering information from the Angora fire to use as input, and that monitoring is already in place, but that additional time is needed for data collection and analysis.

Michael Hogan reiterated that most of what they modeled was forest treatments, but that that does need to be balanced by the potential of future fires. Particularly with climate change, studies show that the number of wildfires in the Sierra has increased and will continue increasing. It was noted that in the CWE analysis for the South Shore, there was a GEO-WEPP analysis being used to predict the water quality effects of not treating an area and having a catastrophic fire instead.

It was noted that as the pressure on USFS increased to treat the Forested Areas, it would be critical to lay out factors important in that consideration: what questions should be addressed, what tools could be used. It was suggested that a Working Group be formed to look specifically at these issues. This group could provide a forum for meaningful discussion regarding the types of fuels reduction/fire management activities proposed and what type of mitigation could off-set potential impacts. While it was acknowledged that this approach could be useful in elevating the

issue to the regional planning level and allow people to assess trade-offs, it was also noted that it should not be so closely tied to the TMDL process that it might delay the process. It is important not to hold up the TMDL because studies/discussions in this particular area are not yet resolved.

Future studies/considerations:

- Consider developing a fuels reduction/water quality Working Group to examine trade-offs associated with increased forest management related to wildfire.
- Establish long-term plan to house the Watershed Model/LPSC model and identify/fund appropriate staff to run/update model at end of Tetra Tech contract.
- Begin incorporating potential impacts of increased fuels reduction activities and catastrophic wildfire, as feasible, into the model.

Summary of Future Studies/Considerations

Technical

- Study short-term and long-term cost tradeoff comparison including analysis of O&M vs. Capital costs.
- Study ways to integrate elements of landscape management into treatment efforts to increase cost effectiveness.
- Use Angora fire as an opportunity for study; begin incorporating impacts of increased fuels reduction activity/catastrophic wildfire, as feasible, into model.
- Incorporate findings of USFS-commissioned study
- Research further how pollutant loads will be affected by increases in mechanical removal of fuels in SEZ and more aggressive fuels reduction in general.

Policy

- Develop consistent inter-agency information/understanding regarding legacy roads; agree on how many legacy roads currently affect soil hydrology
- Develop criteria for erosion control project implementation – splitting forest and upland
- Develop/clarify proximity to waterbody analysis
- Identify long-term funding for updating and running models
- Determine where/how wildfire prevention enters into an all-agency management equation
    - Specify the role of the TMDL in this process
    - Help identify the factors that need to be considered using models
    - Determine need to establish a related working group?

Lake Tahoe Total Maximum Daily Load
Stream Channel Focus Team
Meeting Summary

September 11, 2007, 2:30 am – 5:00 pm

Session 1 objective: Discuss potential options for reducing stream channel sources of fine particles, nitrogen and phosphorus to Lake Tahoe

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Meeting Attendees: Virginia Mahacek, Craig Oerhli, Mike Rudd, Nicole Beck, Elizabeth Harrison, Cyndie Walck, Tim Hagan, Scott Carroll, Jennifer Quickel, Hannah Schembri, Kim Gorman, John Reuter, Chad Praul, Bob Larsen, Doug Smith, John Riverson, Larry Benoit, Jeremy Sokulsky, Jack Landy, Dave Roberts, Michelle Sweeney (facilitator), Rebecca Bryson (note-taker)

Summary of the Presentations

Introduction and Opening Statements

The facilitator opened the meeting by explaining that that this was the first meeting of the Stream Channel Focus Team, comprised mainly of agency staff. She noted that there are three other focus teams meeting: Atmospheric Deposition, Urban and Groundwater, and Forest Uplands. The objectives of the meeting are:

9. To update the Focus Team on the latest TMDL-related research and answer any initial questions and clarify the materials presented,
10. To get feedback from the Focus Team on how the information is organized and presented prior to the first public presentation,
11. To receive input on potential options for reducing stream channel sources of fine particles, nitrogen and phosphorus to Lake Tahoe, and
12. To provide recommendations on additional research needed or policy matters raised by proposed pollution controls.

Water Board Presentation:

Bob Larsen, the Project Leader from the Lahontan Regional Water Quality Control Board (Water Board) gave a brief overview of the TMDL process and findings to date. This presentation and the most recent documents produced by the TMDL can be found at: http://www.waterboards.ca.gov/lahontan/TMDL/Tahoe/Tahoe_Index.htm.

Stream Channel Experts' Presentation

Virginia Mahacek, from Valley & Mountain Consulting, the leader of the Stream Channel SCG presented the team's findings. Their presentation is available at the URL listed in the previous paragraph. A summary of their analysis can be found in section 4.2 of the Lake Tahoe TMDL Pollutant Reduction Opportunity Report, also available at the URL above.

Question and Comment Session

Bank Stabilization vs Channel Restoration: Cyndie Walck pointed out that bank stabilization may be more effective at reducing erosion at a spot location; however, failure often occurs where the protection ends. Therefore, one would have to stabilize the entire channel bed to be effective. She suggested that the comparison of load reductions in Tier 1 and Tier 3 is not representative because while the stabilization effort may increase the bank's strength, it does not necessarily decrease the stream power and so it transferred the problem to the next non-stabilized stream reach.

Virginia pointed out that it was not possible to analyze the response of all treated/ untreated areas. She noted that in general stone toe treatments are considered to be 80% effective at the spot and 50% overall. She stressed that these treatments are relatively cheap and if the team was to consider only the potential water quality impacts, this approach is considerably more cost-effective. She suggested that it is necessary to consider this approach in certain areas where restoration is constrained by property ownership or access issues.

She explained that because the funding did not come through in time for advanced CONCEPTS modeling, this remains one of the least understood aspects. She noted that the data from her team's analysis was the first attempt to consistently quantify application of PCOs in the streams (and it could only be validated for the entire stream level).

Here Virginia stressed that as part of the overall TMDL pollutant budget estimates, stream channel inputs represent only a small fraction of fine sediment particles. However, the costs associated with decreasing those inputs—even if the Channel Restoration approach is employed—are the most cost-effective when compared to the PCOs for other source categories.

Future studies/considerations:

- Need better quantitative monitoring data to improve the effectiveness of the BSTEM and CONCEPTS modeling approach. However if there is no data from field measurements, then it is not possible to validate the modeling results.

Cost/Benefit Ratios- Impacts to Wildlife: Jennifer Quickel asked for clarification regarding the water quality cost/benefit ratios for Tier 1, 2 and 3 improvements and asked about the implications of the cost/benefit ratios are in terms of wildlife impacts.

Virginia asked people to look at the table on the last page of the handout (below), which contained no actual values. For the top three streams, the average cost is $30,000/MT under the Tier 1 (Channel Restoration) option. For the Tier 3 (Bank Protection Option) the average cost was about $1300/MT. So, Channel Restoration is 30 times more expensive. She noted that these calculations were not per mile, but for the total (Cost/MT reduced). She clarified that the $30,000 average is based on the numbers that for Blackwood, the estimated cost would be approximately $28,000, Upper Truckee would be about $44,000 and Ward would be about $18,000 for an average of $30,000. Jennifer noted that she was less concerned about the total estimated costs, and more concerned with the potential impacts to wildlife and how that was not incorporated here. In fact the cost comparisons seem to strongly point to the Bank Protection as the most favorable option. Virginia reiterated that this analysis had focused only on water quality performance as per the charge and Water Board staff stressed that simply having this table does not mean that the Water Board will support Tier 3 Bank Protection implementation. It was agreed that the others values associated with stream restoration had not been calculated or

included yet and that this type of assessment of the additional benefits would need to be part of future research.

Length of Stream Treated: Cyndie Walck asked about what percentage of each stream was anticipated to be treated under the bank stabilization option, and noted that she assumed that the full channel restoration would address a larger percentage of the stream. Virginia clarified that for both Tier 1 and Tier 3 treatments, the team assumed the same length of streambank would be treated for each stream. Therefore, the spatial scale is consistent. For Upper Truckee, they estimated that 11km would fall under the category of high to moderate failing of banks. For Blackwood, the number is 7km and for Ward 3 km. These numbers are held constant across treatment tiers. So, on the Upper Truckee, the team analyzed the impacts of using Tier 1 treatments to treat 11km of the Upper Truckee and then analyzed the impacts of using Tier 3 treatments on those same 11km.

Virginia explained, however, that the variation in the cost effectiveness of the PCOs is due to the fact that certain sections will involve different degrees of grading and construction to install and that will affect the costs. In addition, each stream reach produces varying degrees of FS (based on what percent FS there is/how high the banks are) so the reduction varies by stream reach as well and this affects the cost/benefit ratio.

She also explained that in the first cut of her analysis, she tried to be more realistic about including those areas that people had already proposed for full restoration vs. spot treatments. She found, however, that this approach exaggerated the cost difference. The reason for this was that full restorations were proposed in areas where the FS loads are not very high, but they are being proposed in certain location for other reasons, such as wildlife habitat. This approach thus overstated the costs in terms of water quality benefits.

The question was raised whether people agreed with the number that installing rip-rap would be 30 times less expensive than stream restoration. Cyndie Walck stressed that in her experience with the “hard” engineered solutions, wherever the bank protection efforts ends, the river will start unraveling it and there are costs associated with fixing the resulting problems. So even if a bank protection approach is used only on a portion of the stream, 100% of the stream may need to be treated in the future in response.

Virginia pointed out that even if you need to account for those additional costs, the two treatments would still be different by a factor of 10. She stressed that when it comes to water quality benefits the numbers are significant not only because the costs associated with bank protection are less, but also because the expected benefits – to water quality – are significantly greater. Channel restoration efforts are estimated to reduce loads by 50% while Bank Protection is estimated to reduce loads by 80%. Therefore, it is not only about the total dollars spent, but also the relative benefits to water quality that are quite significant by Bank Protection. She concluded by pointing out that the good news is that there is now good, consistent information from the modeling the team conducted about what it costs to do these types of PCOs in the Basin; the more difficult issue is that no one has put a value on the other non-water quality related benefits.

Overlap with Other Source Categories: Mike Rudd pointed out that efforts to reduce stream loads through channel restoration may also help reduce loads from other sources. For example, recreating floodplains could serve as a sink for upland pollutnats before they reach the Lake Tahoe. It may be important to add the value of PCO effectiveness relative to upland sources, but these improvements could be accounted under the upland source categories. Water Board staff

noted that the TMDL will help evaluate these overlaps. The Water Board is not advancing any particular set of PCOs; they are simply trying to understand/illustrate what the water quality benefits of various types of PCOs would be and what some of the associated costs would be.

Relative Emphasis on Stream Channel Inputs: Since stream channel sources of sediment particles are relatively low, will there come a time in the TMDL process where the decision-makers decide that it is not useful to put time and resources into these efforts?

Virginia turned the conversation back to Cyndie's comment that the water quality impacts are not accurately represented. She acknowledged that the team was not able at this time - due to time and resource constraints - to study the response of treated versus untreated areas over time. Originally, the team wanted to use the CONCEPTS model to analyze how each stream channel would respond both spatially and over a sequence of hydrologic events into the future. She acknowledged that these limitations should be considered in any future judgments/decisions about what treatments should or could be done in the Basin.

However, she also noted that the literature on the effectiveness of stone toe treatments do show 80% effectiveness in terms of water quality performance and Channel Restoration efforts only show 50%. Even if these estimations change over time, the costs still remain quite different. The question for the land managers would be whether they really want to opt for the cheaper, more effective option based on the estimated water quality benefits, when it does not provide benefits to other resource areas. It was also pointed out that full channel restoration cannot be applied everywhere as there will be questions of whether the land adjacent to the stream is available in certain areas.

Capturing Upland Load Reduction Benefits: The Focus Team then discussed again the issue of how to capture the estimated load reductions from uplands sources due to channel restoration efforts. John Reuter stressed that he did not have a strong opinion on where it should be included in the TMDL, but that it would be very important to include. He suggested including it with some caveat that the funding was not available at the time to study this concept in more detail, but that there is a need for further analysis of this issue in the future.

He asked if there was any data available from the CTC project on the rechannelization of the Upper Truckee River that has estimated water quality benefits that could somehow be incorporated into the report until better analysis is available. Bob Larsen noted that the Water Board has asked for this data and but has not received it. If the Water Board does receive questions about this issue, they can always respond that SNPLMA has studies underway to address this issue. Virginia noted that there is no other information out there about water quality and that the Upper Truckee project information will be the first data available.

She also noted that it is only possible to validate the data based on the outputs from the entire stream. There is no data yet that demonstrates the effect on water quality from one specific PCO/treatment option. It was noted that there are a few groups starting to work on this, but it would be misleading to say that someone/some group is currently analyzing this specific issue. John Reuter noted that it will be critical for each of the Source Categories to consider/point out the other benefits associated with the PCOs because the general public does not always make those connections and may just look only at the cost/benefit numbers.

Virginia explained that it is critical to gather more quantitative monitoring data of stream restoration sites because the performance estimates in the literature are so dramatically different – they ranged from <10% effectiveness to >85% for the same PCO. She also explained the costs

do assume a certain amount of maintenance to restore bank protections/channel restoration efforts after large flood events, when necessary. Cyndie pointed out again that although these numbers may show 100% effectiveness at the point of installation, 50 feet down the stream, there may be major problems that are not accounted for in this calculation and the resulting analysis.

Virginia stressed again that while it is important, it will be difficult to monitor and collect data for these small-scale projects because there is no way to validate those numbers at a larger scale. It is not helpful to have more data at the project-scale when we cannot validate the numbers to that scale.

Future Studies/Recommendations:

- Need quantitative monitoring of stream restoration projects as a first step for studying many of the following issues and this monitoring is needed over a long time period so that a variety of conditions are captured.
- Non-water quality benefits need to be considered/evaluated; this could be true for other source categories as well (e.g. air quality benefits associated with decreased vehicle emissions)
- When/if funding becomes available for CONCEPTS modeling, the model should be used to evaluate the pollutant reductions associated with restoration (i.e. reconnection of floodplains)
- Use SNPLMA funding to further evaluate the benefits of increased overbank flooding, increased connectivity to the floodplain
- Ensure that potential load reductions of uplands sources related to stream channel restoration are captured somewhere in the TMDL report/analysis – either in this Source Category or one of the Uplands Source Category

Historical Sediment Delivery Rates: Phil Scoles asked whether historical sediment delivery rates have been calculated for Ward, Blackwood and Upper Truckee River and whether it is known how much the human influences factor into the sediment delivery rate. He was concerned about efforts to change loads from natural sources and interfering with natural processes. A participant noted that it is difficult to separate out the causes of disturbances. He also pointed out that when Andrew was here, he could not determine yet at which stage the watershed was in based on a 6 stage theory of river evolution.

Virginia suggested that this question also applies to the uplands sources and she asked whether this was discussed in the other Source Categories. She noted that whether or not to treat a specific source is a policy question. However, if the natural sources make the problem difficult to treat from an engineering perspective, then land managers may chose to not treat it – not because it captures natural sources, but because it more difficult/costly to treat. In this case it is a technical question, not a policy question.

Here Cyndie Walck raised the question that if 80% of the current loads are “normal” or naturally occurring, then do we want to reduce the loads by 80%, or is 50% through channel restoration more appropriate and reflective of natural conditions. Virginia acknowledged that yes, these changes would lead to major decreases in all sediment sources, which is a trade-off that would have to be assessed.

Framing the Issue: Cyndie noted that while it is ok to present the numbers in this format to a technical group familiar with the trade-offs, she cautioned against presenting the data in this form

to the public that might be more inclined to focus on the bottom line. A participant stressed that for this reason it is critical for the people participating in this meeting to attend the public meetings in order to raise these important considerations.

Sue Norman also pointed out that the information in chapter 6 should be included much earlier in the report and that this would ease people's concerns because it discusses how the larger benefits of stream channel restoration should be considered. The TMDL team noted that this information is available in the Executive Summary of the Pollutant Reduction Opportunity Report. Sue stressed that it will be important for Water Board staff to help clarify the TMDL process because others are not as steeped in the process.

Positive Benefits: Craig Oehrli then announced that one major benefit of the analysis today is that it has already encouraged USFS to develop monitoring plans early in the project process. He is the project lead for the Blackwood project. In the past, they would have not considered the floodplain sediment modeling that they are now considering in the pre-project phase and so this data will be available in the future. And interestingly, his team is also facing similar concerns about uncertainties and variables as mentioned here. He emphasized the need for further research to quantify the benefits of floodplain reconnection for reducing sediment and nutrient inputs from the UTR Blackwood/Ward watersheds overall.

Virginia noted that although the team was not charged with developing a model to evaluate how the stream channel PCOs might impact other Source Categories, her team did develop a conceptual framework for doing so, which can be found in the appendix of their report. Virginia ended on an encouraging note by concluding that having the numbers and the appendices of data with the standardized descriptions of PCOs should be very useful. As well as having regional-based, local estimates about how to scale costs is a valuable resource. Finally, her team's analysis has emphasized the need to have more quantitative data on a project scale.

Summary of Future Studies/Considerations

- Start collecting better quantitative monitoring data to improve the effectiveness of the BSTEM and CONCEPTS modeling approach.
- Determine a way to characterize/quantify non-water quality benefits; this could be applicable to other source categories as well
- Use CONCEPTS modeling as available to evaluate
    - additional load reductions in other source categories/upland areas resulting from stream channel restoration
    - additional benefits beyond water quality performance, where possible
- Assess water quality benefits associated with overbanking and increasing the connectivity with the flood plain

Lake Tahoe Total Maximum Daily Load
Atmospheric Deposition Focus Team
Meeting Summary

September 10, 2007, 1 - 4 p.m.

Session 1 objective: Discuss potential options for reducing atmospheric sources of fine particles, nitrogen and phosphorus to Lake Tahoe

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Meeting Attendees: Dr. Richard Countess, John Reuter, Chad Praul, Bob Larsen, Doug Smith, Karen Fink, David Fournier, John Riverson, Karen Fink, Charles Emmett, Jolaine Johnson, Larry Benoit, Jeremy Sokulsky, Jack Landy, Michelle Sweeney (facilitator), Dave Roberts, Gordon Shaw, Rebecca Bryson (note-taker)

Summary of the Presentations

Introduction and Opening Statements

The facilitator opened the meeting by explaining that that this was the first meeting of the Atmospheric Deposition Focus Team, comprised mainly of agency staff. She noted that there are three other focus teams meeting the next day: Urban Uplands/Groundwater, Forest Uplands, and Stream Channel. The objectives of the meeting are:

13. To update the Focus Team on the latest TMDL-related research and answer any initial questions and clarify the materials presented.
14. To get feedback from the Focus Team on how the information is organized and presented prior to the first public presentation
15. To receive input on potential options for reducing atmospheric sources of fine sediment particles, nitrogen and phosphorus to Lake Tahoe, and
16. To provide recommendations on additional research needed or policy matters raised by proposed pollution controls.

Water Board Presentation

Bob Larsen, the Project Leader from the Lahontan Regional Water Quality Control Board (Water Board) gave a brief overview of the TMDL process and findings to date. This presentation and the most recent documents produced by the TMDL can be found at: http://www.waterboards.ca.gov/lahontan/TMDL/Tahoe/Tahoe_Index.htm.

Atmospheric Experts' Presentation

Dr. Richard Countess, the Team Leader from the Atmospheric Deposition source category group (SCG) then gave a presentation of the findings from his team. The presentation is available at the URL listed in the previous paragraph. A summary of their analysis can be found in section 2.2 of the Lake Tahoe TMDL Pollutant Reduction Opportunity Report, also available at the URL above.

Question and Comment Session

Presentation of Information: There were several questions/comments on the way information was presented and the PCOs were segregated into the different tiers and source categories. Several participants suggested this type of presentation might be difficult for the general public to grasp and assess.

John Reuter explained that the SCG Teams were specifically asked to divide the information this way to form a basis for the overall framework. Based on this initial analysis and stakeholders' input on the individual strategies, the Water Board will develop packages or combinations of PCOs across Tiers and Source Categories. These packages will then be analyzed using the Clarity Model to assess the collective, anticipated benefit to lake clarity. While the Focus Team is seeing a great level of detail, the consultant team plans to aggregate the results at a higher level for the public audience.

Synergies with Other Source Categories: There was then some discussion about how many of the control measures in this category would overlap or synergize with those in other categories – most specifically urban runoff. It was suggested that these synergies be highlighted and emphasized in the technical documents where possible. It was also suggested that the cost estimates try to reflect that as well. For example, deposition occurs both on the lake and on the surrounding land that may contribute to the pollutant load that eventually makes it to the lake through urban runoff. Since the lake comprises nearly ½ the surface area of the Basin, reduction in atmospheric deposition on the lake also could theoretically mean a similar amount reduced in urban runoff. Cost/benefit estimates should reflect that theoretically, up to double the benefit could result.

Pollutant Budget: Dr. Countess asked about the basis for Lake-wide fine sediment particle number budget and whether the Water Board could provide references. The TMDL team noted that all references will be cited in the Phase I Technical Report to be released on Sept 14.

Source of Emissions: Gordon Shaw asked what percentage of emissions was from resuspended soil dust versus tailpipe emissions. For local paved highways the ratio is about 53 to 1; for other paved roads, the ratio is about 16 to 1; for unpaved roads, the ratio is about 8,000 to 1.

Vacuum Sweepers: John Reuter asked whether the types of vacuum sweepers the SCG considered in their analysis of Tier 2 and Tier 3 options were similar to what currently exists in the Basin or more efficient. Dr. Countess explained that they were considering a much more efficient type of street sweeper. The PM-efficient vacuum sweepers are about twice as expensive but collect and retain a much higher percentage of the road dust material compared to ordinary street sweepers. He estimated the Basin would need 6 units for biweekly sweeping and 12 units for weekly sweeping. This assumes 75 miles of roadway/week for each sweeper.

Cost-Effectiveness (Slide 19): It was pointed out that 1 ton of inorganic nitrogen is not equivalent to 1 ton of FS in terms of clarity reduction. It was suggested that the slide 19 be changed to reflect the cost per percent of budget going into the lake. It was noted that since the clarity of the lake is influenced more by the particle count than by mass, it would be useful if the table in slide 19 could be changed to reflect that as well. Finally Dr. Countess noted that since atmospheric sources of phosphorus are associated with atmospheric sources of FS, the atmospheric deposition budget and load reduction estimates for phosphorus should be based on particle count rather than mass.

The group also discussed what government agencies typically consider to be cost effective. In the past $5/lb was considered to be cost effective. The cost-effectiveness for the PCOs for FS is approximately $5/lb for Tiers 2 and 3.

Finally, there was a question of whether it is possible to invest separately in PCOs for FS and nitrogen. Dr. Countess responded in the affirmative to this question and stated that you might have one agency responsible for PCOs focused on nitrogen and another agency focused on PCOs for FS. He explained that the cost estimates for phosphorus reduction are identical to that for FS reduction since atmospheric sources of phosphorus are associated with atmospheric sources of FS. Since the phosphorus content of FS for atmospheric FS sources is ~0.3%, the cost-effectiveness of the PCOs for phosphorus are about 333 times that of the cost-effectiveness of the PCOs for FS.

Visitor Fee Revenue/Vehicle Reduction Discussion: Dr. Countess first addressed how the visitor fee revenue based on a fee of $20/day was derived, explaining that it would be charged per vehicle per day for those visitors electing to drive into the Basin rather than leave their car at a park-n-ride lot at the major access points to the Basin. The assumed revenue generated by this fee shown on Slide 20 was based on an average of 2 people per car. He also noted that the daily fee could be $10/day or $30/day; $20 was just an initial suggestion.

Then there ensued a long discussion on the political viability of this option. In the past, businesses/politicians have been concerned that such an approach could drive away visitors to the Basin. It was also suggested that there is not enough data to show that charging a fee would in fact reduce the number of visitors' vehicles in the Basin and by how much. Dr. Countess pointed out that his team had recommended conducting surveys to answer this issue.

Gordon Shaw suggested that another possibility was to try to reduce/eliminate vehicle trips once visitors/residents were in the Basin. One option here is to create an extensive paid parking system. The advantage of this is that the system could be developed on an incremental basis. It was asked what the community would need to see in order to support this program, and how the TMDL project could help. Gordon noted that Tahoe often considers itself out front, but many cities are ahead of us. Presenting research about what other areas are doing in this area and the positive benefits could help change minds.

He also noted that in terms of getting people off the roads, it is a matter of carrots and sticks. He thought carrots such as a very efficient transport system could help get 5-10% of cars of the road, but sticks would be needed for real change. He noted that the fees for the parking could offset the costs of the transit system.

Suggested Future Research:

- Research other areas, like Yosemite, that have initiated such projects and the resulting impacts on car usage.
- Get a legal opinion on how the daily visitor fee could work as the current understanding is that state run highways funded by the federal government cannot have fees associated with them without an act of Congress.

Karen Fink asked how the numbers shown on Slide 20 were derived. Does the transit system proposal assume that people all park and use the mass transit? Dr. Countess explained that under Tier 2 the goal would be to reduce mobile sources by 10%. Under this scenario, the pay and ride system would be designed to get 10% of the visitors arriving by car to park/ride while 90% would

pay the fee. Under Tier 3, it assumes 75% are paying fees. Charles Emmett noted that while one might assume that the fees generated could help pay for the mass transit system involving clean burning hybrid buses, that scenario does not always happen in reality.

Mass Transit System: Gordon Shaw asked about using CNG versus diesel electric for the mass transit system. It was noted that CNG fueled vehicles may emit as much nitrogen and greenhouse gases as gasoline and diesel fueled vehicles. It was agreed that the document should acknowledge this point because stakeholders may ask about it. Charles Emmett asked if/how the estimates on vehicle emissions were made regarding the increased FS emissions from the buses that would ensue under the proposed mass transit system. Charles pointed out that buses typically produce significantly more pollutant emissions due to their weight and number of wheels compared to cars. It should be pointed out that the SCG team assumed that each bus would replace a minimum of 8 cars on the roads.

Suggested Future Research:

- Analyze the break-even point of nitrogen and resuspended road dust emissions from the increased number of buses of a mass transit system and the subsequent reduction in number of cars.

Framing the Discussion: Finally, it was pointed out that both the visitor fee and the mass transit system were not control measures per se; rather the control measure is to decrease vehicles by a specific percentage and the discussion should be framed accordingly. Several participants noted that neither the visitor fee, nor the mass transit system are new ideas in the Basin and would likely meet with resistance. Therefore, the more the Water Board could frame the control measure as reducing car use, the better. Karen Fink suggested including a "middle strategy" option for on-road vehicle sources of nitrogen in addition to the major, expensive (if one excludes the revenue generated by visitor fees) option of instituting a mass transit system. It should be pointed out that the SCG team did not assume fees for the use of the mass transit system by either visitors or local residents.

Suggested Future Research:

- Study the socio-economic factors that drive people's behavior in order to understand how best to reduce car usage in the future, both visitors and local residents.

Remote Sensing Option: Dr. Countess also suggested another alternative noting that the mass transit system would be expensive on an annual basis if one did not implement visitor fees. He noted that most of the inorganic nitrogen problem was likely coming from 10% or less of the vehicles. He suggested that for just a few million dollars, it would be easy to set up a remote sensing program to detect the gross NO_x polluters. He thought this might receive more acceptance as it truly targets those causing the problem. Charles Emmett noted that although it could be considered, (1) the locals tend to have the dirtiest cars so they might not support this option, (2) the remote sensing technology does not work very well in the Tahoe air basin where there are high levels of dust on the paved roads, and (3) cars that don't meet smog check requirements, do not necessarily have the highest NO_x emissions. Charles also noted that untuned cars may actually have lower NO_x, although they may also have higher hydrocarbon emissions.

Eliminated PCOs: A meeting participant asked which PCOs for minor sources were eliminated (as referred to in Slide 9). For example, the report contains a control measure for commercial boating but the presentation did not address that in Slides 19 and 20. Dr. Countess explained that they eliminated the proposed PCO for commercial boats because they had recently learned that commercial boating activity are a negligible source of nitrogen emissions in the Basin. CARB's

2005 emission inventory for the Basin indicated that commercial boating accounted for 14% of the total NO_x emissions, but recent data from TRPA indicate it is less than 1%. Dr. Countess explained that his team did not recommend any control measures for recreational boating that accounts for about 6% of the total NO_x emissions or for aircraft that accounts for about 2% of the total NO_x emissions. He also explained that the proposed PCO for residential wood combustion (RWC) assumes a 25% reduction in RWC activity for Tier 2 and a 50% reduction for Tier 3. However, since RWC accounts for only about 3% of the total NO_x emissions, the resulting inorganic nitrogen load reductions were not significant.

Prescribed Burns: Dr. Countess noted that prescribed burns were accounted for under "Area Sources" and make up about 2% of the total NO_x emissions. Wildfire had not been accounted for but as John Reuter noted, there was not much data on wildfire emissions in the Basin. John reported that inputs of nitrogen to the lake from the recent Angora Fire in the form of air deposition comprise only 2-4 % of the annual input for all sources. Jack Landy asked whether growth in the amount of prescribed burns due to increased fuel reduction were accounted for in the load reduction estimates and the answer was no. It was noted that none of the SCGs had been tasked with looking at growth or likely future change in pollutant loads. [Although the urban runoff SCG did consider a build-out scenario, as stated in the Focus Team meeting on September 11th.] Dr. Countess noted that the Basin-wide emission inventory included Basin-specific emissions data for prescribed burns, campfires and residential wood burning based on a UC Riverside study done for CARB in 2004.

Suggested Future Research:

- Analyze the number and type of boats on the lake. It should be noted that Charles Emmett stated that TRPA has a fairly good emissions inventory for boats operating on the lake and that CARB has signed off on TRPA's estimates. Dr. Countess suggested that TRPA's underlying assumptions should be reviewed.
- Analyze potential increases in boat use/emissions related to proposed changes to the shore zone ordinance.
- Analyze impacts of expected increases in fuels management (also taking into account potential biomass utilization).
- Analyze potential air quality impacts of future growth/build-out.

Sources on Vehicle Miles on Unpaved Roads: There was a question about the accuracy of the daily vehicle miles assumed by the SCG team for unpaved roads (namely 20). Dr. Countess explained that the number was derived from the CA DOT's estimate of 36-40/mile-day on an annual basis, which seemed high for unpaved roads in Tahoe because unpaved road emissions essentially go to zero for many unpaved roads at high elevation in the winter. He assumed 20 vehicles/mile-day for unpaved roads in the Basin on an annual basis, even though the numbers may be lower. However, he also assumed heavier vehicles with more wheels than vehicles traveling on paved roads that would cause an increase in resuspended road dust.

Deicers vs. Sand/Cinders: Dr. Countess noted that his team did not analyze the impact of switching from sand/cinders to deicers. He had assumed that the sand/cinders were removed quickly but meeting participants noted that during winters in the Basin, it could be as long as 3-4 months before roads are cleaned.

Suggested Future Research:

- Additional analysis of the potential load reductions of switching from sand/cinders to deicers

Protocols for Air Deposition Measurements: Charles Emmett asked about the protocols used for the field measurements leading to the atmospheric deposition pollutant load budget to determine if they matched existing Basin protocols. John Reuter stated that two sets of data were used, namely (1) CARB's atmospheric deposition results for N, P and FS from the 2003 Lake Tahoe Atmospheric Deposition Study (LTADS) and (2) UC Davis and TERC deposition bucket estimates for N and P from field measurements conducted for at least a decade. Dr. Countess pointed out that CARB's estimate for phosphorus was about one-third that of the UC Davis and TERC estimates.

Transportable Fraction: Dr. Countess pointed out that particle size plays a role in the transportable fraction of FS and P. For emissions of fine elemental carbon particles from combustion processes, that are typically less than 1 micron in diameter, he assumed a transportable fraction of 100%; for FS and phosphorus associated with FS, he assumed a transportable fraction of 13% for the Basin.

Relationship of Phosphorus to FS: There was some discussion of what percentage of phosphorus is associated with FS. CARB's LTADS results and chemical profiles based on source test results for the major sources of FS in the Basin indicate a phosphorus content of 0.3% whereas the pollutant load budget in the TMDL report indicates a phosphorus content of 0.9%.

Suggested Future Research

- Assess what percentage of P is associated with atmospheric sources of FS

Wrap-up and Next Steps

The facilitator thanked Dr. Countess and members of the Focus Team for their input and emphasized the importance of the Focus Team members attendance at the follow up meetings outlined below:

September 27th 8am to 5pm: Pathway Forum Workshop
October 11th 8am to 5pm: TMDL Focus Team Meeting (with all Teams Together)
October 25th 8am to 5pm: Pathway Forum Workshop
December 6th: 8am to 5pm: Pathway Forum Workshop
February 7th: 8am to 5pm: Pathway Forum Workshop and Focus Team Mtg Final

Identify, Screen and Analyze Pollutant Controls
Forum September 27, 2007 Meeting Materials

PATHWAY Forum Agenda

Lake Tahoe TMDL
September 27, 2007, 8:30a.m. – 4:30 p.m.

Topic: Options for reducing sources of fine particles, nitrogen and phosphorus to Lake Tahoe

Location: Lake Tahoe Community College, Aspen Room (new library building)

8:30 Registration and refreshments

9:00 PATHWAY objectives September 2007 - March 2008 (Harold Singer)

9:30 The core questions of the TMDL

Questions addressed: (Geoff Schladow and John Reuter)
What pollutants are causing Lake Tahoe's clarity loss?
How much of each pollutant is reaching Lake Tahoe?
How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?

Current question: (Bob Larsen)
What are some options for reducing pollutant inputs to Lake Tahoe?
What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

12:00 The Clarity Challenge (Harold Singer, Tom Porta)

12:30 Lunch

1:30 What are options for reducing pollutant inputs to the Lake? (Jason Kuchnicki and Chad Praul)

How to interpret and use results
Key considerations
September – Organize your thoughts on options for reducing pollutant inputs.
Provide feedback to the TMDL team mid-October.

2:00 Discussion about options to reduce pollutant inputs to the Lake

---

3:00 Break

3:15 Continual improvement and funding cycles and opportunities (Jason Kuchnicki)

3:25 Overview of approach to focus question for fall - winter discussion (Harold Singer)

3:45 Public comment period

4:00 Update on TRPA and USFS activities (John Singlaub, Terri Marceron)

Charting a course to

Clarity

The Lake Tahoe Total Maximum Daily Load

How are we going to restore Lake Tahoe's famed clarity?

PATHWAY
A VISION FOR TAHOE'S FUTURE

Charting a course to

Clarity

TMDL Core Questions

Questions Addressed

Charting a Course

The Lake Tahoe TMDL Technical Report

The Pollutant Reduction Opportunities Report

Current Question

Future Questions

TMDL Core Questions

Questions Addressed

What pollutants are causing Lake Tahoe's clarity loss?

How much of each pollutant is reaching Lake Tahoe?

How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?

Findings published in the *TMDL Technical Report*

TMDL Core Questions

Questions Addressed

What are options for reducing pollutant inputs to Lake Tahoe?

Findings published in the *Pollutant Reduction Opportunity Report*

TMDL Core Questions

Current Question

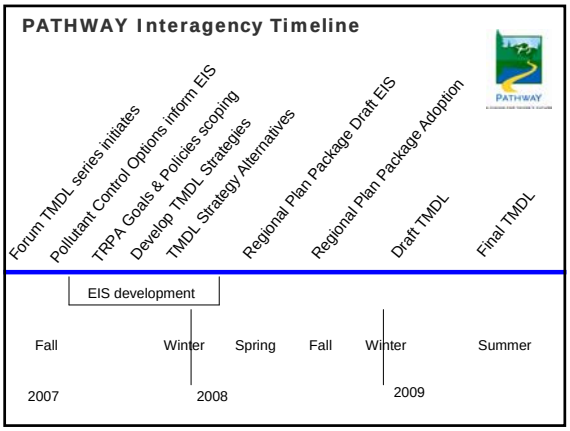
What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

TMDL Integration into PATHWAY

TRPA will be evaluating the full range of pollutant control options, along with your input, in the environmental document for its Regional Plan update.

PATHWAY
A VISION FOR TAHOE'S FUTURE

PATHWAY Interagency Timeline



Fall – Winter 2007/2008 Forum Topics & Meeting Format

September 27, 2007	October 25 and December 6, 2007		February 7, 2008
meeting & presentation	workshop meeting	workshop meeting	meeting & presentation

Documents Posted Online

http://www.waterboards.ca.gov/lahontan/TMDL/Tahoe/Tahoe_Index.htm

http://ndep.nv.gov/bwqp/tahoe.htm

http://tiims.org

Charting a course to

Clarity

How are we going to restore Lake Tahoe's famed clarity?

Research and Modeling

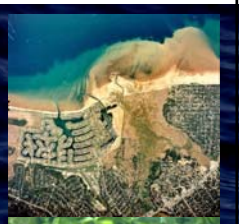
Results update

Questions addressed

- What pollutants are causing Lake Tahoe's clarity loss?
- How much of each pollutant is reaching Lake Tahoe?
- How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?

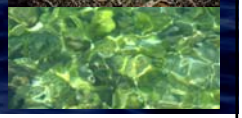
What pollutants are causing Lake Tahoe's clarity loss?

Fine sediment



Algae

phosphorus
+
nitrogen



The Lake Tahoe TMDL Research Program

- Proactively addressing critical gaps in scientific understanding of Lake Tahoe's clarity loss
- Developing a science-based approach to reducing pollutant inputs
- Developing tools to inform management decisions
- Integrating lake, watershed and air processes in a modeling framework

The Lake Tahoe TMDL Research Program

Research…

- that is significant at the national level
- involving over 150 people
- creating tools that will last and evolve with the continual improvement cycle
- made possible by important financial commitments to Lake Tahoe

The Lake Tahoe TMDL Research Program

Regional, National and International Experts

- UC Davis
- DRI
- UNR
- CARB
- US ACOE
- USGS
- USDA - Nat. Sed. Lab
- Tetra Tech, Inc.
- Hydroikos
- GeoSyntec
- Lahontan
- NDEP
- Caltrans
- NDOT
- nhc
- 2NDNATURE
- IERS
- Valley + Mountain Consulting
- Entrix
- Countess Environmental
- Environmental Incentives
- USDA - LTBMU
- USDA - NRCS
- US NPS
- US EPA
- TRPA
- NTCD
- CTC

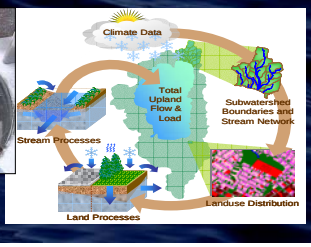
The Lake Tahoe TMDL Research Program

Sources of information

- Historical Tahoe data
- Literature
- New monitoring
- Lab experiments
- Field experiments
- Demonstration projects
- Statistical analysis
- Modeling (with verification)
- Best professional judgment

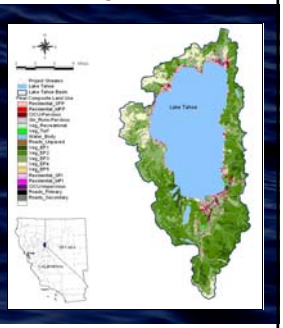
The Lake Tahoe TMDL Research Program

TMDL Technical Report includes results of 15 new studies



The Lake Tahoe TMDL Research Program

Reliable GIS Land Use Layers



The Lake Tahoe TMDL Research Program

Modeling

Urban runoff, forest runoff and groundwater
- Deposition modeling
- LTAM
- Load modeling

Atmospheric deposition
- LSPC hydrology and loading
- Statistical modeling

Stream channel erosion
- Modeling using CONCEPTS

Lake response
- Lake Tahoe clarity model

The Lake Tahoe TMDL Research Program

The Lake Tahoe Watershed model enables…

- Estimation of pollutant inputs from the entire watershed
- Estimation of pollutant inputs by land use
- Estimation of pollutant inputs based on management scenarios

The Lake Tahoe TMDL Research Program

Urban runoff

Stormwater monitoring

- 16 sites Basin-wide
- Similar scope as LTIMP
- Covers a variety of land uses

The Lake Tahoe TMDL Research Program

Urban runoff

Groundwater loading

- Existing well data
- Spatial distribution of loading
- Load of nitrogen and phosphorus (not particles)
- Good agreement between 2003 US Army Corps study and 1997 US Geological Survey studies

The Lake Tahoe TMDL Research Program

Urban runoff

Fine particles

Land Use Category	Land Use Name or Watershed	Runoff Fines Distribution Mass (< 20 um)
Urban	Residential_SF Residential_MF CICU Roads_Primary Roads_Secondary	57 ± 18 %
Non-Urban	General Creek Blackwood Creek Ward Creek Trout Creek	13 ± 3 %

Data comes from stream and stormwater monitoring

Difference larger when size vs. weight considered

The Lake Tahoe TMDL Research Program

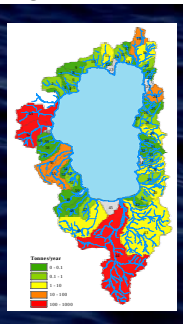
Atmospheric deposition

- Data from multiple sources
- Estimates for fine particles, nitrogen and phosphorus
- Seasonal (wet vs. dry) deposition
- Importance of local sources

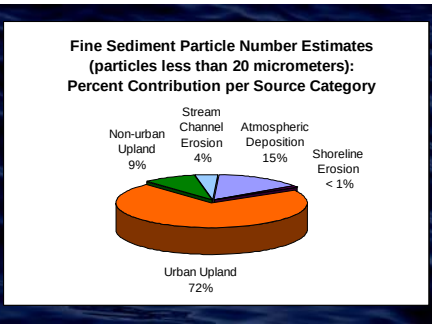
The Lake Tahoe TMDL Research Program

Stream channel erosion

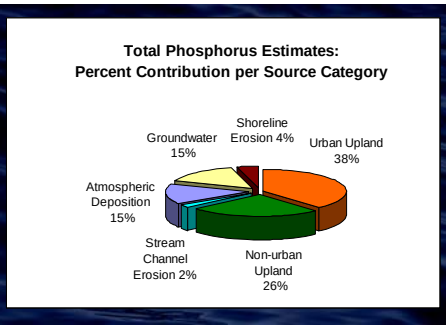
- First time that total sediment and fine sediment loading from stream channels has been sufficiently studied



How much of each pollutant is reaching Lake Tahoe?

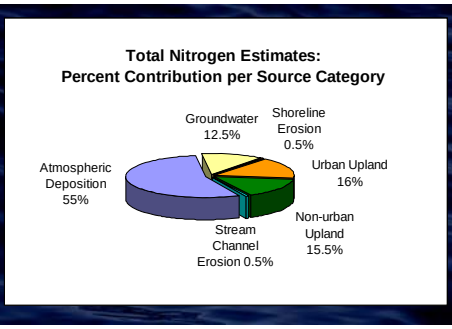


How much of each pollutant is reaching Lake Tahoe?



Research and modeling results update

How much of each pollutant is reaching Lake Tahoe?



Research and modeling results update

The Lake Tahoe TMDL Research Program

Confidence and Uncertainty

Confidence Level
High Confidence
Medium Confidence
Low Confidence

Research and modeling results update

The Lake Tahoe TMDL Research Program

Confidence and Uncertainty

High

- Based on reliable and extensive field data or modeling supported by extensive field data.
- Peer-reviewed studies exist specifically for the Tahoe Basin.
- Weight of evidence provided by similarity to other independent studies for Lake Tahoe.

Source Category		Total Nitrogen (metric tons/year)	Total Phosphorus (metric tons/year)	Number of Fine Sediment Particles ($x10^{10}$)
Upland	Urban	63	18	348
	Non-Urban	62	12	41
Atmospheric Deposition	(wet + dry)	218	7	75
Stream Channel Erosion		2	<1	17
Groundwater		50	7	NA**
Shoreline Erosion		2	2	1
TOTAL		397	46	481

Research and modeling results update

The Lake Tahoe TMDL Research Program

Confidence and Uncertainty

Medium

- Supporting data base is either not extensive and/or comprehensive.
- Primarily non peer-reviewed studies exist for the Tahoe basin.
- Weight of evidence provided by studies for Lake Tahoe is limited.

Source Category		Total Nitrogen (metric tons/year)	Total Phosphorus (metric tons/year)	Number of Fine Sediment Particles ($x10^{10}$)
Upland	Urban	63	18	348
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Research and modeling results update

The Lake Tahoe TMDL Research Program

Confidence and Uncertainty

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TOTAL		397	46	481

Research and modeling results update

The Lake Tahoe TMDL Research Program

Confidence and Uncertainty

Low

- Estimates based on a single study that was considered preliminary or not enough data was collected.

Source Category		Total Nitrogen (metric tons/year)	Total Phosphorus (metric tons/year)	Number of Fine Sediment Particles ($x10^{10}$)
Upland	Urban	63	18	348
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Research and modeling results update

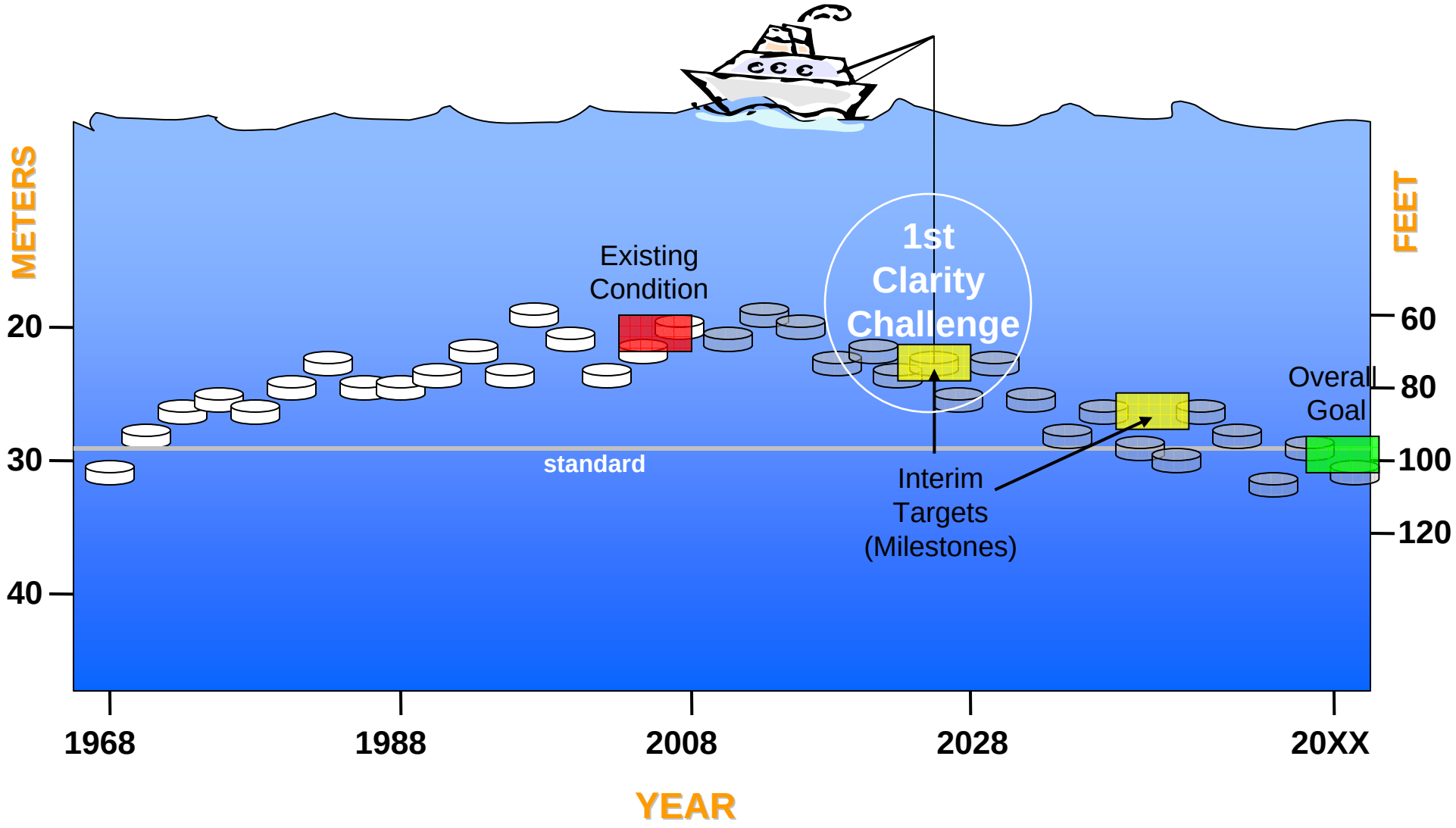
Charting a course to

Lake Tahoe Total Maximum Daily Load Technical Report

www.waterboards.ca.gov/lahontan/TMDL/Tahoe/Tahoe_Index.htm

Clarity

The Clarity Challenge



Charting a course to

Clarity

What are the options for reducing pollutant inputs to Lake Tahoe?

Pollutant Reduction Opportunities

Introduction to results

Questions Addressed

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Pollutant Reduction Opportunities

The findings of this Pollution Reduction Opportunity work are intended to provide informed insight into currently available opportunities to reduce pollutant inputs

Current Question

Pollutant source categories

- Urban runoff and groundwater
- Atmospheric deposition
- Forest runoff
- Stream channel erosion

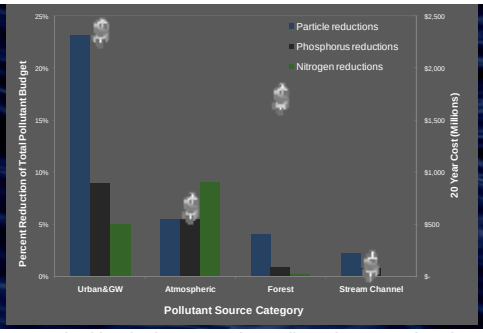
What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

What are the options for reducing pollutant inputs to Lake Tahoe?

- Four groups of experts
- Important results
- Using the results

Questions Addressed

Average potential reductions and cost



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Treatment Tiers

Represent different levels of effort and cost

3 tiers for each source category

Each tier is unique

Several exceptions

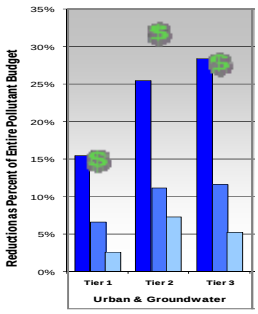
What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Tiers : Urban runoff and groundwater

Tier 1: enhanced version of the EIP

Tier 2: advanced practices, applied more aggressively in a project area

Tier 3: Pump and treat system complemented by advanced practices



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

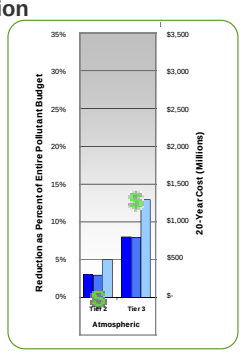
Tiers : Atmospheric Deposition

Tier 1: baseline – no reduction calculated

Tier 2: reduce Vehicle Miles Traveled (VMT) by 10%

Tier 3: reduce VMT by 25% and increase stationary source controls

Cost offsets



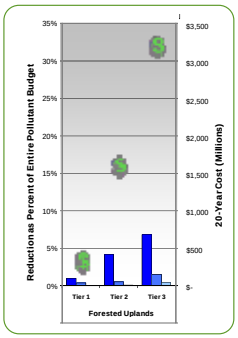
What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Tiers : Forest runoff

Tier 1: surface treatments and (currently) required management practices

Tier 2: mulch treatments and full management practices

Tier 3: tilling and full restoration to "native" conditions



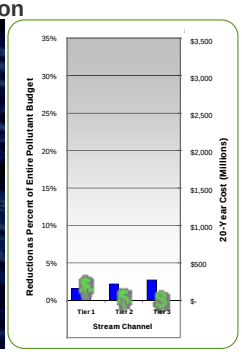
What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Tiers : Stream channel erosion

Tier 1: full restoration unconstrained

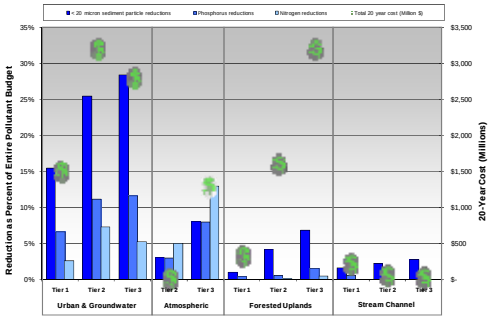
Tier 2: mix of restoration and stabilization, constraints considered

Tier 3: bank stabilization, no floodplain reconnection



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Combined estimates



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?

- Urban runoff sources are best emphasis for achieving the clarity challenge
- Atmospheric deposition sources provide best nitrogen reduction potential
- Stream channel restoration provides small but inexpensive reductions
- Forest runoff sources provide small reductions

Questions Addressed

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Pollutant Reduction Opportunities

- The findings of this Pollution Reduction Opportunity work are intended to provide informed insight into currently available opportunities to reduce pollutant inputs
- Recognizing that future research is essential to the continual improvement of this information, suggestions for future research are welcome

Current Question

Appendix B
Part 3

Formulate Integrated Strategies

TMDL Focus Team Agenda

Lake Tahoe TMDL
October 11, 2007, 8:30 a.m. – 1:30 p.m.

Topic: What strategy should we implement to reduce pollutant inputs to Lake Tahoe? Discussion of pollutant control opportunities and packages to meet the Clarity Challenge.

Location: Lake Tahoe Community College

8:00 Welcome and Refreshments

8:30 Welcome and Agenda Overview (Allegro Communications)

8:40 Context for Discussion (Doug Smith)
The Clarity Challenge

8:50 Pollutant Reduction Opportunities and Packages (Jason Kuchnicki)

9:10 Recommendations (Bob Larsen)
Stream Channel Restoration
Forest Management Practices

9:50 Atmospheric Pollutant Control Opportunities (John Reuter)

10:20 Urban Runoff Pollutant Control Opportunities (Larry Benoit)

10:50 Break

11:00 Pollutant Control Package Options (Jason Kuchnicki / Jeremy Sokulsky)

1:30 Adjourn

Charting a course to

Clarity

The Lake Tahoe TMDL is organized around a set of critical questions

2

Central questions of the Lake Tahoe TMDL

The first 3 questions addressed…

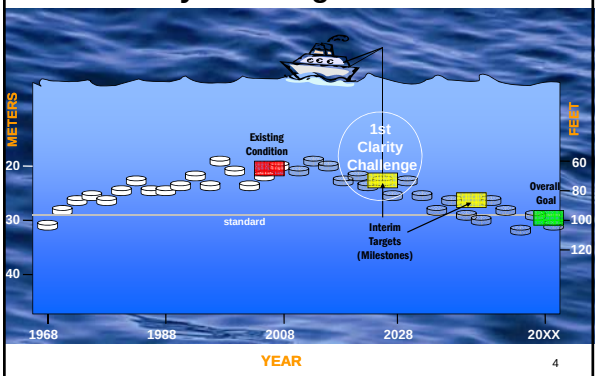
What pollutants are causing Lake Tahoe's clarity loss?

How much of each pollutant is reaching Lake Tahoe?

How much of each pollutant can Lake Tahoe accept and still achieve the clarity goal?

3

The Clarity Challenge



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The Clarity Challenge

Restoring Lake Tahoe's clarity challenges us to go beyond what we are doing today.

We are all responsible for achieving the Lake Tahoe clarity challenge.

5

Lake Tahoe TMDL questions

September question…

What are the options for reducing pollutant inputs to Lake Tahoe?

The current question…

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

6

Features of a strategy to reduce pollutant inputs

Continue restoring Stream Environment Zones

7

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Features of a strategy to reduce pollutant inputs

Implement forest management practices as planned

8

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Features of a strategy to reduce pollutant inputs

Evaluate options for reducing pollutants from atmospheric sources

9

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Features of a strategy to reduce pollutant inputs

Evaluate options for reducing pollutants from urban sources

10

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

A number of ways to achieve the clarity challenge

Today…

We will evaluate **packages** which integrate pollutant control opportunities from streams and forest sources and **focus discussion on the atmospheric and urban sources** where the decisions to be made will benefit most from your input.

11

Charting a course to

Clarity

Meeting Goals

- PRO Analysis Reorientation
- Introduce integrated packages and receive feedback
- Discuss considerations relevant to package development
- Identify new/different package approaches

Pollutant Reduction Opportunities Reorientation

- **Address TMDL Questions:**
  - What are the options for reducing pollutant inputs?
  - What strategy should we implement?
- **Handouts:**
  - Estimated Potential Pollutant Reductions
  - TMDL Treatment Tiers & Example Pollutant Control Options

What are the options for reducing pollutant inputs to Lake Tahoe?

Integrated Packages

- Integrated packages include some level of implementation across all source categories
- Packages allow for the determination of various ways to achieve the clarity challenge

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Integrated Package Components

- **Theme**
  - Extension of Current Practice
  - Focus On Innovation
  - All Out Push
- **Level of Application**
- **Pollutant Reductions**
- **Costs**
- **Resulting Clarity**

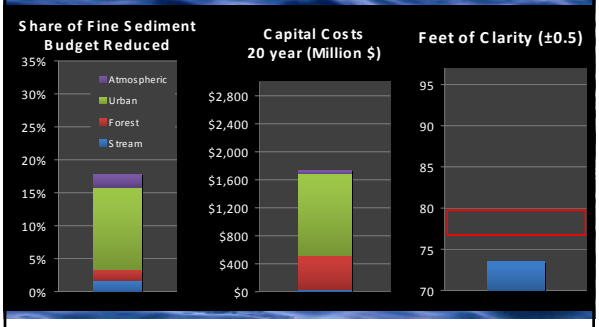
What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Integrated Package Example: Extension of Current Practice Level of Application

	Percent Application (%)	< 20 micron sediment particle reductions	20 year capital cost (Million $)	Annual O&M cost (Million $)
Atmospheric				
Tier 2 FS&P/Stationary	**70%**	2%	$20	$0
Tier 3 FS&P/Stationary	**0%**	0%	$0	$0
Tier 3 Mobile	**0%**	0%	$0	$0
Total	*OK*	*2%*	*$48*	*$13*
Urban & Groundwater				
Tier 1	**80%**	12%	$1,120	$2
Tier 2	**0%**	0%	$0	$0
Tier 3	**0%**	0%	$0	$0
Total	*80%*	*12%*	*$1,120*	*$2*
Forested Uplands				
Base Package		*2%*	*$465*	*$4*
Stream Channel				
Tier 2	**80%**	2%	$40	$0
Total	*80%*	*2%*	*$40*	*$0*
Scenario Total		**18%**	**$1,673**	**$20**

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Integrated Package: Extension of Current Practice Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

7

Slides for Afternoon Session

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

8

Integrated Package: Extension of Current Practice Level of Application

	Percent Application (%)	< 20 micron sediment particle reductions	20 year capital cost (Million $)	Annual O&M cost (Million $)
Atmospheric				
Tier 2 FS&P/Stationary	**70%**	2%	$20	$0
Tier 2 Mobile	**10%**	0%	$28	$13
Tier 3 FS&P/Stationary	**0%**	0%	$0	$0
Tier 3 Mobile	**0%**	0%	$0	$0
Total	*OK*	*2%*	*$48*	*$13*
Urban & Groundwater				
Tier 1	**80%**	12%	$1,120	$2
Tier 2	**0%**	0%	$0	$0
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Total	*80%*	*12%*	*$1,120*	*$2*
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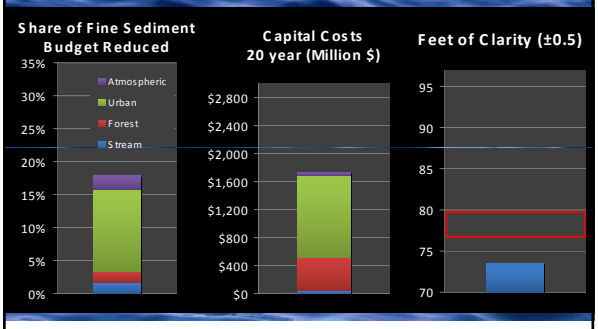
Total	*80%*	*2%*	*$40*	*$0*
Scenario Total		**18%**	**$1,673**	**$20**

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

9

Integrated Package: Extension of Current Practice Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

10

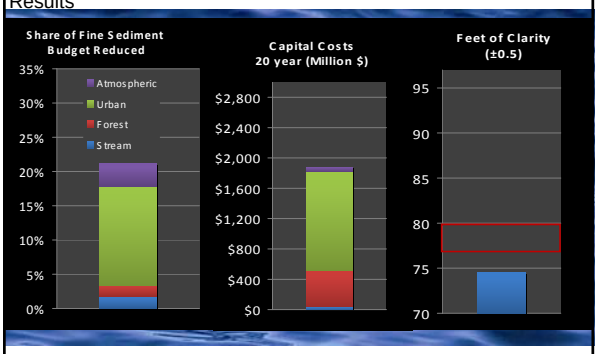
Integrated Package: Focus on Innovation Level of Application

	Percent Application (%)	< 20 micron sediment particle reductions	20 year capital cost (Million $)	Annual O&M cost (Million $)
Atmospheric				
Tier 2 FS&P/Stationary	**10%**	0%	$3	$0
Tier 2 Mobile	**10%**	0%	$28	$13
Tier 3 FS&P/Stationary	**40%**	3%	$30	$0
Tier 3 Mobile	**0%**	0%	$0	$0
Total	*OK*	*3%*	*$60*	*$13*
Urban & Groundwater				
Tier 1	**20%**	3%	$291	$1
Tier 2	**0%**	0%	$0	$0
Tier 3	**40%**	11%	$1,007	$6
Total	*60%*	*14%*	*$1,298*	*$7*
Forested Uplands				
Base Package		*2%*	*$482*	*$4*
Stream Channel				
Tier 2	**80%**	2%	$40	$0
Total	*80%*	*2%*	*$40*	*$0*
Scenario Total		**21%**	**$1,879**	**$24**

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

11

Integrated Package: Focus on Innovation Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

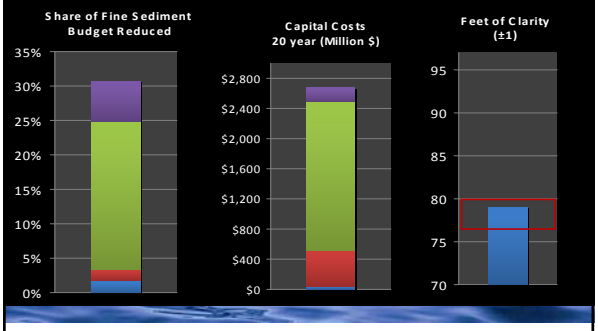
12

Integrated Package: All Out Push
Level of Application

	Percent Application (%)	< 20 micron sediment particle reductions	20 year capital cost (Million $)	Annual O&M cost (Million $)
Atmospheric				
Tier 2 FS&P/Stationary	**20%**	1%	$6	$0
Tier 2 Mobile	**20%**	0%	$55	$26
Tier 3 FS&P/Stationary	**70%**	5%	$52	$0
Tier 3 Mobile	**10%**	0%	$69	$33
Total	*OK*	*6%*	*$182*	*$59*
Urban & Groundwater				
Tier 1	**30%**	5%	$437	$1
Tier 2	**10%**	3%	$279	$2
Tier 3	**50%**	14%	$1,258	$8
Total	*90%*	*21%*	*$1,974*	*$11*
Forested Uplands				
Base Package		*2%*	*$482*	*$4*
Stream Channel				
Tier 2	**80%**	2%	$40	$0
Total	*80%*	*2%*	*$40*	*$0*
Scenario Total		**31%**	**$2,678**	**$74**

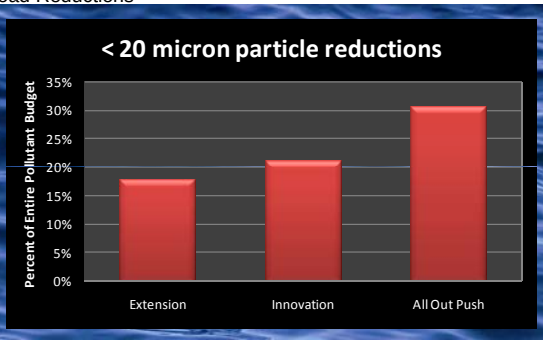
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 13

Integrated Package: All Out Push
Results



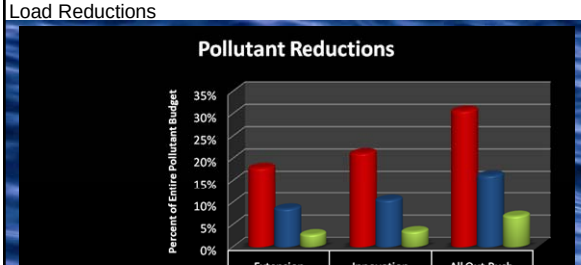
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 14

Comparison of Integrated Package Comparisons
Load Reductions



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 15

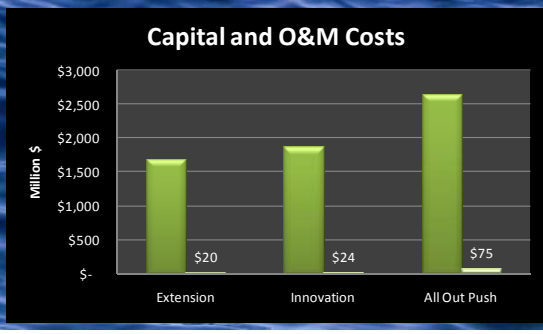
Comparison of Integrated Package Comparisons
Load Reductions



	Extension	Innovation	All Out Push
< 20 micron particle reductions	18%	21%	31%
Phosphorus reductions	9%	11%	16%
Nitrogen reductions	3%	4%	7%

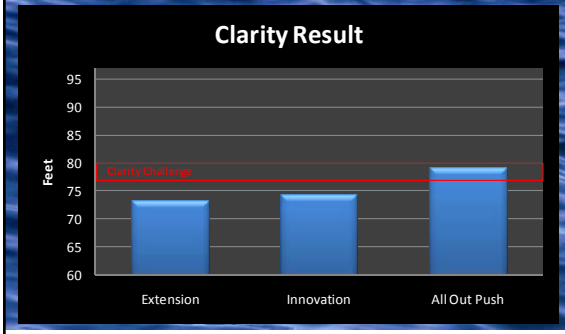
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 16

Comparison of Integrated Package Comparisons
Costs



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 17

Comparison of Integrated Package Comparisons
Clarity



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 18

Items for Discussion

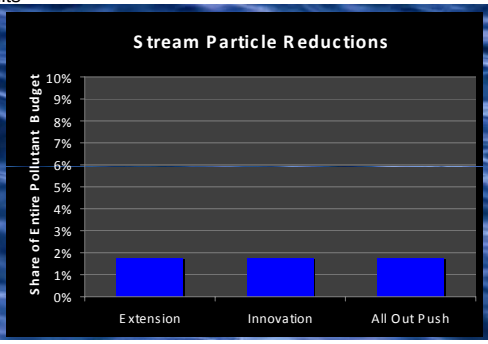
- **Discuss considerations relevant to package development**
  - Benefits & tradeoffs to each package
  - Potential barriers to implementation & achievable levels of application
  - Public acceptability
- **Identify new/different package approaches**

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 19

Slides for Bob's Recommendations

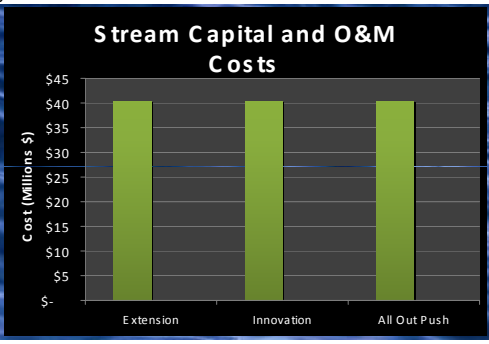
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 20

Stream Channel Erosion Results



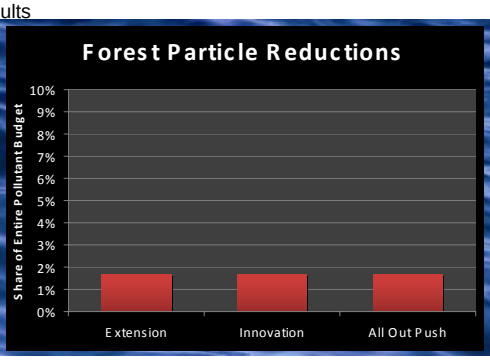
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 21

Stream Channel Erosion Costs



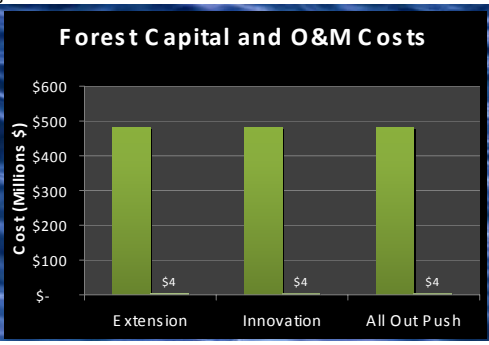
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 22

Forest Runoff Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 23

Forest Runoff Costs

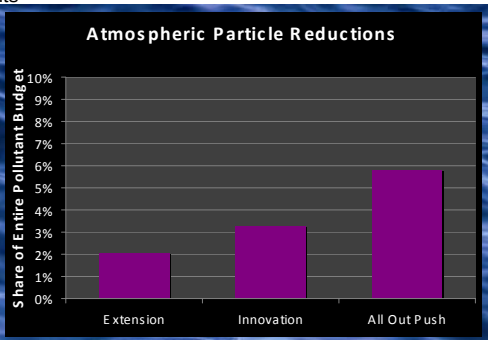


What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 24

Slides for John's Atm

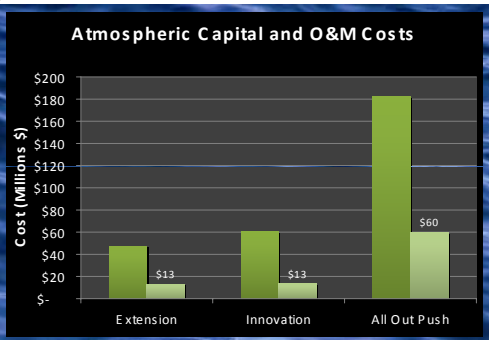
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 25

Atmospheric Deposition Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 26

Atmospheric Deposition Costs

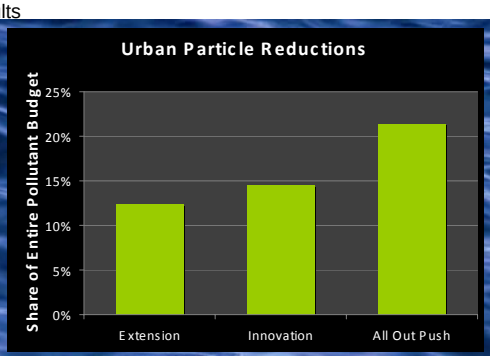


What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 27

Slides for Larry's Urban

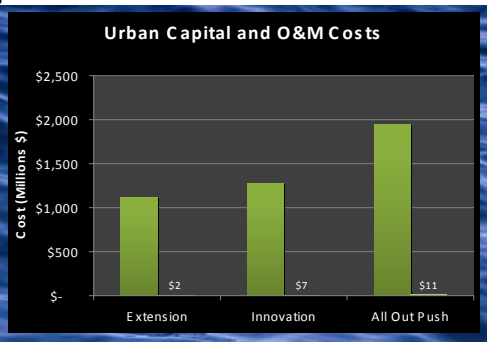
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 28

Urban Runoff Results



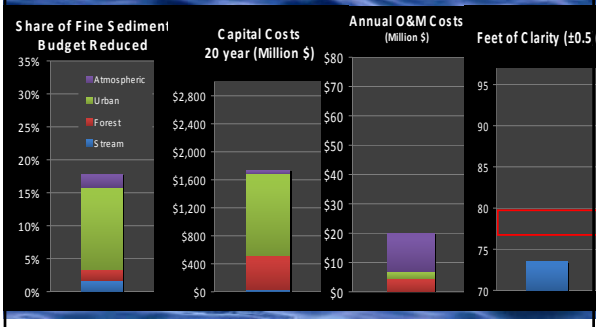
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 29

Urban Runoff Costs



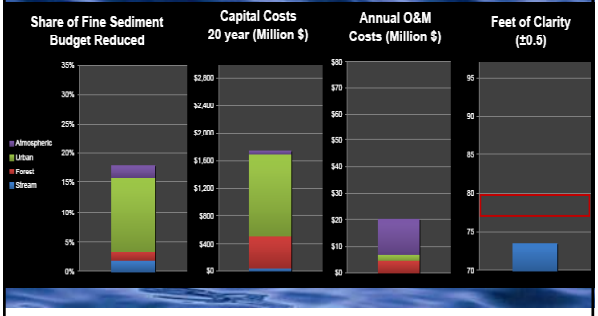
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 30

Integrated Package: Extension of Current Practice
Results



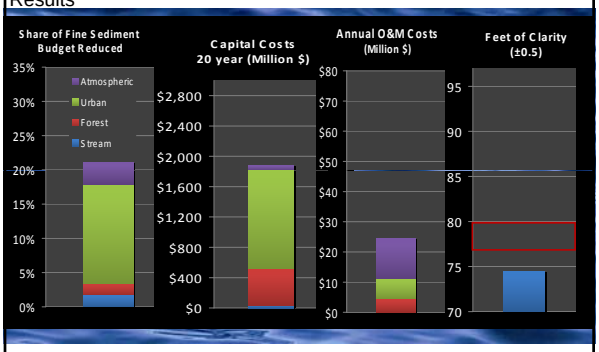
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 31

Integrated Package: Extension of Current Practice
Results



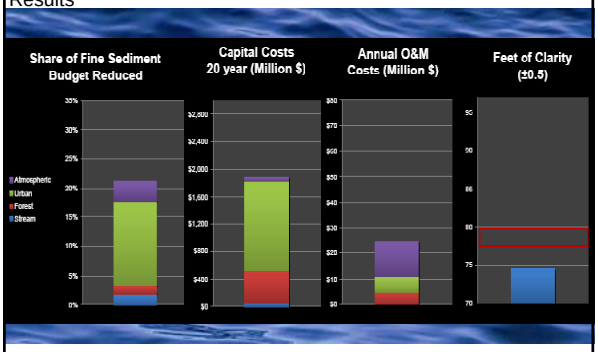
What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 32

Integrated Package: Focus on Innovation
Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 33

Integrated Package: Focus on Innovation
Results

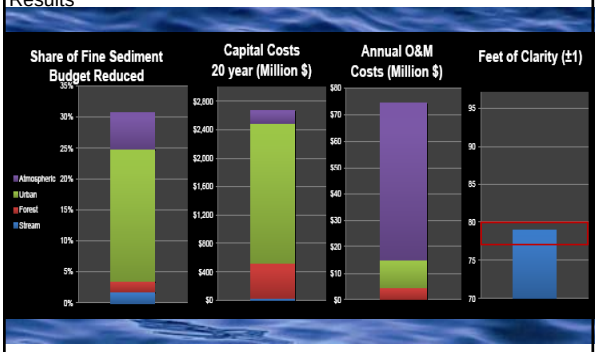


What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 34

Integrated Package: All Out Push
Results

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 35

Integrated Package: All Out Push
Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 36

Charting a course to

Clarity

Implementation Recommendations

Proposed Approach
to
Simplify and Target
the
Development of Integrated Packages

2

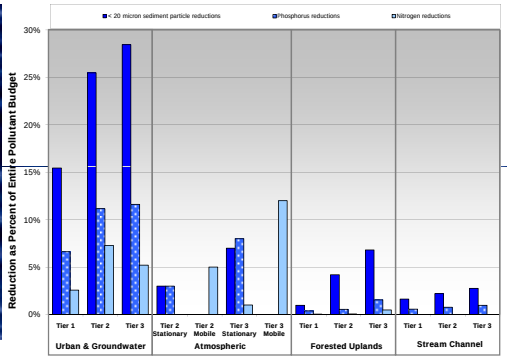
Implementation Plan Development

- Identify pollutant control opportunities
- Quantify pollutant control options
- Prepare implementation packages
- Solicit stakeholder feedback

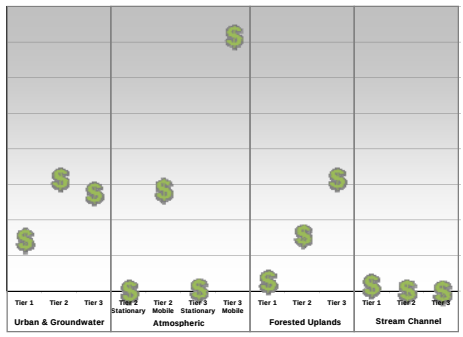
What are the options for reducing pollutant inputs to Lake Tahoe?

3

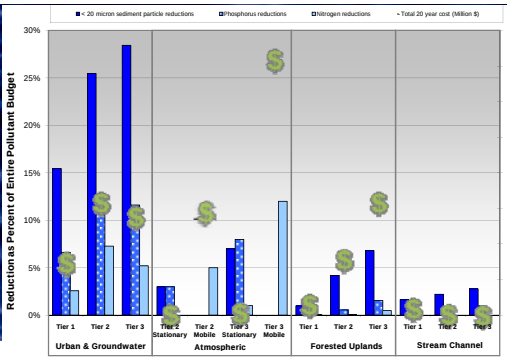
Estimated Potential Load Reductions



Estimated Potential Costs



Combined Load Reductions and Costs

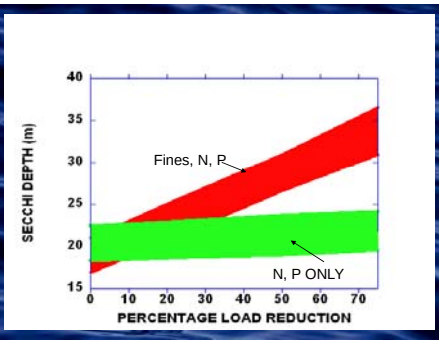


Emphasize Fine Sediment Removal

- Fine sediment is responsible for 2/3 of the clarity condition
- Reducing fine sediment has a greater potential to improve lake clarity
- Track and account for nutrient removal

7

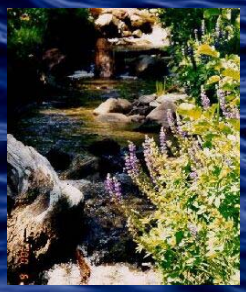
Clarity Response - Fine Sediment is the key



8

Recommendations

- Implement forest management practices as currently planned
- Continue stream restoration efforts

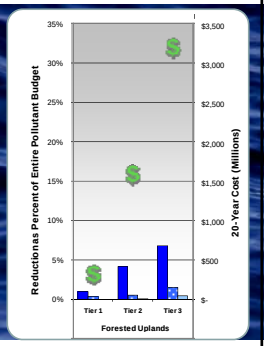


What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

9

Forest Upland Implementation

- Load reduction opportunities are relatively limited
- Additional reduction efforts do not appear cost effective
- Current practices effectively reduce loads



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

10

Forest Upland Implementation Recommendation

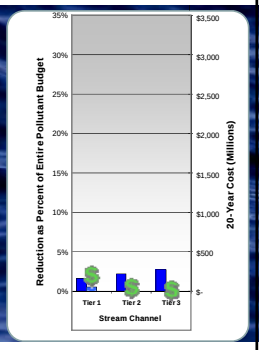
- Restore/maintain roads as planned
- Revegetate/treat disturbed lands
- Treat forest soils

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

11

Stream Channel Restoration

- In-channel sources are small
- Restoration is cost effective
- Restoration offers multiple benefits
- Restoration likely provides additional water quality benefits



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

12

Stream Channel Restoration Recommendation

Continue current restoration activities

Support monitoring and research

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

13

Simplify

Focus on the most important pollutant

Continue stream restoration and forest management work

Focus on how to implement larger opportunities

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

14

Charting a course to

Clarity

Packaging Approach – Forest Uplands

Treat/maintain 80% of unpaved roads
70% Tier 1, 10% Tier 3

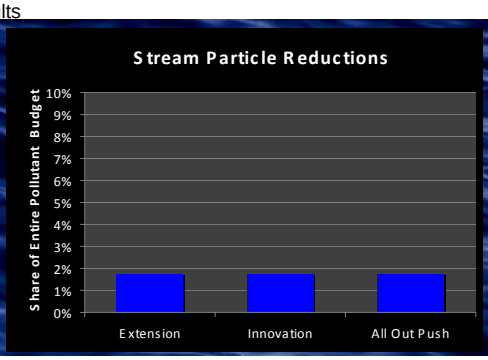
Restore 80% disturbed areas (ski runs, campgrounds, etc.)
70% Tier 1, 10% Tier 3

Conduct fuels management on 20% of the forest
10% Tier 2, 10% Tier 3

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

16

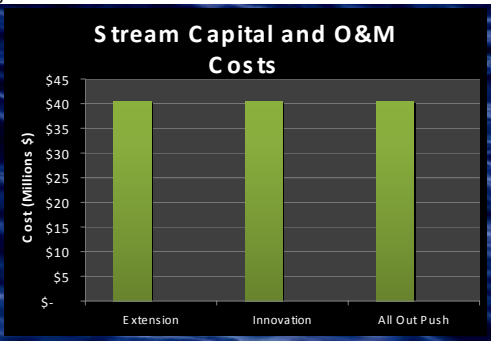
Stream Channel Erosion Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

17

Stream Channel Erosion Costs



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

18

Packaging Approach – Stream Channel Restoration

80% implementation on the Upper Truckee River, Blackwood Creek, and Ward Creek

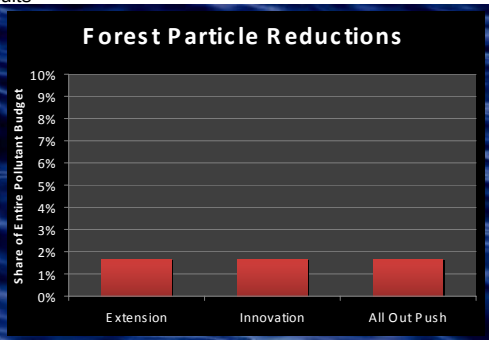
Assume Tier 2 - mixed restoration and bank protection

Support restoration on other disturbed stream systems

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

19

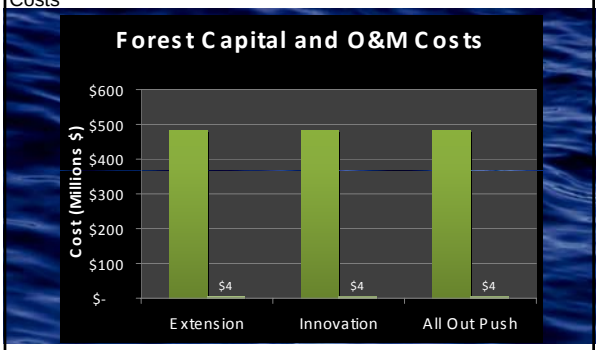
Forest Runoff Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

20

Forest Runoff Costs



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

21

Charting a course to

Clarity

Charting a course to

Atmospheric Deposition Pollutant Control Opportunities

Clarity

Atmospheric deposition analysis

Load reduction estimates based on emission reduction estimates

Customized update of *California Air Resources Board Emissions Inventory*

Considered:
- mobile sources, paved roads & parking, unpaved roads, construction disturbance, wood combustion

Used published equations / relationships to estimate reduction from each source

Atmospheric deposition emission inventory summary

Table 2-8. Annual average percent contribution of sources of pollutants in the Basin

Source	Percentage of pollutant from a specific source		
	Inorganic nitrogen	Phosphorus	Inert species
Mobile	87	<1	1
Stationary (non-RWC)	10	< 1	< 1
RWC	3	7	2
Unpaved Roads	–	44	46
Paved Roads	–	40	43
Building Construction	–	7	5
Paved Road Construction	–	5	2

Atmospheric deposition treatment tiers

Tier 2

Suggested combination of pollutant control opportunities based on literature values to provide realistic estimates of potential load reductions

Tier 3

Suggested combinations of pollutant control opportunities that provides upper bound on load reduction.

Tier 2 pollutant control opportunities

Stationary
- Bi-weekly PM-effective street sweeping (all paved roads)
- Pave dirt roads at access points
- Limit speeds on unpaved roads
- Gravel 50% of unpaved roads
- Require adequate soil moisture during earth moving operations
- Use dust suppressants on road building projects
- 20% reduction in residential wood burning emissions

Mobile
- 10% VMT reduction through user fees and incentives
- Comprehensive transit service

Tier 3 pollutant control opportunities

Stationary

- Tier 2 controls plus
- Weekly street sweeping (all paved roads),
- Pave all unpaved roads,
- Use dust suppressants on building construction projects,
- Adjust residential wood burning emissions reductions from 20% to 50%

Mobile

- 25% VMT reduction through user fees and incentives (entry fees)
- Comprehensive transit service

PCOs Applied to Tiers

Table 2-2. PCOs selected for atmospheric sources of pollutants

Source category	PCO	Tier 3	Tier 2
Mobile	M1. Fee for visitors	X	X
	M2. Shuttle service for visitors and residents	X	X
	M3. Commercial boating restrictions	X	X
Paved Roads	1. PM-efficient vacuum sweeper	Weekly	Biweekly
	2. Switch from sand/cinders to deicers	X	X
	3. Pave unpaved roads at access points	X	X
Unpaved Roads	4. Pave road	X	
	5. Gravel for 50% of roads		X
	6. Speed restriction for 50% of roads		X
Construction Sites	7. Chemical suppressant	X[a]	X[b]
	8. Speed restriction		X
	9. Require > 12% soil moisture during earthmoving operations	X	X
Res. Wood Combustion	10. 50% curtailment	X	
	11. 20% curtailment		X

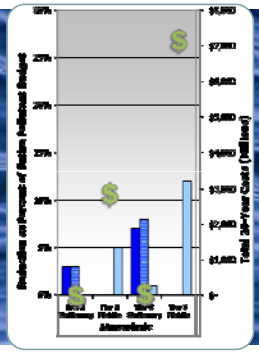
Atmospheric deposition tiers

Tier 1: baseline – no reduction estimated

Tier 2: stationary source controls and reduce Vehicle Miles Traveled (VMT) by 10%

Tier 3: reduce VMT by 25% and increase stationary source controls

Cost offsets



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Atmospheric deposition recommendation

Given:

1) the overwhelming affect of fine particle reduction on lake clarity,
2) the lower affect of N-reduction on clarity,
3) the high cost associated with mobile source control for N,

… it is recommended that with efforts now to meet the Clarity Challenge, atmospheric pollutant reduction strategies focus on stationary sources for particle/P control.

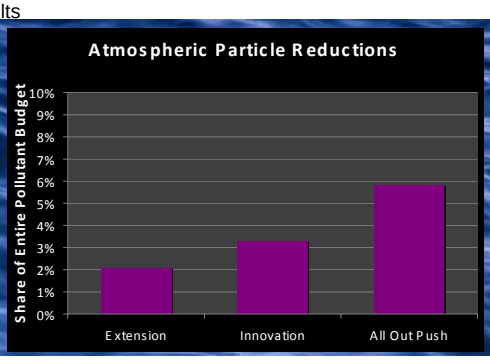
TRPA and others should continue to engage in VMT reduction discussions to meet other Thresholds

Atmospheric deposition

For consideration:

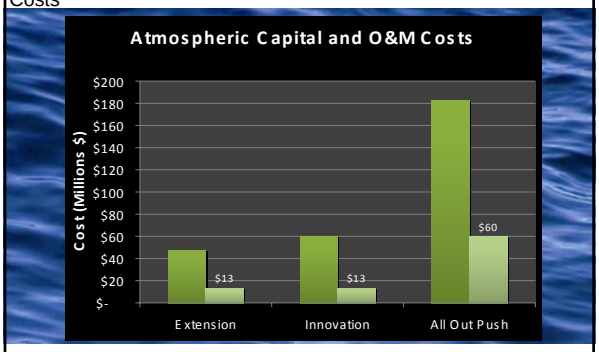
- ✓ Street sweeping,
- ✓ Use of traction materials for particle/P removal
- ✓ Restoration of unpaved surfaces

Atmospheric Deposition Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Atmospheric Deposition Costs



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Charting a course to

Clarity

Charting a course to

Urban Runoff Pollutant Control Opportunities

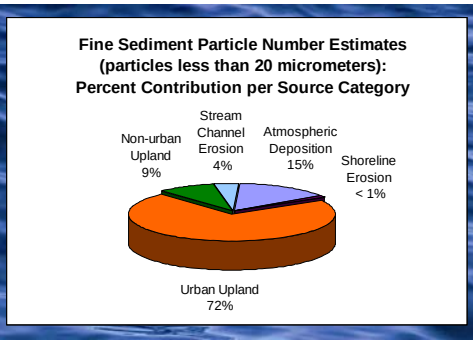
Clarity

Urban runoff analysis

- Tahoe and national data utilized and applied to analysis
- Watershed model used for Basin-wide extrapolation
- Baseline data from Tahoe land use loads and EMCs

What are the options for reducing pollutant inputs to Lake Tahoe?

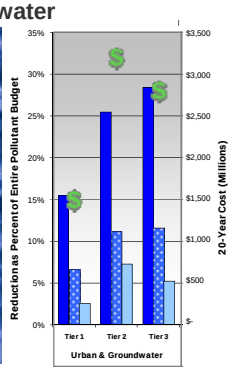
Urban runoff – our biggest opportunity



What are the options for reducing pollutant inputs to Lake Tahoe?

Tiers: Urban runoff and groundwater

- Tier 1: extension of recent EIP projects
- Tier 2: advanced practices, applied more aggressively in a project area
- Tier 3: Pump and treat system complemented by advanced practices



What are the options for reducing pollutant inputs to Lake Tahoe?

Tier 1 pollutant control opportunities

- Upper end of existing practices and level of application to all urban subwatersheds
- Sweeping in intensive traction abrasive areas (in balance with application of abrasives or deicers)
- Increased fertilizer management as PSC
- 50% Private Property BMPs included for PSC, HSC

What are the options for reducing pollutant inputs to Lake Tahoe? 6

Tier 2 pollutant control opportunities

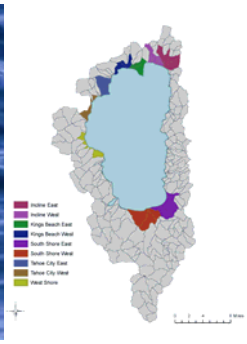
- Advanced deicing strategies
  - Additional Sweeping
  - Deicing solutions
- Media filters in stormwater vaults
- Turf management strategies and required education for professional turf mangers
- Control of retail fertilizer sales
- Additional Operation & Maintenance (SWT)
- 100% Private Property BMPs

What are the options for reducing pollutant inputs to Lake Tahoe? 7

Tier 3 pollutant control opportunities

Pump and Treat System to Concentrated Settings
- Tier 1 conveyance
- Localized holding ponds
- 9 regional treatment facilities
- Microfiltration

Tier 2 treatments to Dispersed Settings



What are the options for reducing pollutant inputs to Lake Tahoe? 8

Considerations for urban runoff pollutant control

To meet the clarity challenge we need go beyond the scope of current practice

Consider application of Tier 1, plus Tier 2 for particular situations

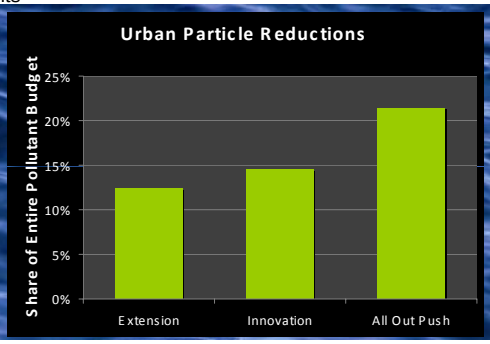
Application of more intense O & M

The package examples to follow offer some levels of tier application

Need to consider Pump & Treat application in some areas in order to approach the clarity challenge

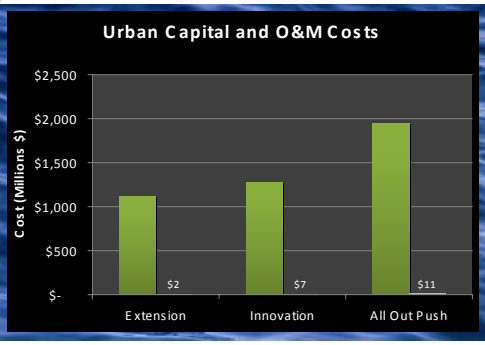
9

Urban Runoff Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Urban Runoff Costs



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Formulate Integrated Strategies

Focus Team Formulate Integrated Strategies Notes October 11, 2007

Lake Tahoe Total Maximum Daily Load
TMDL Focus Teams Meeting Summary

October 11, 2007, 8:30am – 1:30 am

Meeting Attendees: Mary Wagner, Karen Fink, G.W. Barrett, Jason Kuchnicki (NDEP), Joyce Brenner,Nova Lance-Seghi, My-linh Nguyen, Barbara Shanley, Rachel Terpstra, Scott Cecchi, Cyndie Walck, Penny Stewart, Stan Hill, John Johnston, Kevin Drake, Craig Oehru, Audrey McCombs, Paul Nielsen, Robert Erlich, Scott Brown, Steve Cooke, Charles Donohue, Catherine Schoen, Gordon Shaw, Jennifer Quickel, Russ Wigart, Tim Hagan, Hannah Schembri, John Reuter, Chad Praul, Bob Larsen, Doug Smith, John Riverson, Larry Benoit, Jeremy Sokulsky, Jack Landy, Michelle Sweeney, Rebecca Bryson (note-taker)

Summary of Recommended Actions

General

The meeting participants supported the Project Team's approach to:

- Develop and recommend a realistic strategy for both forest uplands and stream channels that builds on existing practices
- Recommend using this consistent strategy for both forests and streams under all 3 packages
- Focus more intense efforts on atmospheric deposition and urban uplands where there are bigger opportunities for load reductions

They also agreed that it would be very useful to have some type of central tracking and quantification of existing clarity achievements and link that to specific projects where possible.

Atmospheric Deposition

The major suggestions were to:

- Maintain a focus on addressing mobile as well as stationary because the VMT affect multiple sources - not only N emissions in the air, but also the amount of FS and P that gets re-suspended and/or ends up as runoff from the roads.
- Package the recommendations in such a way that encourages Basin to promote actions that facilitate "behavioral change"
- The area of traction materials/aids is an important place to study further.
- Try Tier 2 over Tier 3 in urban areas

Urban Uplands

The major comments and suggestions were:

- Evaluation of road projects will be easier with the TMDL methodology as it reflects "reasoned prioritization"
- Gut check the assumption that 60% of urban areas (as opposed to 80%) can be treated
- Look at Tier 2 as much as possible; focus on advanced BMPs other than pump and treat
- Want to see a refinement of the analysis based on full Basin body of knowledge
- Continue to expand the pump and treat inquiry and research further the cost effectiveness of different approach. Is there a certain approach that would be more effective given local conditions.
- Consider moving snow and then treating it elsewhere
- Funding could be more of an issue than human capacity

New Ideas

- It is important to include actions focused on sociological fixes/behavior change to complement the technological fixes
- Focus on scaling/incremental steps
- SWQIC process a good example of this. Improve quantification of benefits. Quantify benefits of collaboration (i.e. project permitting and business interests)
- Crediting and trading source control measures (include those that cannot be measured). This would increase source controls.
- Attempt to develop some packages that disaggregate settings in urban and other source categories
- Include some trade off analysis
    - Identify a certain amount of money and then run the clarity model to optimize actions

Future Research Suggestions

- Conduct pump and treat feasibility study
- Connect strategy/packages with clarity model
- Consider the impacts of greater implementation of defensible space practices
- Consider the impacts of future growth (USGS+)
- Consider the impacts of climate change
- Study further the time and duration in which change is expected (using the clarity model)
- Study the long-term impacts of the existing sewage system
- Incorporate the benefits of stream channel restoration into other sources
- Characterize and include other non-water quality benefits of stream channel restoration
- Include benefits of overbanking and increasing floodplain connectivity
- Quantify the benefits of a water quality project
    - Natural resource economic analysis
    - Spatial and temporal challenges make funding this data collection difficult
    - Must address quantifying nutrient cycling on the floodplain
- More stream data needed in general

Policy Issues to Consider

- How to best include the non-quantifiable measures in the TMDL
- What is the transition plan
- What should the implementation plan be give the time and duration in which change is expected

I. Background

Below is a summary of the October 11th meeting of the four TMDL Focus Teams. This summary provides a listing of the primary issues raised during the discussion. It is not intended to serve as a meeting transcript.

This meeting was designed to present and receive feedback on various strategies developed by the Water Board to reduce pollutants inputs to Lake Tahoe. The meeting goals were to:

- Review the PRO (Pollutant Reduction Opportunities) analysis in more detail
- Introduce three preliminary integrated packages developed by the consultant team and Water Board staff; receive feedback
- Discuss technical and policy considerations related to each proposed package

Identify and consider new/different approaches

II. Overall Findings/Recommendations

The meeting participants supported the team's approach to:

- Develop and recommend a realistic strategy for both forest uplands and stream channels that builds on existing practices
- Recommend using this consistent strategy for both forests and streams in all 3 packages
- Focus more intense efforts on atmospheric deposition and urban uplands where there are bigger opportunities for load reductions

They also agreed that it would be very useful to have some type of central tracking and quantification of existing clarity achievements and link that to specific projects where possible.

Some recommended modifications to the proposed approach and areas for further study were:

- To not disregard the importance of VMT as a source of FS
- To consider ways to promote sociological fixes as well as technological fixes to encourage behavior changes that can result in pollution load reductions
- To modify Package #2 to include more extensive application of innovative BMPs and run model to assess whether a stepped up approach would achieve the clarity target.
- To further evaluate the feasibility and cost-effectiveness of using potentially cheaper pump and treat options in the Tahoe Basin

III. Summary of Introductory Presentations

- Michelle Sweeney welcomed participants and explained that whereas at the Sept 10-11 set of meetings, participants considered pollution control options in one Source Category, the goal of this meeting is to consider an integrated set of options (Integrated Package) across Source Categories.
- Doug Smith (Water Board) reported that the Water Board's current proposed strategy for the TMDL is to set interim clarity goals. In September, meeting participants discussed various options for reducing loads in one Source Category; this month the goal is to begin development of a strategy to implement these pollution source controls.
- Jason (NDEP) explained that based on the Source Category Groups' (SCGs) analysis and the feedback from the Sept 10th and 11th Focus Team meetings, three proposed Integrated Packages have been developed: (1) Extension of Current Practice, (2) Focus on Innovation, and (3)All Out Push
- Bob Larsen (Water Board staff) reviewed the actions proposed for forest and stream channels. He reported that both the Water Board and NDEP agree that current efforts in these areas are generally effective at reducing loads and are in line with the load reduction goals. Therefore, in an effort to simplify, the proposed actions for forest uplands and stream channel will the same for all 3 proposed strategies.
- John Reuter (UC Davis) explained how the Atmospheric Deposition SCG approached its analysis and reviewed the summary of the results by tier and by pollutant. He explained that the SCG team considered reduction in FS and P differently than N because the former come from stationary sources and the later from mobile sources. He noted that the team is recommending to focus the atmospheric deposition strategies mostly on stationary FS and P controls, and not mobile N controls as it would be less expensive. Finally, he noted that the estimated reduction of 6% in this Source Category is significantly higher than the <2% estimated for the forest and stream categories but it comes at a cost. Another way to look at it, however, is that the All Out Push option would constitute almost a 50% reduction from this Source Category.
- Larry Benoit (TRPA) explained that urban uplands represent the biggest source of FS (72% of the total FS) and thus the greatest opportunity for pollutant reduction. In his presentation, he reviewed the types of PSCs that the Urban Uplands SCG had analyzed and included in each tier. He stressed that the results are Basin-wide and that the SCG used all the Tahoe-specific data available to generate these numbers. Highways are included as part of the urban uplands.

IV. Questions/Comments

A. General Questions

Assumptions Used for the Integrated Packages (Steve Cook): The team explained that the assumptions used to develop the Integrated Packages are not documented in any official report so far as they represent very recent work. They are, however, provided in the handouts distributed. A primary purpose of this meeting is to help refine these assumptions.

Cost Estimates: The team explained that the cost estimates do not add up exactly because they were rounded up.

B. Stream Channels Questions

Costs: The team explained that Tier 2 is cheaper than Tier 1 because Tier 1 represents a full restoration of the entire river, while Tier 2 is a combination of stream restoration and bank stabilization efforts. Unlike the other Source Categories, Tier 1 for the Stream Channel category represents the higher level of effort.

Property Ownership Issue: The team explained that Tier 1 represents full channel restoration and assumes that some segments of each stream channel are owned by private property owners, which could limit potential restoration efforts. The analysis assumed 80% of Upper Truckee, Ward and Blackwood could be restored. Tier 1 was does include acquisition costs as well as the costs to move sewer lines.

Assumptions under Stream Channel Tier 2(Cyndie): There was some discussion about what Tier 2 includes, how it is categorized, and what represents a full restoration effort. It was agreed that even for a full restoration project here in Tahoe, there are bridges, homes and golf courses that have to be incorporated, which prevent it from being a full restoration.

Recommended Changes

1. Lower the percentage of bank stabilization suggested under Tier 2 to both reflect the current status and set a higher bar for encouraging restoration approaches.
2. Better explain that Tier 2 includes a wide range of actions.

C. Forest Uplands

Application of Tier 3 (Cyndie): The team explained that 100% application at a Tier 3 level would mean all unpaved roads would be eliminated in the Basin.

Ski Run Loads (Robert): The team reported that ski run pollution load reduction numbers are not included in the estimated loads from new ski runs; they are looked at existing loads. They expect appropriate BMPs to be applied on these new runs to ensure that there are no new loads or that those loads can be offset in some way.

Future Growth: The TMDL will include some discussion of the implications for pollutant load increases if the Basin is build out at current planning levels.

Impacts related to Temporary Access for Fuels Reduction: (Charlie NDSL) The impacts and costs associated with construction of temporary access roads for fuels reduction work were included in the analysis.

Pile Burnings (Robert): The team noted that the impacts of pile burning are addressed under atmospheric deposition.

Source for the Fuel Reduction Activity Data: The team confirmed that the estimate that 20% of the forested areas in the Basin would receive fuels reduction treatment was derived based on information provided by the Forest Service. Tim Hagan pointed out that at a meeting yesterday, the Forest Service had reported they planned to conduct fuels reduction activities on 56,000 acres in the Basin within 10 years.

Implementation Timeframe: The team clarified that the 20% number represents the efforts of the Forest Service over the next 15 years only. Although the clarity target is 20 years out, the team is basing its analysis on a 15 year implementation horizon with 20 year results.

D. Atmospheric Deposition

Questions

Breakdown of Mobile Sources: The break down of estimated loads between boats and cars is that 17.8% comes from boating.

Residential Wood Burning vs. Prescribed (Scott Cecchi): The team explained that the analysis had shown that pile burning was not a significant source in response to the question as to whether it was better to burn wood in a fireplace or in a pile burn.

Overlap between Atmospheric Deposition and Other Source Categories: The team explained that under atmospheric deposition, the SCG studied the loads from atmospheric deposition sources only (ie. resuspended FS particles and nitrogen emissions from cars) versus the FS, N and P that enters the Lake through runoff from roads. The loads from runoff were calculated separately by the urban team for urban areas (and for forest roads by the forest team). The costs of addressing each were also calculating separately. For example, urban BMPs and measures such as placement of water bars do not address dust – only runoff.

Sweeping: Larry Benoit noted that the O&M costs for weekly sweeping were included in the capital costs under this Source Category in response to concerns about the increased O&M.

Recommendations:

- Include more analysis of road sanding/grinding of the road sanding impacts, including what type of gravel is used. [Response: It is included in the analysis].
- Pollution control measures and restoration projects that reduce pollutant loading from resuspended sediments and runoff should be evaluated/ prioritized accordingly.

Urban Uplands

Questions

Planning and Design Costs: The team confirmed that the costs for planning and design were included in the Total 20 year cost estimates.

Costs per Percent Reduction: The team confirmed that they had done a "bang for the buck" analysis, or an analysis of cost per percent reduction by category. It is in the Pollution Reduction Opportunities Report but it is not shown in the handouts distributed.

Cost Estimates for Tier 2: The team confirmed that a Tier 2 approach is more expensive than Tier 3 because Tier 2 includes some state-of-the-art options and it is intended to cover a wider geographic range. The big difference in the cost is the cost of acquiring the additional property for the wider geographic range and more innovative BMPs and related O&M.

Costs of Residential BMPS: Scott (NTCD) The team explained that the costs for Tier 2 do include the costs for private parcel implementation. They noted that the costs for private BMPs are not a large percentage, but you took out cost of residential BMPs, the cost estimates for Tier 1 and Tier 2 would be more similar.

Costs of Pump and Treat: Scott (NTCD) The team noted that the costs for acquiring the land necessary to build large, local holding ponds for the pump and treat systems, are included in the estimates. They acknowledged that while expensive, the feasibility analysis showed that that it is less expensive to acquire land for a concentrated pump and treat facility than to acquire land for the more geographically wide-spread Tier 2 approach.

Location of Pump and Treat Systems: The team also explained that under Tier 3 category, the assumption is that pump and treat would be used in high density areas only. In the low density areas, there will be some private property application of BMPs.

Traction Material: The team noted that there had not been much analysis on the effects of pollutant loads from using different road materials (ie. rubberized roads) because (1) these types of roads are very new, and (2) there is not much data to evaluate the potential impacts.

Stream Restoration (Gabby): The team noted that stream restoration was not included in the BMP/strategy package for urban runoff but that hydrologic source controls such as reducing impervious coverage are included.

Future Inclusion of More Innovative Techniques: John stressed that the Innovation/All Out Push options do not have to include every innovative PCO at the start; they can be incorporated over time. However, if the Basin agencies buy into the Innovation package, it commits the Basin to pursuing this path.

Comments/Recommendations

- Impacts related to traction material used should be considered/studied further. [Response: There is a reference to and simple analysis of what the potential impacts of such an option would be included in Tier 2.]
- The cost estimate for urban measures of $1.2 Billion for Tier 1 actions seems very low - by an order of magnitude or two. It was suggested that there be further analysis of these estimates. [Response: Each implementing agency will have to conduct its own analyses to get a more account estimate.]
- The TRPA pump and treat feasibility study will be very helpful and should study options for developing a pump and treat system that is more natural, uses wetlands.

Summary of Key Concepts from the First Half Presentations

- Interim clarity goal is 77-80 feet (This is not a change of standard; it is an interim goal)
- The team assumed that the implementation actions will take place over 15 years and then there will be 5 years for the results of those actions to come to fruition
- TMDL team recommendations are to
    - focus on fine sediment
    - pursue stream channel and forest mgmt as planned
    - Focus on At dep and urban sources
- Within atmospheric deposition, the team recommended a focus on stationary sources to reduce FS and P
- Urban runoff is the biggest opportunity to improve clarity. It is a Basin-wide approach with cost estimates at Basin-wide. We will need to consider some level of pump and treat.

V. Second Half of the Meeting: Presentations/Q&A

Overview of the Three Strategies/Integrated Packages

Jason reviewed the handout with each of the three Strategies/Integrated Packages. He pointed out that the focus was on FS reductions in order to help simplify the analysis (because FS is the biggest factor and it also captures P). The main conclusions were that under Integrated Package #1 (Extension of Current Practices), it will not be possible to reach the clarity target. Similarly, Integrated Package #2 (Innovation Package) gets closer to the target but does not reach it. Under Integrated Package #3 (All Out Push), however, we would expect to reach the clarity goals.

The team asked the meeting participants for confirmation that they would agreed with the consultant team's proposal to (1) keep the forest and stream measures consistent across the three strategies and in keeping with current practices and (2) focus on atmospheric deposition and urban sources. The meeting participants confirmed that they supported this approach.

Comments/Questions:

General:

How Integrated Packages Will Be Used: The team explained that once the packages developed/refined, they will be used to help inform the allocation process. The Water Board intends to allocate by source. This will drive the regulatory process - by jurisdiction. Doug Smith explained that these allocations will be used to initial reach the interim target of 77 feet, and this will be a regulation, but that the ultimate goal is even higher.

There was a follow up question about why the group is reviewing packages that do not reach the interim target. John Reuter explained that the team first developed the packages and then ran the clarity model. Therefore, the run of the modeling shows that the first 2 may be off the table and that the whole process is really challenging. It was suggested that the first Package could be used as a "no action" alternative in a programmatic EIS situation.

Interim Target Approach: The team is moving ahead under the assumption that the proposed approach of having an interim target approach will be approved. At the Pathways Forum there seemed to be support for such an interim approach. Sue Norman asked whether there was any discussion at the Forum of realistic financial bounds to achieving this interim target. It was reported that the Pathways Forum group/executives had not discussed what we could realistically expect to achieve with respect to resources. The Forum had not been presented all three Packages presented here and thus had not "signed off" on pursuing an approach such as the All Out Push/Strategy 3 approach to achieve that interim target.

It was suggested that a combination of package 1 and 2 would get close to 75 feet of clarity, and is it worth another 1 billion to try to reach 77 feet. It was pointed out that there is a legal constraint that does not allow for any degradation of an outstanding national resource and furthermore the ultimate goal is even higher than 77 feet.

Rationale for the 77-80 Foot Interim Target: There were some questions about how the 77-80 feet number was derived and why a range is show in the charts. John reported that there is some analysis that shows it is possible to achieve that target, and it was a policy call based on that information. The team explained that although 77-80 feet of clarity is the target, a range is depicted in the charts because there will be annual variations.

Expected Lake Response to Reduced Loads: When asked whether once the loads are significantly reduced, would we expect to see a rapid increase in clarity and is the relationship more exponential or linear in nature, John Reuter replied that it is a linear relationship. The science predicts that within the first 7-9 years of pollutant reductions, the clarity will respond accordingly, then it will begin to level off. He further clarified that the predicted response is based on an average of the last 10 years of a 20 year implementation plan.

Level of Analysis: When asked whether the same level of analysis was used to develop the three packages as was used to develop the tiers (which was quite rigorous), Water Board/NDEP acknowledged that the packages were developed based on their discretion with some additional technical analysis. Bob stressed that even a minimal amount of analysis shows if we continue with our current practices, we will not reach the target, so more effort is needed.

Questions/Comments Regarding Packages 1, 2, 3

Clarification on Package #1 (Extension of Current Practices): This team confirmed that Package #1 means using existing technologies to implement the best of current practices with a new emphasis on FS. Jason stressed that the existing practices in the Basin are already state of art, but the Basin faces specific challenges that are more difficult than other areas and therefore it is necessary to keep pushing the envelope.

Would Package #1 Turn the Corner?: Gabby asked whether it would be true to assume from this analysis that if the Basin agencies simply extended their current practices, we would turn the corner and improve clarity just a bit. The team noted that while there might be some level of improvement that would result from just extending current practices, it would not result in scientifically significant clarity improvements.

Suggested Modifications to Package #2: Identify watersheds dominated by residential areas and assume Tier 1 treatments in those areas. Include some Tier 2 actions in Package #3. There are already regulations in place that allow for Tier 2 actions, but not necessarily for Tier 3.

Categorize Urban Upland Actions by High and Low Density Areas: Sue Norman suggested that the team evaluate and present the options for the three packages by land type category (high density/low density) because she anticipates that it will be important to focus efforts on the high density residential areas – where there are high loads and difficult technical challenges. Sorting the analysis accordingly will help facilitate further discussion/analysis.

Strengthen Package #2 to Potentially Meet the Clarity Challenge (Theresa): Building on Sue's concept of presenting/evaluating options based on the high density/ low density categories, Theresa suggested focusing the innovative options on the high density commercial areas. The team stressed that it is each city's decision of how to get there. The Water Board and NDEP can only recommend what they think it most appropriate. She stressed, however, that this step should not wait until the implementation stage to define and that the TMDL analysis should at least help guide jurisdictions about what is more effective. She suggested that it is possible to use the numbers/data presented today to do a simple analysis of how to make Package #2 stronger by incorporating more innovative BMPs and possibly able to achieve the clarity target through this way without having to rely as much on pump and treat.

Realistic Application of BMPs: The team asked participants to gut-check the application numbers they used. Penny Stewart noted that asking stormwater agencies to do a better job of stormwater treatment on 80% of the roads in a 15 year timeframe as called for even under Package #1 is unrealistic. Steve Cook suggested that given the property issues, utility, and maintenance practices that get in the way, 60% application is more reasonable than 80%. A participant asked what the 80% number entailed. The team reported that it meant installing the infrastructure to treat 80%.

BMP compliance: The team asked the group for feedback on how to adjust its assumptions regarding residential BMP compliance (ie. 90% compliance). It was suggested that in those areas where there is a pump and treat system, then it should be possible to consider loosening the BMPs in that area vs areas where pump and treat is not an option.

Issue of Capacity: The group ended by discussing the capacity issue. Even with sufficient funding, do the agencies have the capacity to take on these packages. Sue Norman pointed out that even if pump and treat turns out to be more expensive; it might be easier to handle capacity-wise. Theresa suggested that for Package 2, the team might consider an option that treats less area, but at a higher level, which might be more efficient and effective. Meeting participants also recommended that the team consider presenting/packaging options in a cost trade-off analysis.

Recommended Actions:

- Develop an additional package (or a refined version of Package 2) that calls for more innovative options in the high density commercial areas. Analyze what the predicted impact would be.
- Consider an option that treats less area, but at a higher level, which might be more efficient and effective.
- When evaluating/presenting the options for the three Packages in the future, separate out the actions in the urban runoff section by land type category (high density/low density)
- Include some Tier 2 actions in Package #3 under Urban Uplands.
- Identify watersheds dominated by residential areas and assume Tier 1 treatments in those areas.
- Revisit estimates of the extent of application that will occur in the next 15 years for all three Packages; consider changing the projected application in Packages #1 and 3 to 60% to be more realistic.
- Consider presenting/packaging options using a cost trade-off analysis.

Atmospheric Deposition Comments/Questions:

Stationary versus mobile: Gordon Shaw strongly encouraged the team not to deemphasize the mobile sources because a car driving down the road produces not only nitrogen emissions, but it also FS from the road dust that gets resuspended into the air and ends up in the urban uplands category as runoff. Even though it may be difficult to quantify, VMT do factor into FS sources and should be included. Tim suggested that the FS sources from VMT can be addressed through project permitting and by looking at what routes the trucks take and where the sweeping is done.

Sociological Component: Gordon also pointed out that many of the actions under consideration focus on technological fixes, however, there is also a sociological component of reducing the demand. There are almost no actions geared at the behavior change aspect included in the proposed Packages - except for the user fee option to reduce VMT. He suggested that a specific focus on/ inclusion of behavior change measures is important.

Consider Smaller, More Manageable Steps to Reduce VMTs: Joyce Brenner pointed out that a large undertaking, such as the user fee, is not required to produce behavior change. Even options such as lowering speed limits on dirt or other roads, and temporarily closing roads when it snows would have an impact. She stressed that the user fee Richard's team recommended was at the extreme and we should consider scaled back options. It would be helpful to consider how to involve the business community in these efforts (i.e.rebates off of ski tickets for taking the bus).

Package Options Strategically: Charles stressed that the team should package the options to move us closer to those behavior changes to the extent possible. For example, in transportation field, pollutants coming off roads should be considered mobile (not stationary). If this report stresses that reality, then the regulatory agencies and their stuff can build off that analysis to make regulations that support behavior change. There are large sums of money associated with transportation so use it!

Recommended Actions:

- Reemphasize the importance of impacts from mobile sources.
- Include actions that focus on producing behavior change
- Consider/evaluate some smaller, more manageable steps to reduce VMTs rather than large-scale user-fee approach
- Package options in a way that encourages/enables agencies efforts to facilitate behavior change
- Consider presenting a technological package (A, B, C) of options and then a sociological package.

Questions/Comments
Urban Stormwater Implementation: RelationsMiship to Existing Practices

Level of Current Practices (Robert Erlich): When asked if the team had assumed in its analysis that a high percentage of best practice is currently being implemented, Jason clarified that the model did not measure the effects of what is already being implemented, it only analyzed the impacts of future BMPs implemented. The reason is that the Watershed Model is calibrated to LTIMP numbers that include current projects.

Enforcement of Implementation: When asked what measures are in place to ensure that additional implementation actions are implemented with no exceptions, the team noted that this is a good question and that the details of implementation are as of yet unclear. Larry noted that a regional stormwater monitoring program would help provide valuable information on loading and monitoring.

Evaluation of Existing Obstacles to Implementation: When asked whether the team had considered the political, technical, financial reasons that the existing practices have not been implemented fully to date (as this might inform the likelihood of future projects to be implemented), the team responded that they had not studied that specifically but that from a Basin-wide analysis, the information suggests that there are areas for improvement.

Difficulty in Estimating Benefits of Existing Projects: There were several questions about the estimated benefits of existing implementation projects on the ground. The team explained that when they prepared the pollution reduction budget, they looked at data from 1994-2004. However, the team did not have a corresponding list with what projects were implemented during that same time period. Therefore, it is not possible with the existing data to link a project with results. John Reuter explained, however, that the science shows that the Lake responds quickly to reductions and that there is only a few years lag time. Because the data does not show much change in Lake Clarity in the past 4-5 years, the evidence suggests that

recent projects have not resulted in significant increases in clarity. It was pointed out, however, that those projects very likely did contribute to the clarity not decreasing to a further extent, which is very significant.

Possible Quantification of and Credit for Existing Projects: Several participants stressed that in order to encourage agencies to take major steps, it would be useful to credit or quantify the impacts of those projects already completed. The team noted that this is a point well-taken. They also stressed that the emphasis on reducing FS loads is a recent development, and therefore the data and info is scarce. As the Basin agencies improve/expand their knowledge, they expect to have more information on this.

Status of Existing Erosion Control Efforts: In response to a question about what percentage of the Basin has received erosion control projects since the 80's, the team explained that there is no database that contains this type of information. They acknowledged that this type of consolidated information would be extremely useful. Scott Brown reported that the BMP inventory completed by Chad in 2005 is currently being updated and will be available in 3-4 months. It will have GIS layers.

Benefit of Existing Efforts: Paul pointed out that at minimum, the number of projects already implemented now will reduce the level of effort necessary to achieve the 80% reductions required because those projects provide the type of infrastructure that can support more advanced solutions.

Integration with the Stormwater Monitoring Plan: The regional Stormwater Monitoring Plan Group has prioritized what it wants to see for monitoring as part of TMDL. We want to see where we get bang for the buck – Basin-wide. Tetra Tech is working on a tool that will do that.

Recommended Actions:

- Develop some type of chart to summarize what pollutant reductions have been achieved already and quantify benefits as possible
- Create a centralized database of all the projects currently in place so that Tetratek can do an analysis of the combined impacts

Questions/Comments
Urban Stormwater Implementation: General

Step Up Use of More Innovative Techniques: **(**Catherine): There does not seem to be a sufficient scientific basis for why pump and treat is more effective, and yet, that is where the team's primary focus is. A wide range of possible measures under Tier 2, which she suspects might be more effective, do not seem to have been considered and should be further evaluated. Only a 10% application of Tier 2 is called for in Package 3. This number should be increased.

Inclusion of More Innovative Techniques: Jason stressed that the analysis was limited to certain types of PCOs for which there is some data. However, because there will be a certain level of innovation required to meet the challenge, Water Board/NDEP would expect to see additional technologies evaluated/used that were not analyzed as part of this study. For example, there are several promising technologies out there they envision being utilized (ie.

"dispersed pump and treat"). The bottom line is that it will be difficult to achieve the clarity goals.

Were Costs for Pump and Treat Overestimated?: Sue Norman asked whether the analysis might have overestimated the cost of Pump and Treat as she was hoping it would prove to be more cost effective. The team had noted that the cost effectiveness analysis was done using a broad stroke; however, the analysis clearly shows that although setting up the conveyance structures can be expensive, the O&M for Pump and Treat is much cost-efficient than having dispersed facilities. This is an important area to have more analysis.

Strategic Use of Pump and Treat: Russ stressed that pump and treat could be a very cost-effective option in some areas, such as Bijou, but not others such as Christmas Valley. As such, it will be important to be strategic about where it is utilized.

Evaluating Other Lower Tech Options for Pump and Treat: Sue noted that she had seen a presentation from a Florida team which had used a low tech (and lower cost) approach. She wondered if that approach would be feasible here. Robert Erlich suggested that options such as discharging to a marsh area to help with de-nitrification and/or managing snow by moving it somewhere to be treated as a lower tech (or complimentary) approach to pump and treat should be further evaluated. The team noted that the feasibility study will be examining various approaches and will study issues such as whether microfiltration is the best approach and where to locate it.

Hidden Costs/Constraints of Pump and Treat: Tim asked the team to reconsider the legal and compliance constraints. Even if you assume you can get the easements, the process itself uses either time or money, which may affect deadlines.

Possible Synergies Between Pump and Treat and Biomass Co-generation: Scott asked whether the team had considered using algae in conjunction with biomass co-generation plant. If we had a Stormwater Utility district that could manage the process, we could supply it as alternative fuel source.

Include Unquantifiable Measures: Tim asked whether the team had limited the actions called for in each Package to include only those activities that would have measurable results. The team responded that in the Packages (and in the TMDL) it is possible to include unquantifiable measures, however, they just cannot compare the relative benefits. Including those actions, however, will provide a margin of safety. It was suggested that the package could be written to be part quantitative and part qualitative.

Trading Options: Jack Landy noted that there are efforts underway to consider trading options for source reduction activities. Although difficult to quantify, source control can reduce loads in far more effective ways than treatment and may therefore be promoted by a functional trading system.

Deep Water Discharge: When asked whether there been any study about a deep water discharge below the level of turnover as a possible alternative, the team responded that there had been a study in 1960 and the option was dismissed.

Cooperation with Caltrans: Joyce Brenner reported that the Caltrans projects do tend to be very expensive – partly because the sand they use is expensive. Caltrans would very much like to use different products but has been told that they can only use certain materials in the Basin. Experimenting with different technology (such as de-icers) could thus be mutually beneficial and we would like to pursue this in more detail.

Look for Synergies: The team explained that the Urban Uplands SCG did look across a wide variety of hydraulic controls, source controls and stormwater controls in order to evaluate the benefits of packaging BMPs in such a way as to get complementary benefits.

Recommended Action:

- Work with Caltrans to evaluate different materials/techniques
- Include a list of unquantifiable actions/BMPs in the plan – along with the quantifiable ones
- Trading could be an effective way to promote behavioral change as opposed to treatment. Identify and attempt to quantify source control measures such that they can be incorporated into a trading analysis
- Further evaluate the costs of different forms of Pump and Treat that would be applicable in the Basin.

:

VI. Summary of Recommended Actions

General

The meeting participants supported the team's approach to:

- Develop and recommend a realistic strategy for both forest uplands and stream channels that builds on existing practices
- Recommend using this consistent strategy for both forests and streams under all 3 packages
- Focus more intense efforts on atmospheric deposition and urban uplands where there are bigger opportunities for load reductions

They also agreed that it would be very useful to have some type of central tracking and quantification of existing clarity achievements and link that to specific projects where possible.

Some recommended modifications to the proposed approach and areas for further study were:

- To not disregard the importance of VMT as a source of FS
- To consider ways to promote sociological fixes as well as technological fixes to encourage behavior changes that can result in pollution load reductions
- To modify Package #2 to include more extensive application of innovative BMPs in high density areas and run model again to assess whether such a stepped up approach would achieve the clarity target.
- To further evaluate the feasibility and cost-effectiveness of using potentially cheaper pump and treat options in the Tahoe Basin

Atmospheric Deposition

The major suggestions were to:

- Maintain a focus on addressing mobile as well as stationary because the VMT affect multiple sources - not only N emissions in the air, but also the amount of FS and P that gets resuspended and/or ends up as runoff from the roads.
- Package the recommendations in such a way that encourages Basin agency to promote actions that facilitate "behavioral change"
- Study further the potential benefits/impacts of using different traction materials/aids
- Try Tier 2 over Tier 3 in urban areas

Urban Uplands

The major comments and suggestions were:

- Evaluation of road projects will be easier in the future with the TMDL methodology in place because it reflects "reasoned prioritization"
- Gut check the assumption that 80% of urban areas can be treated (60% is more realistic)
- Look at Tier 2 as much as possible; focus on advanced BMPs other than pump and treat
- Want to see a refinement of the analysis based on full Basin body of knowledge

- Continue to expand the pump and treat inquiry and research further the cost effectiveness of different approach. Is there a certain approach that would be more effective given local conditions.
- Consider moving snow and then treating it elsewhere
- Funding could be more of an issue than human capacity

New Ideas

- It is important to include actions focused on sociological fixes and behavioral change in order to complement the technological fixes
- Focus on scaling/incremental steps
- Improve quantification of benefits. Quantify benefits of collaboration (i.e. project permitting and business interests) SWQIC process a good example of this.
- Promote crediting and trading source control measures (including those that cannot be measured). This would increase use of source controls.
- Attempt to develop some packages that disaggregate settings in urban and other source categories
- Include some trade off analysis
    - Identify a certain amount of money and then run the clarity model to optimize actions

Future Research Suggestions

- Conduct pump and treat feasibility study
- Connect strategy/packages with clarity model
- Consider the impacts of greater implementation of defensible space practices
- Consider the impacts of future growth (USGS+)
- Consider the impacts of climate change
- Study further the time and duration in which change is expected (using the clarity model)
- Study the long-term impacts of the existing sewage system
- Incorporate the benefits of stream channel restoration into other sources
- Characterize and include other non-water quality benefits of stream channel restoration
- Include benefits of overbanking and increasing floodplain connectivity
- Quantify the benefits of a water quality project
    - Natural resource economic analysis
    - Spatial and temporal challenges make funding this data collection difficult
    - Must address quantifying nutrient cycling on the floodplain
- More stream data needed in general

Policy Issues to Consider

- How to best include the non-quantifiable measures in the TMDL
- What is the transition plan
- What should the implementation plan be give the time and duration in which change is expected

VII. Summary of Questions from the Board

Clarity Challenge:

- What is your general level of confidence of the costs and pollutant reduction values (Scott Brown NTCD)?
- Need system to estimate the benefits/effects of past effort? What would the Lake clarity be if all the projects had not been done. Need to be able to show benefit for past efforts and dollars spent. (Cyndie Walck)
- Revise Clarity Challenge to be just enough to give a sense of turning the corner (above annual noise) but closer to what is achievable/affordable. Or allow for a combined quantitative/qualitative approach. Credit conservatively what has not be qualified (Catherine Shoen)
- Would many of the particles already in the Lake settle with time? (i.e. does the decrease of inputs lead to an increase in clarity or just decrease in rate of loss) Are many nutrients/sediments are in temporary storage on their way to the Lake (in delayed response? (Cyndie Walck)
- The Clarity Challenge is married to our funding challenge. What is the plan for improving the tracking and accounting for nutrient and sediment reductions since our efforts to date have been insufficient. We have not been able to quantify benefits in the past which is problematic when trying to justify funding expenditures and requests. (Paul N)
- Is there evidence that pollutant loads to the Lake have been increasing (i.e. last 10-15 years)? If so, look at what sources may be increasing, and what policies allow this increase (i.e. new development). Also credit existing projects for reducing their increase (Robert Erlich)

Stream Channel

- Tier 2 rehabilitation: the percentage for stabilization in Tier 3 is too high vs the percentage for restoring under Tier 1. Emphasize that the difference between Tier 1 and Tier 2 is much due to constraints (property ownership, infrastructure) (Cyndie Walck)
- Tier 3 costs are too low. Need to consider that the costs are based on stabilizing hot spots but that they would on activating result in additional bed and bank treatment that would be much more spatially extensive and costly. (Cyndie Walck)
- Tier 1 and 2 vs Tier 3. Make sure that the habitat ecosystem benefits are emphasized. Make sure to note that additional benefits may be realized by increasing the wetland floodplain function. (Cyndie Walck)

Forest Management

- Has USFS considered prioritizing dirt roads and bike trails that are prone to constant disturbance? Proximity to sensitive areas? (Stan Hill)
- Is the assumption that any fuel reduction projects will do full restoration and removal of roads and skid trails constructed for access? (Cyndie Walck)
- What percentage of legacy/non-system roads does 10% of Tier 3 represent of those roads. Distinguish that Tier 3 is full restoration and recontouring of those roads not just close access and rip surface. (Cyndie Walck)

Atmospheric Deposition

- I heat my home with wood that would otherwise be burned in piles. I believe that burning dry, seasoned wood in a stove is cleaner than in a pile. An additional consideration is that pile burning usually occurs in the winter when the piles are wet and starved for oxygen due to being buried under snow, which causes them to burn inefficiently. Which practice is best? How does this compare to fossil fuel emissions if I turn on the furnace? (Scott Cecchi)
- What about ash? I have my wood burning stove ash removed by South Tahoe refuse with my garbage. How does this compare with the ash left from pile burning? Is the ash from pile burning significant in terms of pollutant loading (nutrients)? (Scott Cecchi)
- Biodiesel for example may have elevated nitrogen emissions (above standard diesel). Overall, should biodiesel and other alternative fuels (CNG, ethanol, etc) be supported in Tahoe? (Scott Cecchi)
- We need to verify that increased sweeping O&M costs are included in capital costs. If not, they need to be considered. (Penny Stewart)
- Atmospheric – mobile sources. Did the expense of implementation of a busing system consider "user fees" – bus fare? Grant funding for transportation? (Stan Hill)
- Atmospheric Tier 2 and 3 mobile do not discount/disregard comprehensive transit service. This should be included (not just stationary). Realize you cannot do a massive busing system but you currently cannot get to/from Truckee or around the lake in an efficient manner (limited time of day/multiple connections) (Cyndie Walck)
- Shouldn't dust suppression on construction sites be considered an extension of standard practice? Tier 2 rather than Tier 3? (John Johnston)
- Street sweeping also creates fine dust; how to capture?
- Analyze the type of rock material used for road sanding? How does it pulverize/break down. Perhaps some geologic/mineral sources would provide less fines. (Cyndie Walck)
- What impact will the upcoming deadline (7/1/08) for wood-burning stoves to be upgraded to EPA compliant stoves have on the proposed 25-50% reduction in residential wood burning? Could this reduction possibly be achieved by enforcement and additional incentives for the ordinance? (Nova Lance Seghi)
- One of the major road maintainers does not use PM-10 compliant sweepers. Does the street sweeping cost include new sweets and does it set emissions standards? (Scott Brown NTCD)
- Do VMT reductions really have no impacts/benefits on FS or P loading? Doesn't VMT cause increase in dust and soil deposition on roadways, so reductions would be a forum of source control? (Jack Landy, USEPA)
- Why does Table ES-5 of the PRO Report show a 3-8% reduction in sediment for mobile Tier 2 an 3, but not the 10/11 "Estimated Potential Pollutant Reductions" handout? (Gordon Shaw)
- Tier 3 stationary calls for paving all dirt roads. Does that include FS roads? Does bi-weekly sweeping mean twice a week or every other week? (Catherine Schoen)
- Pile burns may not be distributed evenly through the Basin – closer to urban areas and closer to the lake. How much load/reduction is due to wood stoves (EPA and Non-EPA compliant, pile burns, controlled burns? R. Eileen

- NDOT has a standard for traction control material that specifies low P. This standard should be extended to all counties and CALTRANS. (Scott Brown NTCD)
- It seems as though the feasibility of paving all dirts roads (even 80%) is very low due to public acceptability, user conflicts, etc. This should be applicable to upland forest areas primarily (Paul Nielsen)

Urban

- Extensive implementation of pump and treat would involve burying probably tens of miles of pipe. This would likely have a significant impact to sediment load due to surface disturbance. Is that temporary sediment increase quantified? (Scott Brown NTCD)
- Tier 3 consists of pump and treat for 60% and Tier 2 for 40%. Then subtracting 40% of Tier 2 costs from Tier 3 totals leaves $1,120B in capital costs and $6 million in annual O&M which again looks low for designing, constructing and operating 6 treatment plants, and required infrastructure. We should look at stormwater collection at key delivery points that do not allow for traditional treatment (highway/bridges) and pumping to areas with passive storage and treatment capacity exists or can be created. (Catherine Schoen)
- Urban capital and O&M costs seem very low (Joyce Brenner)
- Without reading the report, I am concerned about how the tiers for urban and groundwater were populated, and capital costs/annual O&M estimated. By loading Tier 2 with aggressive application without realistic limitations on property acquisition and maintenance costs, it drives the cost up and beyond the estimated costs for pump and treat for 60% of urban areas (very hard to believe). Loading Tier 2 in this way, pushes the conclusion to utilizing pump and treat. While I believe we can come up with some pretty good estimates for advanced BMP implementation and maintenance, we do not have the experience to as accurately cost out pump and treat, system for storm water (chararterized by intermittent peak flows). I suspect land acquisition for pump and treat facilities, basins for additional capture of peak storage and locating infrastructure should push up the price for pump and treat as well. (Catherine Schoen)
- Has the application of salt been analyzed with respect to its effect on its affinity to hold P and N and particle cohesive characteristics? (Stan Hill)
- Have you considered using the cultured periphyton (being tested by TERC) for biodiesel production? This could be combined with the proposed biomass co-generation facility that is being proposed, which uses exhaust from biomass combustion to grow algae for biodiesel. (Scott Cecchi)
- CALTRANs did pilot studies on conventional (Pump and treat) technologies that might be helpful in the feasibility study. Tahoe SW to chemical coagulation to sand/fabric filters. (John Johnston)
- Integrate methods outlined in CASQA effectiveness assessment guidance.
- In addition to the effort to gain 100% BMP compliance, we also need programs in place to ensure the maintenance of these private BMPs. Without proper maintenance, desired effectiveness is lost.
- Placer County already recovers approximately 150% of traction abrasive material applied during current street sweeping efforts. Granted, we are picking up much more than placed, including additional sediment not a part of sanding efforts. Perhaps looking towards methods other than sanding yet would still provide the same level of

safety would be more effective (a brine solution vs sanding) or perhaps rather than additional sweeping/ apply less by using more efficient application/spreading technology (Nova Lance-Seghi)

Focus Team Potential Pollutant Reductions (handout)

Table 1. Share of Pollutant Budget Reduced by Source Category and Tier. *Percentages represent the share of the overall pollutant budget (see below) for the specified pollutant reduced with 100 percent application of the given Source Category Tier. Costs are associated with implementation of the specified tier. See Tier Description Sheet for details of the controls included in each tier.*

	< 20 micron sediment particle reductions	Phosphorus reductions	Nitrogen reductions	Capital cost - 20 year (Million $)	Annual O&M cost (Million $)	Total 20 year cost (Million $)
Atmospheric						
Tier 2 FS&P/Stationary	3%	3%	0%	$28	$0	$35
Tier 2 Mobile	0%	0%	5%	$280	$130	$2,900
Tier 3 FS&P/Stationary	7%	8%	1%	$74	$1	$88
Tier 3 Mobile	0%	0%	12%	$690	$330	$7,200
Urban & Groundwater						
Tier 1	15%	7%	3%	$1,400	$3	$1,500
Tier 2	25%	11%	7%	$2,800	$21	$3,200
Tier 3	28%	12%	5%	$1,700	$9	$2,800
Forested Uplands						
Tier 1	1%	0%	0%	$170	$6	$320
Tier 2	4%	1%	0%	$1,400	$7	$1,600
Tier 3	7%	2%	0%	$3,100	$0	$3,200
Stream Channel						
Tier 1	2%	1%	N/A	$210	$0	$210
Tier 2	2%	1%	N/A	$51	$0	$50
Tier 3	3%	1%	N/A	$15	$0	$15

Table 1 Field Descriptions:

< 20 micron sediment particle reductions – Share of the entire <20 micron sediment load to Lake Tahoe reduced by the specific Source Category Tier.

Phosphorus reductions – Share of the entire total phosphorus load to Lake Tahoe reduced by the specific Source Category Tier.

Nitrogen reductions – Share of the entire total nitrogen load to Lake Tahoe reduced by the specific Source Category Tier.

20 year capital cost (Million $) – Capital costs for the Source Category Tier over 20 years, in millions of dollars. Where useful life of projects is less than 20 years, capital costs reoccur.

Annual O&M cost (Million $) – Operation and maintenance costs for the Source Category Tier for one average year, in millions of dollars.

Total 20 year cost (Million $) – Capital costs and operation and maintenance costs for the Source Category Tier over 20 years, in millions of dollars. Average annual O&M costs occur each year.

Table 2. Estimated Pollutant Loads to Lake Tahoe by Source Category. Green cells are high confidence estimates and red cells are low confidence estimates. Source: Lake Tahoe TMDL Technical Report 2007.

Source Category		Total Nitrogen (metric tons/year)	Total Phosphorus (metric tons/year)	Number of Fine Sediment Particles ($x10^{18}$)
Upland	Urban	63	18	348
	Non-Urban	62	12	41
Atmospheric Deposition	(wet + dry)	218	7	75
Stream Channel Erosion		2	1	17
Groundwater		50	7	NA
Shoreline Erosion		2	2	1
TOTAL		397	46	481

PATHWAY Forum Agenda

Lake Tahoe TMDL
October 25, 2007, 8:30a.m.–4:30p.m.

Topic: Honing in further on the question, "What strategy should we implement to reduce pollutant inputs to Lake Tahoe?" today we will discuss ways of packaging pollutant control opportunities to meet the Clarity Challenge.

Location: North Lake Tahoe Conference Center

8:30	**Registration and refreshments**
9:00	**Welcome and agenda overview** (Kearns & West)
9:10	**Context for the day's discussions** (Singer/Porta)
9:35	**Stream restoration & forest management recommendations** (Larsen)
10:10	**Atmospheric pollutant control opportunities** (Reuter) (presentation / brief discussion / Q&A)
10:40	**Urban runoff pollutant control opportunities** (Benoit) (presentation / brief discussion / Q&A)
11:15	**Break**
11:30	**Discuss illustrative scenarios and review recommendations**
12:30	**Lunch**
1:30	**Discuss ways of packaging pollutant control opportunities**
3:15	**Break**
3:30	**Discussion summary** (Kearns & West/TMDL Team)
4:00	**Update on TRPA and TMDL document timing** **Other relevant Pathway updates** **Public comment period**
4:30	**Adjourn**

Discussion themes and questions

Lake Tahoe TMDL
October 25, 2007, 8:30 a.m. – 4:30 p.m.

PATHWAY
A VISION FOR TAHOE'S FUTURE

Topic: Honing in further on the question, "What strategy should we implement to reduce pollutant inputs to Lake Tahoe?" today we will discuss ways of packaging pollutant control opportunities to meet the Clarity Challenge.

Our goal today is to receive your input on ways of packaging pollutant control opportunities into an overall strategy to meet the Clarity Challenge.

In both small group discussion (1:30 – 2:30) and full group discussion (2:30 – 3:15) your insight is sought in terms of

I. New scenarios you would like to suggest
II. Your feedback on the sample illustrative scenarios
III. Your sense of the social, technical and financial range of feasibility to implement the scenario or its individual pollutant control opportunities
IV. Your input about the public acceptability of individual pollutant control opportunities – especially for atmospheric and urban sources.

The following questions are designed to help you provide productive feedback. You are not confined to discussing these questions, nor is it expected that we will fully address all of these questions in discussion today. Your response to these questions is welcome throughout the month of November.

I. New scenarios you would like to suggest

You are invited to share ideas for approaches / emphases you would like to see in a final strategy.

- What would be the ideal combination of pollutant control opportunities to implement over the next 15 years to meet the Clarity Challenge?
- What themes would be emphasized in your "ideal strategy"?

Sample approaches / emphases given so far have been on: using innovative technology; focusing on most-pervasive application of existing technology possible etc.

II. Feedback on the sample illustrative scenarios

Illustrative scenario A

- What components of this scenario would you like to see modified? In what way (such as emphasize, more or less)? Why?
- Are there elements of this scenario that you would like to keep? Why?
- Are there elements of this scenario that are unacceptable? Why?
- Any pollutant control options that should be added? Why?
- Are there elements of this scenario that should be considered base elements of all strategies? Why?

Other Illustrative scenarios (same questions as above)

III. Social, technical and financial range of feasibility

Social

- What ways of meeting the clarity challenge can people really support?
- Are there behaviors / practices that institutions are already seeking to change that the clarity challenge can give context / meaning to (or benefit from)?
- Are there behaviors / practices that individuals (residents and or visitors) want to change that the clarity challenge can give context / meaning to (or benefit from)?
- What social factors might come into play that could "make or break" any given approach to the clarity challenge?

Technical

- Would you like to see an emphasis on improving the technologies we currently apply in the Basin? Why?
- Are there technologies we currently apply in the Basin that you consider ineffective and therefore would recommend against their inclusion in future scenarios? Why?
- Would you like to see an emphasis on broader and more-rigorous application of the technologies we currently use in the Basin?
- Are there technologies that we already apply in the Basin that are really effective regarding clarity advances and that people would like to see more of? Why?
- Are there practices / technologies that should be investigated further regarding their relevance to the clarity challenge? If so please give examples?
- Are other localities / regions putting things on the ground that you would like to have looked into for the Tahoe clarity challenge application?
- Are the technologies / approaches discussed in the Pollutant Reduction Opportunity Report palatable good-but-with-reservation, unacceptable? Why?
- Are there technological factors that could come into play and "make or break" the clarity challenge? If so what are they?

Financial

- What is the range of financial resources that the Basin can reasonably expect to raise (from sources such federal, state, local) to meet the clarity challenge?
- To what extent is Lake Tahoe clarity a financial priority of taxpayers?
- What do politicians and/or property owners want to be able to show as gain from investment?
- What proportion of the overall budget for managing basin resources should apply to water quality targeted objectives? Why?
- Is there an "integrated scenario" that is particularly palatable from a clarity-gain-for-investment perspective?

IV. Individual pollutant control opportunities – focus on atmospheric and urban sources

Urban & groundwater

Among the urban and groundwater "example controls" that are listed in the bullet points on your "TMDL Treatment Tiers and Example Pollutant Control Opportunities" handout are there any in particular that

- You would particularly like to see included in an integrated strategy, why?

- You would object to seeing in an integrated strategy, why?

Atmospheric
Among the atmospheric “example controls” that are listed in the bullet points on your “TMDL Treatment Tiers and Example Pollutant Control Opportunities” handout are there any in particular that

- You would like to see included in an integrated scenario, why?
- You would object to seeing in an integrated scenario, why?

Thank you for helping the TMDL team identify scenarios and specific actions that can be assembled into a strategy for meeting the Clarity Challenge in a way that will work.

Setting Description Table (October 25, 2007)

Setting name	*Definition*
Atmospheric Settings	
Setting 1	The entire band of land less than 0.2 kilometer from the Lake. Pollutant emissions from this Setting will reach the Lake most readily.
Setting 2	The entire band of land less than 1 kilometer from the Lake (includes Setting 1).
Setting 3	The entire band of land less than 3 kilometers from the Lake (includes Settings 1 & 2)
Setting 4	The entire Lake Tahoe Basin (includes Settings 1, 2, & 3)
Urban and Groundwater Settings	
Concentrated – Steep	Areas where impervious coverage is relatively concentrated and there is minimal space for PCOs to be constructed. Average slope of the area is *greater than* 10%.
Concentrated – Moderate	Areas where impervious coverage is relatively concentrated and there is minimal space for PCOs to be constructed. Average slope of the area is *less than* 10%.
Dispersed – Steep	Areas where impervious coverage is relatively dispersed and there is adequate area for PCOs to be constructed within the impervious coverage area or downhill from it. Average slope of the area is *greater than* 10%
Dispersed – Moderate	Areas where impervious coverage is relatively dispersed, and there is adequate area for PCOs to be constructed within the impervious coverage area or downhill from it. Average slope of the area is *less than* 10%.
Forested Uplands Settings	
Setting A	Highly disturbed areas with significant compaction such as unpaved roads.
Setting B	Areas subject to major soil disturbance such as ski runs, campgrounds, and steep bare slopes. These areas are characterized by moderate vegetative cover, little mulch or duff, and low-infiltration capacity.
Setting C	Typical Tahoe forested areas that are managed for forest health and defensible space. These areas are characterized by well-established plant communities, thick duff layers and high soil-hydrologic function. The large majority of the Basin land area falls into Setting C.
Stream Channel Settings	
Upper Truckee River	The entire restorable channel of the Upper Truckee River.
Blackwood Creek	The entire restorable channel of Blackwood Creek.
Ward Creek	The entire restorable channel of Ward Creek.

Tier name	*Summary definition*	*Example Controls*
Atmospheric		
Tier 2* Transportation Infrastructure	A set of Pollutant Control Opportunities (PCOs) for stationary sources of fine sediment and phosphorous that effectively removes pollutants, deemed cost effective. Numeric estimates based on average literature values.	• Vacuum sweep streets (bi-weekly, fine-sediment-effective) • Pave dirt roads at access points • Limit speed on unpaved roads • Gravel 50% of unpaved roads, including forest roads • Require adequate soil moisture while moving soil • Suppress dust on road building projects • Reduce residential wood burning emissions by 20%
Tier 2* Vehicle Emissions	A set of PCOs for mobile sources of nitrogen that effectively removes pollutants and is considered cost effective. Numeric estimates based on average literature values.	• Reduce Vehicle Miles Traveled (VMT) by 10% through incentives/disincentives (see PRO report for baseline) • Comprehensive transit service
Tier 3 Transportation Infrastructure	A set of PCOs for stationary sources of fine sediment and phosphorous, deemed highly effective in removing pollutants and may be more costly than Tier 2. Numeric estimates based on high literature values.	Tier 2 controls plus: • Vacuum sweep streets (bi-weekly, fine-sediment-effective) • Pave all unpaved roads • Suppress dust on construction projects • Reduce residential wood burning emission by 50%
Tier 3 Vehicle Emissions	A set of PCOs for mobile sources of nitrogen, deemed highly effective in removing pollutants and may be more costly than Tier 2. Numeric estimates based on high literature values.	• Reduce Vehicle Miles Traveled (VMT) by 25% through incentives/disincentives (see PRO report for baseline • Comprehensive transit service
Urban & Groundwater		Note: each tier is defined differently for each setting. These descriptions are representative of controls used.
Tier 1*	An upper-end use of existing practices and technologies. Spatial application within the treatment area considers typical site and funding constraints. Assumes incomplete compliance with current private property BMP requirements.	• Stabilize and re-vegetate road shoulders • Vacuum sweep streets (in heavily sanded areas) • Upgrade fertilizer / turf management to reduce nutrient application and provide optional education • Remove impervious and soft coverage (increase infiltration) • Re-route runoff for additional treatment • Install and maintain detention & sedimentation basins • Install and maintain stormwater vaults and hydrodynamic separation devices
Tier 2	A significantly more intense application of advanced, gravity-driven treatment technologies applied aggressively within the treatment area. Traditional limitations on property acquisition and maintenance rates are relaxed in this Tier. Assumes complete compliance with current private property BMP requirements.	• Apply advanced deicing strategies (possibly eliminate sand) • Upgrade infrastructure operation and maintenance • Upgrade management of fertilizers (and add education component) • Upgrade fertilizer / turf management to reduce nutrient application and require education for turf managers • Control retail fertilizer sales within the Basin • Recommend landscaping practices that reduce nutrient mobilization • Install and maintain retention ponds, infiltration basins or wetland basins that involve biological/chemical treatment processes • Install and maintain stormwater vaults and hydrodynamic separation devices that include media filtration

Tier name	Summary definition	Example Controls
		• Install and maintain sand filters
Tier 3	A collection, pumping, and centralized treatment system (Pump & Treat) in concentrated settings with large contiguous areas. Tier 2 controls in dispersed settings.	• Install and maintain stormwater collection and conveyance infrastructure. Address 60% of the urban project area with stormwater treatment. Apply Tier 2 controls in dispersed settings (40% of urban areas).

Tier name	Summary definition	Example Controls
Forested Uplands		Note: each tier is defined somewhat differently for each Forested Setting (e.g. unpaved roads, ski runs, and "undisturbed" forested areas). These describe representative activities.
Tier 1*	Includes standard treatments used or required by management agencies in current practice.	• Install and maintain (annually) full unpaved roadway BMPs (waterbars, armored ditches, rut stabilization) • Hydro-seed and tackify ski runs • Implement forest treatments with ground-based equipment and required BMPs
Tier 2	A middle level of treatment that includes state-of-the-art practices designed to achieve functional rehabilitation of hydrologic properties.	Tier 1 controls plus: • Capture on-site, unpaved roadway sediment • Mulch and revegetate with seedlings on ski runs • Install and maintain "full BMPs" (to increase infiltration and reduce runoff on landings, trails and roads) in forested areas
Tier 3	Treatments designed to develop site conditions that will mimic undisturbed, natural conditions after a period of time. This Tier represents the maximum load reduction possible in the setting and assumes runoff volume and quality similar to natural background conditions.	• Re-contour roads (plus tilling, organic soil amendments, mulch, and revegetation with seedlings and seeding) • Results in return to native forest conditions with natural hydrologic function • Fully restore legacy roads and trails
Stream Channel		
Tier 1	**Unconstrained Restoration.** A set of treatments that modifies planform, increases length and sinuosity, connects floodplain and decreases slope such that a restored condition is eventually reached. Designed to achieve load reductions as well as other ecosystem objectives such as riparian habitat, flood control, and recreation value. Assumes ideal construction access and sequencing. Traditional limitations on property acquisition are relaxed in this Tier.	• Lower stream channel banks and reduce angle to accommodate more frequent over-bank flow and reduce erosion/slumping of channel banks • Increase channel length and sinuosity which will over- time decrease channel bed slope • Restore riparian vegetation • Reconnect floodplains (remove infrastructure) • Remove any infrastructure (bridges) that restrict stream channel flow
Tier 2*	**Rehabilitation.** A combination of channel restoration (Tier 1) and simple bank protection (Tier 3) that focuses on cost-effective treatments. Property ownership is considered a factor.	• 45% of project length is bank protection (Tier 3) • 35% is restoration (Tier 1) • 10% bank strengthening • 5% toe stabilization • 5% bank lowering/angle reduction
Tier 3	**Bank protection.** A basic set of channel armoring and minor bank slope reductions that increase hydraulic resistance and reduce bank failure. Does not achieve multiple ecosystem objectives.	• Install rip rap on channel banks • Install grade controls • Remove overhanging banks • (No additional floodplain connection)

* These Tiers include pollutant controls that are most closely related to those used in the most effective EIP projects however; they do not represent a baseline or status quo condition that applies to existing projects.

Welcome

PATHWAY Forum

TMDL Meeting #2 of 4

October 25, 2007

Meeting Goal

Forum members give input on ways of packaging pollutant control opportunities to meet the Clarity Challenge.

Agenda Review

- 9:00 Welcome and agenda overview
- 9:10 Context for the day
- 9:35 Stream restoration & forest management recommendations
- 10:10 Atmospheric pollutant control opportunities
- 10:40 Urban runoff pollutant control opportunities

Agenda Review

- 11:15 Break
- 11:30 Discuss illustrative scenarios and Review stream & forest recommendations
- 12:30 Lunch

Agenda Review

- 1:30 Discuss ways of packaging pollutant control opportunities
- 3:15 Break
- 3:30 Discussion summary
- 4:00 Update on TRPA/TMDL document timing
- Other relevant Pathway updates
- Public comment period
- 4:30 Adjourn

Next Steps

December 6 — PATHWAY Forum Meeting #3 of 4

Presentation of integrated pollutant control opportunity packages to meet the Clarity Challenge

Package design will be directly informed by the feedback and ideas you provide today and in the coming weeks.

Ground Rules

- Respect all interests and participate in good faith
- Focus on interest-based discussions, not position-based ones
- Listen for understanding and openly discuss issues with others who hold diverse views
- Stay on topic, providing comments during the relevant section of the agenda
- Hold your questions until allotted question-and-answer segments

Ground Rules

- Keep questions/comments brief and to the point
- Please don't repeat a comment or point that someone else has already stated
- Assure that all members are heard and that one person speaks at a time
- Share ideas and concerns with other Forum members, Pathway agencies, and the facilitators

Reminders

- Not making decisions today
- No "right" or "wrong" opinions
- Want to hear a broad range of perspectives
- We'll never have "enough" science, but we have a lot more than we did 40 years ago
- TMDL team wants to hear your thoughts and perspectives outside of the Forum meetings as well

Charting a course to

PATHWAY Forum

TMDL Meeting #2 of 4

October 25,2007

Clarity

Meeting Goal

Give input on ways of packaging pollutant control opportunities to meet the clarity challenge

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 2

Meeting Objectives: morning

1) Hear and consider base recommendations for stream, forest, atmospheric and urban pollutant reduction

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 3

Meeting Objectives: mid-day

1) View sample scenarios which illustrate ways to package pollutant control opportunities to meet the clarity challenge

2) Discuss and give input on base recommendations for stream & forest pollutant reduction

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 4

Meeting Objectives: afternoon

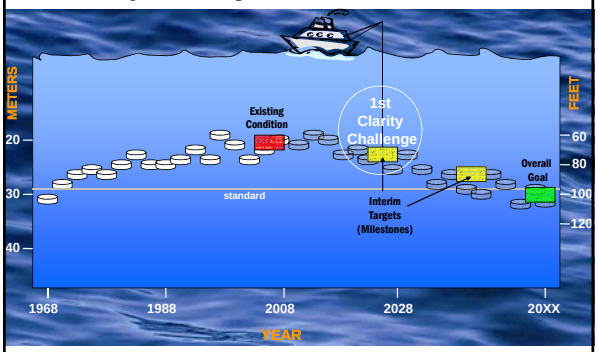
1) Discuss ways of packaging pollutant control opportunities to meet the clarity challenge

Small group and full forum discussion will provide the TMDL team with your input about:

- Individual pollutant control opportunities
- Strengths and weaknesses of the sample scenarios
- The social, technical and financial range of feasibility for reaching the clarity challenge
- Your "integrated package" suggestions

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 5

The Clarity Challenge



6

Pollutant Reduction Opportunity Project

Four Source Category Groups
- Stream Channel Erosion, Forest Uplands, Atmospheric Deposition, Urban Uplands

Basin-wide load reduction estimates

Different "Tiers" of implementation effort
- See Handout

What are the options for reducing pollutant inputs to Lake Tahoe?

7

Pollutant Reduction Opportunity Project

Load reductions for each source by tier

Cost for each tier of implementation
- 20-year capital cost
- Annual operations and maintenance cost

Handout summarizes project results
- Tiers are the scenario building blocks

What are the options for reducing pollutant inputs to Lake Tahoe?

8

Illustrative Pollutant Reduction Scenarios

Illustrative scenarios include some level of implementation across all source categories

Scenarios illustrate that there are various ways to achieve the clarity challenge

Illustrative scenarios are to initiate discussion NOT proposed outcomes

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

9

Illustrative Scenario Components

Approach description

Percent fine sediment reduction by source

Costs
- 20-year capital
- Annual operations and maintenance

Resulting clarity

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

10

Example Illustrative Scenario Description

Emphasis of this example illustrative scenario:
Continuation of Current Best-Practices

"This scenario represents continued implementation of current best practices, emphasizing broad implementation of pollutant controls for reducing atmospheric fine sediment and treating urban runoff. This approach will not achieve the Clarity Challenge."

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

11

Example Illustrative Scenario Description

- **Atmospheric** fine sediment and phosphorus reduction focus from 70% of roadways & reduced use of woodburning stoves
- **Urban & Groundwater** extending current best practices over 70% of urban area, achieving partial implementation of private property BMPs
- **Forest** treating 80% of unpaved roads, ski runs, campgrounds and other disturbed forested areas using current best practices & standard BMPs fuels treatment projects
- **Streams** combine stream channel rehabilitation and restoration on 80% of the potential project areas on each of the Upper Truckee River, Ward Creek and Blackwood Creek

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

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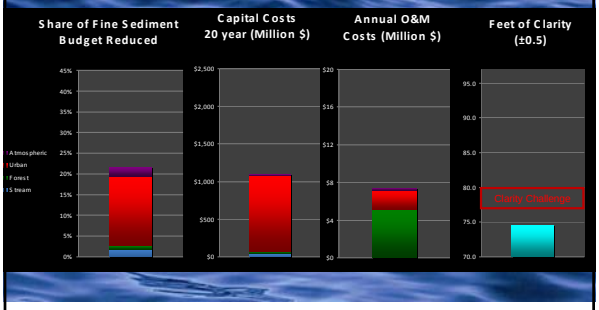
Example Illustrative Scenario – Data Output



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

13

Ways of packaging to meet the Clarity Challenge

Discussion

- New / different package approaches you suggest
- Your thoughts about the sample scenarios – what are their strengths, weaknesses, benefits, tradeoffs
- Your sense of the social, technical and financial range of feasibility for reaching the clarity challenge
- Your input about individual pollutant control opportunities – especially for atmospheric and urban sources

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

14

Charting a course to

Clarity

Implementation Recommendations

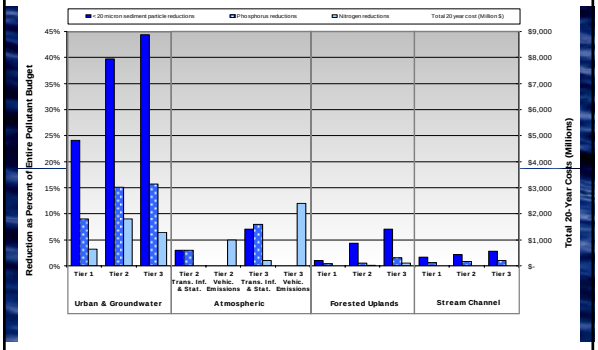
Proposed Approach
to
Simplify and Target
the
Development of Integrated Packages

Implementation Plan Development

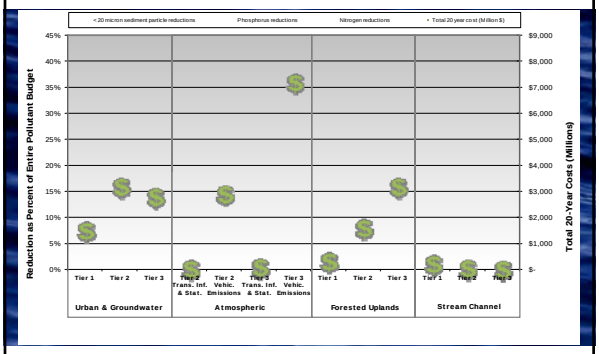
- **Identify pollutant control opportunities**
- **Quantify pollutant control options**
- **Prepare implementation packages**
- **Solicit stakeholder feedback**

What are the options for reducing pollutant inputs to Lake Tahoe?

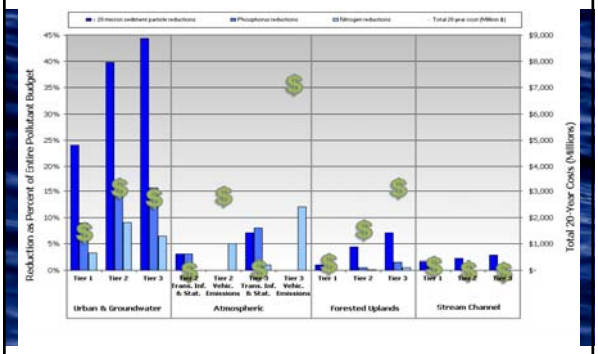
Estimated Potential Load Reductions



Estimated Potential Costs



Combined Load Reductions and Costs

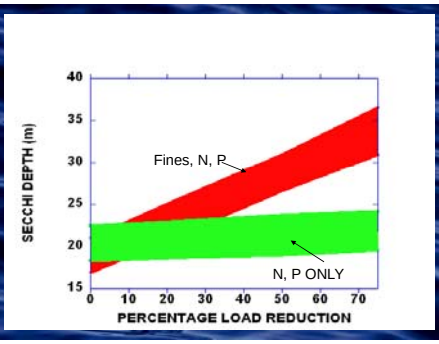


Emphasize Fine Sediment Removal

- Fine sediment is responsible for 2/3 of the clarity condition
- Reducing fine sediment has a greater potential to improve lake clarity
- Track and account for nutrient removal

7

Clarity Response - Fine Sediment is the key



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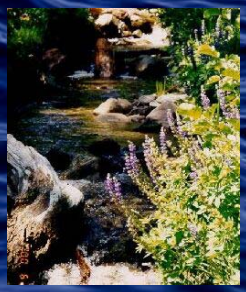
Recommendations

- Implement forest management practices as currently planned
- Continue stream restoration efforts

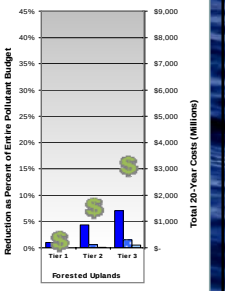


What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

9

Forest Upland Implementation

- Load reduction opportunities are relatively limited
- Additional reduction efforts do not appear cost effective
- Current practices effectively reduce loads



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

10

Forest Upland Implementation Recommendation

- Restore/maintain roads as planned
- Revegetate/treat disturbed lands
- Treat forest fuels

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

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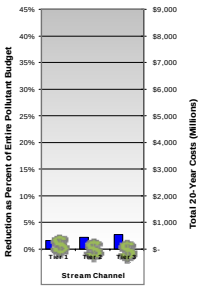
Stream Channel Restoration

- In-channel sources are small
- Restoration is cost effective
- Restoration offers multiple benefits
- Restoration likely provides additional water quality benefits



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

12

Stream Channel Restoration Recommendation

Continue current restoration activities

Support monitoring and research

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

13

Simplify

Focus on the most important pollutant

Continue stream restoration and forest management work

Focus on how to implement larger opportunities

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

14

Charting a course to

Clarity

Packaging Approach – Stream Channel Restoration

80% implementation on the Upper Truckee River, Blackwood Creek, and Ward Creek

Assume Tier 2 - mixed restoration and bank protection

Support restoration on other disturbed stream systems

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

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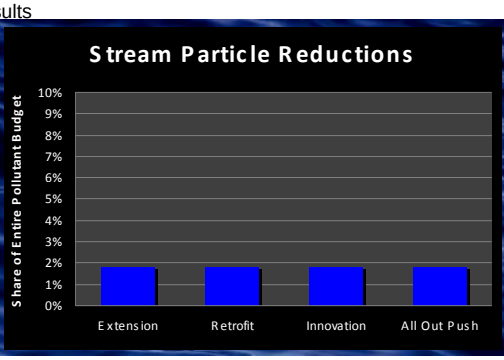
Stream Channel Erosion Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

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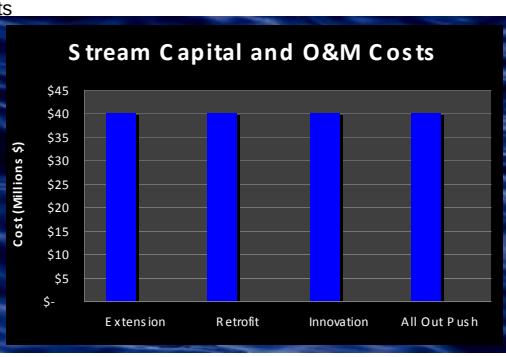
Stream Channel Erosion Costs



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

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Packaging Approach – Forest Uplands

Treat/maintain 80% of unpaved roads
60% Tier 1, 10% Tier 2, 10% Tier 3

Restore 80% disturbed areas (ski runs, campgrounds, etc.)
60% Tier 1, 10% Tier 2, 10% Tier 3

Conduct fuels management on 20% of the forest
10% Tier 1, 5% Tier 2

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

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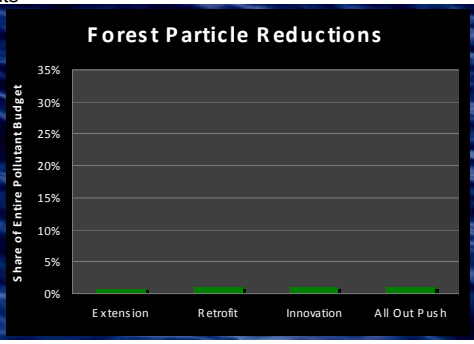
Forest Runoff Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

20

Forest Runoff Costs

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

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Charting a course to

Clarity

Charting a course to

Atmospheric Deposition Pollutant Control Opportunities

Clarity

Atmospheric deposition analysis

Load reduction estimates based on emission reduction estimates

Customized update of *California Air Resources Board Emissions Inventory*

Considered:
- mobile sources, paved roads & parking, unpaved roads, construction disturbance, wood combustion

Used published equations / relationships to estimate reduction from each source

Atmospheric deposition emission inventory summary

Table 2-8. Annual average percent contribution of sources of pollutants in the Basin

Source	Percentage of pollutant from a specific source		
	Inorganic nitrogen	Phosphorus	Inert species
Mobile	87	<1	1
Stationary (non-RWC)	10	< 1	< 1
RWC	3	7	2
Unpaved Roads	–	44	46
Paved Roads	–	40	43
Building Construction	–	7	5
Paved Road Construction	–	5	2

Atmospheric deposition treatment tiers

Tier 2
- Suggested combination of pollutant control opportunities based on literature values to provide realistic estimates of potential load reductions

Tier 3
- Suggested combinations of pollutant control opportunities that provides upper bound on load reduction.

Tier 2 pollutant control opportunities

Transportation Infrastructure & Stationary
- Bi-weekly PM-effective street sweeping (all paved roads)
- Pave dirt roads at access points
- Limit speeds on unpaved roads
- Gravel 50% of unpaved roads
- Require adequate soil moisture during earth moving operations
- Use dust suppressants on road building projects
- 20% reduction in residential wood burning emissions

Vehicle Emissions
- 10% VMT reduction through user fees and incentives
- Comprehensive transit service

Tier 3 pollutant control opportunities

Transportation Infrastructure & Stationary

- Tier 2 controls plus
- Weekly street sweeping (all paved roads),
- Pave all unpaved roads,
- Use dust suppressants on building construction projects,
- Adjust residential wood burning emissions reductions from 20% to 50%

Vehicle Emissions

- 25% VMT reduction through user fees and incentives (entry fees)
- Comprehensive transit service

Atmospheric deposition pollutant control opportunities applied to tiers

Table 2-2. PCOs selected for atmospheric sources of pollutants

Source category	PCO	Tier 3	Tier 2
Mobile	M1. Fee for visitors	X	X
	M2. Shuttle service for visitors and residents	X	X
	M3. Commercial boating restrictions	X	X
Paved Roads	1. PM-efficient vacuum sweeper	Weekly	Biweekly
	2. Switch from sand/cinders to deicers	X	X
	3. Pave unpaved roads at access points	X	X
Unpaved Roads	4. Pave road	X	
	5. Gravel for 50% of roads		X
	6. Speed restriction for 50% of roads		X
Construction Sites	7. Chemical suppressant	X[a]	X[b]
	8. Speed restriction		X
	9. Require > 12% soil moisture during earthmoving operations	X	X
Res. Wood Combustion	10. 50% curtailment	X	
	11. 20% curtailment		X

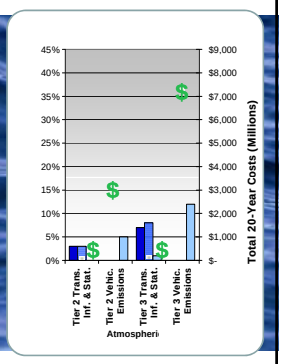
[a] For road and building construction projects
[b] For road construction projects only.

Atmospheric deposition tiers

Tier 1: baseline – no reduction estimated

Tier 2: transportation infrastructure & stationary source controls, and reduce Vehicle Miles Traveled (VMT) by 10%

Tier 3: reduce VMT by 25% and increase transportation & stationary source controls



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Atmospheric deposition - additional VMT consideration

- VMT and transportation contributes to road dust re-suspension as well as vehicle emission.
- Initial estimates of Basin-wide fine particle reduction from reduced VMT:

  0.4% from Tier 2 or 10% VMT reduction
  0.9% from Tier 3 or 25% VMT reduction

Atmospheric deposition recommendation

Given:

1) the large affect of fine particle reduction on lake clarity,
2) the lower affect of N-reduction on clarity,
3) the high cost associated with mobile source control for N,
4) the lower impact of significant VMT reductions on Basin-wide fine particle reduction:

… it is recommended that in early efforts to meet the Clarity Challenge, atmospheric pollutant reduction strategies focus on particle/P control. Efforts to reduce VMT for the purpose of N-control should be considered based on a larger discussion of transportation.

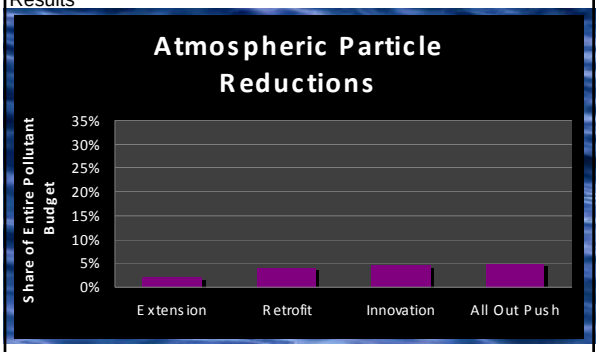
TRPA and others should continue to engage in VMT reducti discussions to meet other Thresholds

Atmospheric deposition

For consideration:

- ✓ **Street sweeping,**
- ✓ **Use of traction materials for particle/P removal**
- ✓ **Restoration of unpaved surfaces**

Atmospheric Deposition
Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

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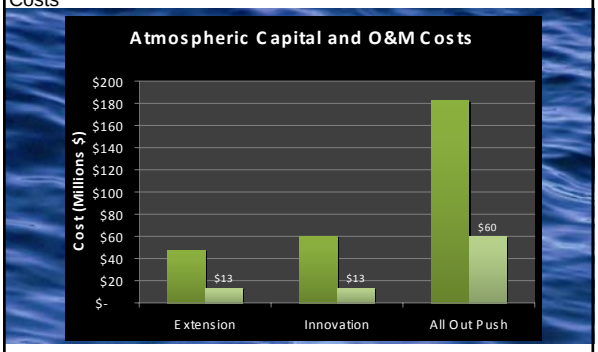
Atmospheric Deposition
Costs



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

14

Charting a course to

Clarity

Charting a course to

Urban Runoff Pollutant Control Opportunities

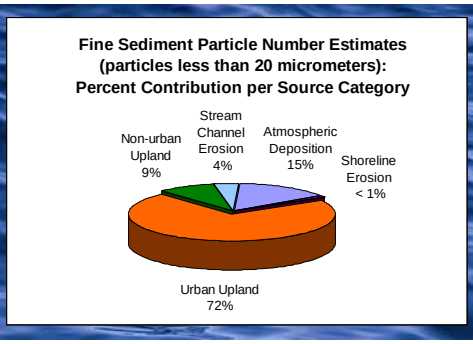
Clarity

Urban runoff analysis

- Tahoe and national data utilized and applied to analysis
- Watershed model used for Basin-wide extrapolation
- Baseline data from Tahoe land use loads modified by stormwater treatment load reductions

What are the options for reducing pollutant inputs to Lake Tahoe?

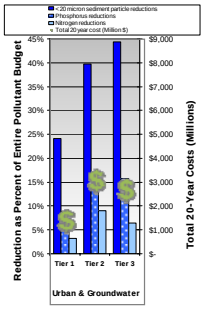
Urban runoff – our biggest opportunity



What are the options for reducing pollutant inputs to Lake Tahoe?

Tiers: Urban runoff and groundwater

- Tier 1: More extensive application of recent EIP project treatments
- Tier 2: Advanced practices, applied more aggressively in a project area
- Tier 3: Pump and treat system complemented by advanced practices



What are the options for reducing pollutant inputs to Lake Tahoe?

Tier 1 pollutant control opportunities

- Upper end of existing practices and level of application to all urban subwatersheds
- Sweeping in intensive traction abrasive areas (in balance with application of abrasives or deicers)
- Increased fertilizer management as Pollutant Source Controls for N and P
- 50% Private Property BMPs included for Pollutant and Hydrologic Source control (reduction)

What are the options for reducing pollutant inputs to Lake Tahoe? 6

Tier 2 pollutant control opportunities

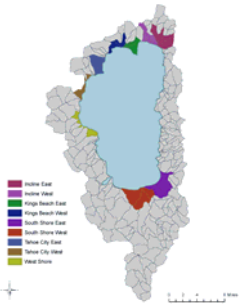
- Advanced deicing strategies
  - Additional Sweeping
  - Deicing solutions
- Media filters in stormwater vaults
- Additional Operation & Maintenance (Stormwater Treatment)
- Turf management strategies and required education for professional turf mangers
- Control of N and P through retail fertilizer sales
- 100% Private Property BMPs

What are the options for reducing pollutant inputs to Lake Tahoe? 7

Tier 3 pollutant control opportunities

Pump and Treat System to Concentrated Coverage areas
- Tier 1 (stormwater collection and plumbing to carry runoff)
- Localized holding ponds
- 9 regional treatment facilities analyzed
- Microfiltration (typically used for drinking water)

Tier 2 treatments to Dispersed Coverage subwatersheds



What are the options for reducing pollutant inputs to Lake Tahoe? 8

Recommendations for urban runoff pollutant control

Need go beyond the scope of current practice to meet the clarity challenge

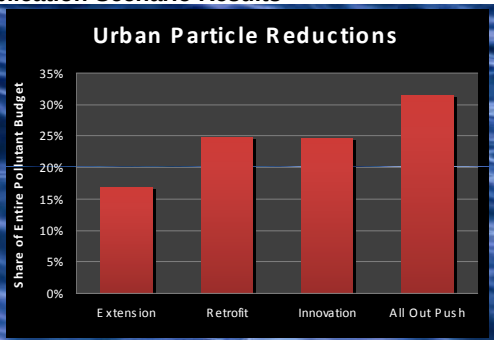
Consider application of Tier 1 level treatment, plus more Tier 2 enhanced treatment for particular situations

Consider Pump & Treat application in some areas in order to meet the clarity challenge

Scenario examples to follow offer some levels of urban treatment applications and pollutant load reductions

9

Urban Runoff Application Scenario Results



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Urban Runoff Application Scenario Costs

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Charting a course to

Clarity

Illustrative Scenario A:
Retrofit & Enhanced Best Practices

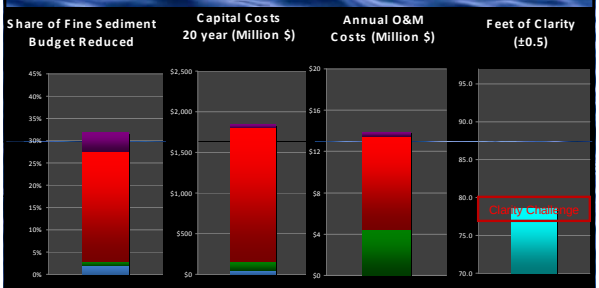
Continue existing best practices & augment with more-advanced and intensive passive treatments of urban stormwater

Address transportation infrastructure and stationary sources of atmospheric fine sediment

Forest & Stream recommendations

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Illustrative Scenario A:
Retrofit & Enhanced Best Practices



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Illustrative Scenario B:
Focus on Innovation & Advanced Practices

Innovate to gain greatest load reduction and treat less area

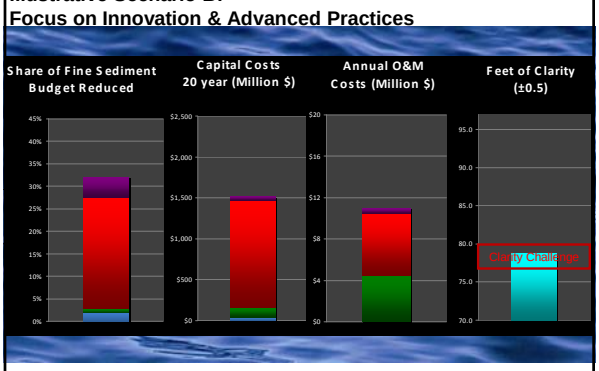
Use conveyance and treatment in dense urban areas and advanced passive treatments in dispersed urban areas

Highly intensive controls to reduce atmospheric deposition of fine sediment from transportation infrastructure and stationary sources

Forest & Stream recommendations

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Illustrative Scenario B:
Focus on Innovation & Advanced Practices



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Illustrative Scenario C:
All Out Push

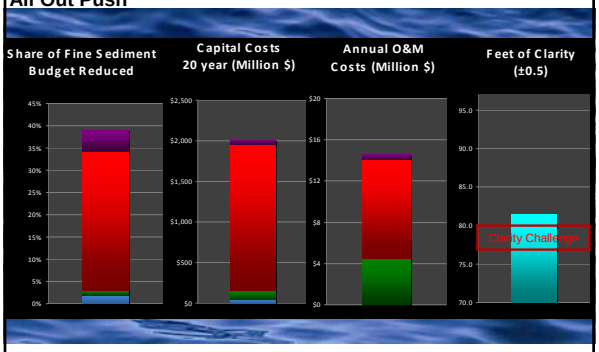
Treat maximum amount of area possible using the most effective pollutant controls

Assumes 80% of all urban and atmospheric sources treated – 60% advanced treatments & 20% current best practice

Forest & Stream recommendations

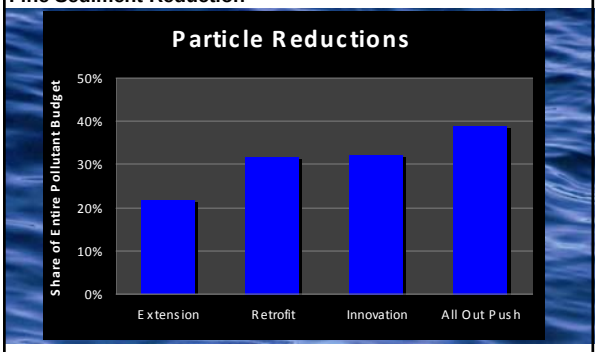
What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Illustrative Scenario C: All Out Push



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Illustrative Scenario Comparison: Fine Sediment Reduction



What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Illustrative Scenario Comparison: Cost

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Illustrative Scenario Comparison: Clarity Result

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Ways of packaging to meet the Clarity Challenge

Discussion

- New / different package approaches you suggest
- Your thoughts about the sample scenarios – what are their strengths, weaknesses, benefits, tradeoffs
- Your sense of the social, technical and financial range of feasibility for reaching the clarity challenge
- Your input about individual pollutant control opportunities – especially for atmospheric and urban sources

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

Charting a course to

Clarity

Emphasize Fine Sediment Removal

- Fine sediment is responsible for 2/3 of the clarity condition
- Reducing fine sediment has a greater potential to improve lake clarity
- Track and account for nutrient removal

Forest Upland Implementation Recommendation

- Restore/maintain roads as planned
- Revegetate/treat disturbed lands
- Treat forest fuels

Packaging Approach – Forest Uplands

- Treat/maintain 80% of unpaved roads
  - 60% Tier 1, 10% Tier 2, 10% Tier 3
- Restore 80% disturbed areas (ski runs, campgrounds, etc.)
  - 60% Tier 1, 10% Tier 2, 10% Tier 3
- Conduct fuels management on 20% of the forest
  - 10% Tier 1, 5% Tier 2

Stream Channel Restoration Recommendation

- Continue current restoration activities
- Support monitoring and research

Packaging Approach – Stream Channel Restoration

- 80% implementation on the Upper Truckee River, Blackwood Creek, and Ward Creek
- Assume Tier 2 - mixed restoration and bank protection
- Support restoration on other disturbed stream systems

Ways of packaging to meet the Clarity Challenge

Discussion

- New / different package approaches you suggest
- Your thoughts about the sample scenarios – what are their strengths, weaknesses, benefits, tradeoffs
- Your sense of the social, technical and financial range of feasibility for reaching the clarity challenge
- Your input about individual pollutant control opportunities – especially for atmospheric and urban sources

Scenario: Continuation of Current Best-Practices

Does Not Meet Clarity Challenge

Details

SCG	Setting	Tier	LOA: Level of Application	LOA Constraint Range	20-year Capital Cost ($ Million)	Annual O&M Cost ($ Million)	Cost Effectiveness (annual total cost $ Million/ % reduction particles)	Particles	TN	TP
Atmospheric	Setting 1	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	70%	0% - 70%	$4.8	$0.1	$0.57	0.5%	0.1%	0.5%
		TIOS Tier 3	-	0% - 0%	-	-	-	-	-	-
	Setting 2	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	70%	0% - 70%	$5.7	$0.1	$0.47	0.7%	0.1%	0.8%
		TIOS Tier 3	-	0% - 0%	-	-	-	-	-	-
	Setting 3	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	70%	0% - 70%	$4.5	$0.1	$0.58	0.5%	0.0%	0.5%
		TIOS Tier 3	-	0% - 0%	-	-	-	-	-	-
	Setting 4	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	70%	0% - 70%	$4.5	$0.1	$0.91	0.3%	0.0%	0.4%
		TIOS Tier 3	-	0% - 0%	-	-	-	-	-	-
Atmospheric Subtotal					**$20**	**$0.2**	**$0.60**	**2.1%**	**0.2%**	**2.2%**
Forest Upland	Setting A	Tier 1	80%	80% - 80%	$4.3	$0.9	$6.1	0.2%	0.0%	0.3%
		Tier 2	-	0% - 0%	-	-	-	-	-	-
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Setting B	Tier 1	80%	80% - 80%	$23	$4.3	$8.5	0.6%	0.0%	0.0%
		Tier 2	-	0% - 0%	-	-	-	-	-	-
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Setting C	Tier 2	-	0% - 0%	-	-	-	-	-	-
		Tier 3	-	0% - 0%	-	-	-	-	-	-
Forest Upland Subtotal					**$27**	**$5.1**	**$7.9**	**0.8%**	**0.0%**	**0.3%**
Stream Channel	Blackwood Ck.	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$11	$0.0	$1.3	0.4%	-	0.2%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Upper Truckee	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$24	$0.0	$1.1	1.1%	-	0.4%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Ward Ck.	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$5.2	$0.0	$1.0	0.3%	-	0.1%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
Stream Channel Subtotal					**$40**	**$0.0**	**$1.1**	**1.8%**	**-**	**0.7%**
Urban & Groundwater	Conc.-Moderate	Tier 1	70%	0% - 70%	$420	$0.9	$2.7	8.2%	1.1%	2.6%
		Tier 2	-	0% - 0%	-	-	-	-	-	-
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Conc.-Steep	Tier 1	70%	0% - 70%	$350	$0.7	$4.6	3.9%	0.5%	1.8%
		Tier 2	-	0% - 0%	-	-	-	-	-	-
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Disp.-Moderate	Tier 1	70%	0% - 70%	$80	$0.2	$1.7	2.5%	0.3%	0.8%
		Tier 2	-	0% - 0%	-	-	-	-	-	-
	Disp.-Steep	Tier 1	70%	0% - 70%	$160	$0.3	$3.7	2.2%	0.3%	1.0%
		Tier 2	-	0% - 0%	-	-	-	-	-	-
Urban & Groundwater Subtotal					**$1,000**	**$2.1**	**$3.1**	**16.9%**	**2.2%**	**6.3%**
Basinwide Total					**$1,100**	**$7.4**		**21.6%**	**2.5%**	**9.5%**

Clarity Result 74.5 feet

Scenario A: Retrofit & Enhanced Best Practices

Meets Clarity Challenge

Details

SCG	Setting	Tier	LOA: Level of Application	LOA Constraint Range	20-year Capital Cost ($ Million)	Annual O&M Cost ($ Million)	Cost Effectiveness (annual total cost $ Million/ % reduction particles)	Particles	TN	TP
Atmospheric	Setting 1	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	40%	0% - 80%	$2.8	$0.0	$0.58	0.3%	0.1%	0.3%
		TIOS Tier 3	40%	0% - 40%	$7.3	$0.1	$0.65	0.7%	0.1%	0.7%
	Setting 2	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	40%	0% - 80%	$3.3	$0.0	$0.48	0.4%	0.0	0.5%
		TIOS Tier 3	40%	0% - 40%	$8.7	$0	$0.45	1.1%	0.1%	1.2%
	Setting 3	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	40%	0% - 80%	$2.6	$0.0	$0.58	0.3%	0.0	0.3%
		TIOS Tier 3	40%	0% - 40%	$6.9	$0.1	$0.56	0.7%	0.1%	0.8%
	Setting 4	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	50%	0% - 80%	$3.2	$0.0	$0.90	0.2%	0.0	0.3%
		TIOS Tier 3	30%	0% - 30%	$5.1	$0.0	$1.0	0.3%	0.0	0.4%
Atmospheric Subtotal					**$40**	**$0.4**	**$0.59**	**4.1%**	**0.5%**	**4.4%**
Forest Upland	Setting A	Tier 1	60%	60% - 80%	$3.2	$0.6	$6.1	0.1%	0.0%	0.2%
		Tier 2	10%	10% - 10%	$0.8	$0.1	$7.7	0.0%	0.0%	0.0%
		Tier 3	10%	10% - 10%	$3.7	$0.0	$7.8	0.0%	0.0%	0.1%
	Setting B	Tier 1	60%	60% - 80%	$17	$3.2	$8.4	0.5%	0.0%	0.0%
		Tier 2	10%	10% - 10%	$3.0	$0.6	$8.1	0.1%	0.0%	0.0%
		Tier 3	10%	10% - 10%	$20	$0	$11	0.1%	0.0%	0.0%
	Setting C	Tier 2	5%	5% - 5%	$71	$0	$22	0.2%	0.0%	0.0%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
Forest Upland Subtotal					**$120**	**$4.5**	**$10.5**	**1.0%**	**0.0%**	**0.4%**
Stream Channel	Blackwood Ck.	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$11	$0.0	$1.3	0.4%	0.0%	0.2%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Upper Truckee	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$24	$0.0	$1.1	1.1%	0.0%	0.4%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Ward Ck.	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$5.2	$0.0	$1.0	0.3%	0.0%	0.1%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
Stream Channel Subtotal					**$40**	**$0.0**	**$1.1**	**1.8%**	**-**	**0.7%**
Urban & Groundwater	Conc.-Moderate	Tier 1	50%	0% - 80%	$300	$0.6	$2.7	5.9%	0.8%	1.9%
		Tier 2	30%	0% - 40%	$350	$2.7	$3.5	5.8%	1.2%	1.9%
		Tier 3	-	0% - 0%	$0.0	$0	$0.0	-	-	-
	Conc.-Steep	Tier 1	40%	0% - 80%	$200	$0.4	$4.6	2.3%	0.3%	1.0%
		Tier 2	40%	0% - 40%	$330	$2.5	$5.9	3.2%	0.8%	0.9%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Disp.-Moderate	Tier 1	40%	0% - 80%	$46	$0.1	$1.7	1.4%	0.2%	0.5%
		Tier 2	40%	0% - 40%	$130	$1	$2.7	2.8%	0.6%	1.2%
	Disp.-Steep	Tier 1	40%	0% - 80%	$94	$0.2	$3.8	1.3%	0.1%	0.6%
		Tier 2	40%	0% - 40%	$190	$1.5	$5.0	2.2%	0.6%	1.4%
Urban & Groundwater Subtotal					**$1,600**	**$9.0**	**$3.6**	**24.8%**	**4.7%**	**9.4%**
Basinwide Total					**$1,800**	**$14.0**		**31.7%**	**5.2%**	**14.8%**

Clarity Result 78.6 feet

Scenario B: Focus on Innovation & Advanced Practices

Meets Clarity Challenge

Details

SCG	Setting	Tier	LOA: Level of Application	LOA Constraint Range	20-year Capital Cost ($ Million)	Annual O&M Cost ($ Million)	Cost Effectiveness (annual total cost $ Million/ % reduction particles)	Particles	TN	TP
Atmospheric	Setting 1	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	40%	20% - 80%	$2.8	$0.0	$0.58	0.3%	0.1%	0.3%
		TIOS Tier 3	40%	0% - 80%	$7.3	$0.1	$0.65	0.7%	0.1%	0.7%
	Setting 2	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	30%	20% - 80%	$2.5	$0.0	$0.48	0.3%	0.0%	0.3%
		TIOS Tier 3	50%	0% - 80%	$11	$0	$0.45	1.4%	0.1%	1.5%
	Setting 3	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	20%	20% - 80%	$1.3	$0.0	$0.58	0.1%	0.0%	0.1%
		TIOS Tier 3	60%	0% - 80%	$10	$0.1	$0.55	1.1%	0.1%	1.2%
	Setting 4	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	20%	20% - 20%	$1.3	$0.0	$0.92	0.1%	0.0%	0.1%
		TIOS Tier 3	50%	0% - 80%	$8.5	$0.1	$0.96	0.5%	0.1%	0.6%
Atmospheric Subtotal					**$45**	**$0.4**	**$0.59**	**4.6%**	**0.5%**	**4.9%**
Forest Upland	Setting A	Tier 1	60%	60% - 80%	$3.2	$0.6	$6.1	0.1%	0.0%	0.2%
		Tier 2	10%	10% - 10%	$0.8	$0.1	$7.7	0.0%	0.0%	0.0%
		Tier 3	10%	10% - 10%	$3.7	$0.0	$7.8	0.0%	0.0%	0.1%
	Setting B	Tier 1	60%	60% - 80%	$17	$3.2	$8.4	0.5%	0.0%	0.0%
		Tier 2	10%	10% - 10%	$3.0	$0.6	$8.1	0.1%	0.0%	0.0%
		Tier 3	10%	10% - 10%	$20	$0.0	$11	0.1%	0.0%	0.0%
	Setting C	Tier 2	5%	5% - 5%	$71	$0.0	$22	0.2%	0.0%	0.0%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
Forest Upland Subtotal					**$120**	**$4.5**	**$10.5**	**1.0%**	**0.0%**	**0.4%**
Stream Channel	Blackwood Ck.	Tier 1	-	0% - 0%	-	-	-	-	-	0.0%
		Tier 2	80%	80% - 80%	$11	$0.0	$1.3	0.4%	0.0%	0.2%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Upper Truckee	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$24	$0.0	$1.1	1.1%	0.0%	0.4%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Ward Ck.	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$5.2	$0.0	$1.0	0.3%	0.0%	0.1%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
Stream Channel Subtotal					**$40**	**$0.0**	**$1.1**	**1.8%**	**-**	**0.7%**
Urban & Groundwater	Conc.-Moderate	Tier 1	20%	20% - 80%	$120	$0.3	$2.7	2.4%	0.3%	0.8%
		Tier 2	-	0% - 80%	-	-	-	-	-	-
		Tier 3	60%	0% - 80%	$570.0	$3.0	$2.7	11.8%	1.3%	3.5%
	Conc.-Steep	Tier 1	20%	20% - 80%	$100	$0.2	$4.6	1.1%	0.1%	0.5%
		Tier 2	-	0% - 80%	-	-	-	-	-	-
		Tier 3	40%	0% - 80%	$310	$1.6	$3.6	4.8%	0.5%	1.4%
	Disp.-Moderate	Tier 1	40%	20% - 80%	$46	$0.1	$1.7	1.4%	0.2%	0.5%
		Tier 2	30%	0% - 80%	$94	$0.7	$2.6	2.1%	0.5%	0.9%
	Disp.-Steep	Tier 1	30%	20% - 80%	$70	$0.1	$3.8	1.0%	0.1%	0.4%
		Tier 2	-	0% - 80%	-	-	-	-	-	-
Urban & Groundwater Subtotal					**$1,300**	**$6.0**	**$2.9**	**24.6%**	**3.0%**	**7.9%**
Basinwide Total					**$1,500**	**$11.0**		**32.0%**	**3.5%**	**13.9%**

Clarity Result 78.7 feet

Scenario C: All Out Push

Exceeds Clarity Challenge

Details

SCG	Setting	Tier	LOA: Level of Application	LOA Constraint Range	20-year Capital Cost ($ Million)	Annual O&M Cost ($ Million)	Cost Effectiveness (annual total cost $ Million/ % reduction particles)	Particles	TN	TP
Atmospheric	Setting 1	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	20%	20% - 80%	$1.4	$0.0	$0.58	0.1%	0.0%	0.2%
		TIOS Tier 3	60%	0% - 80%	$11.0	$0.1	$0.65	1.0%	0.2%	1.0%
	Setting 2	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	40%	20% - 80%	$3.3	$0.0	$0.48	0.4%	0.0%	0.5%
		TIOS Tier 3	40%	0% - 80%	$8.7	$0.1	$0.45	1.1%	0.1%	1.2%
	Setting 3	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	20%	20% - 80%	$1.3	$0.0	$0.58	0.1%	0.0%	0.1%
		TIOS Tier 3	60%	0% - 80%	$10.0	$0.1	$0.55	1.1%	0.1%	1.2%
	Setting 4	VE Tier 2	-	0% - 0%	-	-	-	-	-	-
		VE Tier 3	-	0% - 0%	-	-	-	-	-	-
		TIOS Tier 2	20%	20% - 20%	$1.3	$0.0	$0.92	0.1%	0.0%	0.1%
		TIOS Tier 3	60%	0% - 80%	$10.0	$0.1	$0.94	0.6%	0.1%	0.8%
Atmospheric Subtotal					**$47**	**$0.5**	**$0.60**	**4.7%**	**0.5%**	**5.0%**
Forest Upland	Setting A	Tier 1	60%	60% - 80%	$3.2	$0.6	$6.1	0.1%	0.0%	0.2%
		Tier 2	10%	10% - 10%	$0.8	$0.1	$7.7	0.0%	0.0%	0.0%
		Tier 3	10%	10% - 10%	$3.7	$0.0	$7.8	0.0%	0.0%	0.1%
	Setting B	Tier 1	60%	60% - 80%	$17	$3.2	$8.4	0.5%	0.0%	0.0%
		Tier 2	10%	10% - 10%	$3	$0.6	$8.1	0.1%	0.0%	0.0%
		Tier 3	10%	10% - 10%	$20	$0.0	$11	0.1%	0.0%	0.0%
	Setting C	Tier 2	5%	5% - 5%	$71	$0.0	$22	0.2%	0.0%	0.0%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
Forest Upland Subtotal					**$120**	**$4.5**	**$10.5**	**1.0%**	**0.0%**	**0.4%**
Stream Channel	Blackwood Ck.	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$11	$0.0	$1.3	0.4%	0.0%	0.2%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Upper Truckee	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$24	$0.0	$1.1	1.1%	0.0%	0.4%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
	Ward Ck.	Tier 1	-	0% - 0%	-	-	-	-	-	-
		Tier 2	80%	80% - 80%	$5.2	$0.0	$1.0	0.3%	0.0%	0.1%
		Tier 3	-	0% - 0%	-	-	-	-	-	-
Stream Channel Subtotal					**$40**	**$0.0**	**$1.1**	**1.8%**	**-**	**0.7%**
Urban & Groundwater	Conc.-Moderate	Tier 1	20%	20% - 80%	$120	$0.3	$2.7	2.4%	0.3%	0.8%
		Tier 2	-	0% - 80%	-	-	-	-	-	-
		Tier 3	60%	0% - 80%	$570	$3.0	$2.7	11.8%	1.3%	3.5%
	Conc.-Steep	Tier 1	20%	20% - 80%	$100	$0.2	$4.6	1.1%	0.1%	0.5%
		Tier 2	-	0% - 80%	-	-	-	-	-	-
		Tier 3	60%	0% - 80%	$460	$2.4	$3.5	7.2%	0.7%	2.0%
	Disp.-Moderate	Tier 1	20%	20% - 80%	$23	$0.0	$1.7	0.7%	0.1%	0.2%
		Tier 2	60%	0% - 80%	$190	$1.4	$2.6	4.2%	0.9%	1.8%
	Disp.-Steep	Tier 1	20%	20% - 80%	$47	$0.1	$3.8	0.6%	0.1%	0.3%
		Tier 2	60%	0% - 80%	$290	$2.2	$5.1	3.3%	0.9%	2.1%
Urban & Groundwater Subtotal					**$1,800**	**$9.7**	**$3.2**	**31.4%**	**4.5%**	**11.2%**
Basinwide Total					**$2,000**	**$15.0**		**38.9%**	**5.1%**	**17.3%**

Clarity Result 81.5 feet

PATHWAY Forum Meeting Summary

PATHWAY FORUM MEETING
October 25, 2007
North Tahoe Conference Center
Kings Beach, California

MEETING ATTENDEES

Forum Members: Laurel Ames, Mike Berg, Mike Bradford, Carol Chaplin, Dennis Cocking, Michael Donahoe, John Falk, Adrian Freund, Dave Hamilton, Bill Hetland, Bill Horn, John McCall, Bruce McNulty, Jennifer Merchant, Barbara Perlman-Whyman, Anga Rebane, Jill Sarick Santos, Kay Scherer, Gordon Shaw, Glen Smith, Steve Teshara, Patrick Wright

PATHWAY Executives and TMDL Team: Harold Singer, Lauri Kemper, Doug Smith, Bob Larsen, Hannah Schembri (Lahontan); Terri Marceron, Bob King (USFS); Tom Porta, Jason Kuchnicki (NDEP); John Singlaub, Larry Benoit (TRPA)

Project Team: John Reuter (Tahoe Environmental Research Center), Jeremy Sokulsky (Environmental Incentives), Michelle Sweeney (Allegro Communications)

Kearns & West Facilitation Team: Anna West, Christine Kennelly, Janet Thomson

WELCOME, INTRODUCTIONS, AGENDA REVIEW

Anna West welcomed the Forum, Focus Team, agencies, and general public. She provided a brief overview of the day's agenda, meeting structure, and groundrules and highlighted the goal of the October meeting: to receive Forum member input on ways of packaging pollutant control opportunities (PCOs) to meet the Clarity Challenge.

CONTEXT FOR THE DAY'S DISCUSSIONS

Harold Singer (Lahontan) explained that the meeting will serve as the start of a dialogue on strategies to achieve the Clarity Challenge including general approach themes and public acceptability of Pollutant Control Opportunities (PCOs). The TMDL agencies are hoping to receive further input between Forum meetings and again at the December 6th Forum meeting. Harold encouraged Forum members to have conversations within their communities and constituencies about the opportunities discussed here today as well.

Harold explained that, for the purpose of initiating dialogue, the Forum will look at scenarios which are "strawman ideas" of how to integrate approaches which utilize different combinations of PCOs. In mid-late December, with the assistance of the input received by Forum members, the TMDL team will put together a draft final scenario(s) which will be the proposed methodology for implementing the TMDL – subject to environmental review.

In order to help narrow the decision space the TMDL team will share the information gathered over the past several years and help Forum members understand where the best opportunities for input lie. The TMDL team is seeking feedback about the scenarios both on an overall level and on a detailed, individual PCO level. Forum members should focus on the social and economic perspective considering questions such as: "Can we sell this PCO or strategy to the basin? To people outside the basin? To potential funders? Can we all rally around these PCOs and strategies?"

The scenarios reach the Clarity Challenge, which is 75 to 80 feet of clarity that will be measured over the last five years of the upcoming twenty-year period. Through the discussion today we want to know whether Forum members think this is feasible. "Can we get to the Clarity Challenge? What will it take? Do the draft scenarios indicate a direction that seems feasible? What adjustments might improve the scenarios?"

Tom Porta (NDEP) provided detail on the scenarios and PCOs for the Forum to review. There are four source categories: stream channel erosion, forest uplands, atmospheric deposition, and urban runoff. We are looking at these categories on a basin-wide scale. Within each category we have various tiers of PCOs that we can examine and we will use those to build our scenarios. The information on the handouts indicates sample PCOs as well as illustrative scenarios with capital costs and O&M costs. The O&M costs portrayed are in addition to what are currently considered "EIP costs."

The pollutant reduction scenarios include some level of implementation across all source categories. We have packaged them so that we receive a certain clarity improvement for each set of PCOs. We want you to tell us whether the scenario is socially and politically acceptable. What are the pitfalls, challenges, and barriers presented by each scenario or components of the scenario?

If we look at the actions we are currently taking and focus on increased implementation we will only get 74 feet of clarity over the next twenty years (just shy of the Clarity Challenge). The three illustrative scenarios we will show in the afternoon result in 75-80 feet of clarity, meeting the Clarity Challenge.

Q. When you have us look at the scenarios you are seeking individual commentary, not consensus opinion from the Forum, is that right?
A. Correct. We are hoping to hear you debate the issues today. If there is consensus, that is wonderful, but we likely will not get there. We want to stimulate discussion today. There is no bad idea; we want to hear everything you have to say.

Q. Specifically, you want us to identify whether there are social, economic, and political problems with the scenarios?
A. Yes. And if we can overcome the problems by doing something specific, let us know what that might be.

Q. How are you calculating costs, especially outside of direct implementation? What if you have transportation incentives, are you using data from other regions?
A. It varies across the board. We can discuss this more fully when we get to the specific areas.

Harold Singer added that the TMDL team recently put together a chart on cost vs. benefit. This is not in relation to any specific scenario but is a broad-brush perspective. It will take $1-$1.5B of capital costs to reach the Clarity Challenge (2007 dollars).

Q. Last month you showed us a chart that indicated we would need to spend several billion dollars. Did that include O&M?
A. Yes, and this chart just shows capital costs.

Q. Do these numbers reflect all the agencies working together towards a common goal with a strategic plan in place?
A. Yes. This also includes private contributions, not just governmental contributions, and private property BMP implementation. As a point of comparison the EIP in the past ten years (including private, local, state, and federal money) spent $1.1B. About half of that funding was for water quality.

Q. Are you confident that you can get all the agencies on board working together and budgeting and planning with these goals in mind?
A. That is part of the feedback we want to hear from you all today. But we do need everyone rallying together to get this to happen.

Q. With the law of diminishing returns, why does this graph of cost vs. benefit seem nearly linear?
A. This is how the cost analysis broke out to this point. It does not show improvements out to 100 feet of clarity, only to a certain point. The graph will flatten out if you extend the clarity improvements.

Q. In the scenarios is the assumption that one size fits all for the basin? Are you doing the same in the Upper Truckee as in a small rural subdivision?
A. No, we tried to combine PCOs appropriate for certain areas.

STREAM RESTORATION AND FOREST MANAGEMENT RECOMMENDATIONS

Jeremy Sokulsky (Environmental Incentives) provided an overview of the handouts. The first handout provides a description of the different source categories, split into tiers and sample PCOs within those tiers. This is not a comprehensive list of PCOs. The second handout provides the pie chart that the Forum has seen before that identifies the extent to which each source category contributes to reductions in clarity. This handout includes the analysis of the pollutant reduction opportunities described at the last Forum meeting including capital and O&M costs. Some of the costs have been changed by taking advantage of the optimal selection of cost-effective measures across source categories. Additionally, the numbers have been revised based on the amount of reduction from urban treatment based on catching an inconsistent assumption. Therefore, today we see a higher pollutant control per dollar in urban areas as compared to last month.

Bob Larsen (Lahontan) presented an overview and requested feedback on recommendations for stream restoration and forest management practices based on the TMDL team's analysis of the data. The intent is to simplify and target development of the TMDL implementation strategy by

focusing on the areas with the greatest decision space and potential for substantial clarity improvements.

The first recommendation is to emphasize fine sediment removal since it is responsible for 2/3 of the clarity condition. Reducing fine sediment has a great potential to improve lake clarity and a focus on this source category will help the TMDL team target implementation actions for the first 20 years.

The two other recommendations relate to streams and forests which, based on the percentage of the total pollutant load to the Lake, account for nearly an order of magnitude less impact than atmospheric and urban sources.

The load reduction opportunities for forest uplands are relatively limited. Additional reduction efforts do not appear cost effective and current practices effectively reduce loads. While Tier 3 implementation can achieve greater reductions, the corresponding cost rises dramatically up to $3B. Current practices are very consistent with the Tier 1 and Tier 2 efforts that effectively reduce pollutant loads. **The TMDL team recommendation is to continue the current work on forest uplands, including road and trail maintenance, re-vegetating and treating disturbed areas, and implementing BMPs while treating forest fuels.**

For stream channels the achievable reductions are not very great, yet stream restoration is highly cost-effective and provides additional water quality and ecosystem benefits. **The TMDL team recommendation is to continue current and planned stream restoration activities and support monitoring and research.** We will be getting more information with respect to water quality benefits in the upcoming years and will adjust our crediting and tracking accordingly.

Jeremy Sokulsky noted that the base assumption in the scenarios that the Forum will see today is that for stream restoration we will do Tier 2 activities, including a combination of restoration activities and bank stabilization around roads. This would be performed at 80% of the potential restorable areas over the next 15-20 years around the Basin and would provide pollutant load reductions of about 2%. For forest uplands, we will treat and maintain 80% of unpaved roads and 80% of disturbed areas (60% with standard practices, 10% of advanced practices, and 10% of restoration) and will conduct fuels management on 20% of the forest, resulting in a 1% basin-wide pollutant load reduction.

Q. What does restoration of unpaved roads in forest areas mean?
A. Decommissioning roads.

Q. What flexibility do we have to assign money to be spent where we want as we review these scenarios?
A. With respect to forest and stream channels there is some variability. If we wanted to have a discussion about that level of implementation we could, though the load reduction is relatively small. With the current funding streams already in place we think it would be best for us to move forward with the recommendations we have given you.

Q. Do the percentages shown reflect units (e.g., acres) or the amount of sediment reduced?
A. This is a basin-wide average. Costs will vary per unit from the average represented here.

Q. Does this work take into account other actions such as defensible space? How do such fuel reduction actions, costs, and impacts fit into this?
A. Defensible space is not part of the forest recommendation. An urban lot doing defensible space would fall under the "urban" category. We assume there is no net load reduction. We assume appropriate BMPs will be used, and there are no load costs or deficits associated with that activity. That would be on a finer scale than this analysis.

Q. Will there be forest fuels management in those areas?
A. We assume 15-20% treatment of areas for forest fuels. That is an estimate, and we assume that the percentage would be treated over 15-20 years. Again, no net benefit or loss, we assume that BMPs are applied and there is no load generation or reduction. We also assumed that there would be some percentage of that area that would have opportunities to increase the levels of BMPs (such as restoration when we leave a treated area to achieve load reduction).

Q. You stated that reducing nitrogen and phosphorous does not give us much improvement in clarity. Is the opposite true that if we increase nitrogen and phosphorus there is not much of a clarity decline?
A. Since 2/3 of the clarity condition is driven by fine sediment, if you increase the nutrient load that still only accounts for 1/3 of the clarity condition. However, it is still important to reduce nutrients since that third is important; we just want to focus on improving the other 2/3 first.

ATMOSPHERIC POLLUTANT CONTROL OPPORTUNITIES

John Reuter (Tahoe Environmental Research Center) provided an overview of the opportunities for pollutant load reduction from atmospheric sources. Atmospheric sources account for about 15% of the pollutant load to the Lake, while urban sources account for 72% of the pollutant load.

The load reduction estimates are based on emission reduction estimates. We looked at the California Air Resources Board (CARB) emission inventory and customized it for the area. We considered mobile sources (tailpipe emissions), paved roads and parking, unpaved roads, construction site disturbance, and wood combustion. We used published equations and relationships to develop information on each source. In the results table note that most of the inorganic nitrogen comes from exhaust. For phosphorous and inert species (a combination of fine particles and the elemental carbon coming from the back of tailpipes), most of the pollution comes from unpaved and paved roads. Controlled burns are not really a factor as we have found that residential wood combustion accounts for 7-10 times more pollutants than controlled burns. Based on work during the Angora Fire we determined that the fallout would have only been about 2-5% of the total pollutant load.

Potential Tier 2 PCOs include realistic estimates of pollutant load reductions, while Tier 3 PCOs provide an upper bound of load reduction (i.e., the "Cadillac version" that assumes that cost and other constraints are not an issue). Sample PCOs include street sweeping, controlling dirt from unpaved roads or construction sites, and a reduction in vehicle miles traveled (VMT). Tier 3 generally includes all of Tier 2 with extra implementation, such as a 25% VMT reduction rather than a 10% VMT reduction. If you did all the Tier 3 reductions you would get a 7% basin-wide

reduction. This is a little more opportunity to work with than forest and stream channel, but not as much capacity for improvement as with urban sources. About half of that 7% reduction comes from vehicle emission controls which are very costly. Reducing VMT reduces not just nitrogen but also fine particles. A 10% VMT reduction will reduce the fine particle pollutant load by 0.4%, while a 25% VMT reduction will reduce the fine particle pollutant load by 0.9%.

Given the large effect of fine particle reduction on lake clarity, the lower effect of nitrogen reduction on clarity, the high cost associated with mobile source control for nitrogen, and the lower impact of significant VMT reductions on basin-wide fine particle reduction, **we recommend that in early efforts to meet the Clarity Challenge, atmospheric pollutant control reduction strategies focus on fine particle and phosphorous control**. Efforts to reduce VMT for the purpose of nitrogen control should be considered based on a larger discussion of transportation. TRPA and others should continue to engage in VMT reduction discussions to meet other thresholds. **We recommend for consideration street sweeping, use of traction materials for fine particle and phosphorous removal, and restoration of unpaved surfaces.**

Jeremy Sokulsky noted that there are large, cost-effective opportunities for reducing fine particles from transportation infrastructure (roads) as well as from stationary sources (both unpaved and paved roads) and from reductions in wood-burning stove use. The three scenarios presented today center on: 1) enhancing current practices; 2) focusing on innovation, and; 3) giving a maximum all-out push to improve clarity. Each scenario on the table results in the same near-5% reduction from atmospheric sources.

Q. Do sweepers exist that have the ability to remove particles smaller than 20 microns?
A. Yes, there are water-based vacuum street sweepers that do not re-suspend everything in the air.

Q. Do mobile sources include boats? Are we considering commercial boat restrictions?
A. The boating restrictions would be in line with TRPA and CARB efforts.

Q. In Nevada we do not have to do annual smog checks. Have you looked into the possibility of requiring smog checks in the Nevada sections of the Basin?
A. That level of discussion still has to happen, but that is a great question.

Q. Is there a significant change or shift in pollutant loads if there is a change in fuel sources, such as to diesel or biofuels?
A. I do not know. That is a good question.

URBAN RUNOFF POLLUTANT CONTROL OPPORTUNITIES

Larry Benoit (TRPA) provided an overview of urban runoff PCOs based on an analysis of urban subwatersheds with greater than 1% coverage. Urban runoff areas are the largest contributor of fine particles to the Lake. The application of Tier 1 PCOs (an extension of current practices with greater implementation) will result in about a 24% reduction in fine particles, while Tier 2 PCOs (advanced practices such as media filtration) results in a 40% reduction in fine particles if applied to 100% of the watershed. Tier 3, comprised of 60% pump and treat in urban watersheds with concentrated impervious coverage and 40% Tier 2 applications in the remaining areas, results in

nearly a 45% reduction in fine particles. The capital costs are displayed on the chart in the presentation. The costs have not accounted for the stormwater infrastructure already in place on the ground.

Tier 1 PCOs include sweeping in intensive traction abrasive areas, increased fertilizer management, and 50% private property BMPs (including all developed parcels – commercial, institutional, residential). Tier 2 PCOs involve more advanced de-icing strategies, media filters in stormwater vaults, additional stormwater treatment, turf management strategies and required education for professional turf managers to reduce fertilizer use, control of nitrogen and phosphorous through retail fertilizer sales, and 100% private property BMPs. Options such as rubberized pavement are not included they cannot yet be quantified. Tier 3 is mainly based on a pump and treat analysis and includes a Tier 1 level stormwater infrastructure for collection of runoff, localized holding ponds for stormwater storage, 9 regional stormwater treatment facilities that employ micro-filtration, and Tier 2 treatments applied to dispersed coverage subwatersheds.

We have three recommendations for urban runoff PCOs in order to meet the Clarity Challenge: 1) we need to consider Tier 1 applications in dispersed coverage areas; 2) we need substantially more Tier 2 treatments (filtration, O&M); and 3) we need to consider pump and treat applications in some areas.

Jeremy Sokulsky explained that the illustrative scenarios will involve three options for urban pollutant load reductions: a retrofit of existing technologies; a focus on innovation, including technologies such as micro-filtration; and an all-out push, doing everything we can do, including some pump and treat. The first two options will result in about a 25% reduction in fine particles, while the all-out push will result in a 32% reduction in fine particles. There is a significant O&M cost for all these applications ranging from $2M/year to $6M-$9M/year due to increased technology installation. For the capital cost projections if you use innovative technology you can get a greater load reduction through implementation over a smaller area of the Basin, resulting in lower capital and O&M costs than through a retrofit of current technologies on a greater land area.

Q. Did you take into account the stormwater work from the EIP?
A. No. Kim Gorman will be helping the Nevada Tahoe Conservation District with completing the EIP database and GIS coverage to help us determine that, but it is also a matter for the operators of that inventory and infrastructure on the ground to help us determine how that fits in and what the value is relative to these implementation costs.

Q. You cannot really count everything you have done today because with the particulate matter standards becoming increasingly restricted, even measures that are in place will require upgrading and retrofitting to make them functional under new scenarios. Is that correct?
A. That is true; the cost would not be one-for-one. Part of the equation is evaluating what we have on the ground relative to those needs.

Q. Under Tier 1 you had an assumption of 50% coverage of BMPs on private property. Where are we today in terms of implementation? Also, do you assume some reduced level of effectiveness for BMPs associated with private property as opposed to a more public solution?

A. Right now we have about 18% implementation of BMPs basin-wide. Nothing in our analysis assumed less effectiveness. However, for Tier 3 the analysis assumes collection and treatment of all runoff from concentrated coverage subwatersheds.

Q. As a local government representative it will be important to see what this means for my jurisdiction before I make decisions and recommendations. I would like to see the information broken out around the Lake.
A. The pump and treat feasibility study will examine both a regional and a local scale. We do not have all the answers, and we will need information from all of you to understand how we might be able to make pump and treat work and where it makes the most sense.

Q. Does the cost for O&M for the "innovation" scenario including maintaining all the micro-filtration systems and infrastructure and conveyance systems to those areas?
A. Yes.

Q. Is pump and treat really less costly, in terms of O&M, than a retrofit?
A. Yes, it is based on the difference in the amount of pipe and other materials required for the retrofit.

DISCUSS ILLUSTRATIVE SCENARIOS AND REVIEW RECOMMENDATIONS

Jeremy Sokulsky presented the three illustrative scenarios to the Forum. Scenario A includes a retrofit of current technologies and enhanced best practices. This scenario will not include pump and treat but will have enhanced practices in urban areas including increased intensity of passive treatments of urban stormwater. It will address transportation infrastructure and stationary sources of atmospheric fine sediment and will have the forest and stream channel recommendations that Bob Larsen presented earlier. The result of this scenario is 78.5 feet of clarity, reaching the Clarity Challenge, at a capital cost of about $1.8B and O&M of about $14M/year.

Scenario B focuses on innovation and advanced practices, minimizing the amount of area treated. This will use conveyance and treatment in dense urban areas and advanced passive treatments in dispersed urban areas. It involves highly intensive controls to reduce atmospheric deposition of fine particles from transportation infrastructure and stationary sources, and the same controls for forest and stream channels. This results in 78.5 feet of clarity at a capital cost of $1.5B and $11M/year of O&M.

Scenario C involves an all-out push, treating the maximum amount of area possible using the most effective pollutant controls. This assumes that 80% of all urban and atmospheric sources are treated, 60% with advanced treatments and 20% with current best practices. It involves the same forest and stream recommendations as the other two scenarios. This results in 81.5 feet of clarity at a cost of $2B in capital costs and $15M/year of O&M.

Q. Do any of these scenarios get better the longer we do them or do they all have a linear relationship?
A. Scenario A taps out the land area first, so you would have to retrofit again if you wanted greater gains. Scenario B leaves areas untreated that would be available for further improvements.

Comment. Some of the items we have defined as "innovative" have been available for years, such as particulate matter-certified street sweepers.
A. That is true, these are broad themes. Some of these "innovative" practices have not yet been tested in the Basin, though they exist elsewhere, so they would be innovative for our area.

Q. Can we disaggregate the data and find out what the pollutant load reductions are for each PCO?
A. We have a table for distribution that shows for each setting what percentage of the area is being treated with each tier of PCOs.

Q. If we like something from one scenario, will we have the data to know what impact that piece will have on other scenarios?
A. If you tell us what you would like to see we can work it into the model and figure out what the effects are.

Q. Is making progress on all source categories an operating principle for us? Do we need to provide feedback according to that paradigm?
A. Let us know which combinations of PCOs you think make the most sense.

Q. Is there a way to help us understand which PCOs involve high O&M costs rather than high capital costs?
A. We understand the difficulty of bearing high O&M costs. You can look at the detailed table to see, per tier and per setting, what the O&M costs are.

Q. What is the relationship between the scenarios and the tiers?
A. We have given you a handout that shows the tiers and the representative PCOs within each of those tiers. The scenarios combine various tiers of PCOs.

Q. These costs do not seem to include items we would be doing at the same time for ecosystem restoration – they only focus on water quality.
A. That is correct. We are focusing on increasing the Lake clarity. Some of our efforts will have ecosystem benefits on other thresholds, but our focus is water quality.

Q. Capital improvements will likely fall on the most urbanized areas, and therefore, on urban taxpayers, is that right? Or will the costs be distributed basin-wide?
A. We would like your input on that issue.

Q. We have heard a lot about particles coming off the roadway. I am confused about VMT being dropped from the scenarios if we have heard that VMT contributes greatly to the fine particle pollutant load.
A. A 25% VMT reduction actually only results in less than a 1% reduction in particles basin-wide. This is why we suggest not focusing on VMT right now.

Jeremy Sokulsky sought and received general agreement from the Forum on the recommendations made in the morning (focusing on fine sediment and focusing the day's discussions on urban and atmospheric source reductions rather than forest and stream channel reductions).

Q. Can we lump together the reductions from fine sediment and from nitrogen and phosphorous so that if one measure only reduces one pollutant load and another gets you both nutrient and fine sediment reductions, you opt for the one that gets you both? It would be helpful for funders to see this information.
A. A lot of the secondary benefits are in the noise within the margin of safety. We can check on that again once we get to a more project-specific level of analysis.

Q. It would be useful to see the impacts that each PCO has on other thresholds.
A. That is the information that we are seeking from you all today.

Q. What are we doing about PCOs that are not measurable but that everyone knows we need to be doing to reduce the pollutant load? How do we take these into account?
A. We are hoping to receive feedback from you about that. We will try to help you get credit for taking those actions especially if they help gain social acceptability for the program. Also, remember that this is an iterative process and we will constantly be getting more information.

Q. Have you factored in the negative tradeoffs of installing riprap for water quality purposes?
A. Our analysis did not look at effects on other thresholds; we were focusing on fine sediment removal. We will support the efforts of the implementing agencies on this.

Q. Does stream channel restoration mean rewatering meadows?
A. Sometimes, yes. In many cases restoring portions of the channel will result in increased overbank frequency. However, our work was focused on stream channel restoration only.

Mike Bradford presented a letter addressed to John Singlaub and TRPA regarding the future use of the Forum to address the Pathway agencies' management plans. He requested that John Singlaub respond to the Forum regarding future collaborative efforts of the group.

Christine thanked Steve Teshara (North Lake Tahoe Resort Association) and Jennifer Merchant (Placer County) for sponsoring lunch for Forum members.

DISCUSS WAYS OF PACKAGING POLLUTANT CONTROL OPPORTUNITIES

Anna West (Kearns & West) asked the Forum to provide feedback in response to four questions:

1) What new or different package approaches can you suggest?
2) What are the strengths, weaknesses, benefits, and tradeoffs of the illustrative scenarios?
3) What is the social, technical, financial feasibility of reaching the Clarity Challenge?
4) What input do you have on individual PCOs?

Please note: For the following comments, those that are *italicized* represent comments from non-Forum members.

Forum Feedback on Illustrative Scenarios

CATEGORY	COMMENT
Scenario A	Scenario A would be the best approach from a marketing standpoint since it builds off what people know. After we do some pilot projects we can move to more creative approaches such as Scenarios B and C.
Scenario A	Scenario A: California Tahoe Conservancy projects underway – need to complete current activities before retrofitting.
Scenario B	Support Scenario B with an eye towards moving to Scenario C in the long term.
Scenario B	Scenario B is good because of its value and applicability for achieving 100 feet of clarity.
Scenario B	Support Scenario B due to issues of technical feasibility/proven technologies.
Scenario B	Scenario B represents a cautious approach to test technology prior to investing lots of money.
Scenario B	Least cost is most important. Prefer Scenario B with its potential for long-term gains.
Scenario B	*Scenario B still has a lot of uncertainty with the outcome.*
Scenario B	*Scenario B may be more publicly feasible since it is not depending upon public to do BMPs.*
Scenario B	Like scenario B – why "ask" short? Don't ask for less than you need – say "Here is what we need to make the clarity challenge."
Scenario B, Scenario C	Prefer the "all-out push" scenario because it allows for a greater margin of error when trying to reach the Clarity Challenge. However, if there are unproven technologies in Scenario C, consider pulling in some aspects of Scenario B so that we do not rely entirely on one application that might not succeed. What would it cost to add more Scenario B items to Scenario C so we do not put all our eggs in the pump and treat basket?
Scenario B, Scenario C	Consider a stormwater utility district as a component of Scenarios B and C (specifically to pay for maintenance).
Scenario C	It looks like we have the correct locations for implementing pump and treat (i.e., areas where it would be difficult to implement private BMPs).
Scenario C	Use pump and treat feasibility study to evaluate Scenario C.
Scenario C	Push to Scenario C – if we don't get there we will be closer to improving clarity. This is about preserving (restoring) the water quality and clarity so we should not cut our efforts short but should do as much as we can.
Scenario C	Scenario C has some "safety" margin built in if we fall a bit short.
Scenario C	*Scenario C may be the best option for first clarity challenge. It's only $20M more but the gain is greater.*
Scenario C	*We already have 15-20 projects that are slated for construction between now and 2010. Those projects likely fall under Scenarios A and B, so we should start putting more efforts to elements of Scenario C.*
Scenario C	*Scenario C is good -- go big because we may make it.*
Transportation	Consider including transportation in these scenarios because it tends to attract funding and public support.
Transportation	Consider including transportation because it has corollary benefits aside from water quality improvements.

Transportation	Need to include VMT in a package because it is important for other thresholds.
Certainty	Concerned with understanding the certainty of achieving the clarity gains proposed for each scenario. We will support whatever the scientists and implementers think will get us the most gain.
Certainty	Include PCOs with high confidence (e.g. P&T) but also address areas of low confidence (e.g. VMT).
Cost/ Incentives	We should use tiered fees based on contribution to a pollutant budget (transport).
Cost/ Incentives	Possibly transition, with/through incentives, from one scenario to the next -> have flexibility.
Cost/ Incentives	Any scenario should be incentive-based.
Cost/ Incentives	Optimize PCOs for cost (provide scenario for EIS).
Program Success	We need to ensure that this program comes with equivalent support, accountability, and enforcement from all areas within the Basin.
Program Success	How much effort will these scenarios take on the part of agencies to enforce? We need to consider this.
Program Success	Consider opportunities that do not involve a change in social behavior, as that takes time to accomplish. Those items that do not involve social behavior should be pursued or implemented first.
Program Success	Pay it forward now to set up for beyond 2027.
Program Success	Ensure that the scenarios contain components that can result in clarity gains early on and do not rely on technologies that will take 10-20 years to develop. The public will need to see gains early on to continue supporting the program.
Program Success	We need to think through the implementation team (all levels of agencies to citizens) to determine if a scenario can succeed.
Program Sucesss	*How long can we anticipate any one scenario can last and maintain its value? (i.e. Scenario A). Understand that certain scenarios or PCOs will ultimately require replacement over time. It's not just 20 years, it's forever.*
Other	Consider having BMPs as the first line of defense, but then having stormwater or subwatershed collection retention and treatment to assist in water quality improvements.
Other	Although forest and stream channels have less of an impact on the Lake clarity they are very visible to Tahoe residents and visitors. Improvements to those sources will help secure public buy-in.
Other	Decentralized micro-treatment opportunity would be a good way to mix and match packages.
Other	Integrate clarity measures with other programs/thresholds to achieve greatest bang for buck.
Other	Lean toward innovation, history shows it will be to good end; insert "creative breakthroughs" into timeline.
Other	*How to plan if one thing makes another obsolete?*

Forum Feedback on New Suggested Scenarios

CATEGORY	COMMENT
New Scenario	Consider an "undevelopment" package that pursues funding to remove vacant parcels to increase coverage.
New Scenario	Consider how the place-based planning efforts coincide with the scenarios provided. Some of those ideas included creating a higher density downtown, removing impervious coverage, having people live where they work, and reducing VMT. Can we create a scenario that takes these into account?
New Scenario	Select Scenario A, but include pilot pump and treat and other innovative PCOs… "Plan 4 Pump?"
New Scenario	Would like to see a scenario with everything that is working now (bumped up, full effort). Try pilots, etc., and look to apply from there (be realistic).
New Scenario	New scenario – compliance with everything already on the books.
New Scenario	Consider a scenario which includes a transportation plan or PCOs: it will help to support collateral benefits to achieve other thresholds. It does not need to be limited to transport (may include P&T, etc.). You can take things that are in other scenarios and craft them in terms of transportation – calculate emissions per person, per mile – to get to the individual responsibility for encouraging action. A transportation scenario is more compelling when it comes to raising funds.
Addition to Scenarios	Consider stormwater export.

Forum Feedback on PCOs

CATEGORY	COMMENT
BMPs	Private BMPs: 100% implementation an unreasonable assumption due to site constraints.
BMPs	We question residential BMP effectiveness.
BMPs	The positive impacts/effectiveness of BMPs should be publicized (if collectively implemented). We need to provide incentives/enforcement – site assessment is a big one.
BMPs	"What you respect is what you inspect" – tie BMPs compliance to defensible space, insurance, etc.
BMPs	BMP maintenance: need registered district to incentivize.
BMPs	Ways to grade costs based on individual BMPs in practice?
BMPs	People would rather pay long term into public system than put down a bunch of cash for private BMPs.
BMPs	*Biggest question is the feasibility/effectiveness of BMPs (commercial/private).*
BMPs	*Feasibility of "install and maintain" as a continuation of what we've been doing.*
BMPs	*Give BMP certifications for communities who join a stormwater utility district.*

BMPs	*We need to consider the success of programs such as BMPs that have not had great success in implementation so far. There is a danger in assuming the feasibility of 50% or 100% implementation of BMPs if we have only achieved 18% so far.*
BMPs	*We need a way to encourage people to maintain their BMPs. Currently there is no accountability for maintenance. Could we get people to pay into a regional system if they do not complete their BMPs?*
BMPs	*If you can provide incentives through stormwater maintenance fees and lower the fees for those who have implemented and maintained their BMPs it might encourage broader implementation.*
BMPs	*BMP becomes a utility to O&M the system rather than "bank on" public to do the right thing. We need proper oversight.*
BMPs	*"High," "increased" BMP installation is not equivalent to current ordinance of 100%. What is reality/feasibility, what's the effectiveness (i.e. high water tables, rapid/slow soils, etc.)? No specific target identified.*
BMPs	*Has the business district been approached re: doing BMPs or paying a fee?*
BMPs, pump and treat	We should weigh the cost of implementing and maintaining and enforcing private BMPs vs. investing in pump and treat. We should also consider site restraints.
BMPs, pump and treat	Is it socially easier to pay a utility tax for pump and treat than to install own BMPs?
BMPs, pump and treat	Is there a BMP / P&T tradeoff? That is, are there redundancies in these?
Pump and treat	Pump & treat is fine as a PCO but we should test it further before putting too much emphasis on it. We should utilize the existing infrastructure and look into localizing efforts over regionalizing efforts.
Pump and treat	Introduce pump and treat slowly until more "proven". Consider the social implementation – will people accept treatment plant next door? Consider the potential negative effect on other thresholds/resource areas.
Pump and treat	Consider stormwater fees as a way to pay for pump and treat.
Pump and treat	Consider public funding for pump and treat.
Pump and treat	Pump and treat should be piloted.
Pump and treat	Pump and treat plants are scenically bad; also bad if smelly, noisy.
Pump and treat	Be realistic about the time it will take to get pump and treat underway.
Pump and treat	Pump and treat is fine as a PCO to consider but we need to know more.
Pump and treat	Concern about cost assessed to individuals to install pump and treat.
Pump and treat	Pump and treat – if you've got to do it, you've got to do it.
Pump and treat	Better to invest in pump and treat than always coming back year after year to redo BMPs.
Pump and treat	*Pump and treat poses constraint with private property (instead of assessment district area-wide?).*
Pump and treat	*Feasibility on pump and treat compared to other options?*

RWC	Reducing emissions from residential wood combustion (RWC), since the public associates these stoves with the "Tahoe experience," will likely meet resistance. Since we will not see a lot of pollutant load reduction from RWC we do not think it makes sense to expend energy pushing this solution. However, considering rebates to incentivize purchase of clean burning stoves makes sense.
RWC	We should educate people about air quality control burn days as a PCO.
RWC	Residential wood combustion is not a good PCO because it provides too little gain for the trouble. It is a health and safety issue. We should just focus on incentives (rebates and EPA compliant stoves). We should use education as a PCO for raising awareness about good / bad times for wood stove use.
RWC	Consider using fuels piles that will be burned anyway as sources for RWC; this will reduce the purchase of outside sources of fuel.
RWC	Don't mess with residential wood combustion – too little gain for the price you will pay with the public.
RWC	RWC – must have incentive program for replacement or upgrade.
Sweeping	Street sweeping is fine as a PCO, but make sure that the frequency and effort are fine-tuned for maximum effectiveness and least nuisance. Street sweeping needs regional effectiveness measuring / adjusting.
Sweeping	Positive PCOs include street sweeping and leaf vacuums/suckers.
Sweeping	Street sweeping should be done, it is done elsewhere in the nation.
Transportation	There is an issue with road shoulder stabilization vs. parking and safety.
Transportation	VMT is an out-dated way of looking at transportation. We should not de-emphasize transportation efforts but it is fine to let VMT specifically go. We should use less salt and sand and look into other favorable alternatives.
Transportation	More research needs to be done to convince that VMT effect on re-entrained dust is minimal.
Transportation	Consider fees for polluting vehicles.
Transportation	Transportation: maintain safety but look to alternatives to road sanding.
Transportation	Mixed (conflicting) message to say "pave unpaved roads" and "reduce VMTs" – because it raises questions about increased accessibility.
Transportation	We should research the trade-offs (pollutants and load reductions) associated with different fuel types.
Transportation	*More talk re: porous/or other pavement technologies.*
Transportation	*Paving/graveling portions of dirt roads.*
General	Focus on PCOs that will not necessarily require social change (or a high degree): "easy sell." Add social change elements over time as it will take a while for this to happen.
General	Consider putting the burden on those who wish to develop land. We considered creating incentives such as allowing construction of an additional storey if developers are willing to conduct greater stormwater treatment activities.
General	Consider focusing on PCOs that are not particularly contentious and do not put the burden on the individual; this will help secure buy-in for these efforts.
General	Flow splitting: land-use, stormwater treatment.
General	Need to identify other costs/benefits (consequences) even if not quantifiable.
General	It's better to encourage behavioral change (personal, decentralized action vs. big projects) than provide technical fix.

General	Need to educate about consequences of failure. 1,000 teacups vs. one large detention basin.
General	Negative PCOs are those that can't be measured.
General	Upper Truckee River – good opportunity to pilot?

Forum Feedback on Other Topics

CATEGORY	COMMENT
Costs	We will need to make serious capital investments in these projects, which likely will require agency support to successfully borrow money for such capital-intensive projects. We will need some sort of unified lake clarity entity or regional stormwater management districts.
Costs	We discussed whether costs should be allocated to property owners (resident or not) and whether costs can be distributed to visitors and other stakeholders. This needs to be looked at for any approach that is taken.
Costs	Consider creating stormwater management districts to help pay for water quality improvements.
Costs	Ask for as much money as we think we can get in order to reach our clarity goals.
Costs	We must have a plan for a local source of revenue.
Costs	How do you sell spending billions of dollars to increase clarity by seven feet?
Costs	Provide context – relate the 2030 ask to the 1990 – 2010 amount actually spent.
Costs	Make sure cost distribution is equitable and can be handled.
Costs	Urban areas, already incorporated, will have an easier time handling large up-front capital costs (e.g. pump and treat).
Costs	Issue with short-term up-front cost (i.e., incremental vs. lump sum).
Costs	*Compare our tax, potential tax to other areas of the country.*
Costs	*We need to make sure that monitoring costs are factored into the equation.*
Costs	*A fed/state rule that limits the amount of tax/assessment placed on the public (2.5% for water rate) when you add all the taxes – there's a breaking point*
Cost-Effectiveness	Focus on most cost-effective areas, watersheds.
Cost-Effectiveness	Prioritize to cost benefit.
Cost-Effectiveness	Target best bang for the buck in each source.
Messaging	Need to focus on public education to let everyone know *why* we need to make this commitment.
Messaging	Consider how you will have to market these PCOs and strategies to agencies and the communities. We need a careful approach that will ensure buy-in.
Messaging	Messaging: scenarios need to include an educational component that will involve selling/marketing. There is the perception is that public is skeptical about agencies implementing what they said or the burden will fall on them.
Messaging	Be careful with messaging – Don't give impression "we don't care about anything but water clarity."
Messaging	Put messages in positive light to fuel energy and innovation, (even unintended

	consequences are likely to be positive).
Messaging	How do we sell the "best" scenario to everyone?
Innovation	We should consider whether focusing on the technologies known today will get us where we need to go. Perhaps focusing on innovative scientific approaches will allow us to reach our clarity goals, even if it takes a little longer to perfect the technology and see the gains.
Innovation	*Consider encouraging companies that want to test or donate projects to work in the Tahoe basin to help us reach success with Scenario B.*
Innovation	*We should create a fund, based on a percentage of erosion control dollars, which is applied towards testing new technologies to improve water quality.*
Program planning	Need interim goals to track progress.
Program planning	Move from stick to carrot…If we are going to ask folks to change behavior, make it more incentive-based and focus on education.
Program planning	We should document the costs and benefits of the strategies, including social aspects.
Program planning	Invest in effectiveness and best chance of success.
Program planning	Demonstrate progress.
Program planning	Need to include adaptability in TMDL to account for changed conditions, both environmental and technological.
Program planning	Want to focus on whatever efforts the scientists are the most confident in the estimates that get the best results.
Program planning	*Continuation considered… in terms of timeframe. Compare to date with vs. long term.*
Program planning	*All need to consider the social impacts.*
Program planning	*What's the most feasible timeframe?*
Responsibility	Increase emphasis on government action (as opposed to individual action). Consumer action seems least likely to make a difference.
Responsibility	Will regulations to reduce loads be basin-wide or to individual areas, or both?
Responsibility	Ensure representative commitment, vision, goal basin-wide *and* by local entity.
Responsibility	Easier to control regulatory agency than 50,000 homeowners.
Responsibility	*Private enterprise for private control options to take over some work (with government oversight).*
Responsibility	*Stormwater management district – MOU; may be able to control variability of all the players.*
Responsibility	*Need a sense of full participation, private, fed, state, local.*
Other	Focus on Upper Truckee River area – set up incremental goals.
Other	Consider that some areas (such as Kings Beach) already have water quality improvement projects in the works. Getting public acceptance for something like a pump and treat project at this point for that area would be tough, since we are already heading down a path and have already invested millions of dollars in our current project.

Other	Streams and forest upland have potentially the greatest link/effect on other thresholds. We should highlight the collateral benefits. These are areas of public visibility. Given current warming climate change trend, stream restoration importance increases.
Other	Concern that water quality will hijack EIP: need to do habitat and other projects.
Other	*Curious to see what would happen if we followed the PBP?*
Other	*Renewed emphasis from CALTRANS on roadway de-icing.*

Anna West distributed worksheets provided to the Forum and general public to capture additional feedback on illustrative scenarios and PCOs. Anna encouraged everyone to fill out the worksheets and submit additional input to the TMDL team or Kearns & West.

ACTION ITEM:
Kearns & West will email the TMDL Feedback Worksheet to Forum members to allow for electronic submissions.

DISCUSSION SUMMARY

Harold Singer thanked the Forum members for providing input on scenarios and PCOs and noted that the feedback received so far has been quite useful. He encouraged everyone to continue the dialogue and consider this meeting the initiation of dialogue about PCOs and strategies. Harold noted that he did not hear any comment today that the Clarity Challenge is not achievable, and he is excited to hear conceptual support for the Clarity Challenge.

UPDATE ON TRPA AND TMDL DOCUMENT TIMING

Lauri Kemper (Lahontan) noted that the TMDL team would like to receive additional feedback as soon as possible so that the input can inform the December 6th Forum meeting. The consultant team will be drafting a final summary document cataloguing the comments received which will be used to develop the TMDL implementation plan and to craft alternatives. The TMDL agencies will work closely with TRPA staff to ensure that the ideas and information for the strategies will be worked into the Regional Plan and Regional Plan EIS. The TMDL team will draft the TMDL implementation plan throughout the winter; the plan should be finished in the spring or summer of 2008. The plan will be externally peer reviewed by fall 2008 in time for the Governing Board's decision in October 2008.

John Singlaub (TRPA) explained that the Regional Plan must be submitted to the Governing Board in late October 2008 for approval. The scoping for the Regional Plan EIS is concluding and the scoping report will be brought to the Governing Board on November 28, 2007. That scoping report will include several of the scenarios created today so that there are a range of implementation strategies to analyze for the EIS. The scenarios will be wrapped in with other thresholds and will include regulatory, incentive-based, and capital expenditures, as well as land use and transportation decisions, as approaches to get the clarity results. TRPA is working in parallel with Lahontan and NDEP which is not ideal but is the best way to handle the situation considering the firm deadline.

The key message is that the work the Forum has been doing will be built into the recommendation to Lahontan and NDEP.

Q. Are we reconstituting the Forum for additional meetings beyond the TMDL series?
A. In February we will have another Forum meeting relating to the TMDL. That meeting can also include an update on where TRPA is headed. There is not currently funding for the Forum in FY08 so the use of the Forum as an advisory group to the Regional Plan is in question.

Lauri Kemper clarified that as part of the TMDL there will be a monitoring program and management system and funding is available for this work. TRPA is currently working on a management system framework and implementation protocols. Conversations regarding allocations for load reductions and how this will affect individual areas will begin in November. Lahontan hopes to have this on the Tahoe Interagency Executives meeting agenda in December. Lahontan will report on where that effort is headed at the February Forum meeting.

Michelle Sweeney (Allegro Communications) thanked the Focus Team members for participating in planning for this Forum meeting and for attending the Forum meeting. Anna West thanked the Forum for attending and participating in the meeting and thanked the TMDL team for presenting the extensive scientific knowledge collected thus far.

Next meeting:
The next Forum meeting will be held on Thursday, December 6th at the Lake Tahoe Community College, from 8:30am to 4:30pm.

To review Forum materials, including presentations from this meeting, please go to:
http://www.PATHWAY2007.org/

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TMDL Package Approaches Worksheet
Lake Tahoe TMDL
October 25, 2007, 8:30 a.m. 4:30 p.m.

Topic: Honing in further on the question, "What strategy should we implement to reduce pollutant inputs to Lake Tahoe?" today we will discuss ways of packaging pollutant control opportunities to meet the Clarity Challenge.

Feedback on the Sample Illustrative Scenarios

The Scenario approach is a useful way of imagining what kind of effort will be needed and what kinds of gains can be achieved for a given level of investment. However, the Department would not support the conversion of scenarios directly into regulations, at least not without a process to approve alternative strategies. In its continuing planning and research program, the Department can foresee the possibility that its best BMP strategy might not align itself directly to the scenarios. During the implementation phase, therefore, the Department would like the opportunity to propose and -- with approval -- implement an alternative BMP strategy that produces the same level of pollutant reduction as the chosen scenario.

Additionally, the Department would support an iterative implementation approach whereby future monitoring results of program-wide effectiveness are used to determine future program modifications and BMP strategies. The Department would expect the model outputs to be re-evaluated using the future monitoring results and the load allocations to be revisited as necessary. While drastic watershed land changes (wildfires) may have an immediate negative impact on clarity, the positive program efforts may require several years to achieve gains in Lake clarity. Timing of program implementation should incorporate the lag in observable gains to effectively leverage the iterative implementation approach.

Illustrative scenario A _____

1. What components of this scenario would you like to see shift? In what way?
2. Are there base elements of this scenario that you would like to keep?
3. Are there elements of this scenario that are unacceptable? Why?

Illustrative scenario B _____

1. What components of this scenario would you like to see shift? In what way?
2. Are there base elements of this scenario that you would like to keep?
3. Are there elements of this scenario that are unacceptable? Why?

Illustrative scenario C _____

1. What components of this scenario would you like to see shift? In what way?

2. Are there base elements of this scenario that you would like to keep?

3. Are there elements of this scenario that are unacceptable? Why?

Feedback on New Package Approaches You Would Like to Suggest

You are invited to share ideas for approaches / emphases you would like to see in a package.

1. What would be the ideal combination of strategies to implement over the next 15 years to meet the clarity challenge?

   The ideal combination of strategies would include source control measures to retain sediments in the watershed and limit the import of additional nutrients into the watershed, treatment control BMPs to remove sediments, and operational BMPs. These measures should be implemented by means of a flexible plan, modified as necessary based on observed results. Methods deemed effective should be emphasized in the future.

2. What themes would be emphasized in your "ideal integrated package"? Sample approaches / emphases given so far have been:
   Focus on developing new technology
   Focus on most pervasive application of existing technology possible

Feedback on Individual Pollutant Control Opportunities

Urban & groundwater

Among the urban and groundwater "example controls" that are listed in the bullet points on your "TMDL Treatment Tiers and Example Pollutant Control Opportunities" handout are there any in particular that:

1. You would particularly like to see included in an integrated package, why?

   Source control measures to prevent nutrients and sediment from entering the system are the Department's preferred controls. Most likely, future treatment control BMPs will be required to meet the Clarity Challenge. If treatment control BMPs are deemed necessary, the Department would favor capital-intensive BMPs over operations-intensive BMPs if overall life-cycle costs (annualized capital costs plus operations) are equal. As a practical matter, it is generally easier to get one-time funding. Capital funds can come from bonds; operational funds must come from annual budget allocations and must compete with other needs. Permanent installations or methodologies that require minimum maintenance will be more effective on highways than those requiring labor-intensive, repetitious tasks.

Localized watershed planning and multi-agency coordination, rather than individual efforts to develop a treatment solution, could provide a greater benefit within the watershed.

2. You would object to seeing in an integrated package, why?

   The Department is concerned about the degree to which the various packages rely on vacuum sweeping. Effective source control will reduce reliance on vacuum sweeping since a smaller quantity of the constituents of concern will be washed onto or added to the impervious surfaces. One issue with vacuum sweeping is that sweeping state highways is more difficult and disruptive than sweeping city streets. Activities most likely would require lane closures creating traffic delays. A second issue is that in the Tahoe environment, vacuum sweeper reliability has been a problem. Finally, the effect of sweeping type and frequency on water quality is not yet well-established in the Tahoe Basin. The comment here is not necessarily to eliminate vacuum sweeping but to refrain from over-estimating its effectiveness and to limit its role in the implementation package. Permanent BMPs requiring periodic maintenance, rather than those requiring regular maintenance, might be a better alternative.

   In addition, instituting a Basin-wide stormwater utility district would provide a means to track efforts and effectiveness throughout the watershed.

Atmospheric

Among the atmospheric "example controls" that are listed in the bullet points on your "TMDL Treatment Tiers and Example Pollutant Control Opportunities" handout are there any in particular that:

2. You would like to see included in an integrated package, why?

1. You would object to seeing in an integrated package, why?

Feedback on Social, Technical and Financial Range of Feasibility

Social

1. What ways of meeting the clarity challenge can people really support?

   Methods that appear fair and equitable will generate broad support. It would be good to focus on community-wide efforts with a regional emphasis on solutions.

2. Are there behavior / practices that institutions are already seeking to change that the clarity challenge can give context / meaning to (or benefit from)?

   The increased use of public transportation in the Basin is one practice that might benefit the

Clarity Challenge, since reducing VMT reduces atmospheric sources of the constituents of concern.

In addition, multi-agency coordination for treatment solutions in storm watersheds is critical, whether this involves a pump and treat approach or the co-location of basins.

3. Are there behaviors / practices that individuals (residents and or visitors) want to change that the clarity challenge can give context / meaning to (or benefit from)?

   Individual driving behavior has the potential to change. Personal vehicle driving frequency could be decreased by making public transportation available to expected destinations (e.g., Emerald Bay, Beaches, casinos, commuting).

4. What social factors might come into play that could "make or break" any given approach to the clarity challenge?

   The implementation style could be very important. Local support will not be great if homeowners perceive the TMDL as a means by which "Big Government" dictates, in minute detail, what they can do with their property. Another issue that is important is the perception of fairness in the application of the rules. All property owners should be treated the same, and requirements should be proportional to property type and size (i.e., golf courses and casinos with large parking lots should be required to do more than individual private property owners).

   A social factor that would promote the Clarity Challenge might be the inauguration of a basin-wide stormwater utility district. Forming such a district would allow stormwater treatment to be portrayed as a utility function, similar to a water or sewer utility, rather than a set of rules that impinge on local homeowners. If the district took responsibility for BMP maintenance, then regulators wouldn't have to enforce BMP maintenance by individual homeowners, which would be a burden on agency staff and would also be perceived as a continuing, annoying intrusion by the homeowner. Models for such a district can be found in onsite wastewater management districts. Anther advantage of a stormwater utility district would be its ability to effectively manage water quality on a larger scale. Using specialized technical skills and equipment, a district could build and maintain advanced BMPs on a neighborhood scale. Most individual homeowners would not be willing or able to build and properly maintain advanced BMPs such as filters on individual lots.

   Availability of funds is an issue, especially when multi-agency requirements compete for limited public funding. Multi-agency commitments (e.g., TRPA thresholds vs. Lahontan water quality goals) may cause undue hardships.

Technical

1. Would you like to see an emphasis on improving the technologies we currently apply in the Basin?

   - Alternative deicing and anti-icing products to minimize need for sand and salt

- Identification of technology that will allow retrofitting of existing drainage facilities

2. Are there technologies we currently apply in the Basin that you consider ineffective and therefore would recommend against their inclusion in future scenarios?

   Although the Department is currently testing them, detention basins are probably not going to prove effective at removing sub-20 μm particles

3. Would you like to see an emphasis on broader and more-rigorous application of the technologies we currently use in the Basin?

   - YES, an emphasis on application of BMP technologies over a broader swath of land uses and more rigorous check on BMP implementation (e.g., pre-sale inspection)
   - Compliance review and more source control to prevent mobilization of sediment, and less emphasis on concentrating volume of water and sending it to a basin

4. Are there technologies that we already apply in the Basin that seem really effective regarding clarity advances and that people would like to see more of?

   Erosion control techniques as per the ski-slope BMPs.

   Filtration is proving to be very effective, but there will be problems with implementing it because of the large footprint required. Reconsidering the design storm criterion might promote more widespread implementation (see other comments on the hydrologic issue in our response to (5), below).

5. Are there practices / technologies that should be investigated further regarding their relevance to the clarity challenge?

   - De-icing/anti-icing products/technologies or procedures
   - Low impact development (LID) approaches such as vegetated stormwater management approaches (e.g., biofiltration, bioretention, vegetated filter strips) that could be installed parallel to roads

   Are the groundwater flows characterized sufficiently to determine whether or not water infiltrated away from the Lake -- such as on Luther Pass or Christmas Valley -- actually reaches the Lake? In other words, is appropriate credit for pollutant removal being given to upland infiltration?

   Controlled land application of stormwater. Would it be possible to employ "pump-and-don't-treat" systems in which runoff is captured and applied to landscaped or forested areas rather than run through treatment plants?

   The design storm (1 inch/hr) should be re-evaluated in light of TMDL goals and BMP capabilities. For instance, in filter design, coarse media is required to pass the design storm flow, but coarse media is not as effective as fine media in reducing pollutants in smaller flows, which occur much more frequently. Given the load reduction goals under the

TMDL, it would be more desirable to provide efficient treatment during most rainfall events and no treatment in unusual events than to provide poor treatment during most rainfall events just so that some treatment could be provided in the unusual events.

6. Are other localities / regions putting things on the ground that you would like to have explored for the Tahoe clarity challenge application?

   - Erosion control as per ski-slope BMPs
   - Low impact development (LID) approaches such as vegetated stormwater management approaches (e.g., City of Portland "Green Streets" program)
   - LID approaches for residential and commercial development

7. Are the technologies / approaches discussed in the Pollutant Reduction Opportunity Report palatable, unacceptable, good-but-with-reservation?

   Implementing a basin-wide stormwater utility district would provide the institutional means to ensure the long-term maintenance of BMPs. However, the Department feels there should be more emphasis on source control BMPs, preventing soil erosion instead of treating stormwater. The technologies discussed seem good as examples, but any/all options should be considered if they are beneficial or functionally equivalent.

   See earlier comment about vacuum sweeping.

8. Are there technological factors that could come into play and "make or break" the clarity challenge?

   Certain assumptions are being made about the ability of BMPs to remove 20 μm particles (as opposed to TSS or turbidity) mainly due to lack of data. If these assumptions prove untrue and the BMPs are not as effective as thought, then the control strategies may come up short with regard to the Clarity Challenge. Many of the current ideas proposed (filters, effective filter media) are not proven technologies. The Clarity Challenge must be based on an iterative implementation in terms of strategy and allocations.

   Currently, the forest and streams are thought to be minor contributors, but is this always the case? Historical data show that clarity drops in wet years. Is it possible that periodic pulses of particles from forests and streams are more significant that the average inflows and that these pulses need to be controlled? Could a one in ten year water year result in greater loading to the Lake from forest and streams than 10 years of urban loading?

   Based on our review, it is unclear whether forest fires are adequately addressed in the implementation scenarios. In just one year, forest fires and the resulting runoff and erosion may be equivalent to many years of urban runoff. The loading to the Lake following wildfires should be considered in the Pollutant Reduction Opportunity Report. Revegetation of burn areas could be an offset opportunity for stakeholders.

Financial

1. What financial resources can the Basin reasonably expect to raise to meet the clarity challenge?

   Financial resources could be obtained via a Basin-wide storm watershed utility district for planning, design, construction, maintenance, and monitoring.

2. To what extent is Lake Tahoe clarity a financial priority of taxpayers?

3. What do politicians and/or property owners want to be able to show as gain from investment?

4. What proportion of the overall budget for managing basin resources should apply to water quality targeted objectives?

   This question might be rephrased as follows: "To what extent will the public support the implementation of the TMDL program through increased property and sales taxes?" The economic impact of increased taxes and user fees on the available revenue should be carefully considered before implementing a scenario.

5. Is there an "integrated package" that is particularly palatable from a clarity-gain-for-investment perspective?

   This is another place where a Basin-wide stormwater utility could be helpful. If stormwater management is housed in a single entity, the chances of efficient and coordinated expenditures of funds is improved, as opposed to everyone doing their own thing.

Please fax your responses by Nov. 16 to (415) 391-8223 or mail to Kearns & **West, 475 Sansome St., Suite 570, San Francisco CA 94111**

Response to letter from G. Scott McGown (Caltrans) to Doug Smith (Lahontan) dated December 3, 2007. Answers to questions pertaining to the *Draft Lake Tahoe TMDL Technical Report* are provided (i.e. #'s 1-7)

Compiled by John E. Reuter, John Riverson and Alan Heyvaert
January 28, 2008

Pollutant Loading Estimates

1. *What changes in the modeling input resulted in the percent contribution of total Uplands sources (Urban and Non-Urban) to the pollutant loading estimate for fine sediment particles changing from 61% to 81% between the April 27, 2006 Regional Board presentation to the Pathway Forum and the release of the* Draft Lake Tahoe TMDL Technical Report *in September 2007?*

The percent sediment load expressed as particle number in the *Draft Technical Report* is 81% for the Upland. Similarly the same report shows sediment mass loading in the <63 μm fraction to account for 64% (Table 4-66). The Lahontan presentation on April 27, 2006 presented information only for the fine sediment mass loading and not for particle number. The 61% and 64% values should be taken as a direct comparison since they both represent mass. We should note that there was change in the values for PM (particulate matter) loading from wet atmospheric deposition. The amount of PM in wet deposition initially reported were based on conservative estimates that were unrealistically high. In February 2007, we received guidance from Leon Dolislager of the California Air Resources Board and loading was re-estimated.

2. *How was the percent contribution of Upland sources (Urban and Non-Urban) to the pollutant loading estimated for fine sediment particles determined?*

The Watershed Model, nor any other similar watershed runoff model, is not capable of estimating fine particle loading in the size ranges needed as input to the Lake Clarity Model, e.g. 0.5-1, 1-2, 2-4, 4-8, 8-16 and 16-32 μm. Consequently, the TMDL Program conducted two critical monitoring programs to directly measure particle size distribution (PSD) in both streamflow and urban stormwater runoff. This provided us with Tahoe-specific field data. The stream PSD work was done in 2002 and 2003; the stormwater monitoring was done in 2003 and 2004. The Watershed Model was able to estimate daily flows from both urban and non-urban land uses. Particle concentrations (number/mL) were on the order of 300 times higher in the urban stormwater samples compared to the streams. All this data was used to estimate fine sediment loading in the Upland category.

3. *Were single Event Mean Concentration (EMC) used to represent Total Suspended Solids (TSS) per land use in the watershed model, or was the load calculated?*

Please refer to the answer to questions 5 & 6 below. Also, Table 2-23 in the *Draft Technical Report* provides derived EMCs for runoff based on model calibration to the measured LTIMP field data for the period 1994-2004.

Urban Stormwater Monitoring Study

4. *Describe the two-year, TMDL Urban Stormwater Monitoring study.*

A total of 19 sites were used for data collection as part of the Stormwater Monitoring study; refer to Figure 4-22 for location. A variety of land uses were captured; however, it was very difficult to separate out on the basis of a single land use. Information on the sites provided by Alan Heyvaert and Jim Thomas (DRI), principle investigators on the project, showed that single and multiple family residential land use, followed by secondary roads and vegetated comprised the major definable land categories. Gunter (2005) developed the following land use categories with the number of stations or auto-samplers used in parentheses: commercial or CICU (4), mixed urban (5), single family residential (6) and multi-family residential (3). The percent impervious cover ranged from 0-94% with most between 35-50%. Sample site availability and logistics limited the ability to sample primary and secondary roads exclusively. The TMDL Team including the watershed modelers from Tetra Tech, Inc. made the conclusion that of the available data, pollutant EMCs from the multi-family residential land use most closely approximated secondary roads. We were able to focus the TMDL urban stormwater monitoring study on non-highway land uses because of the monitoring programs operated in the Tahoe basin during 2000-2003 by Caltrans (CTSW-RT-03-054.36.02; Table 4-4) and 2002-2003 by Nevada NDOT/DRI (Jones et al. 2004).

The chart at the end of this document was also developed by Heyvaert and Thomas and provides information on the number of storm events samples in 2003 and 2004 and the percent of total flow captured by the auto-samplers. Numerous composite or single samples representing the hydrograph of each storm event provided extensive coverage of changing conditions during each event. A total of 622 individual storm events were sampled at all the TMDL monitoring sites accounting for a mean of 54% of annual flow volume in 2003 and 32% in 2004 (Illustration #1). Of these storm event samples, 164 provided data on the particle size distribution for urban runoff.

Sampling methodology as well as details of the analytical methodology were determined by Heyvaert and Thomas and details are available upon request. Autosamplers with flow meters were used to sample throughout the storm event. Particle size analysis was performed on a Beckman Coulter LS-13320 laser diffraction analyzer, with data reported in volume percent distributions for pre-selected particle size bins (phi series). These data were then converted to relative percent mass and to particle numbers per size bin, under assumptions of particle uniform density and shape. Values were related back to levels of measured TSS for reference to percent composition.

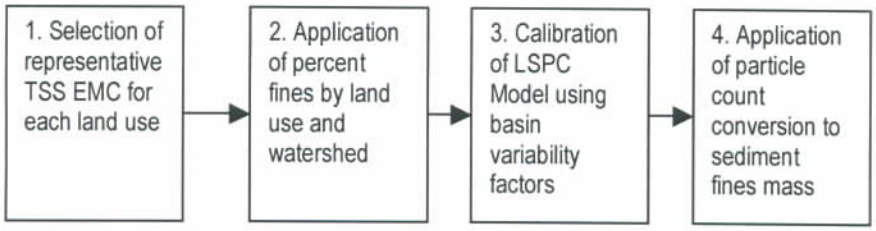
Mean precipitation at Tahoe City during 2003-2004 was 27.4 inches. This compares to 25.3 inches between 2000-2002, 40.3 inches in 2005-2006 and 34.8 inches over the 26-year period from 1981-2006.

Particle Size Distribution

5. *How was particle size distribution determined for all land source sources?*

6. *What land use results were used to determine the particle size distribution for the CICU, Primary Roads, and Secondary Roads Urban sources? Were the same percentages used for the size distribution of fine sediment particles for each of these sources?*

This is in response to both questions 5 & 6 that are related. It describes the general process that was used to estimate the baseline fine sediment particle by land use, with a focus on primary roads. The primary objective of the process was to characterize the *relative magnitudes* of pollutant levels among the 20 land use categories of interest. While calibration to observed LTIMP values required a degree of spatial scaling, the relative source loading ratios was strictly preserved. Preserving this relative distribution during the modeling phase preserves the relative magnitudes of TMDL allocations in subsequent phases. The flow chart below highlights the relevant steps in the particle count estimation process.



a. TSS Event Mean Concentration

The first step in the process was to use available information to estimate an Event Mean Concentration (EMC) of Total Suspended Solids (TSS) for overland runoff from the different modeled land use categories. For primary roads, the two sources of information used to select the EMC were the Caltrans 2003 summary report (CTSW-RT-03-054.36.02), and a report from NDOT and DRI looking at highway stormwater runoff and BMP effectiveness on portions of SR 28 and US 50 in Nevada (Publication No. 41209). EMC for TSS from other land uses is described on pages 4-57 to 4-60 of the *Draft Technical Report*,

Primary Roads were assigned an EMC of 793 mg/L of TSS. This value is an average of the two sources of information: Caltrans (2002-2004 mean value: 759 mg/L), and NDOT/DRI (mean value 2002-2004 827 mg/L).

b. Particle Size Distribution

In addition to the EMCs, the fraction of the TSS comprised of fine sediment (< 63 μm) was estimated for each urban land use category using available stormwater sampling information. Primary roads were assigned 85.4 percent of fine sediment, similar to the other urban land uses. This meant that for every 100 mg of total sediment produced, 85.4 mg were fines less than 63 μm in size. The percent of fines in runoff from the non-urban land uses was taken as the in-

stream concentrations taken from those LTIMP monitoring sites not influenced by urban flow. The lower portion of Table 4-24 shows these values for the various LTIMP watersheds.

The same urban sediment distribution was applied to all primary roads, regardless of location. There was no distinction between the particle size distribution applied to CICU, Roads Primary and Roads Secondary land uses because the data available came from locations where there was a combination of these land uses.

c. Basin-Wide Factors for Soil Variability and Quadrant

The third step was the development of the basin-wide factors for soil variability and quadrant. These factors were developed by calibrating the model to match the loads observed at the LTIMP stream monitoring stations. These do not affect the relative contribution of each land use, since they are applied uniformly to the total upland load. Depending on the LTIMP stream, the scaling factors increase or decrease the total land loads modeled.

d. Fines Load to Particle Count

Once the model was calibrated, the fine sediment load (mass) was calculated. This value was then multiplied by the 'fines load to particle count conversion' factor, to estimate the particle counts. The particle conversion factor was 7.49245E+16 particles per metric ton for urban areas, and 8.64062E+15 particles per metric ton for non-urban areas. These factors were developed by Dr. Goloka Sahoo of the UC Davis, Department of Civil & Environmental Engineering. Both the urban and non-urban conversions considered (a) the mass of fine sediment, (b) the relative distribution of particle number in each size classes based on field data, (c) a representative particle volume in each size class based on the assumption that particles are spherical, and (d) a particle density of 2.56 g/cm^3.

7. *Was the Caltrans report CTSW-RT-03-054-36.02 considered when determining particle size distribution?*

It is acknowledged that Caltrans did report on particle size distribution from Year 2 and Year 3 of their Tahoe basin monitoring study. According to Table 5-1, found in their June 2003 summary report, influent runoff was collected for six runoff events in Year 2 (three at the Tahoe Airport site) and three at the Echo Summit site. During Year 2, a total of 10 individual runoff events (five at each of the two locations) were sampled for particle size distribution. This comprised a total of 16 individual storm events. While Caltrans sampled BMP effluent for particle size distribution we were primarily interested runoff concentrations prior to BMPs.

Using summary data provided by Caltrans in their 2003 summary report, the overall particle concentration associated with the Echo Summit influent runoff was 1.48 x 10^6 particles/mL and 5.96 x 10^6 particles/mL for the Tahoe Airport influent runoff. Based on their 16 samples these values were about 10 tens less than reported for the TMDL SWM study that considered 164 samples from nine sites.

Given that (a) the Caltrans samples were analyzed using the 'electrozone method' (based on the Coulter principle) and the SWM was analyzed using laser diffraction backscattering, and that methodology can affect results, (b) Caltrans sites were more non-urban highway in character and the SWM focuses on the urban zone including roads, and (c) there was a difference in number of samples collected, we decided that it was best to use the TMDL SWM particle size distribution results to be consistent with data from the other urban land uses monitored.

We fully acknowledge that no single method alone can answer all questions relevant to particle size analysis and water quality conditions of source water and receiving waters in the Lake Tahoe Basin. Rather, it is a combination of approaches that will provide the most cost-effective assessment for different types of samples. The data from these methods are not necessarily equivalent, and usually derive from a different set of assumptions on composition, density, shape, aggregation, size range, etc. There is a critical need for comparative analyses and for recommendations on data reporting methods, formats and the data conversions appropriate for reporting results by different methods. Indeed, Alan Heyvaert, Geoff Schladow and Todd Caldwell recently received funding under Round 7 of the SNPLMA science program for a project entitled, **Tahoe Basin Particle Size Analysis and Protocol Development**. This will go a long way towards resolving these issues and unifying the particle size distribution data set for the Lake Tahoe Basin. As mentioned above, until that occurs we felt that applying the urban SWM data (which includes roads) would be appropriate. Further discussion; however, is welcome and an adaptive management framework could be used to update the roadway particle data when it becomes available.

Illustration #1. Produced by Alan Heyvaert and Jim Thomas for the TMDL Stormwater Monitoring project. Shows number of storm events monitored during the project and the percent of the annual runoff captured by the sampling.

ID	Site Name	Events	Flow (%)	Events	Flow (%)
		2003		2004	
AD	Andria Dr.	12	28%	12	12%
BB	Bonanza Ave.	17	82%	2	7%
BC	Bijou Creek	na	na	43	86%
CI	Coon Street	13	na	10	4%
DC	Don Cheapo's	15	36%	21	23%
DD	Dale Dr.	16	83%	18	37%
GE	Glorene and Eighth	na	na	7	62%
IR	IV Raley's	21	38%	26	34%
MD	Mountain Dr.	4	60%	4	3%
NW	Northwood Blvd.	15	9%	28	40%
O3	Osgood Ave.	17	68%	28	58%
RB	Regan Beach	14	86%	21	15%
RC	Roundhill 4.2	20	36%	7	32%
S1	TCWTS	24	42%	26	13%
SB	Speedboat Ave.	26	86%	32	75%
SC	SLT Casinos	3	3%	32	10%
SG	Shivagiri	na	na	16	26%
SQ	Sequoia Ave.	12	na	8	7%
SY	SLT-Y	26	94%	26	74%
	mean:	16	54%	19	32%

Response to letter from Nevada Tahoe Conservation District to Nevada DEP dated December 14, 2007. Answers to questions pertaining to the *Draft Lake Tahoe TMDL Technical Report* are provided (i.e. #'s 1 and 5)

Compiled by John E. Reuter, Goloka Sahoo and Geoff Schladow
January 28, 2008

1. *Understanding the basis for the assumptions in the TMDL science, modeling and literature would greatly improve the ability to interpret their importance in relation to the share of pollutants being proposed for the Urban Upland.*

A number of key assumptions were required to estimate pollutant loading from the Urban Upland. Many of these are discussed in the *Draft Technical Report* while others are more extensively discussed in the final watershed model report, available through the Lahontan Water Board (Tetra Tech, Inc. 2007. Watershed Hydrologic Modeling and Sediment and Nutrient Loading Estimation for the Lake Tahoe Total Maximum Daily Load. Final modeling report. Prepared for the Lahontan RWQCB and University of California, Davis.).

Many of the key assumptions are listed below:

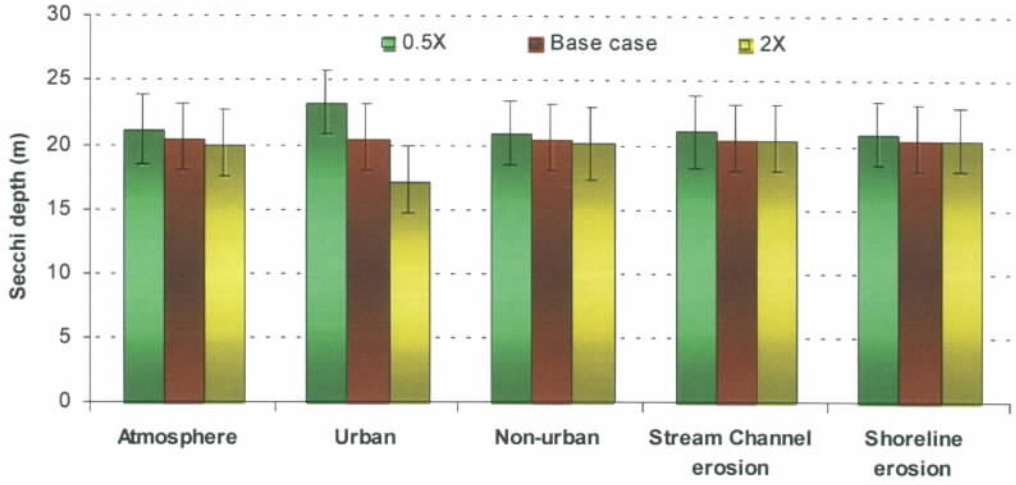
- Existing, albeit the limited, number of SNOTEL weather sites was sufficient to model runoff and discharge to Lake Tahoe. Results validated very well compared to the five previous basin-wide annual stream-flow estimates (Table 4-17, *Draft Technical Report)*.
- Measured and literature-derived Event Mean Concentrations (EMCs) for TSS, nitrogen and phosphorus species were adequate for modeling pollutant load in Tahoe's tributaries. Table 4-41 shows a generally good comparison between model output and LTIMP loading estimates.
- Concentrations of pollutants measured at the TMDL stormwater monitoring sites reflected that delivered to Lake Tahoe. Since stormwater monitoring sites were widespread around the Basin and since average values were used, spatial variability was not considered an issue.
- Average EMCs were applied basin-wide. Given the difficulty of establishing urban stormwater monitoring sites to capture runoff from a single land use only, we considered averaging our best available approach.
- Relationships between average EMCs and flow were representative for different storm events, seasons and precipitation years. Again, due to the complexity of sampling and modeling that would be required to accommodate changing EMCs throughout the year, we considered this a feasible approach. An inclusive and comprehensive data for urban runoff was virtually nonexistent prior to the TMDL stormwater monitoring project. It was agreed that we would need more years of data to be able to model seasonal or event based loading with confidence.
- The same urban sediment distribution was applied to all primary roads, regardless of location. There was no distinction between the particle size distribution applied to CICU, Roads Primary and Roads Secondary land uses because the data available came from locations where there was a combination of these land uses.
- Particle size distribution (number of particles in specific size classes) could be determined from estimates of modeled fine sediment mass (<63 μm) based on the assumption that particles were spherical in shape with a density of 2.56 g/cm^3. Such a 'mass to particle

number' converter was developed and calibrated to yield results identical to the watershed Model.

5. *It is unclear what inputs have gone into the models and what the sensitivity of those inputs are. It would be very helpful to have a list of spreadsheets explaining what parameters appear to show the greatest level of sensitivity, and the modeling efforts that were performed to ascertain these details.*

A total of 37 model parameters were used in the Lake Clarity Model. Please refer to Table 5-15 of the *Draft Technical Report for a list of these parameters as well as the assigned values.* In addition, input variables to the model included climate (wind, precipitation, solar radiation, etc.), groundwater nutrient loading, land-based surface runoff from the watershed for nutrients and fine particles, atmospheric deposition of particulate matter and nutrients.

Pages 5-33 to 5-39 of the *Draft Technical Report* presents a sensitivity and uncertainty analysis. It was concluded that particles have a significant affect on Secchi depth clarity. A more detailed analysis of the sensitivity of that key variable is given below. Green bars represent the modeled Secchi depth (over 15-20 years of simulation runs) expected <u>if</u> the particle size loading data for urban and non-urban land uses combined were actually one-half of that used for the base case. Likewise, the yellow bars show modeled Secchi depth if the actual particle loads was really twice that used for the base case. Loading from the urban source category was the most sensitive because loading was the great. Secchi depth could vary by 2-3 meters <u>if</u> the particle loading was incorrectly estimated as either a factor of 2 to low or too high.



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Flex your power!
Be energy efficient!

December 3, 2007

Doug Smith
Chief, TMDL & Basin Planning Unit
Regional Water Quality Control Board
Lahontan Region
2501 Lake Tahoe Blvd.
South Lake Tahoe, CA 96150

Re: Submittal of Technical Questions Regarding the Draft Lake Tahoe Total Maximum Daily Load Technical Report

Dear Mr. Smith:

Caltrans appreciates the Regional Board taking the time to prepare for and host the technical workshop on December 18, 2007 to address stakeholder questions regarding the *Draft Lake Tahoe Total Maximum Daily Load (TMDL) Technical Report*. Pursuant to your request at the November 14, 2007 Lake Tahoe TMDL Implementation Stakeholder meeting for questions to assist in your preparation for the technical workshop, we respectfully submit the following questions as points to discuss at the workshop:

- **Pollutant Loading Estimates**

  1. What change in the model input resulted in the percent contribution of total Upland sources (Urban and Non-Urban) to the pollutant loading estimate for fine sediment particles changing from 61% to 81% between the April 27, 2006 Regional Board presentation to the Pathway Forum and the release of the *Draft Lake Tahoe TMDL Technical Report* in September 2007?

  2. How was the percent contribution of Upland sources (Urban and Non-Urban) to the pollutant loading estimate for fine sediment particles determined?

  3. Were single Event Mean Concentration (EMC) used to represent Total Suspended Solids (TSS) per land use in the watershed model, or was the sediment load calculated?

- **Urban Stormwater Monitoring Study**

  4. Please describe the two-year Urban Stormwater Monitoring study mentioned on p. 1-13 of the *Draft Lake Tahoe TMDL Technical Report*, including:

     i. Sample sites and the land uses characterized
     ii. Number of auto-samplers per land use, including:

1. Residential Single-Family
2. Residential Multi-Family
3. Commercial/Institutional Communications/Utilities (CICU)
4. Primary Roads
5. Secondary Roads

iii. Dates and years samples were collected
iv. Number of storms sampled
v. Methodology for sample collection
vi. Antecedent conditions (dry/wet years)
vii. Methodology for analysis of particle size distribution

- **Particle Size Distribution**

5. How was particle size distribution determined for all land use sources (Table 4-24 of *Draft Lake Tahoe TMDL Technical Report*)?

6. What land use results were used to determine the particle size distribution for the CICU, Primary Roads, and Secondary Roads Urban sources? The same percentages were used for the size distribution of fine sediment particles for each of these sources?

7. Was Caltrans report CTSW-RT-03-054.36.02 considered when determining particle size distribution?

- **Implementation Scenarios**

8. What information was used to generate the costs (both capital and operations and maintenance) for the BMPs used in Implementation Scenarios A-C, presented at the October 25, 2007 Pathway Forum meeting?

Thank you for requesting our input for the discussion. We look forward to attending the technical workshop and stakeholder meeting on December 18.

Sincerely,

G. SCOTT MCGOWEN
Chief Environmental Engineer

City of SLT Comments – Sent via email 11/14/07

Doug;

A couple of concerns from today's meeting...

If the decline in lake clarity is being caused primarily by sediment from an urban setting and the primary urban areas are in California, it would appear that the City is in the cross hairs. Assuming the cost to reduce particles in the 25%-30% range is about $2B and that the City and surrounding urban setting is responsible for 50%, we are looking at a cost of about $1B over the 20 years or $50M annually. This assumes everything is linear.

Currently City staff can annually produce about $4M in projects. Assuming $50M can be made available on an annual basis, there are major capacity problems associated with this much work.

We also have concerns about existing technology and its ability to remove the fine sediment especially in regard to contact time in cold settings. As lake clarity continues to decline, there are questions about the effectiveness of the BMPs in our current tool chest as well as EIP project selection.

In regard to allocations, at this juncture the watershed scenario seems the most logical. We can determine loading where it enters the lake as well as tributary loading.

Until we hear more in the workshop on how the TMDL process was developed we cannot agree to an allocation scenario nor provide you with any milestones.

The City attendees for the workshop will be;

David Jinkens
John Greenhut
Stan Hill
Robert Erlich

We look forward to working with you on the project.

Comments from Steve Cooke, NDOT, sent via email 12/5/07

Jason,

Quite truthfully there is way too much information to review to fully understand the whys and hows behind the work to date on the TMDL. The folks involved with this process no doubt have spent a good deal of time to get their arms around this animal and they should be commended for their work. I have had limited time to spend on the review so my focus has been looking over the Pollutant Reduction Opportunity Report. I apologize in advance if some of the question presented below could be easily answered assuming I knew exactly where to look.

- What assumptions are made to address precipitation differences across the Lake in an west to east direction?
- What assumptions are made to address operational differences between the two states and five counties that are located in the Basin?
- On page 22, it's stated that O&M cost are preliminary and need to be verified. Given this, how realistic are the O&M costs and how is this current "preliminary" uncertainty addressed when using this data to drive the decision making process? Lots of

decisions will be based on the financial information presented so if that information is not representative then how can everyone feel comfortable making decisions?

- I see the phrase "professional experience" or "profession judgment" used frequently throughout this report. How many years of Tahoe based professional engineering experience/judgment is there? You can't beat both professional experience and judgment but if it is not Tahoe based then it isn't truly an asset.
- What's the definition of and what constitutes primary and secondary roads?
- On page 30 Costs, what were the sources of the cost information? Did it evolve from work conducted in the basin? How current was this information? "PCO costs were estimated using literature values from previous examples of the PCO....." Were these literature values Tahoe based?
- Page 88, Road Abrasive Applications, I see mention of Caltrans traction sand and salt usage but no mention of NDOT's values. NDOT values have to be factored into the equation, evaluated and included in the evaluation process. Based on the timeline used for the Caltrans data, the NDOT Tahoe Basin Sand/Salt usage information is presented as follows:

1995-96 to 2004-05 Sand Usage: 25,374 cubic yards (1.2 tons/cy) or 30,449 tons or 27,618 MT or 2762 MT/yr
1995-96 to 2004-05 Salt Usage: 9,100 cubic yards (1.0 ton/cy) or 8,254 MT or 825 MT/yr
Number of lane miles: 105
Average sand application per lane mile: 80-100 pounds
Sand application per lane mile for unusual conditions: 500 pounds
If you wish to see the raw data for sand salt usage or for maintenance activities such as sediment removal or cost data, let me know and I can e-mail it to you.

- Page 96, Hydrologic Source Controls: What type of soil or infiltration rate is assumed? Is it a universal basin soil or rate? Does is vary by region?
- Many of the O&M cost need to be revised per the Maintenance Descriptions. For NDOT when Vactor, or culvert cleaning is in progress, traffic control needs to be set up and a water truck and support equipment and related manpower is required. For all other maintenance operations, traffic control is required. Were these items considered when developing the cost information?
- On page 154, why weren't escalation factors included in the cost estimation? Without escalation, future cost can not properly accounted for.
- On page 154, the length of 2000 ft assumed for storm drain cleaning is not realistic. Typically culvert segment lengths correspond to roadway widths. So for NDOT, a culvert reach to be cleaned would be 50-60 feet. To inspect 2000 feet of storm drain would require the maintenance crew to set up and tear down operations approximately 35-40 times which in turn would result in a greater aggregate time than the 2 hours that is currently estimated. Also its not too common to have stormdrain systems at Tahoe especially of the length presented.

Call me if you have questions. Since I'm late submitting this information, I'm also sending it to Rob Larsen.

Cheers !!

Steve M. Cooke, P.E.
Nevada Department of Transportation
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E-Mail: scooke@dot.state.nv.us

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TO: NEVADA DEPARTMENT OF ENVIRONMENTAL PROTECTION

FROM: THE NEVADA CONSERVATION DISTRICT

SUBJECT: NTCD COMMENTS ON THE LAKE TAHOE TMDL

DATE: 12/13/2007

Thank you for the opportunity to comment on the Phase 2--Pollutant Reduction Strategies for the Lake TahoeTMDL. On behalf of the Nevada Stormwater Association, NTCD would appreciate a conversation or clarification of several aspects of Phase II as follows:

Overall

1. Assumptions are prevalent throughout much of the TMDL science, modeling and literature (e.g., 50% compliance with the BMP retrofit program). Understanding these assumptions and the basis for them would greatly improve the ability to interpret their importance in relation to the share of the pollutant reductions being proposed for the Urban Upland. Getting a better handle on this would be a good step toward understanding the TMDL products.

2. There is likely a 2 to 3 year time span between the time the TMDL reports were released and the TMDL is implemented as part of TRPA's Regional Plan. Water quality/erosion control projects are still being designed and implemented to a standard that we know does not address fine sediment load. Will there be any interim steps taken to address this regulatory gap?

3. It is confusing that dollar amounts, statistics, and pollutant reductions are so fluid in Phase 2 of the TMDL. For example, information provided at the last Focus Team meeting indicated that the Clarity Challenge could only be met through Tier three implementation at a cost of over $4 billion. One week later at the Forum meeting all three Tiers were shown to reach the Clarity Challenge, with a cost of $2 billion. We are aware that these changes are due to optimization modeling and that this is a fluid process, however are concerned that data presented has been radically different from week to week.

4. An additional point of confusion is that the PRO report has information that is already outdated where Tier 3 has lower pollutant reductions than tier 2. These inconsistencies have made it difficult to have a common understanding of the information and have made it difficult to get accurate information out to our constituents. Where can one find comprehensive look at the most up-to-date information?

5. It is unclear what inputs have gone into the models and what the sensitivity of those inputs are. It would be very helpful to have a list of spreadsheets explaining what parameters appear to show the greatest level of sensitivity, and the modeling efforts that were performed to ascertain these details.

PRO Report

6. For the Atmospheric strategy, it was suggested that controlled burns performed on public lands were shown to be an insignificant source of pollutants. At the Pathway Forum it was stated that controlled burns account for between 1-2% of the total fines budget, and so additional actions/reductions would not be required from these public entities. Residential wood burning stoves however, are estimated to account for about 3% of the total fines budget; which is considered significant enough to suggest removing up to 50% of residential wood burning stoves. It seems the scale and confidence of the atmospheric analysis is such that 2% is essentially the same as 3%.

7. Load reduction estimates depicted in Tier 2 and Tier 3 of the Urban and Groundwater SCG are based on residential BMP implementation rates of 50% and 100% respectively. There are many challenges to assisting homeowners with their BMPs; 100% compliance seems a bit optimistic considering basin wide compliance is about 20% at this point. Is there a way to model current levels of BMP implementation and then adjust those levels as implementation rates improve over time?

8. It is not clear if replacement and life cycle costs are included in the overall planning costs? Could you please describe how these types of costs are incorporated into the PRO report estimates? And can you provide some estimate of the total comprehensive cost to reach the clarity goal of 100 feet?

TMDL Allocations and Milestones

9. Equitable allocations are primary consideration for a successful partnership between TMDL regulators, implementers and the public. Many of the load allocation schemes presented by the TMDL Team are potentially contrary to this effort. Equal percent reductions of any sort (allocation schemes a, b, and c) appear highly unreasonable. This strategy would penalize those who have developed responsibly, and benefit those who have not. In addition, this approach would <u>not</u> take into account important differences in soils, precipitation regimes, slope, coverage types and amounts, and urban management practices such sanding and sweeping frequencies. It is unclear why the TMDL load estimation models would not be considered for use in allocation development.

10. The TMDL process for developing a five-year milestone is unclear, and therefore difficult to comment on. There have been no discussions on what tools a jurisdiction or entity would use to determine such a milestone. In order for this process to be equitable, a common tool or method should be developed that is used by all. Utilizing various methods for estimating pollutant reduction milestones may well be controversial if the methods are not comparable.

11. Understanding the allocation process to Nevada jurisdictions is confusing. It would be helpful to spend some more time on how Nevada fits in to the TMDL allocation equation.

TMDL Crediting and Tracking

12. It is our understanding that once the TMDL is implemented there will be a program for tracking and crediting pollutant reductions. We are very interested in knowing how EIP projects will be credited if they were constructed after the pollutant budget was established, but before the TMDL is implemented? This is a very important issue since a significant investment has already occurred toward fulfilling Nevada's commitment to the EIP.

Appendix B
Part 4

Develop and Refine the Recommended Strategy

PATHWAY Forum Agenda

Lake Tahoe TMDL
December 6, 2007, 8:30a.m. – 4:30p.m.

Topic: "What strategy should we implement to reduce pollutant inputs to Lake Tahoe?" Today the TMDL team presents revised scenarios of pollutant control opportunities to meet the Clarity Challenge. Today's objectives include giving an overview of how the TMDL proceeds into 2008 and hosting discussion about how to connect the strategy to actions.

Location: Lake Tahoe Community College, Aspen room

8:30	**Registration and refreshments**
9:00	**Welcome and agenda overview** (Kearns & West)
9:10	**Context for the day's discussions** (Singer)
9:30	**Presentation: Technical feedback on issues raised in October and TMDL adjusted scenarios** (Sokulsky)
10:15	**BREAK**
10:30	**Discussion in small groups: TMDL adjusted scenarios** (K&W)
11:30	**Discussion debrief with large group** (K&W)
12:00	**Lunch**
1:00	**Presentation: Connecting the strategy to actions. How will we implement the Clarity Challenge?** (Singer)
1:30	**Discussion in small groups: Connecting the strategy to actions. How will we implement the Clarity Challenge?** (K&W)
2:15	**BREAK**
2:30	**Discussion debrief with large group and closing remarks** (K&W/Singer)
3:45	**What's next:** • **2008 TMDL activities** (Kemper) • **TRPA Regional Plan update** (Singlaub)
4:00	**Public comment period**

4:30 Adjourn

PATHWAY Forum

Lake Tahoe TMDL
December 6, 2007, 8:30a.m. – 4:30p.m.

10:30-12:00 Discussion in Small Groups: TMDL adjusted scenarios (K&W)

1. From what was presented this morning and over the last few months, what ideas can you embrace? What ideas do you like? Why?

2. Which ideas are hot buttons? Which ideas are most controversial? Why?

3. What conclusions on meeting the Clarity Challenge can you draw from the information presented?

4. The proposed scenario requires financial investment. What are your ideas on funding to meet the Clarity Challenge?

5. It will be necessary to develop innovative practices to achieve the Clarity Challenge, however increases uncertainty in planning. What's the best approach to incorporate innovative practices into the strategy, while continuing to make near-term progress? How should we focus effort and investment on research and development of innovative practices?

PATHWAY Forum

Lake Tahoe TMDL
December 6, 2007, 8:30a.m. – 4:30p.m.

1:30-2:15 Discussion in Small Groups: Connecting the strategy to actions. How will we implement the Clarity Challenge?

1. Given that the focus/priority is urban fine sediment reductions, your feedback in October was to focus on incentives rather than regulation. How do we incentivize actions to reduce fine sediment in urban areas? Based on the coverage information shared today, what are innovative (not regulatory) ways to reduce coverage in the basin?

2. Much of the onus of implementation will fall on municipalities and transportation agencies. What are the best things each of the following can do to support the municipalities and transportation agencies' success?
    - You/Individuals
    - Your constituency

3. What are the pros, cons, and challenges of establishing a basin-wide storm water utility district?

4. There's the saying "what gets funded, gets done". What can individuals/constituencies do to support funding to achieve the clarity challenge?

5. What can individuals/different constituencies do to reduce fine sediment/pollutant loads to help us achieve the lake clarity goal? Consider:
    - Homeowners/Homeowner Associations
    - Real Estate interests
    - Tourists
    - Environmental/conservation interests
    - Recreational interests
    - Business interests
    - Municipalities and government agencies
    - Education/social interests
    - Other?

6. What do you see as the value of innovation in meeting the Clarity Challenge?

7. What are the best education/outreach ideas and/or approaches to build support for reaching the clarity challenge?

Welcome

Tahoe Pathway TMDL

Forum Meeting

December 6, 2007

Meeting Goal and Objective

Today the TMDL team presents technical feedback on the TMDL scenarios based on the Forum's input from October and seeks additional feedback on scenarios and implementation.

The meeting objectives include giving an overview of how the TMDL proceeds into 2008 and hosting discussion about how to connect the strategy to actions.

Agenda Review

8:30	Registration and sign-in
9:00	Welcome and agenda overview
9:10	Context for the day's discussions
9:30	Presentation: Technical feedback on issues raised in October and TMDL scenarios
10:15	Break
10:30	Discussion in small groups: TMDL scenarios
11:30	Discussion debrief in larger group: TMDL scenarios
12:00	Lunch

Agenda Review

1:00	Presentation: Connecting the strategy to actions. How will we implement the Clarity Challenge?
1:30	Discussion in small groups: Connecting the strategy to actions. How will we implement the Clarity Challenge?
2:15	Break
2:30	Discussion debrief with large group and closing remarks from Harold Singer
3:45	What's next: 2008 TMDL activities and Regional Plan update
4:00	Public comment period
4:30	Adjourn

Ground Rules

- Respect all interests and participate in good faith
- Focus on interest-based discussions, not position-based ones
- Listen for understanding and openly discuss issues with others who hold diverse views
- Keep questions/comments brief and to the point
- Please don't repeat a comment or point that someone else has already stated
- Assure that all members are heard and that one person speaks at a time
- Share ideas and concerns with other Forum members, Pathway agencies, and the facilitators

Charting a course to

Clarity

1

Objectives

Discuss: Scenarios to inform a TMDL pollutant reduction strategy

Discuss: How the strategy relates to actions to achieve the Clarity Challenge

Define: next steps for the TMDL in 2008

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

2

What We Heard - Desires

Take an approach that makes sense (Do what works + Be cost effective & efficient)

Emphasize incentives over regulation

Establish a system of accountability

Address transportation system issues

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

3

What We Heard – Desires

Pursue public solutions (recall sewage export line)

Engage individuals in the solution

Pursue water quality solutions that also achieve other ecosystem benefits

Do what you can now while pursuing innovative approaches for the future

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

4

What We Heard – Specific Actions

Road sweeping
- Good but be flexible about when & how

Urban stormwater pump and treat
- Investigate and pilot before making it an emphasis

Transportation
- Look at reduced & alternative road sands
- Vehicle miles traveled is important to consider

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

5

What We Heard – Specific Actions

Private property BMPs
- Good but be realistic in planning & provide flexibility

Residential wood combustion
- Fine for incentives and education, not a focus

What strategy should we implement to reduce pollutant inputs to Lake Tahoe?

6

What We Heard: Questions Addressed

Response to October 25 feedback is two-fold

- Additional information regarding common comments/questions
- Illustrative scenarios revisited

What We Heard: Questions Addressed

What are the "other" benefits of proposed TMDL controls?

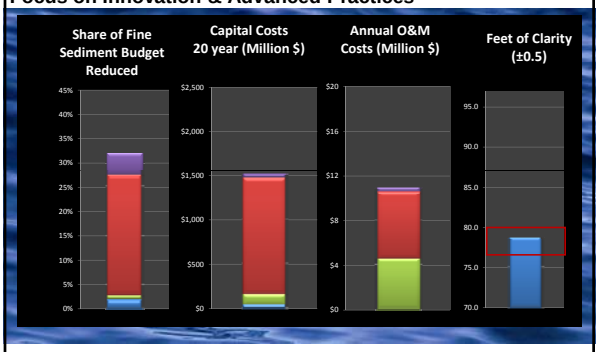
What can we do with a high level of confidence?

How will focusing on transportation and individuals reducing their driving improve clarity?

What are the effects of increasing/decreasing impervious cover?

Do we need to invest in innovation now?

Recall Scenario B:
Focus on Innovation & Advanced Practices



What about Other Ecosystem Benefits?

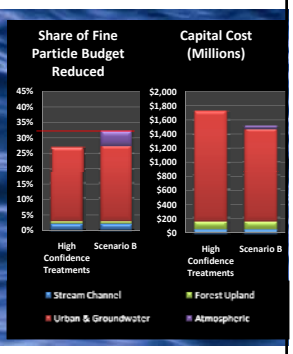
- Many water quality controls have other benefits
- Efforts to improve status of other resources also benefit water quality

Scenario B	Wild/ Fish	Soil	AQ	Veg	Noise	Scenic	Rec
Urban & GW	●	●	●●	●	●		
Atmospheric	●		●●	●	●	●●	
Streams	●●	●●		●●		●●	●
Forest	●●	●●		●●		●	

Can We Focus on High Confidence Controls?

Assumptions
- Combines analytic confidence and feasibility
- Removes atmospheric and pump and treat controls
- Places practical limits on advanced urban controls

Key results
- Does not achieve Clarity Challenge
- More expensive than Scenario B
- Requires additional analysis during master planning effort



What about VMT?

VMT reduction is important for a number of thresholds

Regional Plan includes measures to reduce VMT

VMT reductions do improve water quality

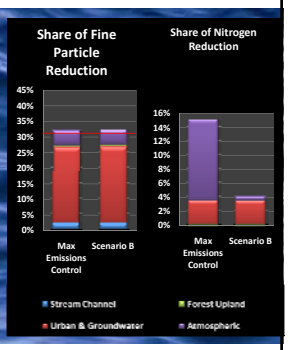
Clarity response does not appear to be driven by nutrient concentration

Additional work is needed to refine atmospheric loading/reduction estimates

What about VMT?

Assumptions
- Scenario B emphasizes roadway dust management
- Add maximum emissions control to Scenario B

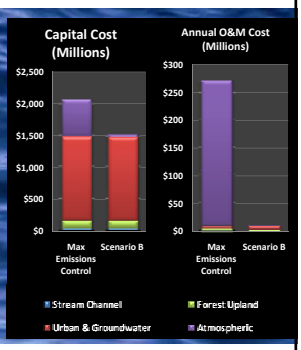
Key results
- Roadway dust management is cost effective
- Vehicle emissions reduce nitrogen, but not fine particles



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 13

What about VMT?

Additional results
- Vehicle emissions reductions can be costly

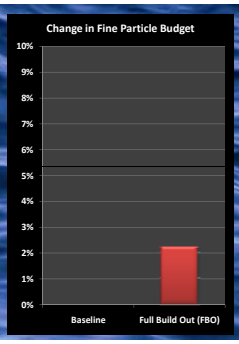


What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 14

What about impervious coverage?

Approx. 2% increase in particle loading at full build out under current rules

Development under current regulations helps control pollutants



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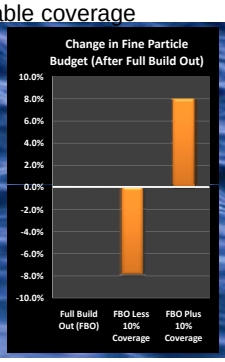
What about impervious coverage?
An increase or decrease in allowable coverage

Changing impervious cover significantly affects fine particle loading

Reducing coverage presents load reduction opportunity



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 16

Charting a course to

Clarity 17

Scenarios Revisited - Feedback

- Move forward now with what we know
- Innovate to increase pollutant reduction per area treated
- Go as far as possible to reaching ultimate goal
- Get other ecosystem benefits as well as water quality when cost effective

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 18

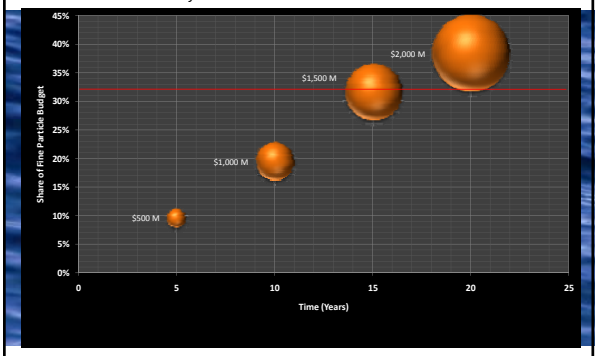
Scenarios Revisited – Assumptions

- **It takes time to innovate and change practices**
  - 5 to 10 years to widely implement new practices
- **Assume a consistent level of effort**
  - Consistent $500 million every 5 years
- **Practical limits on ability to treat**
  - 80% maximum treatment of any type of area
  - 20% current best practices

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 19

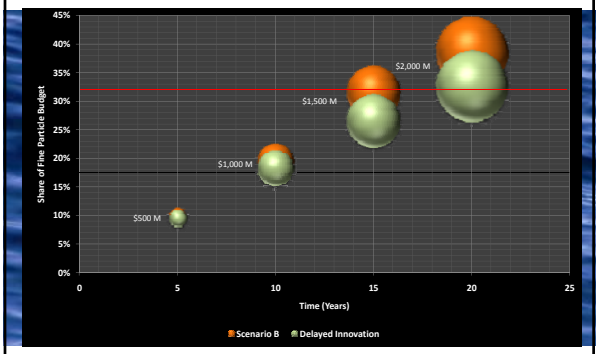
Time Sequence - Move Forward & Innovate

Similar to Scenario B at 15 years



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 20

Comparison to Delayed Innovation by 10-years



What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 21

Considerations

- **Existing practices can achieve significant improvements in first 5-10 years**
- **Need innovative practices to**
  - Achieve Clarity Challenge in 15 years
  - Move beyond the clarity challenge
- **Research & planning can reduce costs**
  - Retrofits can lead to additional cost

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 22

Considerations - Recap

- **High-confidence controls alone will not achieve the clarity challenge**
- **Water quality controls improve other ecosystem services and visa versa**
- **Transportation**
  - Roads/infrastructure maintenance an excellent opportunity
  - Vehicle emissions costly for their clarity impact
- **Impervious coverage does affect lake clarity**
- **Early innovation increases opportunities & effectiveness**

What strategy should we implement to reduce pollutant inputs to Lake Tahoe? 23

Charting a course to

Clarity 24

Connecting the TMDL Strategy to Actions

Stakeholder	$	Actions	Permits & Regulations	TMDL Document	
				Allocations	Strategy
Federal	★	✓	WDRs NPDES	#	
State	★	✓	**NPDES**	#	
Regional (TRPA)	★	✓			
Local Govt	★	✓	**NPDES**	#	
Private	★	✓	Const/NPDES WDRs		

TMDL Implementation Plan

How do all the TMDL pieces fit together?

PATHWAY Forum Meeting Summary

PATHWAY FORUM MEETING
December 6, 2007
Lake Tahoe Community College
South Lake Tahoe, California

MEETING ATTENDEES

Forum Members: Laurel Ames, Blaise Carrig, Carol Chaplin, Pat Davison, Michael Donahoe, Jerome Evans, John Falk, Lew Feldman, Elise Fett, Dave Hamilton, Nancy Harrison, Ellen Lapham, Steve Leman, John McCall, Bruce McNulty, Jennifer Merchant, Rochelle Nason, Barbara Perlman-Whyman, Anga Rebane, Glen Smith, Steve Teshara, Carl Young, Patrick Wright

PATHWAY Executives and TMDL Team: Harold Singer, Lauri Kemper, Bob Larsen, Hannah Schembri (Lahontan); Mike LeFevre, Bob King (USFS); Kathy Sertic (NDEP); John Singlaub, Larry Benoit (TRPA)

Project Team: John Reuter (Tahoe Environmental Research Center); Jeremy Sokulsky, Chad Praul (Environmental Incentives); Michelle Sweeney (Allegro Communications)

Kearns & West Facilitation Team: Anna West, Christine Kennelly, Janet Thomson

WELCOME, INTRODUCTIONS, AGENDA REVIEW

Anna West welcomed the Forum and additional attendees to the third of four TMDL meetings. She provided a brief overview of the day's agenda and groundrules and highlighted the goal of the December meeting: to have the TMDL team present technical feedback based on the questions raised by the Forum in October; and to start a dialogue around implementation of the TMDL.

CONTEXT FOR THE DAY'S DISCUSSIONS

Harold Singer (Lahontan) welcomed everyone to the meeting. So far the TMDL team has been talking about concepts and strategies, but today's meeting will focus on implementation. How will the objectives get accomplished? Very few of the strategies discussed so far will be prescribed; instead, there will be a performance oriented approach. We hope the implementing agencies and the broader community will support implementation of these actions, both from a funding and a social acceptability perspective. In the afternoon we will discuss this in more detail, in addition to the question of what the next steps are for the TMDL after today.

We have learned a lot from your input and feedback so far. I want to keep the dialogue open and remind you that this is not the end of the TMDL strategy discussion. This dynamic process will continue for the next 10-20 years; these discussions are merely setting the stage.

Today we will provide technical feedback on the scenarios in response to your questions from October. We will discuss the strategies in the context of a larger regional plan and the impacts of strategies on other thresholds. We will also look at the confidence levels for individual strategies.

PRESENTATION ON TECHNICAL FEEDBACK ON ISSUES RAISED IN OCTOBER AND TMDL SCENARIOS

Bob Larsen noted that the main questions arising from the October 25th Forum meeting included the following: What are the "other benefits" of the strategies? What can we do with a high level of confidence? How will focusing on transportation and individuals reducing their driving improve clarity? What are the effects of impervious cover? And, do we need to invest in innovation now? For the purpose of the discussion, Bob used "Scenario B" from the October meeting as the base.

The first slide in the presentation shows the extent to which load reduction activities will have additional ecosystem benefits. The red dot indicates that a pump and treat system in urban areas may negatively affect noise. However, most of the strategies we propose will have positive benefits on fish and wildlife, soil, air quality, vegetation, scenic qualities, noise, and recreation. Activities undertaken by agencies with other goals may positively impact water quality. Restoration is not a single issue but is highly interconnected; we expect TMDL goals will have an overall positive benefit on the Basin ecosystem.

Regarding confidence, we have a great deal of data for urban strategies, higher than for atmospheric and pump and treat controls where we do not have as much confidence as we expected. If we were to take a high confidence approach to implementing measures we might want to scale back advanced treatments. That would only provide us with a 32% reduction in fine sediments and we will not necessarily meet the Clarity Challenge. Taking a high confidence approach might actually cost us more. However, remember that these estimates are on a Basin-wide scale; we will be doing a finer level of planning before implementation.

At the last Forum meeting we explained that reducing vehicle miles traveled (VMT) is costly and does not provide significant benefit for Lake clarity. There are other reasons to look at controlling VMTs, and the Regional Plan includes a number of measures to address VMT reduction. Reducing VMT has a large effect on nitrogen loading to the Lake but that does not greatly improve clarity.

We recently performed some model runs to look at impervious cover to determine how future development might affect clarity. We took the available developable parcels and maximized development under current rules (4000 parcels). After running the model we found that the fine sediment budget is increased by 2%. This is a positive result that indicates that our coverage rules and regulations have been very effective at limiting the amount of fine sediment pollutants from urban areas. We performed a second run starting from the full build-out scenario and increased the amount of Basin-wide coverage by 10%. This resulted in a significant increase in fine sediment deposition to the Lake. In conclusion, current coverage regulations are working well; revising them to allow for more development than under current rules would have a significant negative effect on Lake clarity.

Q. The California Air Resources Board (CARB) is voting today on implementation of the emissions plan under AB32. Are we ahead of the curve at looking at emissions or will this be a moving target for us as CARB sets new goals?
A. We are probably a little ahead of the curve, but we will need to continue to work on VMT and addressing dust sources, managing the roadway system as best we can.

Q. Does the coverage estimate here assume 100% BMP?
A. Yes.

Q. Is the assumption that no new roadways are built?
A. Yes.

Comment: This model seems like an overly generally approach and it does not deal with the fact that different areas of coverage have different controls. This approach seems flawed. We need to be talking on a much more specific community level.
Response: We will take that into consideration as we continue planning.

Comment: The folks at Washoe County and NDOT have a lot of thoughts about types of road paving. They are busy doing maintenance and see a lot of problems with the existing process they use. Some of the most advanced pavement surfaces are coming from Africa and not Europe. I will continue to work with Washoe and NDOT on this; it is a huge issue considering the amount of time we spend waiting in traffic for roads to be repaired.

Q. Does the model take into account atmospheric warming? And if not, would that affect the outcome?
A. The models do not take that into account. We have done some analysis: warming will likely affect the results.

Jeremy Sokulsky (Environmental Incentives) noted that the TMDL team heard from the Forum that we should: move forward as soon as possible with strategies that will reduce pollutant load to the Lake; innovate; strive as best we can to meet and exceed the Clarity Challenge; and balance the water quality solutions with overall ecosystem benefits.

It will take some time to innovate and change practices. Aggressive treatment of urban stormwater or effective controls on atmospheric pollutants from roadways will likely take 5-10 years to implement on the ground. We assume that 20% of the area in the Basin will be very difficult to treat, and 20% of the gain that we see in the first 15-year period will be from using current best practices. If we assume an even level of effort around the Basin implementing current best practices with some level of advanced controls (using $500 million of capital costs every five years towards pollutant reduction) we will get to the middle of the Clarity Challenge, about a 32% reduction in fine sediments. This is somewhat analogous to Scenario B presented in October, with a bit of an extra focus on innovation. In contrast, if we do not focus on innovation for the first ten-year period we will not reach the Clarity Challenge.

Q. Does the $500 million every five years include the cost for research and development of innovative practices?
A. No.

Q. To what extent does technological innovation save costs for operations and maintenance?
A. We will hope to get efficiencies of scale, though this analysis does not take that into account.

Jeremy noted that, in conclusion, the high confidence pollution control opportunities alone will not be sufficient. We will need to incorporate some degree of innovation. We have heard from you that we should not just stop at the Clarity Challenge – if we can reach beyond that, we should. It will be up to funders and regulators to see how quickly we can get pollutant load reductions. Early innovation does increase the opportunity and cost-effectiveness of what we have available to us.

DISCUSSION DEBRIEF FROM SMALL GROUP DISCUSSIONS REGARDING TMDL SCENARIOS

Forum members split into small groups to discuss the TMDL scenarios and implementation, then had a broader discussion as a full group. The input that follows is categorized according to the topics raised. *Please note that the input below in italics was raised by non-Forum members.*

Feedback from Forum members on funding:

Concerned about costs in every scenario. Open up the concept of revisiting the compact (it may not be attainable). Need a funding plan *beyond* fixing the lake, local funds cannot do it alone.
Tahoe is not the only place doing all of this and it could mean more competition for funds.
Need a unified state and federal program for federal lobbying (like EIP), a coordinated and unified voice. Agencies need to come together.
Need central database for finding other innovation and funding efforts.
We need to consider projects from the perspective of capital costs instead of O&M costs. If one project has high capital costs it may be the preferred way to go rather than one with a lower capital but high O&M.
There are TMDL strategies that you would not need to fund. With certain code changes we could get incentives and integral funding mechanisms for people to do what they want to do. For example, if TRPA ticketed landowners for not removing snow on their sidewalks, that is a free service to the community. There are many other similar examples.
We could allow extra coverage but require BMP installations with innovations. We could gain a little extra from allowing coverage where people are doing more than BMPs.
Second homeowners in this community benefit quite a bit from services but do not participate in a lot of ways in the community. We might be able to get tax revenue from them.
Consider implications for getting funding if goals are not fully supported.
Funding should be a combination of private incentives and local jurisdictions finding funding, including counties, not just Basin.
Need local funding to get matching state and federal funds.
Higher taxes? Or more regulation.
Regional revenue sources: property tax. Not change, but redistribute increases (Nantucket real estate transfer tax).
Need regional revenue sources to achieve Clarity Challenge.
Funding is huge in those counties – concern on equity to broader community? Pass costs on to visitors.
Include occupancy tax.

Who funds incentives?
TOT probably not the way to go; it is hard politically.
Sales tax increase may be viable, may be problematic; apply to certain things?
Could the timesharing community be a source of funding?
Avoid adding to the burden of people who live here.
Basin user fee is not palatable. [Note provided by TRPA after the meeting: The current TRPA Compact prohibits "a tax or charge that is assessed against people or vehicles as they enter or leave the region."]
Consider the idea of entertainment- or recreation-specific sales tax.
Try not to tax non-polluting activities, or tax all so we can get funding to maintain bike trails, etc.
We should create a financial scenario to determine how we might pay for the TMDL. If we can see the options we can go to our constituents and have them share their opinions on funding ideas.
We should think about ways to get local funding and have local leadership for TMDL issues. We may not continue to get federal funding and we will need the local governments to initiate efforts.
Further distribution of cost in areas that have more load.
Financial/political strategy needs to be dovetailed: local leadership and ownership to entice federal contribution. Pressure for states and feds to step-up.
Need a reason for local implementation and understanding where the money is coming from.
Effectiveness agreement. Funding: how to work together? Have to spend $500 million in 5 years consider, federal budget lag, agency interactions, contractor availability.
Find steady stream of funding: consider regional revenue, per capita difficulty.
Pollution issues from urban and transportation infrastructure -- revenue sources should come from use related fees.
What about review/oversight costs from regulatory agencies, TAC capability?

Feedback from Forum members on innovation:

Regulatory innovation: change what does not work, implement current and new regulations that do work.
If you reduce coverage in one area, be innovative somewhere else. Watershed basis/larger scale. Monitor to make sure it is doing what you want.
New development should focus on innovative practices.
Consider innovations in technology in snow removal.
Need R&D research analysis instead of regulatory people running around.
Need a better mechanism, central clearinghouse, of what innovations are working.
Innovate and do what we know. Year 1- pump and treat R&D ($1 million prize competition).
Turn Tahoe into a national center for research and demonstration for innovation so that developers come here to test their ideas. Adjust the codes and allowances to encourage new ideas to hit the ground. Create a clearinghouse for projects to find out which solutions work. Conduct a competition nationwide for different projects to solve the clarity problem.
Incentivize innovation and consider removing regulations that are keeping us from making progress.
Pump and treat is expensive, but a system that is predictable and we are confident it will work. Maybe too many assume assigned to pump and treat. Pump and treat lacks other ecosystem benefits.
Articulate pump and treat assumptions, does not get at source control.
What is advanced technology?

Feedback from Forum members on incentives:

Where could code change incentivize or de-incentivize certain behaviors? Consider private sector changes (sidewalk/snow removal example).
Take old buildings with high levels of coverage and get innovative with BMPs and incentives. Use the code as leverage. If you want to build, must do x, y, z, etc.
Create incentives for small development, not only large development.
Special projects bypass the code and allow the poor code that de-incentivizes the "little people/businesses" to stay in existence longer.
Incentivize the little guys to get them vested. Once they are involved, it builds.
Incentivize private side to reduce coverage in most impacted areas.
Incentives not regulation, or incentives to *enhance* regulation

Feedback from Forum members on allocation:

How many particles are we being assigned, understand sub-basin contribution. Land use model.
Need to account for what is already on the ground reducing loads (refine watershed model).

Feedback from Forum members on education:

Need educational component for all of these, will cost money also.
Would be good for Lahontan to do traveling education.
Need message to legislature that we can solve the problem. Present with we have on the ground relative to where we need to go.
Message to legislature- greater understanding, certainty of success in achieving goals.
Important to get information out on new technology.
More precise info will generate more public support.
Public perception is that current practices will not help us toward our goal.

Feedback from Forum members on PCOs:

Appreciate efforts to look at other ecosystem benefits. Get the best bang for the buck.
Leafblowers? How to incentivize? Maybe break on maintenance business license to get rid of them.
Hot button issue: 10% impervious coverage reduction- how does it affect recreation? How does it affect tourism/lifestyle?
Transportation investment is key: helps with community, safety. Get transportation experts to help. Street sweepers (good ones), easy. How to pay for? Get broader local funding entity?
VMT is a big element to the Basin.
Sand/brake lining: trucking it in, need to take it out.

Feedback from Forum members on other topics:

Concerns: if you do not mandate prescriptions, leads to litigation?
Are the vehicles having that much of an impact on clarity?
So important to tie clarity improvements to other thresholds.
Take away fear factor (like talking to IRS) of asking questions of regulatory agencies (BMPs, etc).
Sort and prioritize the issues (VMT, wood stoves) -- what do they help, if they are not clarity challenge biggies?
Coverage model should be dumped. Focus on sub-watersheds.

Additional idea: compare cost/benefit of pump and treat with coverage reduction. (Downtown "old buildings" are around $6 million/acre).
Some frustration that we do not have all the answers, but we have to make progress based on what we know.
We talked about expanding water quality benefits to the rest of the thresholds to sell it to the public.
We should consider operations, maintenance, and monitoring costs, not just O&M.
Uncertainty with data and important to appreciate that we looked at this, that it was addressed, but how confidence affects costs- show all scenarios together.
Look at confidence among all scenarios.
Current practice yields improvement
Look at PDP (5 years +)

Rochelle Nason (League to Save Lake Tahoe) requested time to address the Forum. She noted that both she and Mike Bradford agree that we must begin to define a new planning process to positively engage the various parties to reach consensus on our desired plan. Regarding funding, Rochelle feels that the federal government is no longer going to fund Tahoe to the extent seen in the past; instead, the community should spend a year trying to resolve issues, then request funding from the government for the agreed-upon needs. We cannot take the current level of funding for granted.

Steve Leman added that the volunteers on the Forum have not been able to continue participating at the same level recently. If the process does not move forward rapidly and with focus we lose the momentum.

Christine thanked David Jinkens from the City of South Lake Tahoe for sponsoring lunch.

CONNECTING STRATEGY TO ACTIONS: HOW WILL WE IMPLEMENT THE CLARITY CHALLENGE?

Harold Singer (Lahontan) presented a diagram (see page 8) to show the Forum how the TMDL will move from strategy to implementation. The Basin gets funding from federal, state, regional, and local government, and from private entities. Entities do not only fund their own activities which results in a mix of shared funding.

The TMDL Implementation Plan will show how the regulatory requirements to improve Lake clarity will be achieved. The document will help the community and regulators understand how to reach clarity goals, and will also show both the Tahoe community and the funders outside the Basin that our goals are achievable. The Plan will focus on allocations, meaning the extent to which entities need to reduce pollutant loads. For the interim goal we will aim for the Clarity Challenge, a 32% reduction in pollutants over the next 20 years.

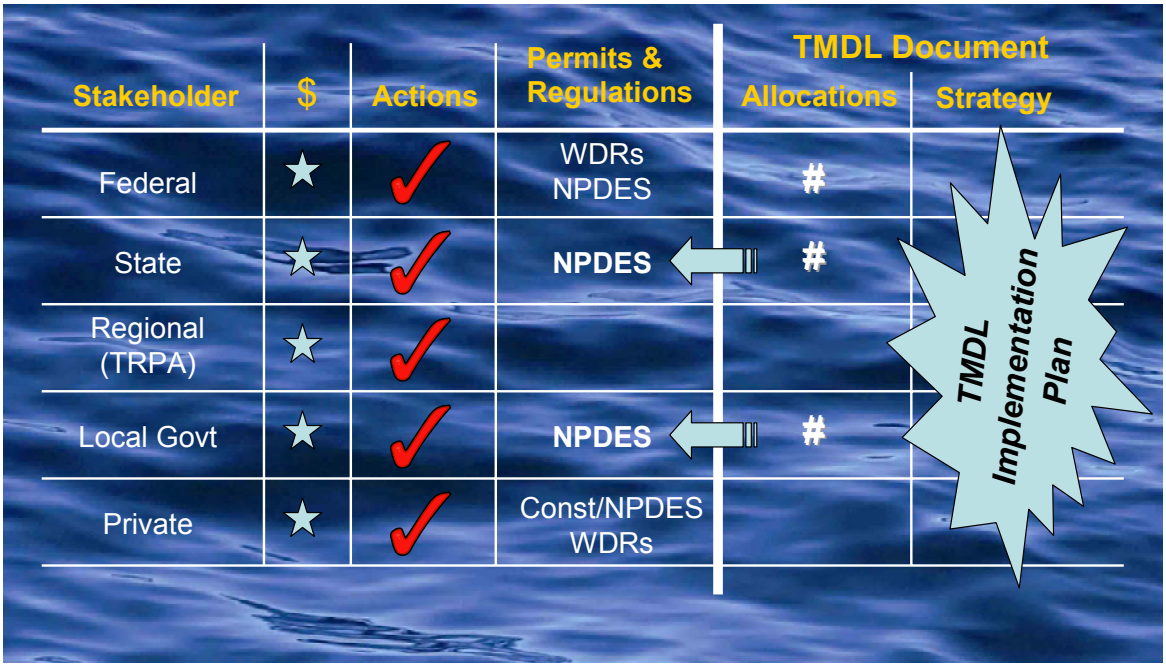
The federal, state, and local governments will receive targets for pollutant load reductions, mainly in the form of NPDES permits. The permits will not be prescriptive in terms of how to reach those targets – that will be up to the individual entity. A pollutant trading system is being investigated as a means to help entities achieve load reductions in whatever manner is most feasible for them. We

anticipate crediting certain types of projects based on expected pollutant reductions for those projects, including appropriate maintenance standards. This system will provide surety for project builders, funders, and regulators. Those who implement projects will know they get credits; those who fund projects will see that they are achieving specific load reductions for those projects; and regulators will see that we are improving Lake clarity through the reduction of pollutant inputs to the Lake. The pollutant trading system will be established in a way that allows it to be consistent around the Lake for trading purposes.

We will include interim milestones in our permits to ensure that we are steadily working to achieve the load reductions. NPDES permits are issued in California and Nevada under delegation from the U.S. Environmental Protection Agency (EPA), so we are implementing federal law in our states. Local government is responsible for all of the stormwater runoff within its jurisdictional boundaries regardless of whether the runoff comes from public or private lands. With some exceptions, federal lands are generally excluded. Actions on private property will be credited towards local government pollutant reductions. Therefore these permits provide incentives for jurisdictions to require certain actions on private properties so that reductions can be achieved.

Lahontan Regional Water Quality Control Board only has jurisdiction over waste discharge. We will need to rely on other entities to achieve pollutant reduction results. For example, Lahontan cannot force Caltrans to undertake stream channel erosion projects. However, we can indicate that we need a 2-3% reduction of pollutants from stream channel erosion and we will need help from other entities to reach that goal.

Connecting the TMDL Strategy to Actions



How do all the TMDL pieces fit together?

1

Q. How do you link the slide this morning that showed we need to invest $500 million every five years to reach the Clarity Challenge, and the TMDL Implementation Plan that does not require any entity to perform any specific action?
A. We are telling entities to take actions to achieve load reductions and we will give credits for specific projects. Entities will have to prove that the actions they take will achieve load reduction. The information we presented this morning indicates that it will likely take approximately $500 million every five years to achieve the Clarity Challenge.

Q. When will we see the list of pollutant reduction actions and their associated fine sediment credits?
A. We have the list of pollutant control opportunities that will add up to the overall load reduction but the crediting system will not be ready until spring or summer 2008. When we develop that system we will be discussing it with the implementing partners so that we can come up with a system that is agreeable to everyone.
Q. We are coming up with a tool to quantify the reductions that will result from projects?
A. Yes.

Q. How do you allocate loads across federal, state, and local entities?
A. We have not yet made a commitment about how we will split the allocations. We hope to make a decision on this, with the help of the implementing agencies, in the early spring.

Q. How will you ensure, when you assign allocations, that you are not telling entities to reduce more pollutant load than what exists in their jurisdictions? Will monitoring be done to indicate what the current pollution level is and what reductions are achieved after project implementation? Will there be a way to fact check the models?
A. Yes, but not on every single project – that is just not feasible. We have to develop mechanisms that give us good feedback about those questions but not on a project by project basis -- perhaps on a project-type or watershed-type basis.

Q. How will innovative projects that do not already have a track record be credited? Will there be a built-in timeline with monitoring to promote innovative ideas?
A. We will have to design the crediting system in a way that promotes innovation in order to get these new projects on the ground. We will probably need multiple entities to work together to get some of the innovative practices running. We will make sure that everyone learns about the positives and negatives of pilot projects so we can see how the innovative technology works and understand the potential outcomes.

Q. If an entity does a project (particularly an innovative project) that does not wind up achieving the anticipated pollutant load reduction, does that entity assume all the risk? If we are trying to promote innovation then we should think about risk management and ensure that no one party assumes all the risk.
A. I do not have a good answer for that yet, but it will have to be part of the crediting system. Perhaps it will be dealt with in the timing of crediting. We do not want to give credit for something that does not achieve pollutant reduction, yet we do not want to discourage innovation. This will be a great challenge.

Q. If the pollutant load allocations only achieve, say, 17% reduction rather than the 32% reduction, who is responsible for regulating the rest? Is it in the hands of the private sector, or is it the local government's responsibility?
A. Not all the load reduction has to be regulated. We will work with implementing agencies to encourage them to meet the goals. We hope that this group will also encourage implementing agencies to achieve the load reductions.

Q. What do you do if other agencies' regulations are inconsistent with yours?
A. We will be encouraging projects that achieve pollutant load reductions. For example, if TRPA's plan envisions 300 acres of streamzone restoration, we will assign a 3% load reduction to that and track it over time. Our approach will not be prescriptive and it will likely be conservation focused.

Q. How do you achieve load reductions appropriately across states?
A. This is not just for the state of California but Nevada as well. Tom Porta and Leo Drozdoff at NDEP buy in to this concept as well and feel that they can implement the same types of load reductions in Nevada.

Q. How will allocations be designed – by drainage, or political subdivision, or another metric? And if you divide allocations into small levels, how will you measure and monitor for each?
A. The allocations will be split between California and Nevada and then each state will determine how to allocate within its boundaries. We do not have all the answers yet. But I can tell you that we will never get there if we try to measure/monitor the load for each individual jurisdiction before assigning allocations. We do have very detailed information about land use by jurisdiction and we can use that information with the model to predict the load for each jurisdiction.

Q. Will entities be competing for capital to accomplish load reduction goals? Do you have a business model through which we can understand this?
A. The EIP is a good model for us. It has operated as a first-come first-served plan but we may need to build into that program how much load reduction projects are expected to achieve. Then those projects with high load reductions will achieve priority. We are hoping not to make this competitive but instead look at it as a package. We are working together to get dollars into the Basin to complete this work. The whole idea is to achieve the bottom line and encourage the best projects to go forward.

Q. Can we get retroactive crediting for reductions achieved under the EIP?
A. The pollutant loads that we are estimating are from the 2003 timeframe (when our computer models were ground-truthed with the stormwater monitoring data). Therefore we will account for projects in the ground retroactively to that time. We are also trying to figure out ways to give credit to entities for their efforts over the last 15 years before the baseline was established in 2003. We will be discussing that with our implementing agencies.

Forum comments on funding, incentives, education, and implementation:

CATEGORY	COMMENT
Funding	Implementing a Basin-wide stormwater utility district would be difficult because California and Nevada have very different sets of laws relating to implementing such a structure. If we were to do it, the best way would be to use existing entities such as the PUDs and create this Basin-wide structure through MOUs. Such a Basin-wide district might be a very valuable way to make and spend money.
Funding	Nevada Tahoe Conservation District launched a study of a stormwater utility district, using contributions from neighborhoods and GIDs to design a project. We have moved into a second feasibility phase. There may be an opportunity for this to work, opening the door to future major projects such as pump and treat, expanded infiltration basins, or other projects. We have been working with all of the GIDs and homeowner associations on the Nevada side, particularly on the southeast shore.
Funding	By installing our own EIPs we have mostly created our own local stormwater utilities. There is not an obvious benefit to a Basin-wide stormwater utility district other than maintenance.
Funding	There may not be another way to take care of maintenance in the long term, so if we do not explore the option of a Basin-wide stormwater utility district we may be ignoring a major way forward.
Funding	There may be a way to engage part-time residents who live in condos and timeshares to contribute to pollutant reductions either initially on purchase or annually in terms of a real estate exchange tax.
Funding	We need to be careful about separating full-time residents from second homeowners; on a philosophical level it is disturbing to separate different classes of property owners for different treatment. Second homeowners have both positive and negative effects on the Basin that we need to take into consideration.
Funding	We should consider aesthetics more carefully. If BMPs are attractive, people will be drawn to the area, business will thrive, and people will want to stop their cars when they drive through. Once you get a toehold this activity funds itself.
Incentives	It would help to move industrial uses into a smaller area off the scenic corridor. We could use permeable paving stones rather than asphalt if the government would provide a rebate from excess coverage mitigation to mitigate for the increased expense of paving stones.
Incentives	Saving people time might be a significant incentive, so creating a faster process for permitting projects in exchange for pollutant load reduction improvements might be successful.
Incentives	If there were an incentive for a private business to perform operations and maintenance, similar to a stormwater utility district, with economies of scale and without the government oversight and taxes, it might be easier to get these functions done.
Education	We should encourage education by leading by example.
Education	We need to remember that education and behavioral change will take time. Perhaps in ten years no one will consider *not* doing BMPs.

Education	People are really looking for a sense of community here. I am working on a transportation project that seeks to improve walking, cycling, and public transit on the north shore. Even just the process of working towards our goal is helping to bring everyone together and create that sense of community.
Implementation	We need to ensure that entities feel that the model is fair as applied to them, that they understand how and why the pie was cut the way it was.
Other	A study in Aspen showed that a single vacation home produces 43.8 tons of carbon dioxide annually, whereas a single family home living there full-year-round produced only 32.4 tons. We should consider ways to encourage Tahoe homeowners to decrease their carbon footprint.

CLOSING REMARKS FROM HAROLD SINGER

Harold Singer reiterated that the TMDL Implementation Plan will not be prescriptive. We will need the full support of both the community and the implementers for this to succeed. Harold encouraged everyone to continue to speak with the TMDL team and ask questions when they arise. This is an adaptive management process, so we hope that you will continue to ask questions and help us to prioritize our actions. We need to make sure there is funding for ongoing research so that we can design the innovative programs that will allow us to reach our clarity goal.

WHAT'S NEXT: 2008 TMDL ACTIVITIES AND TRPA REGIONAL PLAN UPDATE

Lauri Kemper (Lahontan) noted that the next Forum meeting will be on April 3rd (on the north shore) rather than February 7th so that the TMDL team will have sufficient time to prepare for a substantive meeting. Prior to that meeting the TMDL team will continue working with the implementing agencies to get input on strategies, crediting, and tracking. Lahontan will also be working with the Forest Service regarding their retrofit and rehabilitation activities.

In April the TMDL team will provide a preview of the Implementation Plan; that plan will then go to peer review and be finalized sometime in late summer 2008. We will share additional information on the allocation process, the crediting and tracking system, and how we plan to distribute load allocations. The April meeting will be primarily informational and will serve as an opportunity to provide closure on the process for the Forum. We will take some final comments and questions at that time to refine the document for public review. We may also seek your advice on the best way to roll out the plan. April will be the last chance to meet with Kearns & West as facilitators since our contract with them expires after that meeting.

In terms of future timing, the allocations will go into permits. We do not anticipate imposing interim targets and load reductions until the TMDL is adopted and approved both by the State Board and the U.S. EPA, so these will not be embodied in permits until 2009-2010. We will have separate public hearings on permits when they are going to be adopted and we will have an open process throughout. Our MOU with the Forest Service expires this summer so we will have an opportunity to update that document in terms of load reductions even if we have not made any final decisions on load allocations.

John Singlaub (TRPA) noted that TRPA is in the beginning of the Regional Plan EIS process. The TMDL approaches and scenarios presented to the Forum have been incorporated into the EIS alternatives, including private property BMPs, coverage, and a focus on fine sediment. Current water quality improvement programs are also included. The alternatives are different combinations of incentives, regulations, and capital improvement efforts. Since the TMDL will be completed after the Regional Plan is complete, if any future code or plan changes are needed we can do a follow-on update to the plan in 2009-2010. We still intend to have a completed Regional Plan in October 2008 so that the allocations will be ready for January 2009. As we have previously discussed, the scope for the Regional Plan has been reduced to Type 1 indicators. There is a big focus on land uses components, trying to shape the kinds of communities we have agreed upon through the planning process and provide both environmental and urban design incentives to get there. As far as the Forum, we will meet in April and we will meet with the Forum Planning Committee on the structure of future involvement for the Forum. Funding is crucial for us, and we will take that into consideration as we move forward.

ACTION ITEM:
Kearns & West will distribute information from TRPA regarding how the TMDL interfaces with the Regional Plan separately from the meeting summary to make sure that all Forum members see the information and are informed.

Anna West thanked the Forum for attending and participating in the meeting and thanked the TMDL team for presenting the information shared at the last three Forum meetings.

Next meeting:
The next Forum meeting will be held on Thursday, April 3, 2008, on the North Shore.

To review Forum materials, including presentations from this meeting, please go to:
http://www.PATHWAY2007.org/

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Implementer Workshop Summary

Implementer Workshop
January 29, 2008
Lake Tahoe Community College
South Lake Tahoe, California

MEETING ATTENDEES

Meeting Attendees: Goloka Sahoo, Mitch Mysliwiec, Kris Klein, Audrey McCombs, Dale Payne, Tobi Tyler, Steve Kooyman, Kim Gorman, Susie Kocher, Liz Harrison, Charlie Donahue, Dave Roberts, Penny Stewart, Scott Cecchi, Ron Roman, Jack Landy, Doug Martin, John McCall, Venessa Gallo, Paul Frost, John Johnson, Kansas McGahan

TMDL Team: Harold Singer, Lauri Kemper, Doug Smith, Bob Larsen, Hannah Schembri (Lahontan); Tom Porta, Jason Kuchnichi (NDEP); John Reuter, Geoff Schladow (UC Davis, TERC); Larry Benoit (TRPA)

Facilitation Team: Jeremy Sokulsky (Environmental Incentives)

CONTEXT FOR THE DAY'S DISCUSSIONS

The objective for this meeting was to present on the background science that is incorporated in the Lake Tahoe TMDL. Presentations have been created to answer questions that have been received prior to the meeting, in an attempt to resolve outstanding issues and questions from the implementing community. The goal for today's meeting is to answer questions related to the background science of the Lake Tahoe TMDL.

AGENDA

9:30 AM – Welcome, Introductions, and Agenda Review

9:40 AM – Context – What is the TMDL process and where we are in the process?

10.00 AM – Baseline Loading Estimates Presentation with Q & A

11:00 AM – Clarity Model Overview and Findings Presentation with Q & A

11:30 AM – Load Reduction Estimates Presentation with Q & A

12:30 – 1:30 LUNCH (ON YOUR OWN – LTCC CAFETERIA WILL BE OPEN)

1:30 PM – Continued Question & Answer Period

2:30 PM – TMDL Implementation and Allocation Components with Q&A

2:45 PM – Allocation Approach with Q&A

3:30 PM – Break

3:45 PM – TMDL Crediting, Tracking, and Verification

4:15 PM – Overarching Questions and Answers and Next Steps

4:30 PM – Adjourn

QUESTIONS

The following are questions that were generated and answered during the meeting.

Question: (Robert Erlich**)** How will the California NPDES Permit be updated, will you change the date, or the numeric effluent standards?

Question: (Steve Kooyman) Where are we at in the adoption process, do we already have a CEQA document submitted?

Question: (Doug Martin) Does Nevada have a TMDL adoption process?

Question: (Susie Kocher) What is the TMDL Program about and is the Lake Tahoe TMDL unique or similar to other TMDLs in the nation? Are there other TMDLs being developed for clarity?

Question: (Steve Kooyman) In creating the streamflow particle number multiplier – were urban impacts affecting the streamflow data?

Question: (Mitch Mysliwiec) How were the particle number converters used in the urban source analysis?

Question: (Robert Erlich) Since ¾ of the fine sediment load is generated in the urban uplands, and with this data having a moderate confidence rating, are you focusing additional monitoring and research here? What monitoring is recommended since monitoring resources are tough to come by? Will the same protocols be used from the TMDL Stormwater Study to compare seasonal variation from year to year and land-use differences (roads vs. single family residential)?

Question: (Kim Gorman) The TMDL stormwater monitoring program protocols may be refined for consistency with storms. Similar approach to NDOT – load based sample throughout the hydrograph. The Basin needs to shift it's understanding of monitoring to not only see how the BMPs are doing, but also gather data to refine EMCs as part of adaptive management.

Question: (Steve Kooyman) We (El Dorado County) are on board with RSWMP and think it needs to move forward. What percent of the load is natural and what is anthropogenic? I need to know how much is controllable.

Question: (Steve Kooyman) Based on the hydrology, large events can have a magnitude far greater than urban predictions (modeling tools) given certain frequencies of storms. If the loading

estimates are based on background conditions (permit effluent concentration limit), large events in the non-urban watersheds can theoretically exceed the permit loading standard.

Question: (Jack Jacobs) What have we done to better understand the electrical charge, fate, and source of these particles?

Question: (Jack Jacobs) As the particles enter the Lake, do they accumulate or settle? How does their electrical charge change?

Question: (Jack Jacobs) Are we at a particular point of "maturation" and how would the particles stabilize? Have we studied this? Is there some balance or change from 20 years out from now?

Question: (Susie Kocher) What percent comes from undisturbed watersheds? Wally Miller's study on fire showed large nitrogen flux.

Question: (Susie Kocher) How much additional Nitrogen and Phosphorus are we getting?

Question: (Mitch Mysliwiec) How were the land-use particle loads assigned?

Question: (John Johnson) The particle size distribution we saw in streams and highways, the numbers explode as you look at the smaller sizes, what is the smallest significant size?

Question: (Kim Gorman) Historically, did the particle charges change as they moved through estuaries that are now gone, and how has that changed? We don't have many backshore natural areas left. If we restore the mouths of streams, maybe the particle charges change as they move forward, any investigations?

Question: (Steve Kooyman) Is the slope of the secchi trend line from 2004 through 2020 different than the historical trend?

Question: (John McCall) I count 16 of 20 points below the trend line, is that a good regression fit? Isn't the standard deviation from averaging 10 years have more to do with precipitation than it is dependant on pollutant reduction?

Question: (Steve Kooyman) Being an implementer, what percent or magnitude of our BMPs would affect a secchi change if you compare a dry vs. wet year? Projects are designed for a 20 year 1 hour storm with an associated load, when we see big storms, the infrastructure is not able to capture the loads.

Question: (Jack Jacobs) Can the LCM (Lake Clarity Model) show the effects of urbanization on secchi depth?

Question: (Penny Stewart) We experienced a drought in the early 90's that continued for years, the secchi depth didn't seem to get better during this period.

Question: (Audrey McCombs) Can you adjust the Clarity Model based on climate change? How will it affect the hydrology and streamflow?

Question: (John Johnson) Are all particles less than 20 micrometers affecting the Lake the same?

Question: (John Johnson) Is the 55 percent reduction on less than 20 micron particles? Yes, but the reality is that the BMPs will remove less of the .5 – 10 micron particles than the larger sizes.

Question: (John McCall) There are questions about the model validity, assumptions, there are questions about the trend and what is causing it; we put BMPs in place in the 1980's and yet most of it was focused on large particles. If we spent 1 billion dollars in EIP funds for sediment of not interest, what confidence do we have in spending another 1.5 billion dollars to get the reductions? Can the Clarity Model predict what we saw in 2006 and 2007? If so, we could really validate the model.

Question: (Jack Jacobs) There's a range of things that implementers have done, but no consistency, yet we've modeled the outcome. Can the Lake Clarity Model show a baseline condition of consistent BMPs across the watershed?

Question: (Vanessa Gallo) Wanted to know about the "genetics" slide - just a clarification.

Question: (Steve Kooyman) We have a lot of TSS data, now we are doing particle size distributions. Is there a way to use our older TSS data?

Question: (Elizabeth Harrison) For runoff samples, do we know the size speciation of the particle size distribution and what amount of phosphorus is attached to the particles?

Question: (Jack Jacobs) To what extent did we have data to base the effectiveness on? Why do we have sediment traps knowing what we know about particle size distributions?

Question: (Jack Jacobs) What is the life cycle of the project implementation?

Question: (Robert Erlich) Is the $45 million capital cost include buying equipment and staff time? Also .4 million in operations and maintenance looks low, since the City of South Lake Tahoe spent approx $400,000 for sweepers for one year including equipment and maintenance.

Question: (Robert Erlich) How do treatment technologies compare for development vs. redevelopment, will the BMP requirements be increased in certain areas?

Question: (Elizabeth Harrison) Were the tiers broken up by land-use?

Question: (Jack Landy) What are the next steps since the Forum and others, is there general consensus? Where are we at now from past work?

Question: (Charlie Donahue) What exactly does innovation mean, what exactly should we do?

Question: (Jack Jacobs) In the 1970's we learned we had to export wastewater from the Basin. If we remove a ton of particles, can we put it back into the Lake? There would be significant operations and maintenance to haul them out of the Basin.

Question: (Robert Erlich) Is the $100 million even feasible or possible to construct this all every year?

Question: (Jack Jacobs) When we are looking at spending this much money, we should acknowledge other benefits.

The following questions were written down and submitted during the meeting for future followup under three major categories:

BASELINE AND CLARITY

Date	Person	Question	Response
Jan 29, 2008	Jack Jacobs	SOIL PARTICLES – Are they electrically charged and has that charge been measured?	
Jan 29, 2008	Jack Jacobs	Does this charge change over time in the Lake?	
Jan 29, 2008	Jack Jacobs	Are the particles accumulating?	
Jan 29, 2008	Jack Jacobs	Discuss data collection and influence of BMP's and local stormwater infrastructure of loading measurements in urban areas?	
Jan 29, 2008	Jack Jacobs	FINE PARTICLES < 20mm as a pollutant – • Discuss the characteristics of these particles • Discuss the fate and transport as they enter the lake • Any expected change over next 50 years in the source of particles	
Jan 29, 2008	Unknown	Many Assumptions - have errors been established?	
Jan 29, 2008	Unknown	Have sensitivity analysis for assumed parameters been completed?	
Jan 29, 2008	Robert Erlich	Are other oligotrophic lakes also experiencing declines in clarity?	

Jan 29, 2008	Robert Erlich	Any differences between lakes that are undeveloped and lakes with development?	
Jan 29, 2008	Charlie Donahue	Critical to highlight/integrate the confidence and uncertainty tables from John R's discussion H, M, L for <20 microns, N, P, as part of baseline load.	
Jan 29, 2008	Jack Jacobs	Implementers desire to identify a baseline condition for each geographical area to control pollutants from urbanization thru BMP's – Yet we have no baseline – What can be determined from modeling to show a baseline condition to allow us to normalize our efforts for credits vs. importance?	
Jan 29, 2008	Robert Erlich	When does fine particle load from urban areas reach the lake? – Understand there are data from G stations and Caltrans 2000-2003 and iceslicer data (2004-5?) Any sensitive analysis possible for fire particles load vs 1)Q 2) Season 3) Rain Intensity 4) Recent application of abrasives	
Jan 29, 2008	Robert Erlich	Since particles <0.5mm may aggregate and begin to affect clarity isn't it important to account for mass of fine particles <0.5mm even if it isn't useful to identify the numbers of particles <0.5mm?	
Jan 29, 2008	John Johnston	Consider doing some model runs with reduce loads, but using PSDs that might come out of BMPs. Maybe 100% removal >20mm	

		75% removal 10-20 50% removal <10 As opposed to x% across all sizes.	
Jan 29, 2008	Mitch Mysliwiec	Stormwater Monitoring – Were auto samplers in the storm drains or creeks?	
Jan 29, 2008	Mitch Mysliwiec	Were samples collected downstream of some form of treatment that could affect PSD's?	
Jan 29, 2008	Mitch Mysliwiec	SMC's – Were the stormwater monitoring sites exactly the same as PSD sites?	
Jan 29, 2008	Mitch Mysliwiec	Clarity model requires 7 bins of particles – Are they calculated with watershed model flow rate used in a 7 regressions?	
Jan 29, 2008	Mitch Mysliwiec	Are the regressions developed by "averaging" results from several streams?	
Jan 29, 2008	Mitch Mysliwiec	Is the TSS calculated by the watershed model multiplied by a PSI to generate inputs to clarity models?	
Jan 29, 2008	Mitch Mysliwiec	In apportioning the fine loads from different land uses, are the watershed model TSS multiplied by an assumed PSD? Are these numbers used in the clarity model?	
Jan 29, 2008	Mitch Mysliwiec	Have change in annual "development" been compared to change in clarity? If nothing was done what would the clarity be 20yrs, 50yrs, 100yrs from now?	
Jan 29, 2008	Jack Jacobs	Historical conditions show dryer conditions result in improved clarity. What can you show in this graphic to indicate loading change from both urbanized and installation of BMP's?	

POLLUTANT REDUCTION ESTIMATES

Date	Person	Question	Response

Jan 29, 2008	John McCall	Model based on 2005 and previous – What does it predict for 2006 and 2007 – Based on actual precipitation?	
Jan 29, 2008	Jack Jacobs	TMDL changes due to climate change – Is the study complete? (Bob TMDL team)	
Jan 29, 2008	Unknown	Do the Nine Sites used to develop the clarity model adequately characterize the Nevada side of the lake since the Nevada side is less urbanized?	
Jan 29, 2008	Unknown	It was mentioned that the EIP did not contain a scientifically based quantification effort – 5 years ago – Is the TMDL team planning on doing a modeling exercise that puts past and future EIP projects in context with regards to improving clarity?	

ALLOCATIONS AND IMPLEMENTATION

Date	Person	Question	Response
Jan 29, 2008	Unknown	How can you amend compliance dates in California permits in advance of TMDL adoption? **Doug Smith, Slide #1**	
Jan 29, 2008	Vanessa Gallo, NDOT	Does the model assume all areas within the basin are hydrologically connected or are losses considered?	
Jan 29,	Vanessa	(Proximity to lake/sump	

2008	Gallo, NDOT	conditions) Will this be considered when allocating load reduction requirements?	
Jan 29, 2008	Vanessa Gallo, NDOT	How will the allocations ensure the most "bang for the buck?"	
Jan 29, 2008	Unknown	What is NDEP's schedule for TMDL adoption and compliance? **Doug Smith, Slide #10**	
Jan 29, 2008	Dale Payne	Are natural ecosystem variations factored into implementation procedures?	
Jan 29, 2008	Dale Payne	Adaptive implementation was briefly mentioned – What will this be comprised of, and how will it be implemented?	
Jan 29, 2008	Dale Payne	How can these be certainly regarding implementation procedures and impounding the clarity of Lake Tahoe?	

Implementer Workshop Summary

Implementer Workshop
February 29, 2008
Lake Tahoe Community College
South Lake Tahoe, California

MEETING ATTENDEES

Meeting Attendees: Mitch Mysliwiec, Liz Harrison, Audrey McCombs, Joyce Brenner, Gerry Willmett, Scott Cecchi, Jack Landy, Paul Frost, Vanessa Gallo, Matt Nussbaumer, Robert Erlich, Penny Stewart, Ron Roman, Doug Martin, Bob Costa, Bill Schnell, Kimble Corbridge, John McCall, Bob Slater, Kansas McGahan, John Johnson

TMDL Team: Harold Singer, Lauri Kemper, Doug Smith, Bob Larsen, Hannah Schembri (Lahontan); Jason Kuchnichi (NDEP); Larry Benoit (TRPA); Jeremy Sokulsky (Environmental Incentives)

CONTEXT FOR THE DAY'S DISCUSSIONS

The objective for this meeting was to present information on TMDL implementation and load allocation components. The TMDL Team presented the proposed allocation approach for the Recommended Strategy with an interactive discussion to show some of the tools and information being used. The TMDL Team introduced future crediting, tracking and validation for implementation projects.

AGENDA

9:00 – 9:15 AM – Welcome and overview

9:15 – 9:45 AM – TMDL Implementation and Allocation Components with Q&A

10:45 – 11:15 AM – Allocation Approach with Interactive Discussion and Q&A

11:15 AM – 12:00 PM – TMDL Crediting, Tracking, and Verification

12:00 PM – Adjourn

QUESTIONS

The following are questions that were generated and answered during the meeting.

Question: (Charlie Donahue) How do you account for the natural or background loads?

Question: (Robert Erlich) Are projects defined to include programs? Funding needs are for projects and programs.

Question: (Kansas McGahan) Will the load allocations be put into our NPDES permits?

Question: (Bob Costa) Do we have a breakdown of the urban landuses?

Question: (Robert Erlich) Would the pie charts for Phosphorus and Nitrogen split out differently?

Question: (Kansas McGahan) Do you have our load allocation number?

Question: (Robert Erlich) Do you have the landuse breakdown within each of the jurisdictional boundaries? Can you distinguish between other landuses that flow into the urban areas?

Question: (John Johnson) Of the 23% of Caltrans' load, what percent is in the urban upland area in the south shore?

Question: (Mitch Mysliwiec) Is the forest landuse load from El Dorado County what shows up in green?

Question: (Joyce Brenner) Will this presentation be available to us online?

Question: (Bob Slater) Are the residential landuses in different forms, such as Christmas valley with much more natural land surrounding the residences as compared to other urban areas? Is the runoff potential based on imperviousness?

Question: (Bob Slater) In the contribution formula, was the imperviousness was looked at on a subwatershed scale?

Question: (Scott Cecchi) Each of the California jurisdictions have applied for California Tahoe Conservancy funding for assistance for the pollutant load reduction strategy, was the IKONOS fine resolution enough for this use? Do we want the jurisdictions to do this with this funding?

Question: (John Johnson) Will there be a reduction in the load allocation for the BMP's that have been installed since 2004, or will credit be given?

Question: (Scott Cecchi) Was the connectivity of the impervious cover looked at?

Question: (Bob Slater) Need to tie the discharge to coverage to support a Prop 218 stormwater utility (possible stormwater fee based on impervious surface area).

Question: (Robert Erlich) Are the primary and secondary road landuses the ones that have load associated with traction abrasives.

Question: (Venessa Gallo) What percent is coverage in NDOT's primary road land use? Is the load different for both states for primary roads since each state does things differently?

Question: (NDOT) When was the IKONOS done?

Question: (Liz Harrison) How do you separate the landuses from the roadway?

Question: (Charlie Donahue) How was the confidence and uncertainty related to urban stormwater since the data is from only a 2 year study? Has there been any calibration/validation on the EMC's?

Question: (Doug Martin) I tried to get Alan Heyvaert's stormwater report, and was not able to find it. As we get info from monitoring, what will that info do to the basin-wide allocations for everyone?

Question: (Bob Slater) Will this be a 5 year interval for the 4 timelines to meet the Clarity Challenge with adaptive management? Not sure how the percent reductions were calculated for the Recommended Strategy? Why does the Forest source category only have a 1% reduction?

Question: (John McCall) Does the expected percent reductions by source include cost-effectiveness (ie. More bang for the buck)?

Question: (Bill Schnell) Have you ran the clarity model to see how the Clarity Challenge will be achieved?

Question: (Robert Erlich) The Clarity Challenge isn't the final standard that needs to be achieved for this TMDL, correct? Although the numbers aren't perfect, we need to focus our attention to think about what we can do now to reduce the fine sediment loads.

Question: (Kimball Corbridge) How much money has been spent to date on the TMDL?

Question: (Bob Slater) The load reductions in the Recommended Strategy seem to not be fair, and disproportionate per source contribution.

Question: (Robert Erlich) If you are looking at recommending a 12% reduction on forest sources and a 34% reduction from the urban sources, the reductions seen in the forest may help with the urban loads.

Question: (Phillip Brozek) Can't the forest reductions be used for the urban, isn't this trading?

Question: (Bob Slater) If we are contemplating a new technology that has not been given a credit, what is the plan to develop the "new" type of credit? How will you deal with the well defined pollutant control vs. the new innovative pollutant control? We need for the policy to support innovation.

Question: (Joyce Brenner) Will there be some type of requirement for how adaptive management will be incorporated – will there be certain language or specification on an annual basis or in the permits? If you have an innovative technique idea and don't know if it will work, will you get credit for doing it, but if it doesn't work, will you then get penalized?

Question: (Bob Slater) Concerned that policy level decisions are being made at the project level.

Question: (Robert Erlich) Like to see incentives to get more efficient use of the money spent on projects by co-mingling flows between Caltrans and the City of SLT's stormwater (geographic

flexibility). Wants to be sure that this cost sharing is not just for the capitol (construction costs) but also for the operations and maintenance too.

Question: (Phillip Brozek) Is the credit for a reduction in particles? Are there any incentives for trying new ideas that will ensure protection from enforcement in permits? There needs to be a connection between the credit, the water quality, and the incentives.

Question: (Scott Cecchi) Where do you draw the line from past activities to get credit?

Question: (Bob Slater) Would you say that activities have been equally or disproportionately implemented among the jurisdictions Basin-wide?

Question: (Doug Martin) Will Lahontan consider giving credits if a California jurisdiction wants to do projects in Nevada?

Question: (Robert Erlich) Leap of faith for monitoring to get a pollutant mass reduced for the jurisdictions.

Question: (Bob Slater) Is it safe to assume the same accomplishment for water quality will be used in the EIP. Doesn’t want to see 2 different systems, they should be identical.

Appendix C: Supporting Tables and Figures

Tables Supporting Chapter 2 & 3

Application Levels for Recommended Strategy Milestone Analysis
Application Levels for Delayed Innovation Analysis
SCG Baseline to Pollutant Budget Scaling Factors

Tables and Figures Supporting Chapter 4

Land Use Composition for All Jurisdictions
Fine Sediment Load by Land Use Category for All Jurisdictions
Relative Land Area by Land Use Category for All Jurisdictions
Approach I: Allowable Load and Percent Reduction for Fine Sediment Particles
Approach I: Allowable Load and Percent Reduction for Phosphorus
Approach I: Allowable Load and Percent Reductions for Nitrogen
Approach II: Allowable Load and Percent Reductions for Fine Sediment Particles
Approach II: Allowable Load and Percent Reductions for Fine Phosphorus
Approach II: Allowable Load and Percent Reductions for Fine Nitrogen
Approach III: Allowable Load and Percent Reductions for Fine Sediment Particles
Approach III: Allowable Load and Percent Reductions for Fine Phosphorus
Approach III: Allowable Load and Percent Reductions for Fine Nitrogen
Approach IV: Background and Anthropogenic Loads for Fine Sediment Particles
Approach IV: Background and Anthropogenic Loads Fine Phosphorus
Approach IV: Background and Anthropogenic Loads Nitrogen
Approach IV: Allowable Load and Percent Reductions for Fine Sediment Particles
Approach IV: Allowable Load and Percent Reductions for Phosphorus
Approach IV: Allowable Load and Percent Reductions for Nitrogen
Approach Comparison for All Jurisdictions (Allowable Fine Sediment Particle Loads)
Approach Comparison for All Jurisdictions (Percent Reductions from Baseline)
Basin-wide and Source Category Percent Load Reductions Resulting from Milestone Analysis
Load Duration Curves for Fine Sediment, Total Nitrogen and Total Phosphorus

Table C-1. Application Level of Each Pollutant Control for the Milestone Analysis of the Recommended Strategy (Supports Section 3.4)

Source Category	Setting	Treatment Tier	First Milestone	Second Milestone	Third Milestone	Fourth Milestone
Atmospheric	Less than 0.2 Km from Lake Tahoe (Setting 1)	Mobile Tier 2	-	-	-	-
		Mobile Tier 3	-	-	-	-
		Non-mob. Tier 2	20%	30%	30%	20%
		Non-mob. Tier 3	10%	20%	50%	60%
	0.2 Km to 1 Km from Lake Tahoe (Setting 2)	Mobile Tier 2	-	-	-	-
		Mobile Tier 3	-	-	-	-
		Non-mob. Tier 2	20%	30%	30%	20%
		Non-mob. Tier 3	10%	20%	50%	60%
	1 to 3 Km from Lake Tahoe (Setting 3)	Mobile Tier 2	-	-	-	-
		Mobile Tier 3	-	-	-	-
		Non-mob. Tier 2	10%	30%	30%	20%
		Non-mob. Tier 3	10%	20%	50%	60%
	Remainder of Tahoe Basin (Setting 4)	Mobile Tier 2	-	-	-	-
		Mobile Tier 3	-	-	-	-
		Non-mob. Tier 2	10%	30%	30%	20%
		Non-mob. Tier 3	10%	20%	50%	60%
Forest Upland Base Package	Unpaved roads and trails (Setting A)	Tier 1	30%	50%	60%	50%
		Tier 2	10%	10%	10%	20%
		Tier 3	-	-	10%	10%
	Ski slopes, camp-grounds, bare slopes (Setting B)	Tier 1	30%	50%	60%	50%
		Tier 2	10%	10%	10%	20%
		Tier 3	-	-	10%	10%
	Typical Tahoe Forest (Setting C)	Tier 2	2%	4%	5%	5%
		Tier 3	-	-	-	-
Stream Channel Erosion	Blackwood Creek	Tier 2	20%	40%	80%	80%
	Upper Truckee River	Tier 2	20%	40%	80%	80%
	Ward Creek	Tier 2	20%	40%	80%	80%
Urban Uplands	Concentrated Coverage, Moderate Slopes	Tier 1	20%	40%	20%	-
		Tier 2	10%	10%	-	20%
		Tier 3	-	10%	50%	60%
	Concentrated Coverage, Steep Slopes	Tier 1	20%	30%	20%	-
		Tier 2	-	10%	-	10%
		Tier 3	-	10%	50%	50%
	Dispersed Coverage, Moderate Slopes	Tier 1	20%	40%	40%	20%
		Tier 2	10%	10%	40%	60%
	Dispersed Coverage, Steep Slopes	Tier 1	20%	30%	30%	10%
		Tier 2	-	-	-	50%

Table C-2. Application Level of Each Pollutant Control for the Delayed Innovation Analysis of the Recommended Strategy (Supports Section 3.4)

Source Category	Setting	Treatment Tier	First Milestone	Second Milestone	Third Milestone	Fourth Milestone
Atmospheric	Less than 0.2 Km from Lake Tahoe (Setting 1)	Mobile Tier 2	-	-	-	-
		Mobile Tier 3	-	-	-	-
		Non-mob. Tier 2	40%	60%	70%	40%
		Non-mob. Tier 3	-	-	10%	40%
	0.2 Km to 1 Km from Lake Tahoe (Setting 2)	Mobile Tier 2	-	-	-	-
		Mobile Tier 3	-	-	-	-
		Non-mob. Tier 2	40%	60%	70%	40%
		Non-mob. Tier 3	-	-	10%	40%
	1 to 3 Km from Lake Tahoe (Setting 3)	Mobile Tier 2	-	-	-	-
		Mobile Tier 3	-	-	-	-
		Non-mob. Tier 2	40%	60%	70%	40%
		Non-mob. Tier 3	-	-	10%	40%
	Remainder of Tahoe Basin (Setting 4)	Mobile Tier 2	-	-	-	-
		Mobile Tier 3	-	-	-	-
		Non-mob. Tier 2	40%	60%	70%	40%
		Non-mob. Tier 3	-	-	10%	40%
Forest Upland Base Package	Unpaved roads and trails (Setting A)	Tier 1	30%	50%	60%	50%
		Tier 2	10%	10%	10%	20%
		Tier 3	-	-	10%	10%
	Ski slopes, camp-grounds, bare slopes (Setting B)	Tier 1	30%	50%	60%	50%
		Tier 2	10%	10%	10%	20%
		Tier 3	-	-	10%	10%
	Typical Tahoe Forest (Setting C)	Tier 2	2%	4%	5%	5%
		Tier 3	-	-	-	-
Stream Channel Erosion	Blackwood Creek	Tier 2	20%	40%	80%	80%
	Upper Truckee River	Tier 2	20%	40%	80%	80%
	Ward Creek	Tier 2	20%	40%	80%	80%
Urban Uplands	Concentrated Coverage, Moderate Slopes	Tier 1	30%	60%	70%	40%
		Tier 2	-	-	10%	30%
		Tier 3	-	-	-	10%
	Concentrated Coverage, Steep Slopes	Tier 1	30%	60%	70%	40%
		Tier 2	-	-	10%	30%
		Tier 3	-	-	-	10%
	Dispersed Coverage, Moderate Slopes	Tier 1	30%	60%	70%	50%
		Tier 2	-	-	10%	30%
	Dispersed Coverage, Steep Slopes	Tier 1	30%	70%	70%	50%
		Tier 2	-	-	10%	30%

*Values represent the percent of total areas treated with pollutant controls. A hyphen indicates that this treatment is not recommended.

Table C-3. SCG Baseline to Pollutant Budget Scaling Factors (Supports Section 3.3)

SCG	Name	SCG baseline	TMDL Budget	Scaling factor
ATM	Particles	75	75	1
ATM	TN	218	218	1
ATM	TP	7	7	1
ATM	Fines	1138.662243	1138.662243	1
ATM	Flow	0	0	1
FU	Particles	39.26269847	41	1.044248144
FU	TN	10.641	62	1.044248144
FU	TP	3.539	12	1.044248144
FU	Fines	4543.97	4745.032238	1.044248144
FU	Flow	44484445	44484445	1
SC	Particles	16.2939	17	1.043335236
SC	TN	0	0	1
SC	TP	0.5550736	0.579127845	1.043335236
SC	Fines	3651.8	3810.051614	1.043335236
SC	Flow	0	0	1
UG	Particles	222.8766287	348	1.561401938
UG	TN	50.7276672	63	1.241925826
UG	TP	13.32132108	18	1.351217338
UG	Fines	2974.682514	4644.675041	1.561401938
UG	Flow	30398373.14	30398373.14	1

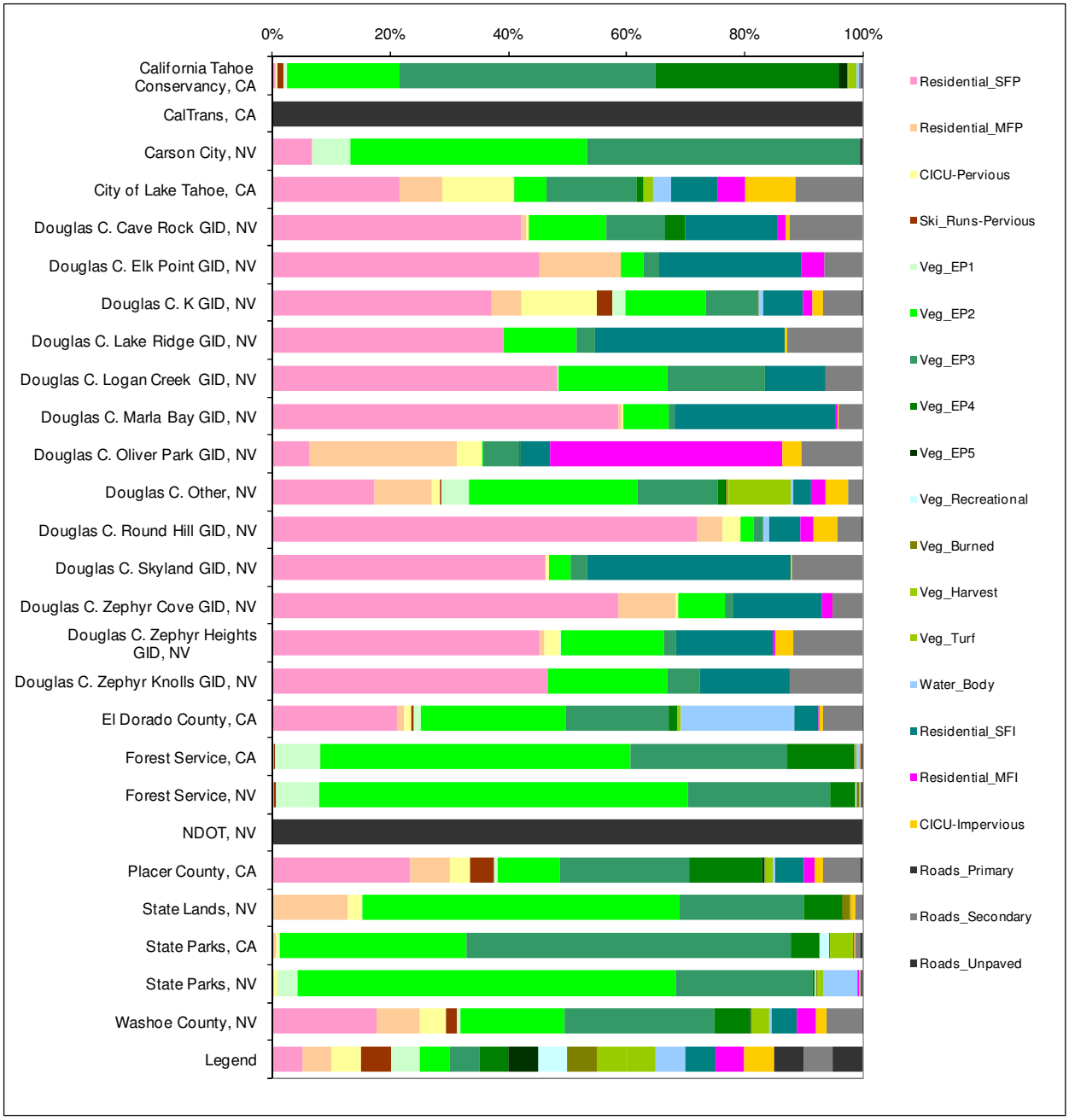

Figure C-1. A comparison of land use composition among all jurisdictions.

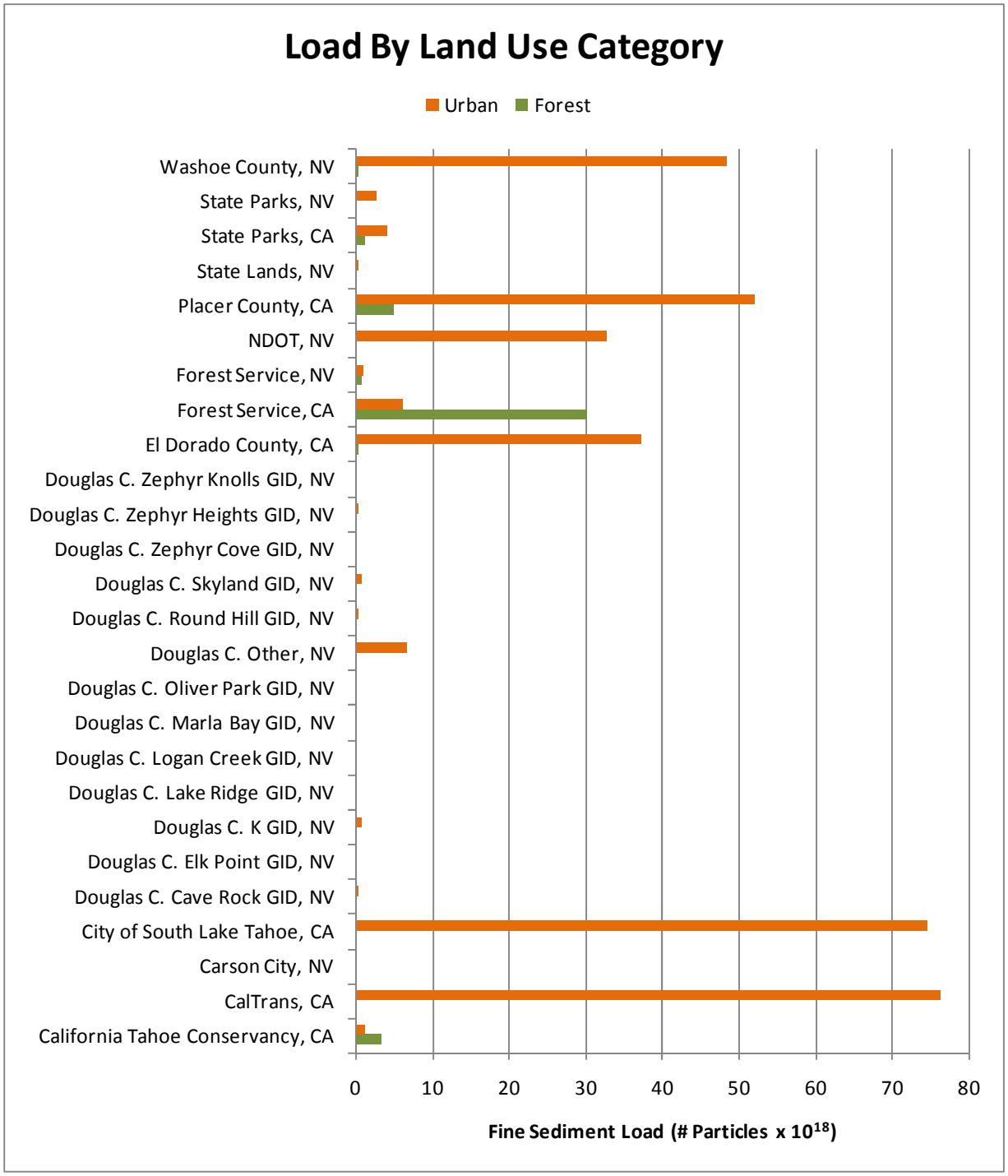

Figure C-2. The portion of each jurisdiction's fine sediment particle load categorized as forested or urban.

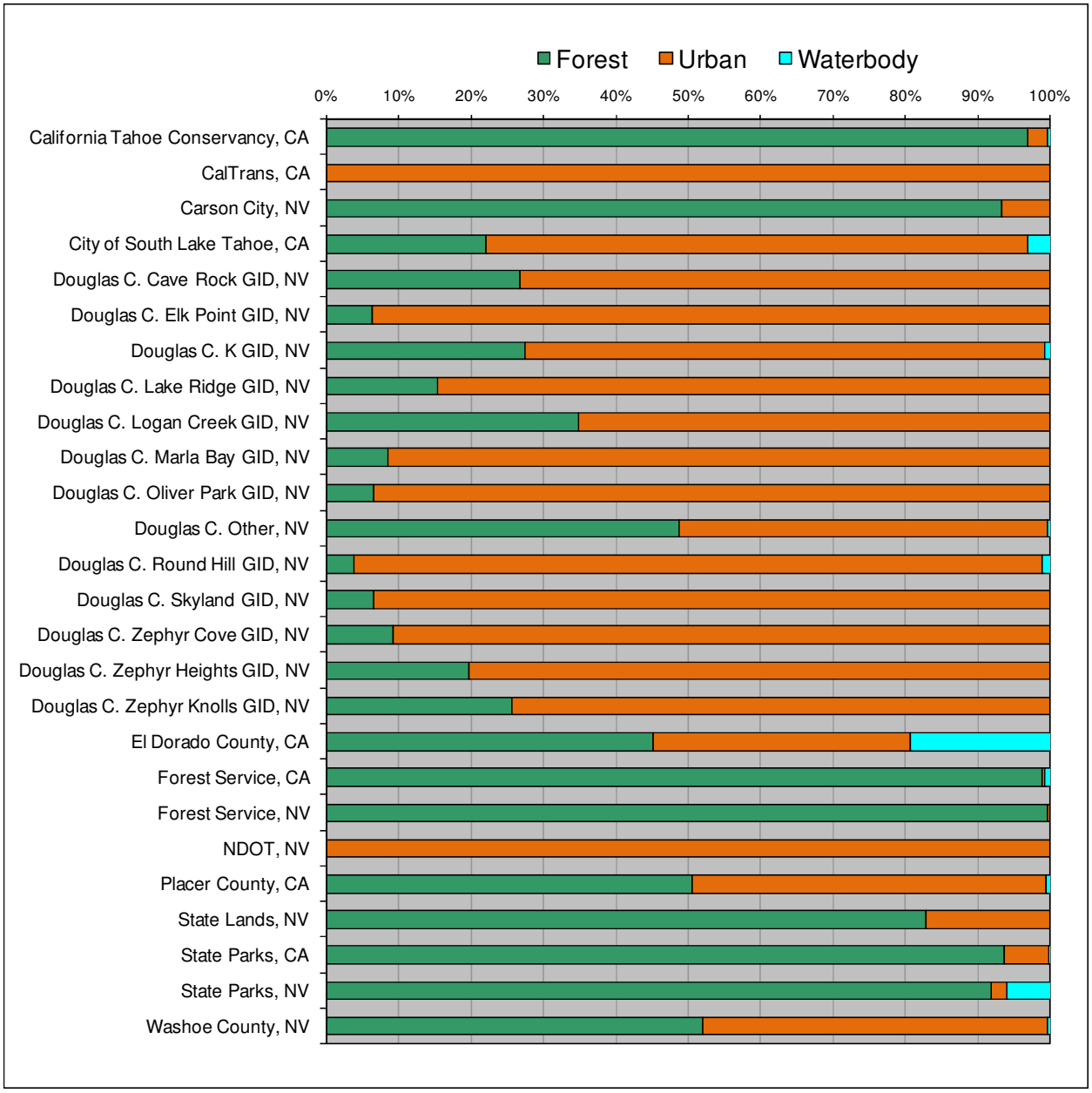

Figure C-3. The relative portion of each jurisdiction's land use, categorized as forest, urban, and waterbody.

Table C-4. Fine Sediment Particle Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach I: Predominant Load Source Approach

Jurisdiction	% Reduction from jurisdiction baseline[1]					Allowable load (particles x10^{18})					
	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	5.7%	8.8%	11.7%	11.8%	20.0%	4.76E+18	4.49E+18	4.34E+18	4.21E+18	4.20E+18	3.81E+18
CalTrans, CA	10.3%	21.2%	33.9%	42.1%	71.2%	7.64E+19	6.85E+19	6.02E+19	5.05E+19	4.42E+19	2.20E+19
Carson City, NV	5.7%	8.8%	11.7%	11.8%	20.0%	1.00E+16	9.47E+15	9.16E+15	8.87E+15	8.85E+15	8.03E+15
South Lake Tahoe, CA	10.3%	21.2%	33.9%	42.1%	71.2%	7.46E+19	6.69E+19	5.88E+19	4.93E+19	4.32E+19	2.15E+19
Cave Rock GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	3.80E+17	3.41E+17	2.99E+17	2.51E+17	2.20E+17	1.09E+17
Elk Point GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	1.62E+17	1.46E+17	1.28E+17	1.07E+17	9.39E+16	4.67E+16
KGID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	7.85E+17	7.04E+17	6.18E+17	5.19E+17	4.55E+17	2.26E+17
Lake Ridge GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	2.13E+17	1.91E+17	1.68E+17	1.41E+17	1.23E+17	6.12E+16
Logan Creek GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	5.09E+16	4.57E+16	4.01E+16	3.37E+16	2.95E+16	1.47E+16
Marla Bay GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	1.33E+17	1.19E+17	1.05E+17	8.78E+16	7.69E+16	3.82E+16
Oliver Park GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	8.12E+16	7.29E+16	6.40E+16	5.37E+16	4.70E+16	2.34E+16
Douglas C. Other, NV	10.3%	21.2%	33.9%	42.1%	71.2%	6.63E+18	5.95E+18	5.22E+18	4.38E+18	3.84E+18	1.91E+18
Round Hill GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	3.63E+17	3.26E+17	2.86E+17	2.40E+17	2.10E+17	1.04E+17
Skyland GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	7.13E+17	6.40E+17	5.62E+17	4.72E+17	4.13E+17	2.05E+17
Zephyr Cove GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	1.03E+17	9.25E+16	8.13E+16	6.82E+16	5.97E+16	2.97E+16
Zephyr Heights GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	4.77E+17	4.28E+17	3.76E+17	3.16E+17	2.76E+17	1.37E+17
Zephyr Knolls GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	1.14E+17	1.02E+17	8.95E+16	7.51E+16	6.58E+16	3.27E+16
El Dorado County, CA	10.3%	21.2%	33.9%	42.1%	71.2%	3.76E+19	3.37E+19	2.96E+19	2.49E+19	2.18E+19	1.08E+19
Forest Service, CA	5.7%	8.8%	11.7%	11.8%	20.0%	3.65E+19	3.44E+19	3.33E+19	3.22E+19	3.22E+19	2.92E+19
Forest Service, NV	5.7%	8.8%	11.7%	11.8%	20.0%	1.95E+18	1.84E+18	1.77E+18	1.72E+18	1.72E+18	1.56E+18
NDOT, NV	10.3%	21.2%	33.9%	42.1%	71.2%	3.28E+19	2.94E+19	2.59E+19	2.17E+19	1.90E+19	9.44E+18
Placer County, CA	10.3%	21.2%	33.9%	42.1%	71.2%	5.69E+19	5.10E+19	4.48E+19	3.76E+19	3.29E+19	1.64E+19
State Lands, NV	5.7%	8.8%	11.7%	11.8%	20.0%	3.89E+17	3.67E+17	3.55E+17	3.43E+17	3.43E+17	3.11E+17
State Parks, CA	5.7%	8.8%	11.7%	11.8%	20.0%	5.29E+18	4.99E+18	4.82E+18	4.67E+18	4.66E+18	4.23E+18
State Parks, NV	5.7%	8.8%	11.7%	11.8%	20.0%	2.83E+18	2.67E+18	2.58E+18	2.50E+18	2.50E+18	2.26E+18
Washoe County, NV	10.3%	21.2%	33.9%	42.1%	71.2%	4.88E+19	4.38E+19	3.85E+19	3.23E+19	2.83E+19	1.41E+19

[1] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-5. Total Phosphorus Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach I: Predominant Load Source Approach

Jurisdiction	% Reduction from jurisdiction baseline[2]					Allowable load (Metric Tonnes)					
	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	0.7%	1.0%	1.5%	1.5%	2.6%	5.09E+02	5.06E+02	5.04E+02	5.02E+02	5.01E+02	4.96E+02
CalTrans, CA	7.0%	13.6%	20.6%	27.4%	46.3%	2.85E+03	2.65E+03	2.47E+03	2.27E+03	2.07E+03	1.53E+03
Carson City, NV	0.7%	1.0%	1.5%	1.5%	2.6%	2.04E+01	2.02E+01	2.02E+01	2.00E+01	2.00E+01	1.98E+01
South Lake Tahoe, CA	7.0%	13.6%	20.6%	27.4%	46.3%	3.61E+03	3.36E+03	3.12E+03	2.87E+03	2.62E+03	1.94E+03
Cave Rock GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	4.20E+01	3.91E+01	3.63E+01	3.34E+01	3.05E+01	2.26E+01
Elk Point GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	2.07E+01	1.93E+01	1.79E+01	1.65E+01	1.50E+01	1.11E+01
KGID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	1.14E+02	1.06E+02	9.81E+01	9.02E+01	8.25E+01	6.10E+01
Lake Ridge GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	2.75E+01	2.56E+01	2.38E+01	2.19E+01	2.00E+01	1.48E+01
Logan Creek GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	7.89E+00	7.34E+00	6.82E+00	6.27E+00	5.73E+00	4.24E+00
Marla Bay GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	1.97E+01	1.83E+01	1.70E+01	1.56E+01	1.43E+01	1.06E+01
Oliver Park GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	8.56E+00	7.95E+00	7.39E+00	6.80E+00	6.21E+00	4.59E+00
Douglas C. Other, NV	7.0%	13.6%	20.6%	27.4%	46.3%	5.80E+02	5.39E+02	5.01E+02	4.61E+02	4.21E+02	3.12E+02
Round Hill GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	4.46E+01	4.15E+01	3.86E+01	3.55E+01	3.24E+01	2.40E+01
Skyland GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	9.27E+01	8.62E+01	8.01E+01	7.36E+01	6.73E+01	4.98E+01
Zephyr Cove GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	1.36E+01	1.27E+01	1.18E+01	1.08E+01	9.91E+00	7.32E+00
Zephyr Heights GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	4.66E+01	4.33E+01	4.03E+01	3.70E+01	3.38E+01	2.50E+01
Zephyr Knolls GID, NV	7.0%	13.6%	20.6%	27.4%	46.3%	1.35E+01	1.26E+01	1.17E+01	1.07E+01	9.82E+00	7.26E+00
El Dorado County, CA	7.0%	13.6%	20.6%	27.4%	46.3%	2.85E+03	2.65E+03	2.47E+03	2.27E+03	2.07E+03	1.53E+03
Forest Service, CA	0.7%	1.0%	1.5%	1.5%	2.6%	8.00E+03	7.94E+03	7.92E+03	7.88E+03	7.87E+03	7.79E+03
Forest Service, NV	0.7%	1.0%	1.5%	1.5%	2.6%	9.45E+02	9.38E+02	9.35E+02	9.31E+02	9.30E+02	9.20E+02
NDOT, NV	7.0%	13.6%	20.6%	27.4%	46.3%	1.15E+03	1.07E+03	9.90E+02	9.11E+02	8.33E+02	6.16E+02
Placer County, CA	7.0%	13.6%	20.6%	27.4%	46.3%	5.41E+03	5.03E+03	4.67E+03	4.30E+03	3.93E+03	2.90E+03
State Lands, NV	0.7%	1.0%	1.5%	1.5%	2.6%	3.69E+01	3.66E+01	3.65E+01	3.63E+01	3.63E+01	3.59E+01
State Parks, CA	0.7%	1.0%	1.5%	1.5%	2.6%	7.67E+02	7.62E+02	7.60E+02	7.56E+02	7.55E+02	7.47E+02
State Parks, NV	0.7%	1.0%	1.5%	1.5%	2.6%	3.39E+02	3.36E+02	3.35E+02	3.34E+02	3.34E+02	3.30E+02
Washoe County, NV	7.0%	13.6%	20.6%	27.4%	46.3%	2.48E+03	2.31E+03	2.14E+03	1.97E+03	1.80E+03	1.33E+03

[2] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-6. Total Nitrogen Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach I: Predominant Load Source Approach

	% Reduction from jurisdiction baseline[3]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	0.1%	0.2%	0.3%	0.3%	0.4%	2.21E+03	2.20E+03	2.20E+03	2.20E+03	2.20E+03	2.20E+03
CalTrans, CA	7.5%	14.3%	19.4%	29.8%	50.5%	5.22E+03	4.83E+03	4.48E+03	4.21E+03	3.66E+03	2.59E+03
Carson City, NV	0.1%	0.2%	0.3%	0.3%	0.4%	1.26E+02	1.26E+02	1.26E+02	1.26E+02	1.26E+02	1.25E+02
South Lake Tahoe, CA	7.5%	14.3%	19.4%	29.8%	50.5%	1.63E+04	1.50E+04	1.39E+04	1.31E+04	1.14E+04	8.05E+03
Cave Rock GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	1.17E+02	1.08E+02	1.00E+02	9.41E+01	8.19E+01	5.78E+01
Elk Point GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	5.48E+01	5.06E+01	4.69E+01	4.42E+01	3.84E+01	2.71E+01
KGID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	8.22E+02	7.60E+02	7.04E+02	6.63E+02	5.77E+02	4.07E+02
Lake Ridge GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	7.36E+01	6.81E+01	6.31E+01	5.94E+01	5.17E+01	3.65E+01
Logan Creek GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	2.56E+01	2.37E+01	2.20E+01	2.07E+01	1.80E+01	1.27E+01
Marla Bay GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	4.99E+01	4.62E+01	4.28E+01	4.03E+01	3.50E+01	2.47E+01
Oliver Park GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	6.95E+01	6.43E+01	5.96E+01	5.61E+01	4.88E+01	3.44E+01
Douglas C. Other, NV	7.5%	14.3%	19.4%	29.8%	50.5%	2.08E+03	1.93E+03	1.79E+03	1.68E+03	1.46E+03	1.03E+03
Round Hill GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	2.32E+02	2.15E+02	1.99E+02	1.87E+02	1.63E+02	1.15E+02
Skyland GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	2.41E+02	2.22E+02	2.06E+02	1.94E+02	1.69E+02	1.19E+02
Zephyr Cove GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	3.63E+01	3.36E+01	3.11E+01	2.93E+01	2.55E+01	1.80E+01
Zephyr Heights GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	1.36E+02	1.25E+02	1.16E+02	1.09E+02	9.51E+01	6.71E+01
Zephyr Knolls GID, NV	7.5%	14.3%	19.4%	29.8%	50.5%	3.76E+01	3.48E+01	3.23E+01	3.03E+01	2.64E+01	1.86E+01
El Dorado County, CA	7.5%	14.3%	19.4%	29.8%	50.5%	1.44E+04	1.33E+04	1.24E+04	1.16E+04	1.01E+04	7.14E+03
Forest Service, CA	0.1%	0.2%	0.3%	0.3%	0.4%	4.57E+04	4.57E+04	4.57E+04	4.56E+04	4.56E+04	4.55E+04
Forest Service, NV	0.1%	0.2%	0.3%	0.3%	0.4%	4.35E+03	4.34E+03	4.34E+03	4.34E+03	4.34E+03	4.33E+03
NDOT, NV	7.5%	14.3%	19.4%	29.8%	50.5%	1.88E+03	1.73E+03	1.61E+03	1.51E+03	1.32E+03	9.28E+02
Placer County, CA	7.5%	14.3%	19.4%	29.8%	50.5%	1.64E+04	1.52E+04	1.40E+04	1.32E+04	1.15E+04	8.11E+03
State Lands, NV	0.1%	0.2%	0.3%	0.3%	0.4%	1.31E+02	1.31E+02	1.31E+02	1.30E+02	1.30E+02	1.30E+02
State Parks, CA	0.1%	0.2%	0.3%	0.3%	0.4%	3.67E+03	3.66E+03	3.66E+03	3.66E+03	3.66E+03	3.65E+03
State Parks, NV	0.1%	0.2%	0.3%	0.3%	0.4%	1.39E+03	1.38E+03	1.38E+03	1.38E+03	1.38E+03	1.38E+03
Washoe County, NV	7.5%	14.3%	19.4%	29.8%	50.5%	9.23E+03	8.53E+03	7.91E+03	7.44E+03	6.47E+03	4.57E+03

[3] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-7. Fine Sediment Particle Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach II: Weighted Load Source Approach

	% Reduction from jurisdiction baseline[4]					Allowable load (particles x10^{18})					
Jurisdiction	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	7.0%	12.3%	18.0%	20.3%	34.4%	4.76E+18	4.43E+18	4.18E+18	3.91E+18	3.79E+18	3.12E+18
CalTrans, CA	10.3%	21.2%	33.9%	42.1%	71.2%	7.64E+19	6.85E+19	6.02E+19	5.05E+19	4.42E+19	2.20E+19
Carson City, NV	6.6%	11.3%	16.2%	18.0%	30.5%	1.00E+16	9.38E+15	8.90E+15	8.41E+15	8.24E+15	6.98E+15
South Lake Tahoe, CA	10.3%	21.2%	33.9%	42.1%	71.2%	7.46E+19	6.69E+19	5.88E+19	4.93E+19	4.32E+19	2.15E+19
Cave Rock GID, NV	10.3%	21.2%	33.8%	42.0%	71.2%	3.80E+17	3.41E+17	2.99E+17	2.51E+17	2.20E+17	1.10E+17
Elk Point GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	1.62E+17	1.46E+17	1.28E+17	1.07E+17	9.39E+16	4.67E+16
KGID, NV	10.3%	21.2%	33.8%	42.0%	71.2%	7.85E+17	7.04E+17	6.19E+17	5.19E+17	4.55E+17	2.26E+17
Lake Ridge GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	2.13E+17	1.91E+17	1.68E+17	1.41E+17	1.23E+17	6.12E+16
Logan Creek GID, NV	10.3%	21.2%	33.8%	42.0%	71.1%	5.09E+16	4.57E+16	4.01E+16	3.37E+16	2.95E+16	1.47E+16
Marla Bay GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	1.33E+17	1.19E+17	1.05E+17	8.78E+16	7.69E+16	3.82E+16
Oliver Park GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	8.12E+16	7.29E+16	6.40E+16	5.37E+16	4.70E+16	2.34E+16
Douglas C. Other, NV	10.3%	21.2%	33.8%	42.0%	71.0%	6.63E+18	5.95E+18	5.22E+18	4.39E+18	3.85E+18	1.92E+18
Round Hill GID, NV	10.3%	21.2%	33.8%	42.0%	71.0%	3.63E+17	3.26E+17	2.86E+17	2.41E+17	2.11E+17	1.05E+17
Skyland GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	7.13E+17	6.40E+17	5.62E+17	4.72E+17	4.13E+17	2.05E+17
Zephyr Cove GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	1.03E+17	9.25E+16	8.13E+16	6.82E+16	5.97E+16	2.97E+16
Zephyr Heights GID, NV	10.3%	21.2%	33.9%	42.1%	71.2%	4.77E+17	4.28E+17	3.76E+17	3.16E+17	2.77E+17	1.37E+17
Zephyr Knolls GID, NV	10.3%	21.2%	33.8%	42.1%	71.2%	1.14E+17	1.02E+17	8.95E+16	7.51E+16	6.58E+16	3.27E+16
El Dorado County, CA	10.2%	21.1%	33.7%	41.8%	70.8%	3.76E+19	3.37E+19	2.97E+19	2.49E+19	2.19E+19	1.10E+19
Forest Service, CA	6.4%	10.9%	15.5%	17.0%	28.8%	3.65E+19	3.42E+19	3.25E+19	3.09E+19	3.03E+19	2.60E+19
Forest Service, NV	8.1%	15.4%	23.6%	28.0%	47.4%	1.95E+18	1.79E+18	1.65E+18	1.49E+18	1.40E+18	1.02E+18
NDOT, NV	10.3%	21.2%	33.9%	42.1%	71.2%	3.28E+19	2.94E+19	2.59E+19	2.17E+19	1.90E+19	9.44E+18
Placer County, CA	9.9%	20.2%	32.0%	39.5%	66.9%	5.69E+19	5.12E+19	4.54E+19	3.87E+19	3.44E+19	1.88E+19
State Lands, NV	10.1%	20.7%	32.9%	40.8%	69.1%	3.89E+17		3.09E+17	2.61E+17	2.30E+17	1.20E+17
State Parks, CA	9.2%	18.4%	28.8%	35.2%	59.5%	5.29E+18	4.80E+18	4.32E+18	3.77E+18	3.43E+18	2.14E+18
State Parks, NV	10.1%	20.9%	33.2%	41.2%	69.7%	2.83E+18	2.54E+18	2.24E+18	1.89E+18	1.67E+18	8.57E+17
Washoe County, NV	10.2%	21.1%	33.7%	41.8%	70.8%	4.88E+19	4.38E+19	3.85E+19	3.24E+19	2.84E+19	1.43E+19

[4] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-8. Total Phosphorus Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach II: Weighted Load Source Approach

	% Reduction from jurisdiction baseline[5]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	2.4%	4.4%	6.6%	8.5%	14.3%	5.09E+02	4.97E+02	4.87E+02	4.76E+02	4.66E+02	4.36E+02
CalTrans, CA	7.0%	13.6%	20.6%	27.4%	46.3%	2.85E+03	2.65E+03	2.47E+03	2.27E+03	2.07E+03	1.53E+03
Carson City, NV	2.4%	4.5%	6.8%	8.7%	14.7%	2.04E+01	1.99E+01	1.94E+01	1.90E+01	1.86E+01	1.74E+01
South Lake Tahoe, CA	7.0%	13.6%	20.5%	27.2%	46.1%	3.61E+03	3.36E+03	3.12E+03	2.87E+03	2.63E+03	1.95E+03
Cave Rock GID, NV	6.9%	13.4%	20.2%	26.9%	45.6%	4.20E+01	3.91E+01	3.64E+01	3.35E+01	3.07E+01	2.29E+01
Elk Point GID, NV	7.0%	13.6%	20.5%	27.3%	46.1%	2.07E+01	1.93E+01	1.79E+01	1.65E+01	1.51E+01	1.12E+01
KGID, NV	6.8%	13.2%	19.9%	26.4%	44.7%	1.14E+02	1.06E+02	9.86E+01	9.10E+01	8.35E+01	6.27E+01
Lake Ridge GID, NV	7.0%	13.5%	20.4%	27.2%	46.0%	2.75E+01	2.56E+01	2.38E+01	2.19E+01	2.01E+01	1.49E+01
Logan Creek GID, NV	6.8%	13.1%	19.8%	26.3%	44.6%	7.89E+00	7.36E+00	6.86E+00	6.33E+00	5.81E+00	4.37E+00
Marla Bay GID, NV	7.0%	13.5%	20.5%	27.2%	46.1%	1.97E+01	1.83E+01	1.70E+01	1.56E+01	1.43E+01	1.06E+01
Oliver Park GID, NV	7.0%	13.6%	20.5%	27.3%	46.2%	8.56E+00	7.96E+00	7.39E+00	6.80E+00	6.22E+00	4.61E+00
Douglas C. Other, NV	6.7%	12.9%	19.4%	25.8%	43.7%	5.80E+02	5.42E+02	5.06E+02	4.67E+02	4.30E+02	3.27E+02
Round Hill GID, NV	7.0%	13.5%	20.5%	27.2%	46.1%	4.46E+01	4.15E+01	3.86E+01	3.55E+01	3.25E+01	2.41E+01
Skyland GID, NV	7.0%	13.6%	20.5%	27.3%	46.2%	9.27E+01	8.62E+01	8.01E+01	7.37E+01	6.74E+01	4.99E+01
Zephyr Cove GID, NV	7.0%	13.5%	20.4%	27.2%	46.0%	1.36E+01	1.27E+01	1.18E+01	1.09E+01	9.94E+00	7.37E+00
Zephyr Heights GID, NV	6.9%	13.4%	20.3%	27.0%	45.7%	4.66E+01	4.34E+01	4.03E+01	3.71E+01	3.40E+01	2.53E+01
Zephyr Knolls GID, NV	6.9%	13.4%	20.2%	26.9%	45.6%	1.35E+01	1.26E+01	1.17E+01	1.08E+01	9.88E+00	7.36E+00
El Dorado County, CA	6.7%	13.0%	19.6%	26.0%	44.0%	2.85E+03	2.66E+03	2.48E+03	2.30E+03	2.11E+03	1.60E+03
Forest Service, CA	1.3%	2.2%	3.3%	3.9%	6.7%	8.00E+03	7.89E+03	7.82E+03	7.74E+03	7.68E+03	7.46E+03
Forest Service, NV	1.1%	1.9%	2.8%	3.4%	5.7%	9.45E+02	9.34E+02	9.27E+02	9.18E+02	9.13E+02	8.91E+02
NDOT, NV	7.0%	13.6%	20.6%	27.4%	46.3%	1.15E+03	1.07E+03	9.90E+02	9.11E+02	8.33E+02	6.16E+02
Placer County, CA	6.1%	11.7%	17.7%	23.5%	39.8%	5.41E+03	5.08E+03	4.77E+03	4.45E+03	4.14E+03	3.25E+03
State Lands, NV	5.0%	9.6%	14.5%	19.1%	32.4%	3.69E+01	3.50E+01	3.33E+01	3.15E+01	2.98E+01	2.49E+01
State Parks, CA	4.0%	7.5%	11.3%	14.9%	25.1%	7.67E+02	7.37E+02	7.10E+02	6.80E+02	6.53E+02	5.74E+02
State Parks, NV	3.1%	5.7%	8.6%	11.2%	18.9%	3.39E+02	3.28E+02	3.19E+02	3.10E+02	3.01E+02	2.75E+02
Washoe County, NV	6.6%	12.7%	19.2%	25.5%	43.2%	2.48E+03	2.32E+03	2.17E+03	2.00E+03	1.85E+03	1.41E+03

[5] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-9. Total Nitrogen Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach II: Weighted Load Source Approach

	% Reduction from jurisdiction baseline[6]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	1.8%	3.3%	4.5%	6.8%	11.6%	2.21E+03	2.17E+03	2.13E+03	2.11E+03	2.05E+03	1.95E+03
CalTrans, CA	7.5%	14.3%	19.4%	29.8%	50.5%	5.22E+03	4.83E+03	4.48E+03	4.21E+03	3.66E+03	2.59E+03
Carson City, NV	1.2%	2.2%	3.1%	4.6%	7.8%	1.26E+02	1.24E+02	1.23E+02	1.22E+02	1.20E+02	1.16E+02
South Lake Tahoe, CA	7.5%	14.2%	19.2%	29.6%	50.1%	1.63E+04	1.51E+04	1.40E+04	1.31E+04	1.15E+04	8.12E+03
Cave Rock GID, NV	7.3%	13.9%	18.9%	29.1%	49.3%	1.17E+02	1.08E+02	1.00E+02	9.46E+01	8.27E+01	5.92E+01
Elk Point GID, NV	7.5%	14.2%	19.3%	29.7%	50.2%	5.48E+01	5.07E+01	4.70E+01	4.42E+01	3.85E+01	2.73E+01
KGID, NV	7.4%	14.0%	19.0%	29.2%	49.5%	8.22E+02	7.61E+02	7.07E+02	6.66E+02	5.82E+02	4.15E+02
Lake Ridge GID, NV	7.4%	14.1%	19.2%	29.5%	49.9%	7.36E+01	6.82E+01	6.32E+01	5.95E+01	5.19E+01	3.69E+01
Logan Creek GID, NV	7.1%	13.5%	18.4%	28.3%	47.9%	2.56E+01	2.38E+01	2.22E+01	2.09E+01	1.84E+01	1.34E+01
Marla Bay GID, NV	7.5%	14.2%	19.2%	29.6%	50.1%	4.99E+01	4.62E+01	4.29E+01	4.03E+01	3.52E+01	2.49E+01
Oliver Park GID, NV	7.5%	14.3%	19.3%	29.8%	50.4%	6.95E+01	6.43E+01	5.96E+01	5.61E+01	4.88E+01	3.45E+01
Douglas C. Other, NV	7.1%	13.4%	18.2%	28.0%	47.4%	2.08E+03	1.94E+03	1.80E+03	1.70E+03	1.50E+03	1.09E+03
Round Hill GID, NV	7.5%	14.2%	19.3%	29.7%	50.2%	2.32E+02	2.15E+02	1.99E+02	1.88E+02	1.63E+02	1.16E+02
Skyland GID, NV	7.5%	14.2%	19.3%	29.7%	50.3%	2.41E+02	2.23E+02	2.06E+02	1.94E+02	1.69E+02	1.20E+02
Zephyr Cove GID, NV	7.4%	14.1%	19.2%	29.5%	49.9%	3.63E+01	3.36E+01	3.12E+01	2.94E+01	2.56E+01	1.82E+01
Zephyr Heights GID, NV	7.4%	14.0%	19.0%	29.2%	49.5%	1.36E+02	1.26E+02	1.17E+02	1.10E+02	9.59E+01	6.85E+01
Zephyr Knolls GID, NV	7.3%	13.9%	18.9%	29.1%	49.3%	3.76E+01	3.49E+01	3.24E+01	3.05E+01	2.67E+01	1.91E+01
El Dorado County, CA	6.9%	13.2%	17.9%	27.5%	46.6%	1.44E+04	1.34E+04	1.25E+04	1.19E+04	1.05E+04	7.71E+03
Forest Service, CA	0.6%	1.1%	1.5%	2.2%	3.7%	4.57E+04	4.55E+04	4.53E+04	4.51E+04	4.48E+04	4.41E+04
Forest Service, NV	0.5%	0.9%	1.2%	1.8%	3.0%	4.35E+03	4.33E+03	4.31E+03	4.29E+03	4.27E+03	4.22E+03
NDOT, NV	7.5%	14.3%	19.4%	29.8%	50.5%	1.88E+03	1.73E+03	1.61E+03	1.51E+03	1.32E+03	9.28E+02
Placer County, CA	6.6%	12.5%	17.0%	26.2%	44.3%	1.64E+04	1.53E+04	1.43E+04	1.36E+04	1.21E+04	9.13E+03
State Lands, NV	5.0%	9.5%	12.9%	19.8%	33.5%	1.31E+02	1.24E+02	1.18E+02	1.14E+02	1.05E+02	8.69E+01
State Parks, CA	2.9%	5.5%	7.5%	11.5%	19.5%	3.67E+03	3.56E+03	3.46E+03	3.39E+03	3.24E+03	2.95E+03
State Parks, NV	1.9%	3.6%	4.9%	7.5%	12.7%	1.39E+03	1.36E+03	1.34E+03	1.32E+03	1.28E+03	1.21E+03
Washoe County, NV	6.8%	13.0%	17.6%	27.1%	45.9%	9.23E+03	8.60E+03	8.03E+03	7.60E+03	6.72E+03	4.99E+03

[6] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-10. Fine Sediment Particle Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach III: Setting Specific Approach

	% Reduction from jurisdiction baseline[7]					Allowable load (particles x10[18])					
Jurisdiction	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	-	-	23.3%	-	-	4.76E+18	-	-	3.65E+18	-	-
CalTrans, CA	-	-	30.8%	-	-	7.64E+19	-	-	5.29E+19	-	-
Carson City, NV	-	-	9.2%	-	-	1.00E+16	-	-	9.11E+15	-	-
South Lake Tahoe, CA	-	-	42.4%	-	-	7.46E+19	-	-	4.30E+19	-	-
Cave Rock GID, NV	-	-	7.0%	-	-	3.80E+17	-	-	3.54E+17	-	-
Elk Point GID, NV	-	-	7.0%	-	-	1.62E+17	-	-	1.51E+17	-	-
KGID, NV	-	-	16.3%	-	-	7.85E+17	-	-	6.57E+17	-	-
Lake Ridge GID, NV	-	-	35.4%	-	-	2.13E+17	-	-	1.37E+17	-	-
Logan Creek GID, NV	-	-	7.0%	-	-	5.09E+16	-	-	4.74E+16	-	-
Marla Bay GID, NV	-	-	35.8%	-	-	1.33E+17	-	-	8.53E+16	-	-
Oliver Park GID, NV	-	-	21.5%	-	-	8.12E+16	-	-	6.37E+16	-	-
Douglas C. Other, NV	-	-	32.3%	-	-	6.63E+18	-	-	4.49E+18	-	-
Round Hill GID, NV	-	-	16.5%	-	-	3.63E+17	-	-	3.03E+17	-	-
Skyland GID, NV	-	-	35.8%	-	-	7.13E+17	-	-	4.58E+17	-	-
Zephyr Cove GID, NV	-	-	35.7%	-	-	1.03E+17	-	-	6.63E+16	-	-
Zephyr Heights GID, NV	-	-	34.7%	-	-	4.77E+17	-	-	3.12E+17	-	-
Zephyr Knolls GID, NV	-	-	35.4%	-	-	1.14E+17	-	-	7.33E+16	-	-
El Dorado County, CA	-	-	31.6%	-	-	3.76E+19	-	-	2.57E+19	-	-
Forest Service, CA	-	-	13.7%	-	-	3.65E+19	-	-	3.15E+19	-	-
Forest Service, NV	-	-	18.0%	-	-	1.95E+18	-	-	1.60E+18	-	-
NDOT, NV	-	-	24.3%	-	-	3.28E+19	-	-	2.48E+19	-	-
Placer County, CA	-	-	34.2%	-	-	5.69E+19	-	-	3.74E+19	-	-
State Lands, NV	-	-	26.3%	-	-	3.89E+17	-	-	2.87E+17	-	-
State Parks, CA	-	-	31.7%	-	-	5.29E+18	-	-	3.61E+18	-	-
State Parks, NV	-	-	29.5%	-	-	2.83E+18	-	-	2.00E+18	-	-
Washoe County, NV	-	-	34.5%	-	-	4.88E+19	-	-	3.20E+19	-	-

[7] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-11. Total Phosphorus Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach III: Setting Specific Approach

	% Reduction from jurisdiction baseline[8]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target
California Tahoe Conservancy, CA	-	-	6.2%	-	-	5.09E+02	-	-	4.78E+02	-	-
CalTrans, CA	-	-	15.6%	-	-	2.85E+03	-	-	2.41E+03	-	-
Carson City, NV	-	-	0.2%	-	-	2.04E+01	-	-	2.03E+01	-	-
South Lake Tahoe, CA	-	-	25.9%	-	-	3.61E+03	-	-	2.67E+03	-	-
Cave Rock GID, NV	-	-	4.9%	-	-	4.20E+01	-	-	3.99E+01	-	-
Elk Point GID, NV	-	-	5.1%	-	-	2.07E+01	-	-	1.97E+01	-	-
KGID, NV	-	-	9.6%	-	-	1.14E+02	-	-	1.03E+02	-	-
Lake Ridge GID, NV	-	-	19.6%	-	-	2.75E+01	-	-	2.22E+01	-	-
Logan Creek GID, NV	-	-	4.9%	-	-	7.89E+00	-	-	7.51E+00	-	-
Marla Bay GID, NV	-	-	19.8%	-	-	1.97E+01	-	-	1.58E+01	-	-
Oliver Park GID, NV	-	-	12.6%	-	-	8.56E+00	-	-	7.48E+00	-	-
Douglas C. Other, NV	-	-	14.3%	-	-	5.80E+02	-	-	4.97E+02	-	-
Round Hill GID, NV	-	-	8.4%	-	-	4.46E+01	-	-	4.09E+01	-	-
Skyland GID, NV	-	-	19.9%	-	-	9.27E+01	-	-	7.43E+01	-	-
Zephyr Cove GID, NV	-	-	19.8%	-	-	1.36E+01	-	-	1.09E+01	-	-
Zephyr Heights GID, NV	-	-	18.6%	-	-	4.66E+01	-	-	3.79E+01	-	-
Zephyr Knolls GID, NV	-	-	19.4%	-	-	1.35E+01	-	-	1.09E+01	-	-
El Dorado County, CA	-	-	17.9%	-	-	2.85E+03	-	-	2.34E+03	-	-
Forest Service, CA	-	-	1.3%	-	-	8.00E+03	-	-	7.89E+03	-	-
Forest Service, NV	-	-	1.0%	-	-	9.45E+02	-	-	9.35E+02	-	-
NDOT, NV	-	-	12.2%	-	-	1.15E+03	-	-	1.01E+03	-	-
Placer County, CA	-	-	15.3%	-	-	5.41E+03	-	-	4.58E+03	-	-
State Lands, NV	-	-	8.3%	-	-	3.69E+01	-	-	3.38E+01	-	-
State Parks, CA	-	-	9.7%	-	-	7.67E+02	-	-	6.93E+02	-	-
State Parks, NV	-	-	7.1%	-	-	3.39E+02	-	-	3.15E+02	-	-
Washoe County, NV	-	-	18.5%	-	-	2.48E+03	-	-	2.02E+03	-	-

[8] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-12. Total Nitrogen Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach III: Setting Specific Approach

	% Reduction from jurisdiction baseline[9]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target
California Tahoe Conservancy, CA	-	-	4.8%	-	-	2.21E+03	-	-	2.10E+03	-	-
CalTrans, CA	-	-	14.2%	-	-	5.22E+03	-	-	4.48E+03	-	-
Carson City, NV	-	-	0.0%	-	-	1.26E+02	-	-	1.26E+02	-	-
South Lake Tahoe, CA	-	-	22.5%	-	-	1.63E+04	-	-	1.26E+04	-	-
Cave Rock GID, NV	-	-	3.6%	-	-	1.17E+02	-	-	1.13E+02	-	-
Elk Point GID, NV	-	-	3.8%	-	-	5.48E+01	-	-	5.27E+01	-	-
KGID, NV	-	-	7.9%	-	-	8.22E+02	-	-	7.57E+02	-	-
Lake Ridge GID, NV	-	-	18.1%	-	-	7.36E+01	-	-	6.03E+01	-	-
Logan Creek GID, NV	-	-	3.6%	-	-	2.56E+01	-	-	2.47E+01	-	-
Marla Bay GID, NV	-	-	18.8%	-	-	4.99E+01	-	-	4.06E+01	-	-
Oliver Park GID, NV	-	-	10.6%	-	-	6.95E+01	-	-	6.22E+01	-	-
Douglas C. Other, NV	-	-	13.8%	-	-	2.08E+03	-	-	1.79E+03	-	-
Round Hill GID, NV	-	-	5.7%	-	-	2.32E+02	-	-	2.19E+02	-	-
Skyland GID, NV	-	-	18.9%	-	-	2.41E+02	-	-	1.95E+02	-	-
Zephyr Cove GID, NV	-	-	18.7%	-	-	3.63E+01	-	-	2.95E+01	-	-
Zephyr Heights GID, NV	-	-	16.1%	-	-	1.36E+02	-	-	1.14E+02	-	-
Zephyr Knolls GID, NV	-	-	18.0%	-	-	3.76E+01	-	-	3.09E+01	-	-
El Dorado County, CA	-	-	16.1%	-	-	1.44E+04	-	-	1.21E+04	-	-
Forest Service, CA	-	-	0.7%	-	-	4.57E+04	-	-	4.54E+04	-	-
Forest Service, NV	-	-	0.7%	-	-	4.35E+03	-	-	4.32E+03	-	-
NDOT, NV	-	-	11.2%	-	-	1.88E+03	-	-	1.67E+03	-	-
Placer County, CA	-	-	15.1%	-	-	1.64E+04	-	-	1.39E+04	-	-
State Lands, NV	-	-	6.7%	-	-	1.31E+02	-	-	1.22E+02	-	-
State Parks, CA	-	-	6.4%	-	-	3.67E+03	-	-	3.43E+03	-	-
State Parks, NV	-	-	4.5%	-	-	1.39E+03	-	-	1.32E+03	-	-
Washoe County, NV			16.2%	-	-	9.23E+03	-	-	7.73E+03	-	-

[9] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-13. Fine Sediment Particle Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach IV: Watershed Model Approach

	% Reduction from jurisdiction baseline[10]					Allowable load (particles x10[18])					
Jurisdiction	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	-	-	23.2%	-	-	4.76E+18	-	-	3.66E+18	-	-
CalTrans, CA	-	-	36.3%	-	-	7.64E+19	-	-	4.86E+19	-	-
Carson City, NV	-	-	9.5%	-	-	1.00E+16	-	-	9.08E+15	-	-
South Lake Tahoe, CA	-	-	38.4%	-	-	7.46E+19	-	-	4.59E+19	-	-
Cave Rock GID, NV	-	-	11.7%	-	-	3.80E+17	-	-	3.36E+17	-	-
Elk Point GID, NV	-	-	11.9%	-	-	1.62E+17	-	-	1.43E+17	-	-
KGID, NV	-	-	17.9%	-	-	7.85E+17	-	-	6.45E+17	-	-
Lake Ridge GID, NV	-	-	8.4%	-	-	2.13E+17	-	-	1.95E+17	-	-
Logan Creek GID, NV	-	-	10.7%	-	-	5.09E+16	-	-	4.55E+16	-	-
Marla Bay GID, NV	-	-	7.7%	-	-	1.33E+17	-	-	1.23E+17	-	-
Oliver Park GID, NV	-	-	22.6%	-	-	8.12E+16	-	-	6.29E+16	-	-
Douglas C. Other, NV	-	-	25.8%	-	-	6.63E+18	-	-	4.92E+18	-	-
Round Hill GID, NV	-	-	11.0%	-	-	3.63E+17	-	-	3.23E+17	-	-
Skyland GID, NV	-	-	8.2%	-	-	7.13E+17	-	-	6.55E+17	-	-
Zephyr Cove GID, NV	-	-	6.5%	-	-	1.03E+17	-	-	9.64E+16	-	-
Zephyr Heights GID, NV	-	-	8.4%	-	-	4.77E+17	-	-	4.37E+17	-	-
Zephyr Knolls GID, NV	-	-	7.7%	-	-	1.14E+17	-	-	1.05E+17	-	-
El Dorado County, CA	-	-	37.6%	-	-	3.76E+19	-	-	2.35E+19	-	-
Forest Service, CA	-	-	12.7%	-	-	3.65E+19	-	-	3.19E+19	-	-
Forest Service, NV	-	-	16.4%	-	-	1.95E+18	-	-	1.63E+18	-	-
NDOT, NV	-	-	27.7%	-	-	3.28E+19	-	-	2.37E+19	-	-
Placer County, CA	-	-	34.0%	-	-	5.69E+19	-	-	3.75E+19	-	-
State Lands, NV	-	-	26.9%	-	-	3.89E+17	-	-	2.84E+17	-	-
State Parks, CA	-	-	29.5%	-	-	5.29E+18	-	-	3.73E+18	-	-
State Parks, NV	-	-	30.2%	-	-	2.83E+18	-	-	1.98E+18	-	-
Washoe County, NV	-	-	33.4%	-	-	4.88E+19	-	-	3.25E+19	-	-

[10] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-14. Total Phosphorus Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach IV: Watershed Model Approach

	% Reduction from jurisdiction baseline[11]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	-	-	5.2%	-	-	5.09E+02	-	-	4.83E+02	-	-
CalTrans, CA	-	-	21.8%	-	-	2.85E+03	-	-	2.23E+03	-	-
Carson City, NV	-	-	0.7%	-	-	2.04E+01	-	-	2.02E+01	-	-
South Lake Tahoe, CA	-	-	14.3%	-	-	3.61E+03	-	-	3.09E+03	-	-
Cave Rock GID, NV	-	-	9.0%	-	-	4.20E+01	-	-	3.83E+01	-	-
Elk Point GID, NV	-	-	9.9%	-	-	2.07E+01	-	-	1.87E+01	-	-
KGID, NV	-	-	7.1%	-	-	1.14E+02	-	-	1.06E+02	-	-
Lake Ridge GID, NV	-	-	7.9%	-	-	2.75E+01	-	-	2.54E+01	-	-
Logan Creek GID, NV	-	-	6.4%	-	-	7.89E+00	-	-	7.39E+00	-	-
Marla Bay GID, NV	-	-	6.5%	-	-	1.97E+01	-	-	1.84E+01	-	-
Oliver Park GID, NV	-	-	12.4%	-	-	8.56E+00	-	-	7.49E+00	-	-
Douglas C. Other, NV	-	-	7.0%	-	-	5.80E+02	-	-	5.40E+02	-	-
Round Hill GID, NV	-	-	5.8%	-	-	4.46E+01	-	-	4.21E+01	-	-
Skyland GID, NV	-	-	7.7%	-	-	9.27E+01	-	-	8.56E+01	-	-
Zephyr Cove GID, NV	-	-	4.7%	-	-	1.36E+01	-	-	1.30E+01	-	-
Zephyr Heights GID, NV	-	-	7.4%	-	-	4.66E+01	-	-	4.31E+01	-	-
Zephyr Knolls GID, NV	-	-	6.5%	-	-	1.35E+01	-	-	1.26E+01	-	-
El Dorado County, CA	-	-	18.7%	-	-	2.85E+03	-	-	2.32E+03	-	-
Forest Service, CA	-	-	3.8%	-	-	8.00E+03	-	-	7.69E+03	-	-
Forest Service, NV	-	-	1.2%	-	-	9.45E+02	-	-	9.33E+02	-	-
NDOT, NV	-	-	17.0%	-	-	1.15E+03	-	-	9.51E+02	-	-
Placer County, CA	-	-	13.6%	-	-	5.41E+03	-	-	4.68E+03	-	-
State Lands, NV	-	-	0.5%	-	-	3.69E+01	-	-	3.67E+01	-	-
State Parks, CA	-	-	3.2%	-	-	7.67E+02	-	-	7.43E+02	-	-
State Parks, NV	-	-	1.1%	-	-	3.39E+02	-	-	3.35E+02	-	-
Washoe County, NV	-	-	6.4%	-	-	2.48E+03	-	-	2.32E+03	-	-

[11] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-15. Total Nitrogen Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach IV: Watershed Model Approach

	% Reduction from jurisdiction baseline[12]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone #3	Milestone #4	Load target
California Tahoe Conservancy, CA	-	-	1.4%	-	-	2.21E+03	-	-	2.17E+03	-	-
CalTrans, CA	-	-	14.5%	-	-	5.22E+03	-	-	4.46E+03	-	-
Carson City, NV	-	-	0.0%	-	-	1.26E+02	-	-	1.26E+02	-	-
South Lake Tahoe, CA	-	-	10.5%	-	-	1.63E+04	-	-	1.46E+04	-	-
Cave Rock GID, NV	-	-	7.1%	-	-	1.17E+02	-	-	1.08E+02	-	-
Elk Point GID, NV	-	-	8.8%	-	-	5.48E+01	-	-	4.99E+01	-	-
KGID, NV	-	-	6.1%	-	-	8.22E+02	-	-	7.72E+02	-	-
Lake Ridge GID, NV	-	-	6.2%	-	-	7.36E+01	-	-	6.91E+01	-	-
Logan Creek GID, NV	-	-	5.5%	-	-	2.56E+01	-	-	2.42E+01	-	-
Marla Bay GID, NV	-	-	5.6%	-	-	4.99E+01	-	-	4.72E+01	-	-
Oliver Park GID, NV	-	-	11.3%	-	-	6.95E+01	-	-	6.17E+01	-	-
Douglas C. Other, NV	-	-	7.1%	-	-	2.08E+03	-	-	1.94E+03	-	-
Round Hill GID, NV	-	-	5.6%	-	-	2.32E+02	-	-	2.19E+02	-	-
Skyland GID, NV	-	-	6.0%	-	-	2.41E+02	-	-	2.26E+02	-	-
Zephyr Cove GID, NV	-	-	3.5%	-	-	3.63E+01	-	-	3.51E+01	-	-
Zephyr Heights GID, NV	-	-	5.5%	-	-	1.36E+02	-	-	1.28E+02	-	-
Zephyr Knolls GID, NV	-	-	4.3%	-	-	3.76E+01	-	-	3.60E+01	-	-
El Dorado County, CA	-	-	14.8%	-	-	1.44E+04	-	-	1.23E+04	-	-
Forest Service, CA	-	-	0.7%	-	-	4.57E+04	-	-	4.54E+04	-	-
Forest Service, NV	-	-	0.6%	-	-	4.35E+03	-	-	4.32E+03	-	-
NDOT, NV	-	-	10.5%	-	-	1.88E+03	-	-	1.68E+03	-	-
Placer County, CA	-	-	7.9%	-	-	1.64E+04	-	-	1.51E+04	-	-
State Lands, NV	-	-	0.0%	-	-	1.31E+02	-	-	1.31E+02	-	-
State Parks, CA	-	-	0.6%	-	-	3.67E+03	-	-	3.64E+03	-	-
State Parks, NV	-	-	2.8%	-	-	1.39E+03	-	-	1.35E+03	-	-
Washoe County, NV	-	-	6.6%	-	-	9.23E+03	-	-	8.62E+03	-	-

[12] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-16. Fine Sediment Particle Loads Relevant to Approach V: Anthropogenic Loading

Jurisdiction	Fine sediment particle load (# of particles)			
	Baseline load	Background load	Anthropogenic load	Anthropogenic load % of baseline[13]
California Tahoe Conservancy, CA	4.76E+18	2.91E+18	1.86E+18	39.0%
CalTrans, CA	7.64E+19	2.24E+16	7.63E+19	100%
Carson City, NV	1.00E+16	7.84E+15	2.21E+15	22.0%
South Lake Tahoe, CA	7.46E+19	1.23E+17	7.45E+19	99.8%
Cave Rock GID, NV	3.80E+17	2.30E+15	3.78E+17	99.4%
Elk Point GID, NV	1.62E+17	6.34E+14	1.62E+17	99.6%
KGID, NV	7.85E+17	1.03E+15	7.84E+17	99.9%
Lake Ridge GID, NV	2.13E+17	5.06E+14	2.12E+17	99.8%
Logan Creek GID, NV	5.09E+16	3.33E+14	5.06E+16	99.3%
Marla Bay GID, NV	1.33E+17	4.52E+14	1.32E+17	99.7%
Oliver Park GID, NV	8.12E+16	5.08E+13	8.12E+16	99.9%
Douglas C. Other, NV	6.63E+18	4.22E+16	6.59E+18	99.4%
Round Hill GID, NV	3.63E+17	1.14E+15	3.62E+17	99.7%
Skyland GID, NV	7.13E+17	1.84E+15	7.11E+17	99.7%
Zephyr Cove GID, NV	1.03E+17	5.23E+14	1.03E+17	99.5%
Zephyr Heights GID, NV	4.77E+17	1.12E+15	4.76E+17	99.8%
Zephyr Knolls GID, NV	1.14E+17	4.54E+14	1.13E+17	99.6%
El Dorado County, CA	3.76E+19	2.88E+17	3.73E+19	99.2%
Forest Service, CA	3.65E+19	2.67E+19	9.80E+18	26.8%
Forest Service, NV	1.95E+18	5.44E+17	1.40E+18	72.1%
NDOT, NV	3.28E+19	9.33E+15	3.28E+19	100%
Placer County, CA	5.69E+19	3.65E+18	5.32E+19	93.6%
State Lands, NV	3.89E+17	1.05E+16	3.79E+17	97.3%
State Parks, CA	5.29E+18	6.00E+17	4.69E+18	88.7%
State Parks, NV	2.83E+18	7.61E+16	2.76E+18	97.3%
Washoe County, NV	4.88E+19	4.20E+17	4.84E+19	99.1%

[13] All values have been rounded to three significant figures.

Table C-17. Total Phosphorus Loads Relevant to Approach V: Anthropogenic Loading

Jurisdiction	Load (Metric Tonnes)			
	Baseline load	Background load	Anthropogenic load	Anthropogenic load % of baseline[14]
California Tahoe Conservancy, CA	5.09E+02	3.60E+02	1.50E+02	29.4%
CalTrans, CA	2.85E+03	1.34E+01	2.84E+03	99.5%
Carson City, NV	2.04E+01	1.70E+01	3.39E+00	16.6%
South Lake Tahoe, CA	3.61E+03	8.09E+01	3.53E+03	97.8%
Cave Rock GID, NV	4.20E+01	2.74E+00	3.93E+01	93.5%
Elk Point GID, NV	2.07E+01	1.22E+00	1.95E+01	94.1%
KGID, NV	1.14E+02	1.32E+01	1.00E+02	88.4%
Lake Ridge GID, NV	2.75E+01	1.33E+00	2.62E+01	95.2%
Logan Creek GID, NV	7.89E+00	9.77E-01	6.92E+00	87.6%
Marla Bay GID, NV	1.97E+01	1.28E+00	1.84E+01	93.5%
Oliver Park GID, NV	8.56E+00	4.00E-01	8.16E+00	95.3%
Douglas C. Other, NV	5.80E+02	7.61E+01	5.04E+02	86.9%
Round Hill GID, NV	4.46E+01	5.35E+00	3.93E+01	88.0%
Skyland GID, NV	9.27E+01	4.29E+00	8.84E+01	95.4%
Zephyr Cove GID, NV	1.36E+01	1.13E+00	1.25E+01	91.7%
Zephyr Heights GID, NV	4.66E+01	2.82E+00	4.38E+01	94.0%
Zephyr Knolls GID, NV	1.35E+01	9.52E-01	1.26E+01	93.0%
El Dorado County, CA	2.85E+03	2.41E+02	2.61E+03	91.6%
Forest Service, CA	8.00E+03	6.96E+03	1.04E+03	13.0%
Forest Service, NV	9.45E+02	8.87E+02	5.77E+01	6.1%
NDOT, NV	1.15E+03	9.81E+00	1.14E+03	99.1%
Placer County, CA	5.41E+03	6.04E+02	4.81E+03	88.8%
State Lands, NV	3.69E+01	1.50E+01	2.19E+01	59.3%
State Parks, CA	7.67E+02	3.25E+02	4.43E+02	57.7%
State Parks, NV	3.39E+02	2.21E+02	1.18E+02	34.8%
Washoe County, NV	2.48E+03	3.92E+02	2.09E+03	84.2%

[14] All values have been rounded to three significant figures.

Table C-18. Total Nitrogen Loads Relevant to Approach V: Anthropogenic Loading

Jurisdiction	Load (Metric Tonnes)			
	Baseline load	Background load	Anthropogenic load	Anthropogenic load % of baseline[15]
California Tahoe Conservancy, CA	2.21E+03	1.75E+03	4.51E+02	20.4%
CalTrans, CA	5.22E+03	7.62E+01	5.15E+03	98.5%
Carson City, NV	1.26E+02	1.18E+02	8.23E+00	6.5%
South Lake Tahoe, CA	1.63E+04	6.51E+02	1.56E+04	96.0%
Cave Rock GID, NV	1.17E+02	1.08E+01	1.06E+02	90.8%
Elk Point GID, NV	5.48E+01	4.71E+00	5.01E+01	91.4%
KGID, NV	8.22E+02	5.79E+01	7.64E+02	93.0%
Lake Ridge GID, NV	7.36E+01	5.25E+00	6.84E+01	92.9%
Logan Creek GID, NV	2.56E+01	4.27E+00	2.14E+01	83.3%
Marla Bay GID, NV	4.99E+01	4.96E+00	4.50E+01	90.1%
Oliver Park GID, NV	6.95E+01	2.46E+00	6.71E+01	96.5%
Douglas C. Other, NV	2.08E+03	2.91E+02	1.79E+03	86.0%
Round Hill GID, NV	2.32E+02	3.36E+01	1.99E+02	85.6%
Skyland GID, NV	2.41E+02	1.66E+01	2.24E+02	93.1%
Zephyr Cove GID, NV	3.63E+01	4.38E+00	3.19E+01	87.9%
Zephyr Heights GID, NV	1.36E+02	1.21E+01	1.24E+02	91.1%
Zephyr Knolls GID, NV	3.76E+01	3.77E+00	3.39E+01	90.0%
El Dorado County, CA	1.44E+04	1.90E+03	1.25E+04	86.8%
Forest Service, CA	4.57E+04	4.35E+04	2.23E+03	4.9%
Forest Service, NV	4.35E+03	4.22E+03	1.33E+02	3.0%
NDOT, NV	1.88E+03	3.75E+01	1.84E+03	98.0%
Placer County, CA	1.64E+04	2.80E+03	1.36E+04	82.9%
State Lands, NV	1.31E+02	5.76E+01	7.31E+01	55.9%
State Parks, CA	3.67E+03	2.26E+03	1.40E+03	38.3%
State Parks, NV	1.39E+03	1.10E+03	2.89E+02	20.9%
Washoe County, NV	9.23E+03	1.65E+03	7.57E+03	82.1%

[15] All values have been rounded to three significant figures.

Table C-19. Fine Sediment Particle Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach V: Anthropogenic Loading

	% Reduction from jurisdiction baseline[16]					Allowable load (particles x10[18])					
Jurisdiction	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target
California Tahoe Conservancy, CA	4.2%	8.5%	13.5%	16.7%	28.3%	4.76E+18	4.56E+18	4.36E+18	4.12E+18	3.97E+18	3.42E+18
CalTrans, CA	10.8%	21.9%	34.7%	42.8%	72.4%	7.64E+19	6.81E+19	5.96E+19	4.99E+19	4.37E+19	2.11E+19
Carson City, NV	2.4%	4.8%	7.6%	9.4%	15.9%	1.00E+16	9.81E+15	9.56E+15	9.28E+15	9.10E+15	8.45E+15
South Lake Tahoe, CA	10.8%	21.9%	34.6%	42.7%	72.3%	7.46E+19	6.66E+19	5.83E+19	4.88E+19	4.27E+19	2.07E+19
Cave Rock GID, NV	10.7%	21.8%	34.5%	42.5%	72.0%	3.80E+17	3.39E+17	2.97E+17	2.49E+17	2.18E+17	1.06E+17
Elk Point GID, NV	10.7%	21.8%	34.6%	42.6%	72.2%	1.62E+17	1.45E+17	1.27E+17	1.06E+17	9.31E+16	4.52E+16
KGID, NV	10.8%	21.9%	34.6%	42.7%	72.3%	7.85E+17	7.01E+17	6.13E+17	5.13E+17	4.50E+17	2.17E+17
Lake Ridge GID, NV	10.8%	21.9%	34.6%	42.7%	72.3%	2.13E+17	1.90E+17	1.66E+17	1.39E+17	1.22E+17	5.90E+16
Logan Creek GID, NV	10.7%	21.8%	34.5%	42.5%	72.0%	5.09E+16	4.55E+16	3.99E+16	3.34E+16	2.93E+16	1.43E+16
Marla Bay GID, NV	10.7%	21.8%	34.6%	42.7%	72.2%	1.33E+17	1.19E+17	1.04E+17	8.69E+16	7.62E+16	3.69E+16
Oliver Park GID, NV	10.8%	21.9%	34.7%	42.8%	72.4%	8.12E+16	7.25E+16	6.34E+16	5.31E+16	4.65E+16	2.24E+16
Douglas C. Other, NV	10.7%	21.8%	34.5%	42.5%	72.0%	6.63E+18	5.92E+18	5.18E+18	4.34E+18	3.81E+18	1.86E+18
Round Hill GID, NV	10.7%	21.8%	34.6%	42.7%	72.2%	3.63E+17	3.24E+17	2.84E+17	2.38E+17	2.08E+17	1.01E+17
Skyland GID, NV	10.8%	21.9%	34.6%	42.7%	72.2%	7.13E+17	6.37E+17	5.57E+17	4.66E+17	4.09E+17	1.98E+17
Zephyr Cove GID, NV	10.7%	21.8%	34.5%	42.6%	72.1%	1.03E+17	9.21E+16	8.07E+16	6.75E+16	5.92E+16	2.88E+16
Zephyr Heights GID, NV	10.8%	21.9%	34.6%	42.7%	72.3%	4.77E+17	4.26E+17	3.73E+17	3.12E+17	2.74E+17	1.32E+17
Zephyr Knolls GID, NV	10.7%	21.8%	34.6%	42.6%	72.1%	1.14E+17	1.01E+17	8.88E+16	7.43E+16	6.52E+16	3.16E+16
El Dorado County, CA	10.7%	21.7%	34.4%	42.5%	71.9%	3.76E+19	3.36E+19	2.94E+19	2.46E+19	2.16E+19	1.06E+19
Forest Service, CA	2.9%	5.9%	9.3%	11.5%	19.4%	3.65E+19	3.55E+19	3.44E+19	3.31E+19	3.23E+19	2.94E+19
Forest Service, NV	7.8%	15.8%	25.0%	30.8%	52.2%	1.95E+18	1.80E+18	1.64E+18	1.46E+18	1.35E+18	9.30E+17
NDOT, NV	10.8%	21.9%	34.7%	42.8%	72.4%	3.28E+19	2.93E+19	2.56E+19	2.14E+19	1.88E+19	9.05E+18
Placer County, CA	10.1%	20.5%	32.5%	40.0%	67.8%	5.69E+19	5.11E+19	4.52E+19	3.84E+19	3.41E+19	1.83E+19
State Lands, NV	10.5%	21.3%	33.8%	41.6%	70.5%	3.89E+17	3.48E+17	3.06E+17	2.58E+17	2.27E+17	1.15E+17
State Parks, CA	9.6%	19.4%	30.8%	37.9%	64.2%	5.29E+18	4.79E+18	4.26E+18	3.66E+18	3.28E+18	1.89E+18
State Parks, NV	10.5%	21.3%	33.8%	41.6%	70.5%	2.83E+18	2.53E+18	2.23E+18	1.88E+18	1.65E+18	8.36E+17
Washoe County, NV	10.7%	21.7%	34.4%	42.4%	71.8%	4.88E+19	4.36E+19	3.82E+19	3.20E+19	2.81E+19	1.38E+19

[16] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-20. Total Phosphorus Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach V: Anthropogenic Loading

	% Reduction from jurisdiction baseline[17]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target
California Tahoe Conservancy, CA	2.0%	3.8%	5.8%	7.6%	12.9%	5.09E+02	4.99E+02	4.90E+02	4.80E+02	4.71E+02	4.44E+02
CalTrans, CA	6.8%	12.9%	19.5%	25.7%	43.5%	2.85E+03	2.66E+03	2.48E+03	2.30E+03	2.12E+03	1.61E+03
Carson City, NV	1.1%	2.2%	3.3%	4.3%	7.3%	2.04E+01	2.01E+01	1.99E+01	1.97E+01	1.95E+01	1.89E+01
South Lake Tahoe, CA	6.7%	12.7%	19.2%	25.3%	42.8%	3.61E+03	3.37E+03	3.15E+03	2.92E+03	2.70E+03	2.07E+03
Cave Rock GID, NV	6.4%	12.2%	18.4%	24.2%	40.9%	4.20E+01	3.93E+01	3.69E+01	3.43E+01	3.19E+01	2.48E+01
Elk Point GID, NV	6.4%	12.2%	18.5%	24.3%	41.2%	2.07E+01	1.94E+01	1.82E+01	1.69E+01	1.57E+01	1.22E+01
KGID, NV	6.0%	11.5%	17.4%	22.8%	38.7%	1.14E+02	1.07E+02	1.01E+02	9.39E+01	8.76E+01	6.96E+01
Lake Ridge GID, NV	6.5%	12.4%	18.7%	24.6%	41.6%	2.75E+01	2.58E+01	2.41E+01	2.24E+01	2.08E+01	1.61E+01
Logan Creek GID, NV	6.0%	11.4%	17.2%	22.7%	38.3%	7.89E+00	7.42E+00	6.99E+00	6.54E+00	6.11E+00	4.87E+00
Marla Bay GID, NV	6.4%	12.2%	18.4%	24.2%	40.9%	1.97E+01	1.84E+01	1.73E+01	1.61E+01	1.49E+01	1.16E+01
Oliver Park GID, NV	6.5%	12.4%	18.7%	24.6%	41.7%	8.56E+00	8.00E+00	7.50E+00	6.95E+00	6.45E+00	4.99E+00
Douglas C. Other, NV	5.9%	11.3%	17.1%	22.5%	38.0%	5.80E+02	5.46E+02	5.15E+02	4.81E+02	4.50E+02	3.60E+02
Round Hill GID, NV	6.0%	11.4%	17.3%	22.8%	38.5%	4.46E+01	4.20E+01	3.95E+01	3.69E+01	3.45E+01	2.74E+01
Skyland GID, NV	6.5%	12.4%	18.7%	24.7%	41.7%	9.27E+01	8.67E+01	8.12E+01	7.54E+01	6.99E+01	5.40E+01
Zephyr Cove GID, NV	6.3%	11.9%	18.0%	23.7%	40.1%	1.36E+01	1.28E+01	1.20E+01	1.12E+01	1.04E+01	8.17E+00
Zephyr Heights GID, NV	6.4%	12.2%	18.4%	24.3%	41.1%	4.66E+01	4.36E+01	4.09E+01	3.80E+01	3.53E+01	2.74E+01
Zephyr Knolls GID, NV	6.3%	12.1%	18.3%	24.0%	40.7%	1.35E+01	1.27E+01	1.19E+01	1.10E+01	1.03E+01	8.02E+00
El Dorado County, CA	6.2%	11.9%	18.0%	23.7%	40.1%	2.85E+03	2.68E+03	2.52E+03	2.34E+03	2.18E+03	1.71E+03
Forest Service, CA	0.9%	1.7%	2.6%	3.4%	5.7%	8.00E+03	7.93E+03	7.86E+03	7.79E+03	7.73E+03	7.54E+03
Forest Service, NV	0.4%	0.8%	1.2%	1.6%	2.7%	9.45E+02	9.41E+02	9.37E+02	9.33E+02	9.30E+02	9.20E+02
NDOT, NV	6.8%	12.9%	19.5%	25.6%	43.4%	1.15E+03	1.07E+03	9.99E+02	9.23E+02	8.53E+02	6.49E+02
Placer County, CA	6.1%	11.5%	17.4%	23.0%	38.9%	5.41E+03	5.08E+03	4.79E+03	4.47E+03	4.17E+03	3.31E+03
State Lands, NV	4.0%	7.7%	11.6%	15.3%	25.9%	3.69E+01	3.54E+01	3.40E+01	3.26E+01	3.12E+01	2.73E+01
State Parks, CA	3.9%	7.5%	11.3%	14.9%	25.2%	7.67E+02	7.37E+02	7.10E+02	6.80E+02	6.53E+02	5.74E+02
State Parks, NV	2.4%	4.5%	6.8%	9.0%	15.2%	3.39E+02	3.31E+02	3.23E+02	3.16E+02	3.08E+02	2.87E+02
Washoe County, NV	5.7%	10.9%	16.5%	21.8%	36.8%	2.48E+03	2.34E+03	2.21E+03	2.07E+03	1.94E+03	1.57E+03

[17] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

Table C-21. Total Nitrogen Jurisdictional Percent Reductions and Allowable Loads at Each Milestone for Approach V: Anthropogenic Loading

	% Reduction from jurisdiction baseline[18]					Allowable load (Metric Tonnes)					
Jurisdiction	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target	Baseline load	Milestone #1	Milestone #2	Milestone (#3)	Milestone #4	Load target
California Tahoe Conservancy, CA	1.5%	2.9%	3.9%	6.0%	10.2%	2.21E+03	2.17E+03	2.14E+03	2.12E+03	2.07E+03	1.98E+03
CalTrans, CA	7.4%	13.9%	18.9%	29.0%	49.1%	5.22E+03	4.84E+03	4.50E+03	4.24E+03	3.71E+03	2.66E+03
Carson City, NV	0.5%	0.9%	1.3%	1.9%	3.3%	1.26E+02	1.25E+02	1.25E+02	1.24E+02	1.23E+02	1.22E+02
South Lake Tahoe, CA	7.2%	13.6%	18.4%	28.3%	47.8%	1.63E+04	1.51E+04	1.41E+04	1.33E+04	1.17E+04	8.49E+03
Cave Rock GID, NV	6.8%	12.8%	17.4%	26.7%	45.2%	1.17E+02	1.09E+02	1.02E+02	9.64E+01	8.55E+01	6.39E+01
Elk Point GID, NV	6.8%	12.9%	17.5%	26.9%	45.5%	5.48E+01	5.10E+01	4.77E+01	4.52E+01	4.00E+01	2.98E+01
KGID, NV	6.9%	13.1%	17.8%	27.4%	46.3%	8.22E+02	7.65E+02	7.14E+02	6.75E+02	5.97E+02	4.41E+02
Lake Ridge GID, NV	6.9%	13.1%	17.8%	27.3%	46.3%	7.36E+01	6.85E+01	6.40E+01	6.05E+01	5.35E+01	3.96E+01
Logan Creek GID, NV	6.2%	11.8%	16.0%	24.5%	41.5%	2.56E+01	2.40E+01	2.26E+01	2.15E+01	1.93E+01	1.50E+01
Marla Bay GID, NV	6.7%	12.7%	17.3%	26.5%	44.9%	4.99E+01	4.66E+01	4.36E+01	4.13E+01	3.67E+01	2.75E+01
Oliver Park GID, NV	7.2%	13.6%	18.5%	28.4%	48.1%	6.95E+01	6.45E+01	6.01E+01	5.67E+01	4.98E+01	3.61E+01
Douglas C. Other, NV	6.4%	12.2%	16.5%	25.3%	42.9%	2.08E+03	1.95E+03	1.83E+03	1.74E+03	1.56E+03	1.19E+03
Round Hill GID, NV	6.4%	12.1%	16.4%	25.2%	42.6%	2.32E+02	2.17E+02	2.04E+02	1.94E+02	1.74E+02	1.33E+02
Skyland GID, NV	7.0%	13.2%	17.9%	27.4%	46.4%	2.41E+02	2.24E+02	2.09E+02	1.98E+02	1.75E+02	1.29E+02
Zephyr Cove GID, NV	6.6%	12.4%	16.9%	25.9%	43.8%	3.63E+01	3.39E+01	3.18E+01	3.02E+01	2.69E+01	2.04E+01
Zephyr Heights GID, NV	6.8%	12.9%	17.5%	26.8%	45.4%	1.36E+02	1.26E+02	1.18E+02	1.12E+02	9.92E+01	7.40E+01
Zephyr Knolls GID, NV	6.7%	12.7%	17.3%	26.5%	44.8%	3.76E+01	3.51E+01	3.28E+01	3.11E+01	2.77E+01	2.08E+01
El Dorado County, CA	6.5%	12.3%	16.7%	25.6%	43.3%	1.44E+04	1.35E+04	1.27E+04	1.20E+04	1.07E+04	8.19E+03
Forest Service, CA	0.4%	0.7%	0.9%	1.4%	2.4%	4.57E+04	4.56E+04	4.54E+04	4.53E+04	4.51E+04	4.46E+04
Forest Service, NV	0.2%	0.4%	0.6%	0.9%	1.5%	4.35E+03	4.34E+03	4.33E+03	4.32E+03	4.31E+03	4.28E+03
NDOT, NV	7.3%	13.8%	18.8%	28.8%	48.8%	1.88E+03	1.74E+03	1.62E+03	1.52E+03	1.33E+03	9.60E+02
Placer County, CA	6.2%	11.7%	15.9%	24.4%	41.3%	1.64E+04	1.54E+04	1.45E+04	1.38E+04	1.24E+04	9.62E+03
State Lands, NV	4.2%	7.9%	10.7%	16.5%	27.9%	1.31E+02	1.25E+02	1.20E+02	1.17E+02	1.09E+02	9.43E+01
State Parks, CA	2.9%	5.4%	7.3%	11.3%	19.1%	3.67E+03	3.56E+03	3.47E+03	3.40E+03	3.25E+03	2.97E+03
State Parks, NV	1.6%	2.9%	4.0%	6.1%	10.4%	1.39E+03	1.36E+03	1.35E+03	1.33E+03	1.30E+03	1.24E+03
Washoe County, NV	6.1%	11.6%	15.7%	24.2%	40.9%	9.23E+03	8.66E+03	8.16E+03	7.77E+03	7.00E+03	5.46E+03

[18] These percent reductions are based on the jurisdictional baselines, not the Basin-wide values presented in Table 4-7.

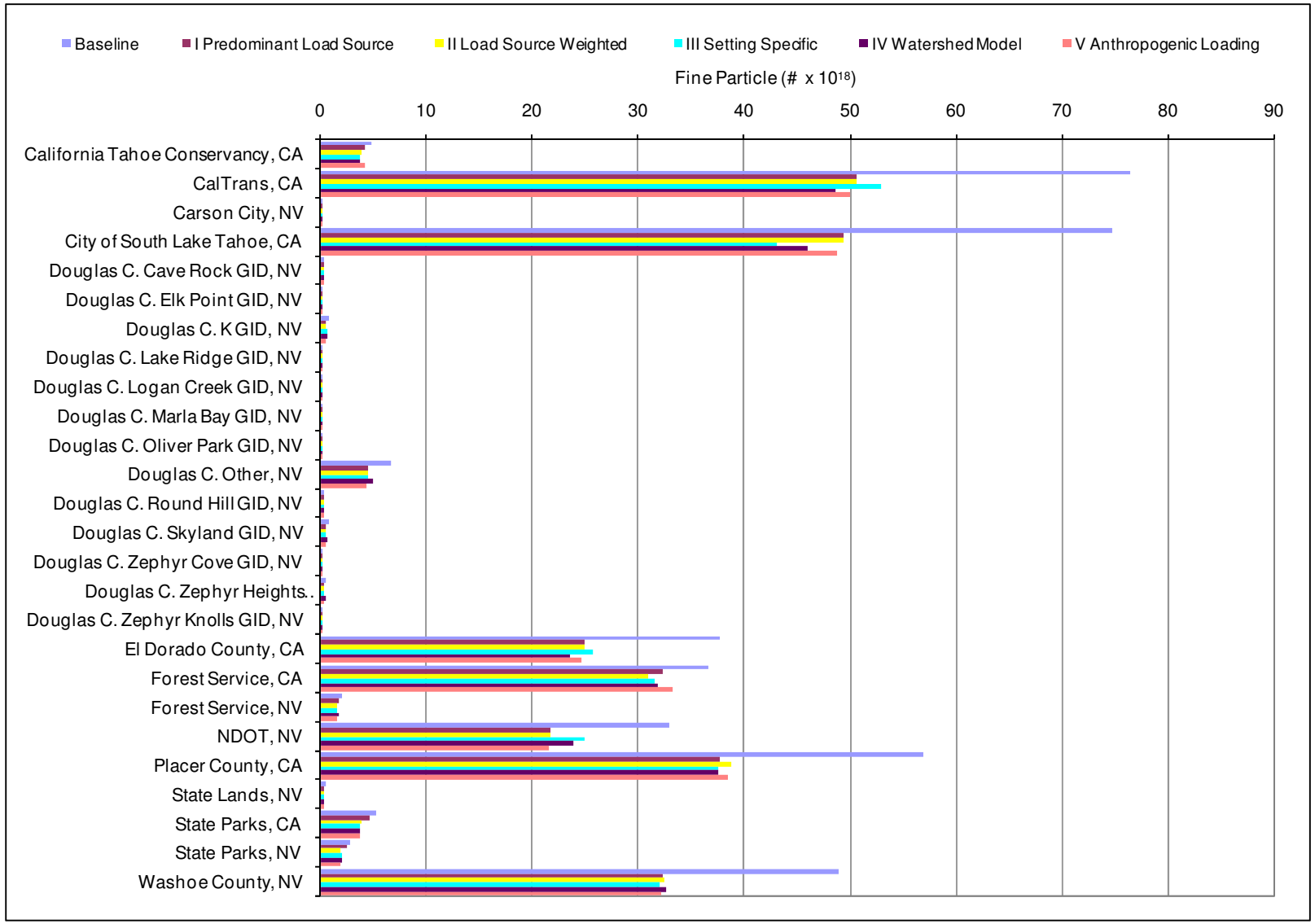

Figure C-4. Allowable fine sediment particle load for all jurisdictions at the baseline, and using predominant load, load source weighted, setting specific, watershed model and anthropogenic loading approaches.

Figure C-5. Comparison of fine sediment particle load reductions as a percent of baseline load using predominant load, load source weighted, setting specific, watershed model and anthropogenic loading approaches.

Table C-22. Table of Basin-wide and Source Category Percent Reductions Used in Allocations Approaches I, II, and III

This set of numbers bases the loads on the Recommended Strategy numbers and John Reuters Numeric target results as of 3 15 08
Percent reduction values beyond the 4th milestone assume the same average rate of reduction achieved between the baseline and 4th milestone.

33.85 20

Particle Reduction	Total Budget		1st Milestone				2nd Milestone				3rd Milestone (Clarity Challenge)				4th Milestone				Numeric Target				20 year average rate of progress
	Basin-Wide Load (Part/yr)	% of Basin-Wide Load	Cumulative Basin-Wide % Reduction	Basin-Wide Particle Load (Part/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Particle Load (Part/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Particle Load (Part/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Particle Load (Part/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Particle Load (Part/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Basin-wide % Reduction
Forest Upland	4.10E+19	9%	0.48%	3.87E+19	5.66%	5%	0.75%	3.74E+19	8.81%	4%	1.00%	3.62E+19	11.73%	4%	1.01%	3.61E+19	11.84%	3%	1.71%	3.28E+19	20.04%	2.6%	0.05%
Urban Upland	3.48E+20	72%	7.45%	3.12E+20	10.29%	78%	15.38%	2.74E+20	21.22%	79%	24.54%	2.30E+20	33.86%	79%	30.50%	2.02E+20	42.09%	79%	51.62%	1.00E+20	71.23%	79.4%	1.53%
Atmosphere	7.45E+19	16%	1.22%	6.87E+19	7.85%	13%	2.37%	6.31E+19	15.26%	12%	4.59%	5.24E+19	29.60%	12%	5.04%	5.03E+19	32.48%	13%	8.53%	3.35E+19	54.98%	13.1%	0.25%
Stream Channel	1.67E+19	3%	0.46%	1.45E+19	13.16%	5%	0.92%	1.23E+19	26.32%	5%	1.83%	7.91E+18	52.64%	5%	1.83%	7.91E+18	52.64%	5%	3.10%	1.82E+18	89.09%	4.8%	0.09%
Total	4.802E+20	100%	9.61%	4.34E+20		100%	19.41%	3.87E+20		100%	31.97%	3.27E+20		100%	38.38%	2.96E+20		100%	65%	1.683E+20		99.9%	1.92%
Basin-wide load check				90%				81%				68%				62%			65.0%	35.0%			

Nitrogen Reduction	Total Budget		1st Milestone				2nd Milestone				Third Milestone (Clarity Challenge)				4th Milestone				Numeric Target				20 year average rate of progress
	Cumulative Basin-Wide % Reduction	% of Basin-Wide Load	Cumulative Basin-Wide % Reduction	Basin-Wide Load (MT/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Load (MT/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Load (MT/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Load (MT/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Particle Load (Part/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Basin-wide % Reduction
Forest Upland	62	18%	0.02%	61.93	0.11%	1%	0.03%	61.90	0.16%	1%	0.05%	61.84	0.25%	1%	0.05%	61.84	0.26%	1%	0.08%	6.17E+01	0.44%	0.8%	0.00%
Urban Upland	63	18%	1.37%	58.26	7.53%	88%	2.61%	54.00	14.29%	88%	3.54%	50.80	19.37%	88%	5.45%	44.20	29.84%	89%	9.22%	3.12E+01	50.50%	92.2%	0.27%
Atmosphere	218	63%	0.16%	217.45	0.25%	10%	0.31%	216.93	0.49%	11%	0.60%	215.93	0.95%	11%	0.66%	215.74	1.04%	11%	1.11%	2.14E+02	1.76%	11.1%	0.03%
Stream Channel	2	1%		2.00	0.00%	0%		2.00	0.00%	0%		2.00	0.00%	0%		2.00	0.00%	0%	0.00%	2.00E+00	0.00%	0.0%	0.00%
Total	345	100%	1.55%	339.64		100%	2.95%	334.83		100%	4.18%	330.57		100%	6.15%	323.78		100%	10%	3.091E+02		104.1%	0.31%
Basin-wide load check				98%				97%				96%				94%			10.4%	89.6%			

Phosphorus Reduction	Total Budget		1st Milestone				2nd Milestone				Third Milestone (Clarity Challenge)				4th Milestone				Numeric Target				20 year average rate of progress
	Cumulative Basin-Wide % Reduction	% of Basin-Wide Load	Cumulative Basin-Wide % Reduction	Basin-Wide Load (MT/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Load (MT/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Load (MT/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Load (MT/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Cumulative Basin-Wide % Reduction	Basin-Wide Particle Load (Part/yr)	Source Category % Reduction	% of Total Milestone LR by Source	Basin-wide % Reduction
Forest Upland	12	32%	0.21%	11.92	0.68%	4%	0.31%	11.88	1.00%	3%	0.47%	11.82	1.49%	3%	0.49%	11.82	1.54%	2%	0.82%	1.17E+01	2.61%	2.4%	0.02%
Urban Upland	18	47%	3.33%	16.73	7.04%	62%	6.45%	15.55	13.61%	63%	9.74%	14.30	20.56%	63%	12.96%	13.08	27.36%	62%	21.94%	9.66E+00	46.31%	62.7%	0.65%
Atmosphere	7	18%	1.60%	6.39	8.67%	30%	3.12%	5.81	16.93%	30%	6.05%	4.70	32.84%	30%	6.64%	4.48	36.03%	32%	11.23%	2.73E+00	60.98%	32.1%	0.33%
Stream Channel	1	3%	0.20%	0.92	7.58%	4%	0.40%	0.85	15.17%	4%	0.80%	0.70	30.33%	4%	0.80%	0.70	30.33%	4%	1.35%	4.87E-01	51.34%	3.9%	0.04%
Total	38	100%	5.34%	35.97		100%	10.28%	34.09		100%	17.06%	31.52		100%	20.88%	30.07		100%	35%	2.457E+01		101.0%	1.04%
Basin-wide load check				95%				90%				83%				79%			35.3%	64.7%			

Some error is noteable in the Numeric Target calculations due to estimates used in source data provided in Clarity Model results.

Flow-Associated Assessment

Lake Tahoe "Clarity Challenge" TMDL
Flow: Sum of Inputs to Lake Tahoe (L/s)
Pollutant: Particles
Data from: 1/1/1990 to 12/31/2004

Flow Range	Associated Flow			Conc. (count/L)		Load (count/day)	
Percentile	Mean	Min	Max	Mean	Max	Mean	Max
0-10	1,376	1,012	1,588	6.6E+07	5.8E+08	7.9E+15	6.8E+16
10-20	1,763	1,589	1,950	1.0E+08	9.4E+08	1.5E+16	1.4E+17
20-30	2,212	1,950	2,522	2.1E+08	1.1E+09	4.0E+16	2.1E+17
30-40	2,859	2,524	3,245	3.1E+08	1.5E+09	7.6E+16	3.7E+17
40-50	3,854	3,246	4,585	3.8E+08	1.9E+09	1.3E+17	6.3E+17
50-60	5,541	4,591	6,689	4.7E+08	2.7E+09	2.3E+17	1.3E+18
60-70	8,640	6,696	11,007	5.7E+08	4.6E+09	4.3E+17	3.4E+18
70-80	14,261	11,023	18,205	6.0E+08	2.6E+09	7.4E+17	3.2E+18
80-90	24,350	18,210	34,291	5.9E+08	2.6E+09	1.2E+18	5.4E+18
90-100	60,418	34,368	165,776	7.9E+08	3.5E+09	4.1E+18	1.8E+19

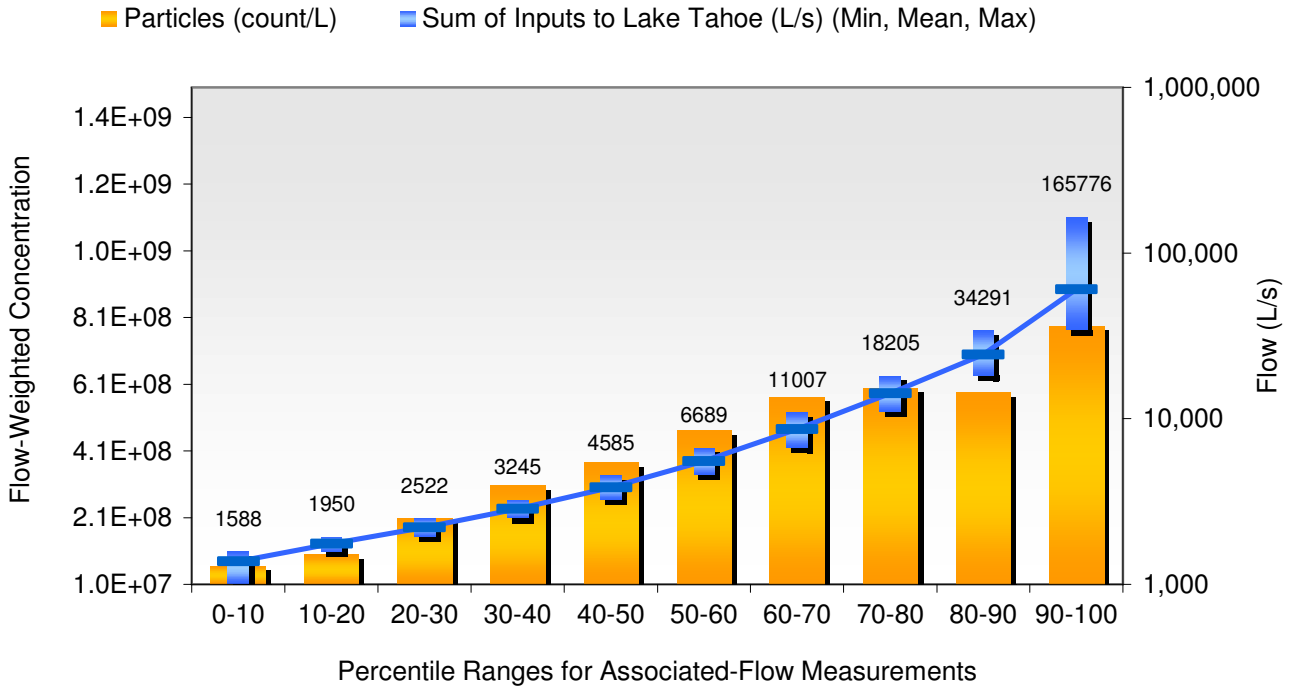

Figure C-6. Flow-associated analysis of daily maximum and average particle loads displayed as flow-weighted concentrations for the third (Clarity Challenge) milestone.

Seasonal Assessment

Lake Tahoe "Clarity Challenge" TMDL
Flow: Sum of Inputs to Lake Tahoe (L/s)
Pollutant: Particles
Data from: 1/1/1990 to 12/31/2004

Time Period	Associated Flow			Conc. (count/L)		Load (count/day)	
Month	Mean	Min	Max	Mean	Max	Mean	Max
Jan	7,456	1,165	353,760	1.0E+09	3.2E+09	6.7E+17	2.1E+18
Feb	8,484	1,198	109,779	7.8E+08	2.8E+09	5.7E+17	2.0E+18
Mar	17,611	3,294	159,306	8.7E+08	4.6E+09	1.3E+18	7.0E+18
Apr	28,654	7,061	113,302	6.6E+08	2.3E+09	1.6E+18	5.8E+18
May	37,149	3,582	165,776	6.3E+08	2.1E+09	2.0E+18	6.6E+18
Jun	26,682	2,693	162,743	5.7E+08	1.3E+09	1.3E+18	3.1E+18
Jul	9,204	1,819	71,979	3.3E+08	9.4E+08	2.6E+17	7.5E+17
Aug	3,227	1,404	12,762	9.7E+07	1.6E+09	2.7E+16	4.3E+17
Sep	2,154	1,210	14,398	1.7E+08	1.6E+09	3.1E+16	2.9E+17
Oct	2,103	1,114	15,281	3.9E+08	2.3E+09	7.1E+16	4.1E+17
Nov	3,400	1,062	74,382	9.1E+08	2.7E+09	2.7E+17	7.9E+17
Dec	4,845	1,012	137,993	1.0E+09	3.3E+09	4.3E+17	1.4E+18

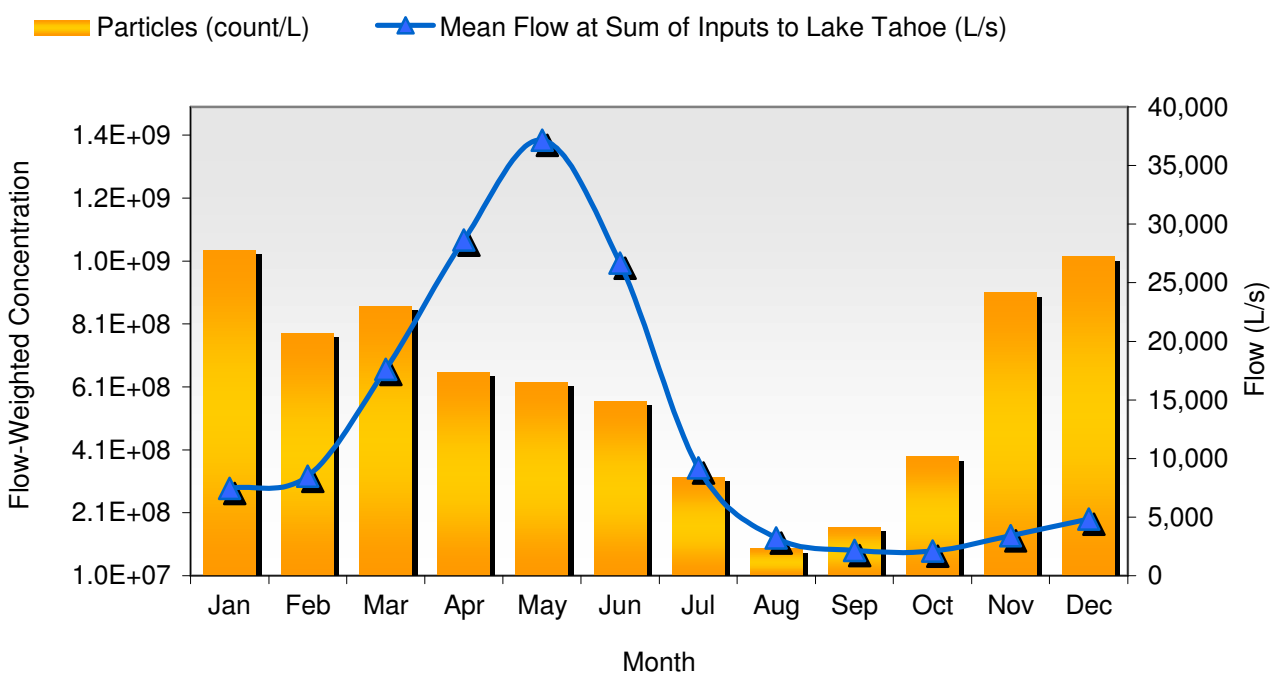

Figure C-7. Seasonal analysis of daily maximum and average particle loads displayed as flow-weighted concentrations for the third (Clarity Challenge) milestone.

Flow-Associated Assessment

Lake Tahoe "Clarity Challenge" TMDL
Flow: Sum of Inputs to Lake Tahoe (L/s)
Pollutant: Total Nitrogen
Data from: 1/1/1990 to 12/31/2004

Flow Range	Associated Flow			Concentration (mg/L)		Load (kg/day)	
Percentile	Mean	Min	Max	Mean	Max	Mean	Max
0-10	1,376	1,012	1,588	0.10	0.70	1.2E+04	8.4E+04
10-20	1,763	1,589	1,950	0.13	1.06	1.9E+04	1.6E+05
20-30	2,212	1,950	2,522	0.23	1.36	4.4E+04	2.6E+05
30-40	2,859	2,524	3,245	0.32	1.58	7.9E+04	3.9E+05
40-50	3,854	3,246	4,585	0.38	1.64	1.3E+05	5.5E+05
50-60	5,541	4,591	6,689	0.44	1.80	2.1E+05	8.6E+05
60-70	8,640	6,696	11,007	0.43	1.81	3.2E+05	1.3E+06
70-80	14,261	11,023	18,205	0.36	1.85	4.4E+05	2.3E+06
80-90	24,350	18,210	34,291	0.28	1.81	5.8E+05	3.8E+06
90-100	60,418	34,368	165,776	0.23	1.55	1.2E+06	8.1E+06

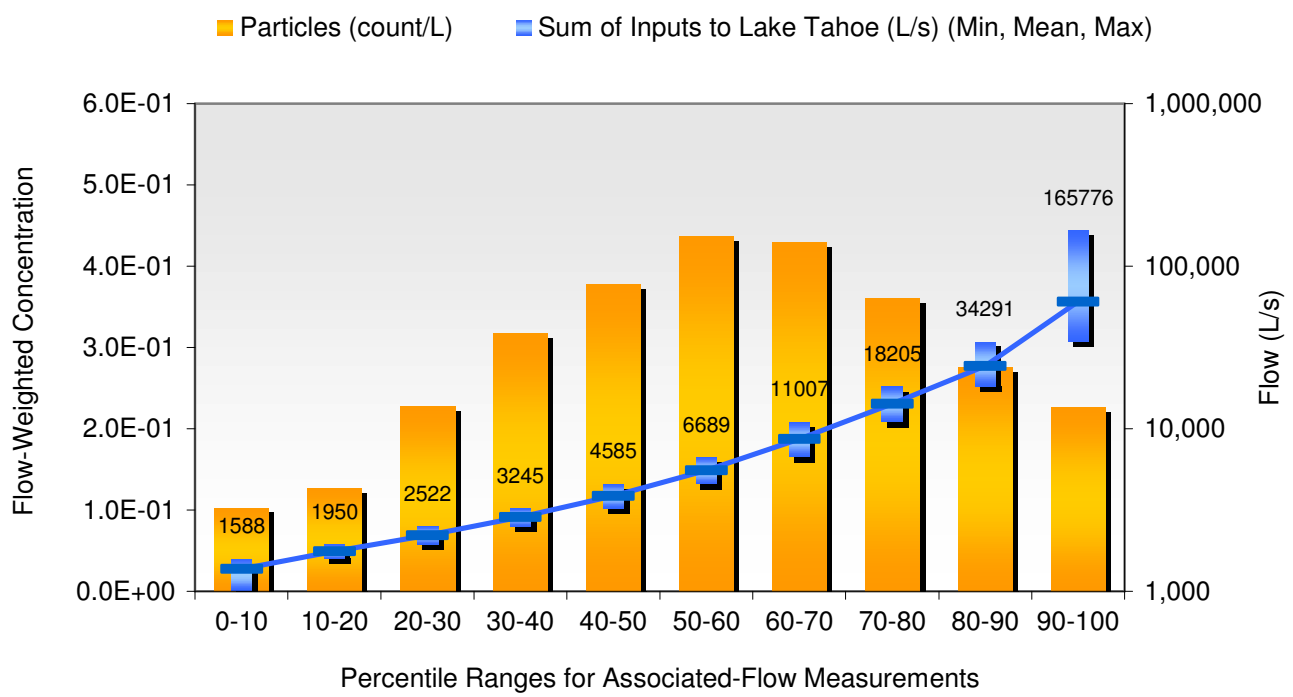

Figure C-8. Flow-associated analysis of daily maximum and average Total Nitrogen loads displayed as flow-weighted concentrations for the third (Clarity Challenge) milestone.

Seasonal Assessment

Lake Tahoe "Clarity Challenge" TMDL
Flow: Sum of Inputs to Lake Tahoe (L/s)
Pollutant: Total Nitrogen
Data from: 1/1/1990 to 12/31/2004

Time Period	Associated Flow			Concentration (mg/L)		Load (kg/day)	
Month	Mean	Min	Max	Mean	Max	Mean	Max
Jan	7,456	1,165	353,760	0.49	1.63	3.1E+05	1.1E+06
Feb	8,484	1,198	109,779	0.52	1.41	3.8E+05	1.0E+06
Mar	17,611	3,294	159,306	0.47	1.51	7.1E+05	2.3E+06
Apr	28,654	7,061	113,302	0.29	1.29	7.1E+05	3.2E+06
May	37,149	3,582	165,776	0.17	0.93	5.4E+05	3.0E+06
Jun	26,682	2,693	162,743	0.14	1.67	3.2E+05	3.9E+06
Jul	9,204	1,819	71,979	0.11	1.23	8.5E+04	9.8E+05
Aug	3,227	1,404	12,762	0.13	1.64	3.5E+04	4.6E+05
Sep	2,154	1,210	14,398	0.20	1.58	3.7E+04	2.9E+05
Oct	2,103	1,114	15,281	0.43	1.85	7.8E+04	3.4E+05
Nov	3,400	1,062	74,382	0.69	1.81	2.0E+05	5.3E+05
Dec	4,845	1,012	137,993	0.59	1.82	2.5E+05	7.6E+05

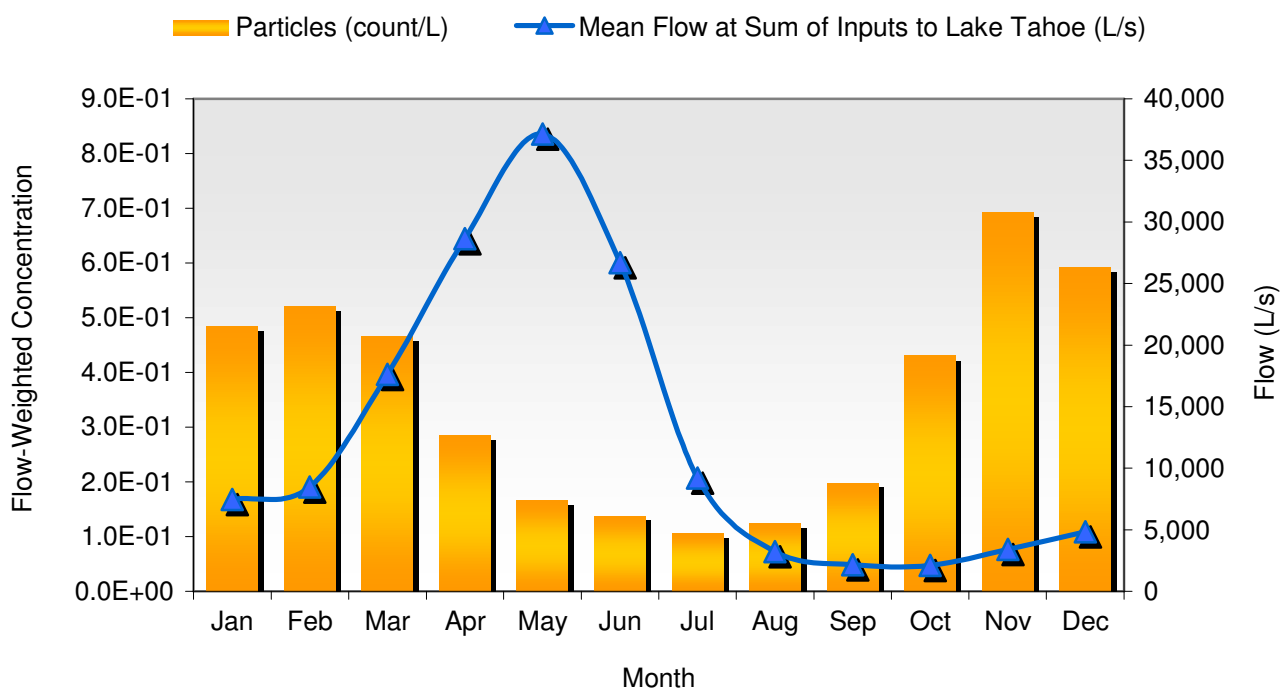

Figure C-9. Seasonal analysis of daily maximum and average Total Nitrogen loads displayed as flow-weighted concentrations for the third (Clarity Challenge) milestone.

Flow-Associated Assessment

Lake Tahoe "Clarity Challenge" TMDL
Flow: Sum of Inputs to Lake Tahoe (L/s)
Pollutant: Total Phosphorus
Data from: 1/1/1990 to 12/31/2004

Flow Range	Associated Flow			Concentration (mg/L)		Load (kg/day)	
Percentile	Mean	Min	Max	Mean	Max	Mean	Max
0-10	1,376	1,012	1,588	0.041	0.097	4.8E+03	1.1E+04
10-20	1,763	1,589	1,950	0.044	0.133	6.7E+03	2.0E+04
20-30	2,212	1,950	2,522	0.055	0.170	1.1E+04	3.2E+04
30-40	2,859	2,524	3,245	0.064	0.214	1.6E+04	5.3E+04
40-50	3,854	3,246	4,585	0.069	0.224	2.3E+04	7.5E+04
50-60	5,541	4,591	6,689	0.075	0.229	3.6E+04	1.1E+05
60-70	8,640	6,696	11,007	0.078	0.320	5.8E+04	2.4E+05
70-80	14,261	11,023	18,205	0.073	0.202	9.0E+04	2.5E+05
80-90	24,350	18,210	34,291	0.067	0.208	1.4E+05	4.4E+05
90-100	60,418	34,368	165,776	0.062	0.185	3.2E+05	9.6E+05

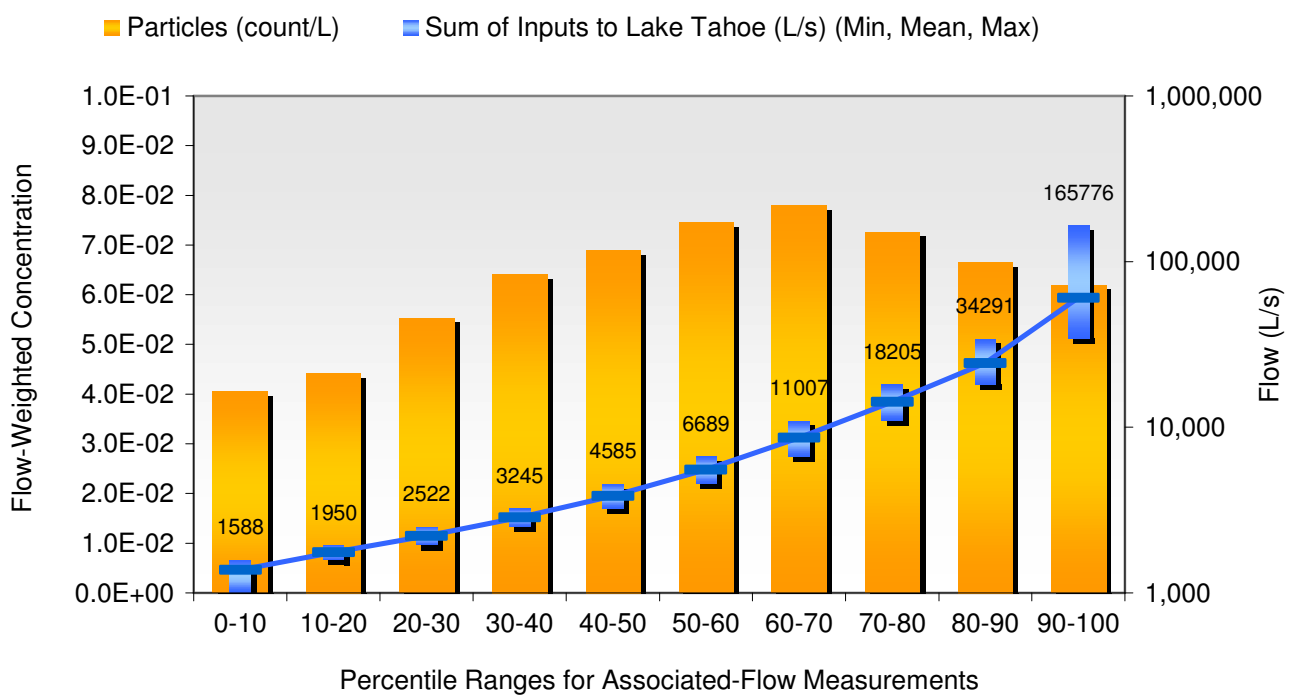

Figure C-10. Flow-associated analysis of daily maximum and average Total Phosphorus loads displayed as flow-weighted concentrations for the third (Clarity Challenge) milestone.

Seasonal Assessment

Lake Tahoe "Clarity Challenge" TMDL
Flow: Sum of Inputs to Lake Tahoe (L/s)
Pollutant: Total Phosphorus
Data from: 1/1/1990 to 12/31/2004

Time Period	Associated Flow			Concentration (mg/L)		Load (kg/day)	
Month	Mean	Min	Max	Mean	Max	Mean	Max
Jan	7,456	1,165	353,760	0.088	0.320	5.7E+04	2.1E+05
Feb	8,484	1,198	109,779	0.089	0.185	6.5E+04	1.4E+05
Mar	17,611	3,294	159,306	0.088	0.247	1.3E+05	3.8E+05
Apr	28,654	7,061	113,302	0.070	0.185	1.7E+05	4.6E+05
May	37,149	3,582	165,776	0.056	0.120	1.8E+05	3.9E+05
Jun	26,682	2,693	162,743	0.050	0.146	1.2E+05	3.4E+05
Jul	9,204	1,819	71,979	0.043	0.144	3.4E+04	1.1E+05
Aug	3,227	1,404	12,762	0.042	0.158	1.2E+04	4.4E+04
Sep	2,154	1,210	14,398	0.049	0.199	9.2E+03	3.7E+04
Oct	2,103	1,114	15,281	0.069	0.229	1.3E+04	4.2E+04
Nov	3,400	1,062	74,382	0.100	0.229	2.9E+04	6.7E+04
Dec	4,845	1,012	137,993	0.096	0.255	4.0E+04	1.1E+05

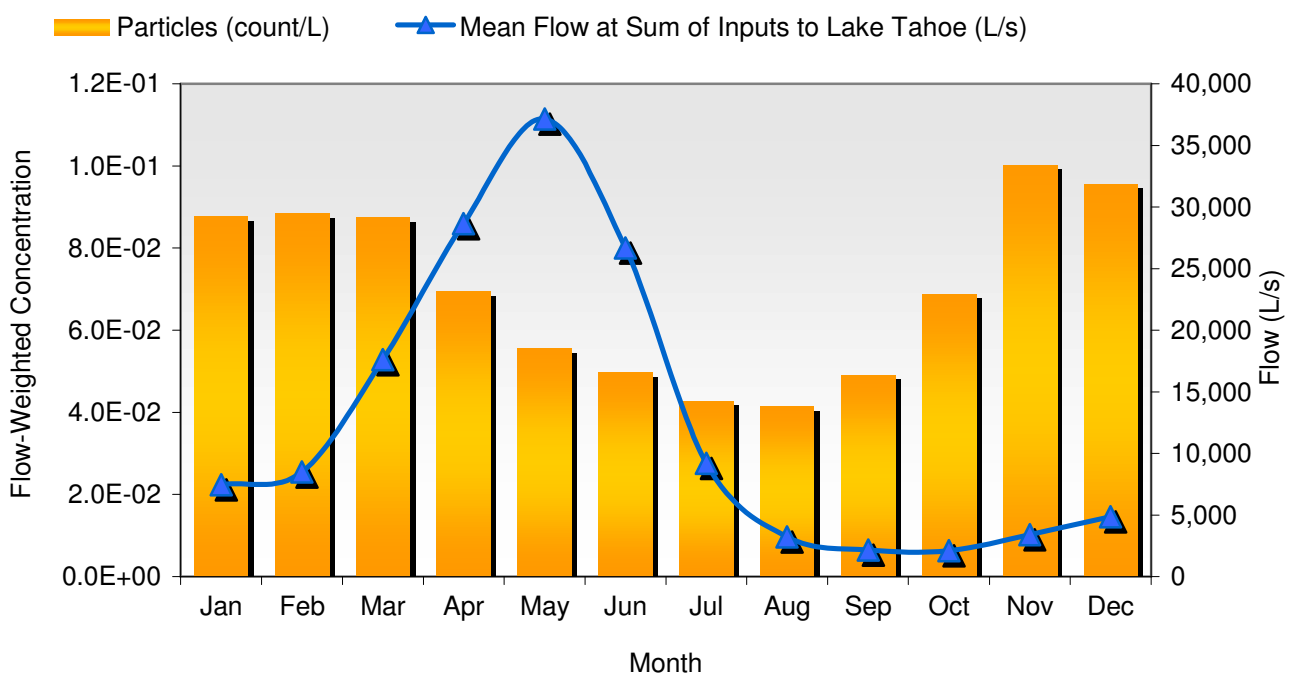

Figure C-11. Seasonal analysis of daily maximum and average Total Phosphorus loads displayed as flow-weighted concentrations for the third (Clarity Challenge) milestone.