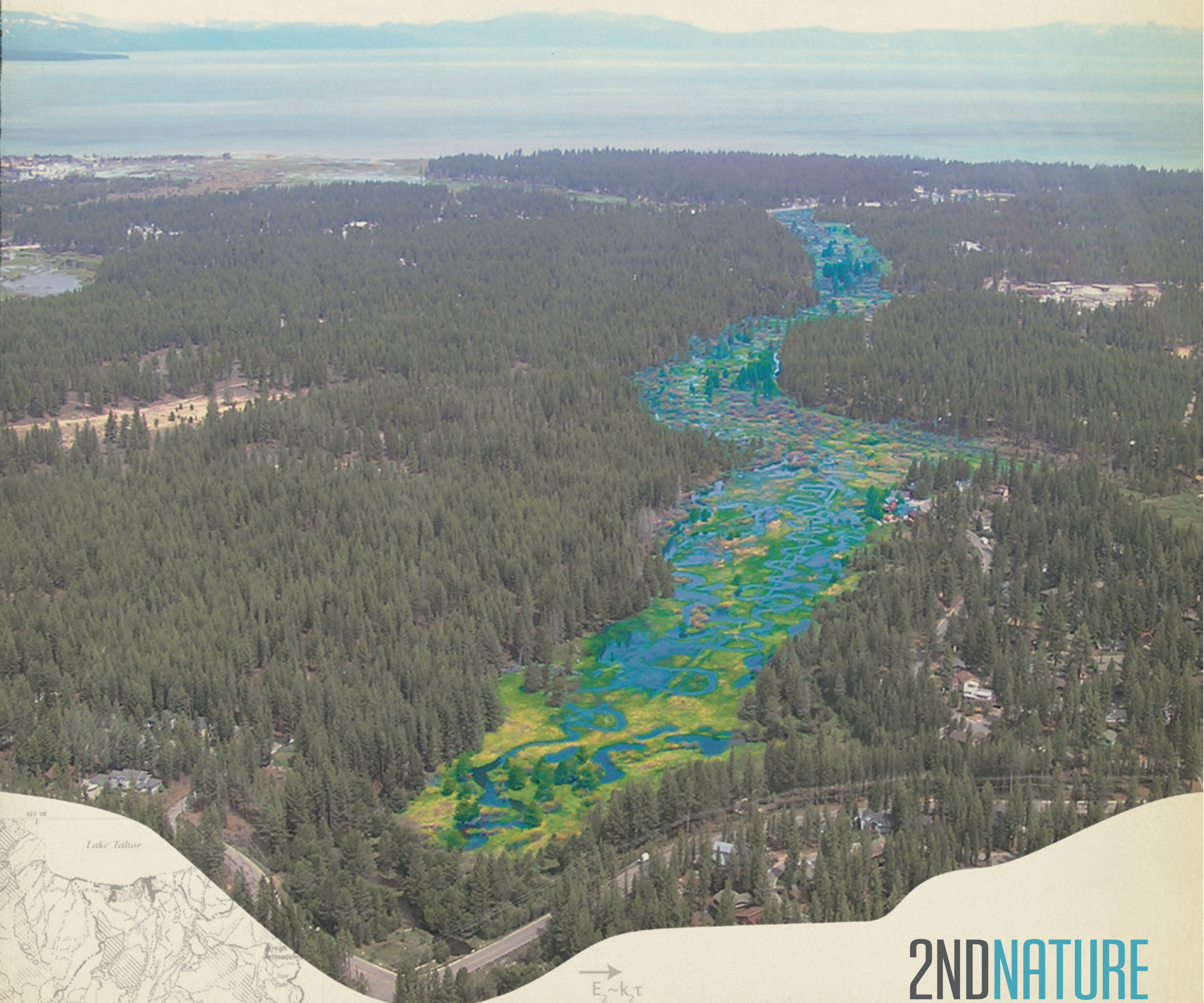
Quantification + Characterization of Trout Creek Restoration Effectiveness

SLRT METHODOLOGY

FINAL CHARACTERIZATION PLAN / April, 2010



$\vec{E_2} \sim k_2\tau$

$E_1 \sim k_1\tau$

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Quantification and Characterization of Trout Creek Restoration Effectiveness; Focused Development of a Stream Load Reduction Methodology (SLRT)

Final Characterization Plan

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CHAPTER 1 – INTRODUCTION

1.1 RESEARCH INTRODUCTION

The proposal entitled *Quantification and Characterization of Trout Creek Restoration Effectiveness* has been funded by USFS SNPLMA Round 9 grant funds with a contract awarded to the 2NDNATURE team in August 2009. The goals and objectives outlined in the research proposal are below.

Goals.
1. Characterize the "desired condition" analog of stream morphology and function in the Lake Tahoe Basin (Trout Creek) by directly applying techniques developed by 2NDNATURE for Lake Tahoe streams.
2. Create a simple empirical methodology to quantify the water quality benefit of stream restoration, using reaches of Trout Creek and Upper Truckee River as tangible examples.

Objectives.
a. Build upon existing SNPLMA research products and others to define and then document the restored Trout Creek physical and chemical conditions.
b. Generate event-based and geomorphic parameters from Trout Creek to further refine the indicators and metrics used to characterize the geomorphic and water quality benefits of stream restoration projects.
c. Analyze and apply the data available to create the Stream Load Reduction Tool to standardize how the water quality benefits of stream restoration projects are estimated in the context of the Lake Tahoe TMDL.
d. Identify opportunities to employ the Stream Load Reduction Tool to evaluate restoration alternatives and future project effectiveness.

This Characterization Plan is the initial deliverable under the research contract and further refines the research team's approach to completing the intended research goals given available resources. Based on discussions and written comments with the *Research Technical Advisory Committee (TAC)* members (March 18, 2010), the research team has narrowed the approach and specific deliverables to be provided under this contract given available resources (Appendix D). Based on the TAC feedback and prioritization the research team has revised the research goals and objectives. To better reflect the priorities of the available resources the research title has been revised to: **Stream Load Reduction Tool (SLRT) Methodology; Case Study: Trout Creek Restored Reach.**

Revised Goals.
1. Provide detailed guidance on the recommended methods to quantify the water quality benefit of stream restoration in the Lake Tahoe Basin.
2. Characterize the "desired condition" analog of a restored stream morphology and condition in the Lake Tahoe Basin (Trout Creek) by directly applying techniques developed by 2NDNATURE and others for Lake Tahoe streams.

Revised Objectives.
a. Create and assess a range (based on complexity) of methods to quantify the total and fine sediment load reduction of stream restoration efforts in the Lake Tahoe Basin, using Trout Creek as the case study.
b. Compile and apply available data to inform the inputs and validate the outputs of Stream Load Reduction Tool (SLRT) estimates.

c. Design and implement a detailed data collection effort from Trout Creek (WY 2010 and 2011) to augment existing data and directly inform SLRT assumptions, input parameters and validate results.
d. If resources are available in WY 2011, apply the riverine module of California Rapid Assessment Methodology (CRAM) to Trout Creek and other sites as appropriate to test applicability of CRAM to discern pre and post restoration effects and detect differences in SEZ condition in the Lake Tahoe Basin.

The allocation of research funds will remain flexible given the unpredictability in the occurrence of overbank flow conditions during the research duration which is necessary to achieve the majority of Objective C. The revised objectives are more specific and include the potential allocation of unused resources in WY2011 should overbank flows not occur. Should resources remain in the research budget following spring snow melt 2011 the research team may implement efforts to meet Objective D. The decisions will be made collectively with the research team and TAC in 2011.

1.2 RESEARCH APPROACH

The 2NDNATURE team recently completed the Riparian Restoration Evaluation and Effectiveness Framework (2NDNATURE 2010) funded by a Round 9 SNPMLA research grant. The 2NDNATURE team wants to build upon the previous efforts, fill any remaining applied research gaps intended by the Round 9 funding, and remain flexible to ensure available resources are expended in the most appropriate and efficient manner given existing needs and constraints. The TAC members who advised the Round 8 Framework efforts will serve as the Round 9 TAC to maintain consistency and most effectively address practitioner, agency and programmatic research needs given available resources. Given discussions, feedback and current priority issues facing stream restoration in the Lake Tahoe Basin, the research team recommends the research focus on the following products, in order of priority:

1. A recommended methodology to estimate pollutant load reduction on an average annual basis as a result of stream environment zone (SEZ) restoration.
2. Site specific data collection during spring peak flow conditions in Trout Creek to inform the assumptions and algorithms of the methodology.
3. Pilot study to evaluate the potential use of CRAM in evaluation of SEZ restoration projects and SEZ assessment in the Tahoe Basin.

The research effort will focus primarily on the development, implementation and analysis of a range of techniques to estimate the sediment load reduction benefits of stream restoration projects. These techniques have varying levels of complexity in the components necessary to provide a Stream Load Reduction Tool (SLRT) methodology to stream practitioners. The development and analyses of this range of estimation techniques will allow a determination of the ability of these techniques to provide accurate, precise results as the complexity of information needed to complete estimations increases. The research will assess the cost and accuracy of each methodology and provide clear recommendations on the scenarios (phase of restoration, size of restoration, scale of restoration, potential application should SEZ restoration project water quality credits be available in the future, etc) for which level of complexity may be most appropriate. The development and validation of SLRT methods will require synthesis and application of existing Trout Creek data obtained by others, as well as detailed data collection by the 2NDNATURE team during the 2010 and 2011 water years.

Should resources remain due to lack of overbank flow conditions in WY2010 and WY 2011, the 2NDNATURE team may apply the existing CRAM riverine module to:

1. Evaluate the ability of CRAM to discern pre- and post- project effects.
2. Evaluate the ability of CRAM to detect large differences in assumed disturbance and SEZ health.

CRAM scores will be generated for pre- and post-restoration for at least 2 restored reaches based on the best available existing data and site visits. The pre-restoration site conditions will be recreated based on existing pre-project data and the extensive personal knowledge of the project team. The existing condition of up to 4 additional SEZ reaches will be evaluated by CRAM using trained field personnel. The purpose of the CRAM evaluation of additional sites will be to place the results of Trout Creek into a regional context based on the evaluation of a small range of comparable low gradient, fine grained substrate streams within the Lake Tahoe Basin. The extent of the CRAM evaluations will be dependent upon available resources following the spring snow melt magnitude in 2010 and prioritization of the CRAM evaluation by the TAC members. If completed, the CRAM pilot study will be summarized in a standalone review of the CRAM results, the limitations of the existing CRAM riverine module and the research team's recommendations to improve the application of CRAM on Lake Tahoe SEZs into the future.

Based on this proposed approach, the research products and schedule are provided in Table 1.

Table 1. Research Products and Schedule.

Contract initiation data 8/20/09

Task 1. Trout Creek Characterization Plan Date Due	Date Due
Obtain any applicable Trout Creek physical, chemical, and/or biological data that 2NDNATURE may not have	11/18/09
Draft Trout Creek Characterization Plan and present to TAC members	3/18/10
Revise and finalize Characterization Plan	4/18/10
Task 2. Trout Creek Characterization	
Instrument and maintain sites	May 2010
Detailed snow melt monitoring (2011 efforts will be conducted if resources remain and are not expended during 2010 efforts)	April – July 2010, 11
CRAM field evaluations (if 2011 resources allow)	July 2011
Manage Database and data	Ongoing
Task 3. Data Analysis and SLRT development	
Integrate all relevant existing hydrologic, geomorphic, and water quality data	July 2011
Refine and analyze SLRT methodologies using existing data	July 2011
Task 4. Technical Report: Trout Creek Characterization and Quarterly Reporting	
Draft Stream Load Reduction Tool and Analysis	Dec 2011
Final Stream Load Reduction Tool and Analysis	February 2012
Quarterly progress reports/invoicing	ongoing

1.3 LOCATION OF RESEARCH

Research and the SLRT modeling example will focus on the restored reach of Trout Creek bound by Pioneer Trail and Martin Avenue in South Lake Tahoe, CA (Figure 1). Existing and upcoming data collection funded under this research will be conducted within the restored reach and associated floodplain to inform modeling assumptions, generate input values for the Trout reach and validate estimates to the extent practical.

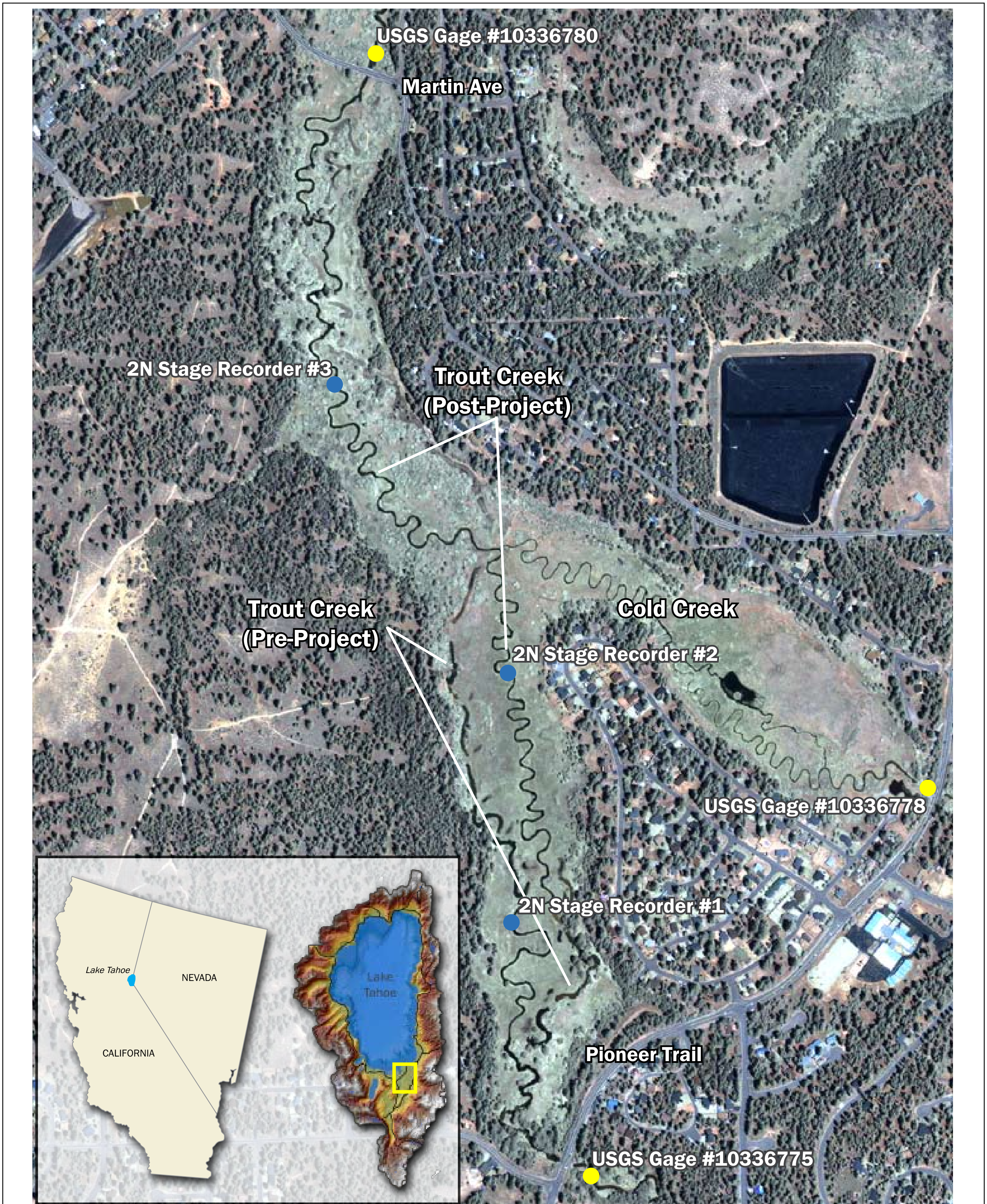

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FIGURE 1: Trout Creek geography and instrumentation site locations. 2NDNATURE stage recorders expected to be deployed from June 2009 through June 2011.

Should CRAM be completed, the evaluations will focus upon the ability of CRAM to detect stream restoration improvements in Trout Creek. In order to achieve this, CRAM scores of pre- and post- conditions of completed projects may include Angora Sewer Reach and Cookhouse Meadow. Additional CRAM evaluations may be completed on highly disturbed sites such as specific Upper Truckee reaches and relatively undisturbed reaches such as Trout Creek and Angora Creek upstream of the restoration sites. Including the larger sample will increase our ability to evaluate Trout Creek effectiveness, and will allow for a pilot test of CRAM in the Lake Tahoe Basin setting.

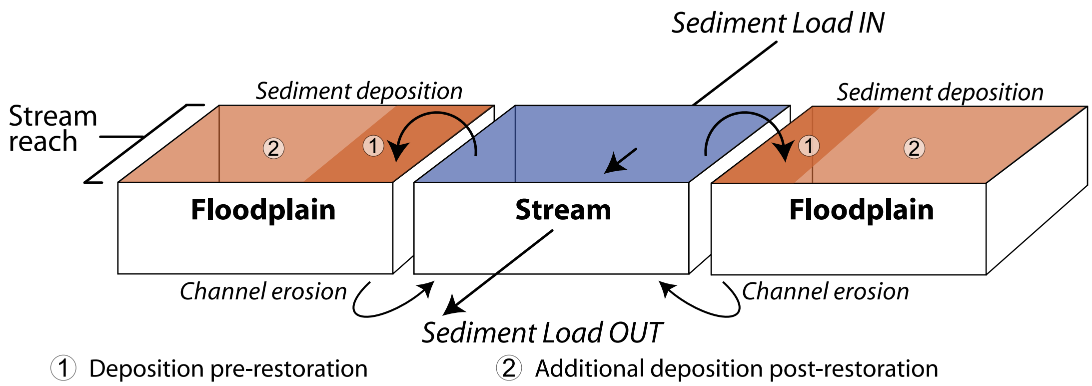
1.4 POLLUTANTS OF CONCERN

Sediment and nutrient species are the pollutants of concern in Lake Tahoe riparian systems due to their identified impact on impairing lake clarity. Fine inorganic sediment particles (FSP <16 µm) have been identified as the primary pollutant impairing clarity (Swift et al., 2006) due the very high residence time of these particles within the lake water column. The Lake Tahoe TMDL (Lahontan Water Quality Control Board and Nevada Division of Environmental Protection, 2009) identified that 72% of the total annual FSP loading to Lake Tahoe originated from urban stormwater runoff and only 4% is the result of streambank channel erosion inputs. However, there is a potentially significant opportunity to reduce long-term FSP loading from urban stormwater when routed to functional SEZs. The SLRT is intended to be a repeatable, relatively accurate and cost-effective methodology to estimate the potential pollutant load reductions expected from restoration of SEZ to more functional conditions. While the pollutants of concern noted within the Lake Tahoe TMDL include total and dissolved nitrogen (N) and phosphorous (P) species as well as total suspended sediment (TSS) and FSP, the initial version of the SLRT will be limited to the fate and transport of TSS and FSP only. Due to some similarities in primary sources and sinks of sediment and nutrients within riparian systems, the general model inputs and factors will likely apply but may need to expand to incorporate N and P estimates in future versions of the SLRT.

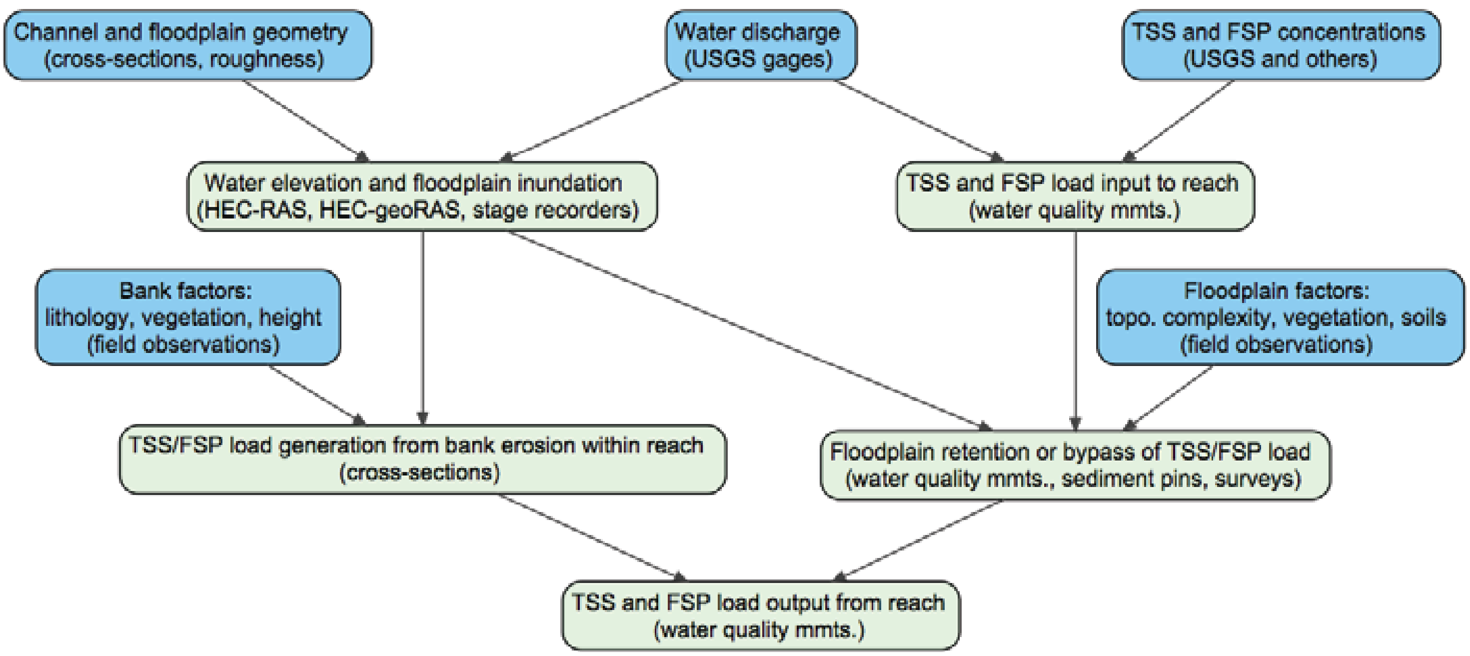
CHAPTER 2 - SLRT MODELING APPROACH

The SLRT will be a repeatable yet cost-effective methodology to estimate the average annual pollutant load at the downstream reach of stream restoration project for both pre- and post-restoration conditions. Water quality effectiveness of a stream restoration project (defined as the expected pollutant load reduction as a result of restoration actions) can be assessed as a function of 1) the storage of pollutants that would otherwise have reached downstream areas (floodplain deposition) and 2) the reduction in pollutant generation via stability of the stream banks that would otherwise have eroded (Figure 2). Thus, the SLRT will allow for a load reduction estimate of a stream restoration effort by determining the expected difference in pollutant loading pre- and post-restoration actions.

Given the range of potential levels of complexity to model the two key processes above, the 2NDNATURE team will develop, implement and analyze a range of modeling approach options to inform the recommendations of the most appropriate water quality benefit estimation methods given cost, complexity of model, complexity of data input necessary for tool and the associated increase in precision and accuracy. The final report will include details of the each of the modeling methodologies, the load reduction estimates based for Trout Creek and recommendation of the appropriate SLRT methods to be used in the future for different scenarios.



Simplest conceptual model: For a given stream reach, transfer of mass (water, sediment) is from the stream to the floodplain and of mass (sediment) from the banks to the stream. The amount of sediment sequestered on the floodplain or produced by channel erosion depends on factors that reflect the physical and biogeochemical processes acting on the total and fine (<16 µm) sediment.



General structure of SLRT models: field measurements of water quality and channel and floodplain characteristics (blue) constrain calculations of floodplain inundation, channel erosion, and floodplain deposition (green). Information and/or data needed to validate and improve calculations are noted in green boxes within parentheses. The difference between sediment load inputs and outputs represents the water quality benefit of the reach. Comparison of the output pre- and post-restoration indicates the net water quality benefits of the project.

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SLRT CONCEPTUAL MODELING APPROACH

FIGURE 2

2.1 SLRT MODELING APPROACH OPTIONS

Geomorphic modifications of incised channels in the Lake Tahoe Basin aim to increase the likelihood of inundating upland areas adjacent to the stream channel, allowing deposition of sediment on the floodplain and decreasing in-channel shear stress that drives sediment generation via channel erosion. Modeling the potential loading of TSS and FSP at the downstream end of stream restoration projects therefore requires several types of information for the pre- and post-project conditions of the subject reach.

To estimate floodplain deposition, we must know 1) TSS and FSP load inputs to the upper portions of the study area (Figure 3.1); 2) the frequency of discharge conditions that cause inundation of the floodplain (Figure 3.2); and 3) the fraction of sediment deposited on the floodplain for different water discharge values, reflected as a retention coefficient (Figure 3.3). To estimate the reduction in stream bank erosion, we must know the amount of channel erosion for different water discharge values (Figure 4).

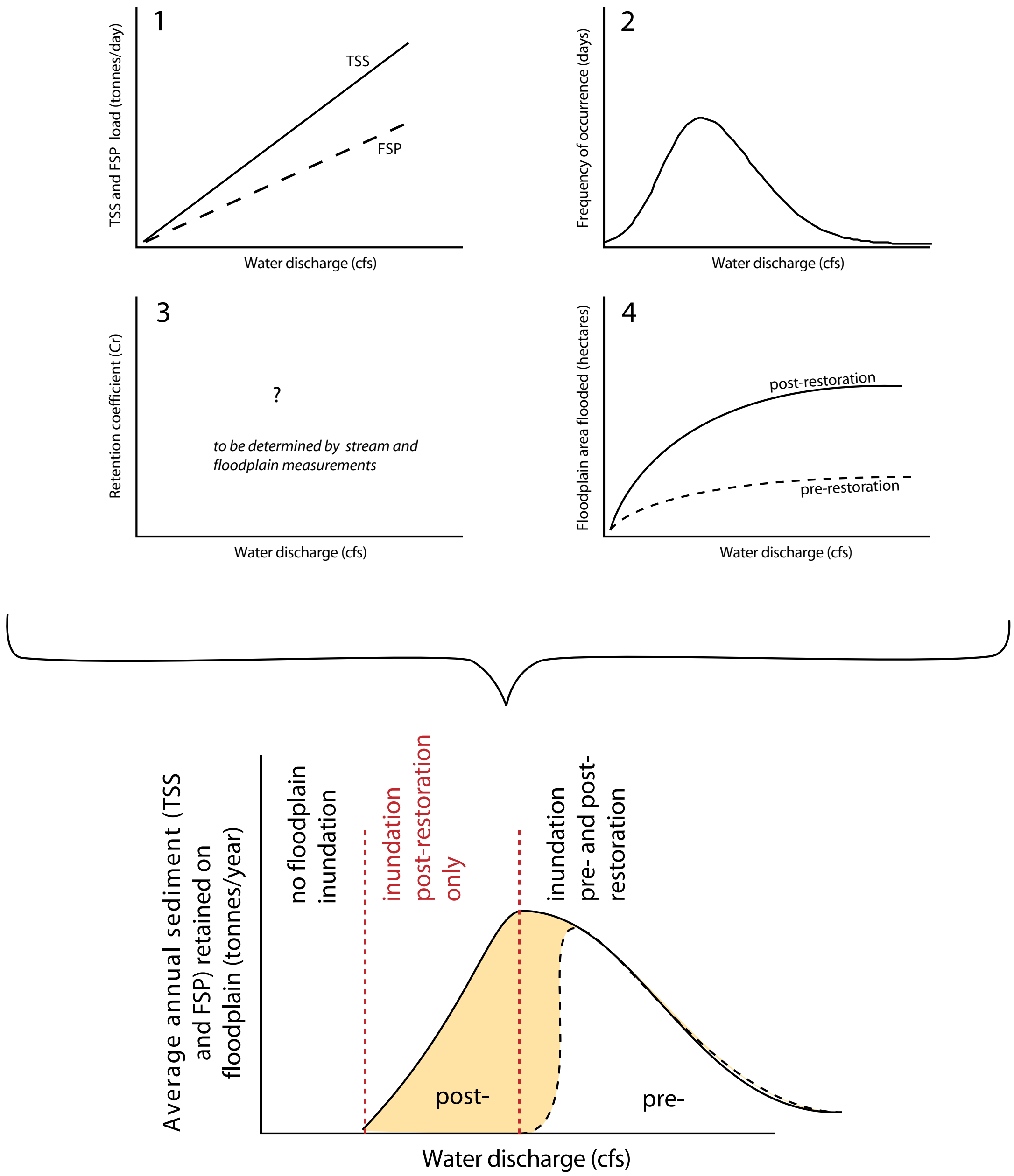
This information can be determined with varying levels of complexity using a combination of modeling and field sampling. Complexity potentially increases accuracy, but also increases cost and potentially decreases portability of the SLRT to different settings. We outline three potential approaches below for the SLRT to model floodplain deposition and channel erosion, from simplest to most complex, with respect to the data collection needs and sophistication of computational tools used. The simplest approach uses one-dimensional modeling that can be implemented in a spreadsheet for the full range of possible discharge conditions, while the most complex approach incorporates two-dimensional modeling to predict the effects of individual discharge events.

2.2 FLOODPLAIN INUNDATION AND DEPOSITION

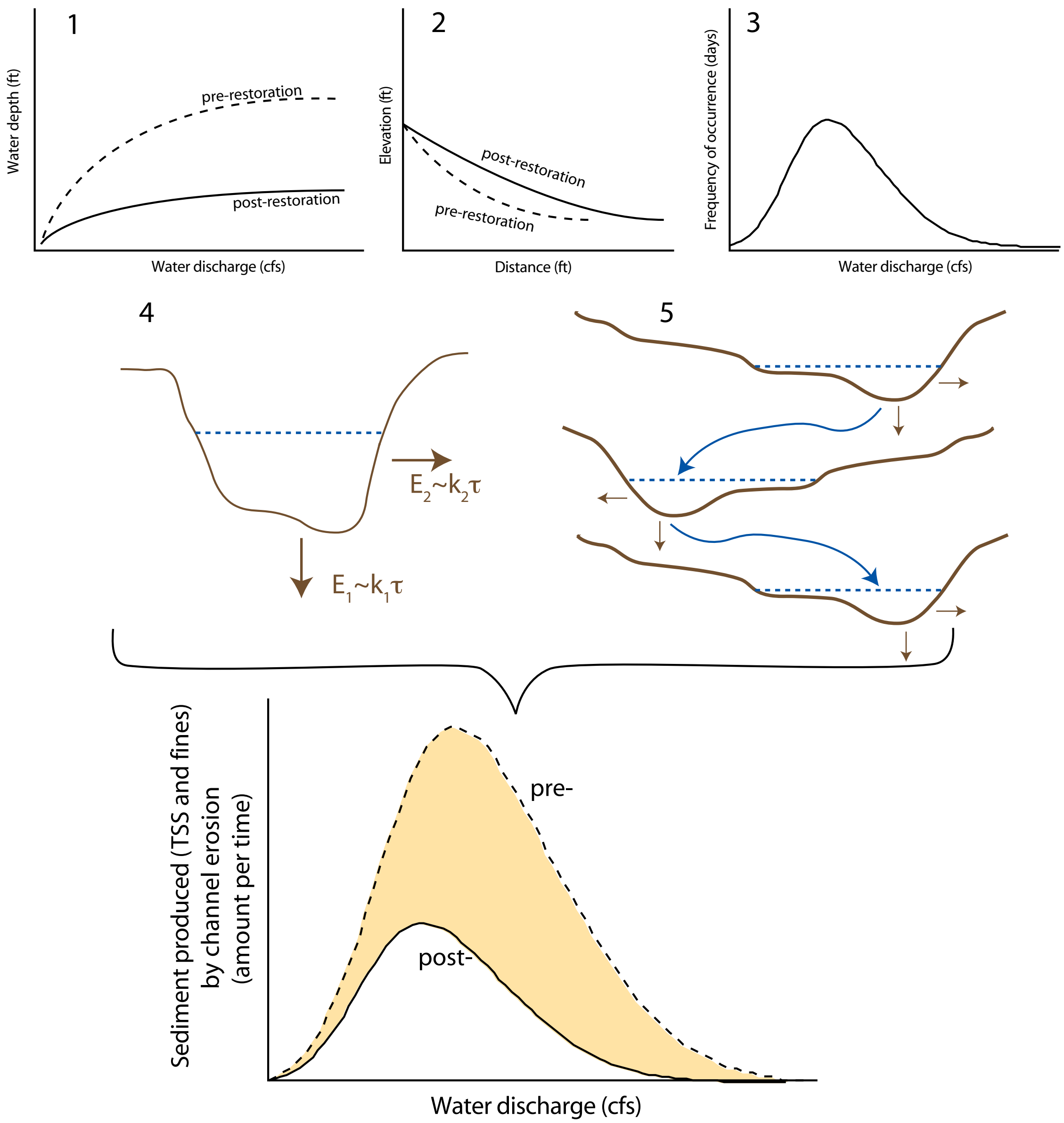
For all floodplain-modeling approaches (summarized in Figure 3), we hypothesize that floodplain deposition need only be assessed for a finite range of discharge values. Low discharge events are irrelevant because they do not exceed the channel capacity of even the restored channel and thus the floodplain will not be inundated for either pre- or post-restoration conditions. We suggest that the extremely high discharge events are not necessary to be modeled by the SLRT because they happen relatively infrequently and will overwhelm the floodplain's ability to retain water with little impact by restored channel-floodplain morphology. These events are likely to produce large sediment loads to downstream areas regardless of the restoration strategy that has been implemented.

Simple Approach. The simplest floodplain component of the SLRT can be implemented in a spreadsheet using the following pieces of information to estimate water quality benefits of stream restoration:

- TSS and FSP samples at different discharge conditions (available for many sites from U.S. Geological Survey stream gages, available online at http://waterdata.usgs.gov/nwis),
- Minimum discharge estimates for floodplain inundation pre- and post-restoration reach conditions (generally determined during restoration planning), and
- Discharge measurements to determine probability (i.e., frequency) of different discharge conditions occurring (can be determined from a histogram of discharge values from U.S. Geological Survey stream gages, available online at http://waterdata.usgs.gov/nwis).



Floodplain deposition model: Deposition on the floodplain for total and fine sediment can be determined in the simplest case using water quality (1) and water discharge data (2) to determine the amount of sediment transported during discharge conditions with inundation post-project but not pre-project. The model can be made more complex by incorporating additional data from floodplain measurements to determine a retention coefficient that estimates the fraction of TSS and FSP load retained on the floodplain for different discharge conditions pre- and post-project (3). The retention coefficient is based on floodplain factors such as vegetation height and density, floodplain area, and topographic complexity. The most complex case incorporates a model of 2D flow to determine specific areas inundated for different discharge conditions (4). We hypothesize that the primary



Channel erosion model: Generation of total and fine sediment by erosion of the channel can be determined in the simplest case using changes in average channel water depth for a given discharge (1) from lowering bank heighs and/or raising bed elevation, and in channel gradient (shown as changes in the longitudinal profile in 2) from increasing sinuosity. The intermediate-complexity case adds additional parameters to consider the probability of particular water discharge occurrence (3) and to separately model vertical incision and stream bank erosion (4). In the complex case, a 2D model (HEC-geoRAS or CONCEPTS) would calculate vertical and horizontal erosion for multiple cross-sections, thereby producing 2D erosion results (5). The cumulative water quality benefit is greatest at intermediate water discharge conditions (bottom graph).

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CHANNEL EROSION MODEL COMPONENTS FOR SLRT

FIGURE 4

The net benefits to water quality from floodplain deposition (ΔD) generated by the restoration project can be calculated as

$$\Delta D = \sum_{i=Q_{post}}^{Q_{pre}} S_i t_i \qquad \text{(E1)}$$

where S_i is the incoming TSS and FSP load for a given discharge and t_i is the expected amount of time that a given discharge occurs over the pre-defined study period. The discharge range considered is between the discharge value at channel capacity post-project Q_{post} (lower values are ignored because no inundation occurs pre- nor post-project) to the discharge value at channel capacity pre-project Q_{pre} (higher values are ignored because inundation occurs both pre- and post-project). The simple approach assumes that all water in overbank conditions reaches the floodplain and that all sediment transported by that water is deposited.

The advantage of this approach is that there are minimal data needs, and therefore the tool is highly portable to different streams within the Tahoe basin. However, this calculation likely overestimates deposition for the range of discharges Q_{pre} to Q_{post} because it is unlikely that 100% of the sediment transported during an inundation event reaches the floodplain and that 100% of the sediment that reaches the floodplain is retained. The calculation likely underestimates post-project deposition at discharge values greater than Q_{pre} (Figure 3, bottom graph) because it assumes no difference between deposition pre- and post-project at these discharge conditions.

Intermediate Approach. The Simple Approach can be made more realistic by including a coefficient R_i that expresses the percent of sediment retained on the floodplain at different discharge conditions (Figure 3.3):

$$\Delta D = \sum_{i=Q_{post}}^{Q_{pre}} R_i S_i t_i \qquad \text{(E2)}$$

When the depth of water on the floodplain is small, vegetation and topographic complexity will slow the water and allow sediment deposition. However, when the depth of water on the floodplain is large, flow will be turbulent and deposition will be inhibited. We propose that a method using rapid protocols can be used to estimate retention coefficients at different discharge conditions by incorporating the following characteristics of the floodplain:

- Floodplain area compared with discharge
- Vegetation density and height,
- Topographic relief (complexity), and
- Soil type (the control on infiltration rate).

We hypothesize that when water is deeper than the topographic relief and vegetation height, some fraction of the surface water introduced to the floodplain passes untreated to downstream areas. Adding this complexity to the Simple Approach allows for different models for floodplains with differing characteristics like high grass and shrub distribution, topographic complexity, and the presence large woody debris that could increase floodplain sediment retention. Different coefficients can be used for pre- and post-project conditions. Unfortunately, few data are currently available to adequately constrain the retention coefficient.

Complex Approach. Two-dimensional models of floodplain flow using a custom finite-element methodology and/or a publically available program like HEC-GeoRAS provide the most realistic reconstruction of water flow across the floodplain and therefore offer 1) the potential to assess the role of floodplain channels to bypass the floodplain at lower-than-expected discharge values, and 2) the possibility of considering non-uniform roughness and vegetation coverage. A HEC-GeoRAS model for pre- and post-project reach conditions will allow the calculation of water depth, velocity, and shear stress for a particular discharge conditions. Floodplain deposition can then be related to depth, velocity and/or shear stress based on floodplain factors such as vegetation height and density. A research group from UC-Davis (S. Andrews, pers. comm.) is developing a similar 2D floodplain model for Trout Creek by modifying the BreZo flood simulation model (available at http://sanders.eng.uci.edu/brezo.html).

The Complex Approach requires the same data as the Intermediate Approach, plus x, y, z data that are not needed for the Simple and Intermediate Approaches from a model input requirements. HEC-RAS model development for cross-sections of the channel is a common element of stream restoration design planning, thus in most instances some key inputs for a HEC-GeoRAS model would be available for past projects and would be collected for future projects. However, for previously completed projects pre-project data may be incomplete for some complex models, and for future projects post-project data must be estimated based on the project design.

2.3 STREAM CHANNEL EROSION

As with modeling of floodplain deposition, we present three different approaches varying in level of complexity and summarized in Figure 4.

Simple Approach. The simplest component of channel erosion of the SLRT can be implemented in a spreadsheet to determine the decrease in the average shear stress acting on the channel from the restoration project. This approach assumes that the amount of sediment generated from the channel via erosion is a direct function of shear stress (cf., Simon et al., 2000). Shear stress (τ) is defined as $\rho_w gds$, where ρ_w is the density of water, g is the acceleration due to gravity, d is the depth of water and s is the slope of the channel.

The following data are needed to determine the reduction in sediment inputs to the system from channel erosion as a result of restoration actions:

- Change in channel depth by lowering banks and/or raising the bed during restoration, generally assessed in the restoration planning and checked through channel cross-section measurements (Figure 4.1)
- Change in channel slope by increasing the channel length during restoration, generally assessed in the restoration planning and checked through channel longitudinal profile measurements (Figure 4.2)

The percent reduction in sediment generated by channel erosion can be estimated using the percent reduction in shear stress ($\Delta\tau$) acting on the channel:

$$\Delta\tau = \left(\frac{d_{post} s_{post} l_{post} - d_{pre} s_{pre} l_{pre}}{d_{pre} s_{pre} l_{pre}} \right) \qquad \text{(E3)}$$

where d_{post}, s_{post}, and l_{post} are the depth of water and slope and length of the channel post-restoration; and d_{pre}, s_{pre}, and l_{pre} are the depth of water and slope and length of the channel pre-restoration. Including the terms l_{pre} and l_{post} accounts for the fact that the post-restoration shear stress acts on a longer channel, which partially counteracts the effects of reducing the shear stress. Assuming that the primary pre-restoration channel erosion was from vertical erosion that led to channel entrenchment, the total sediment reduction per year (ΔE) would then be:

$$\Delta E = \rho_b \frac{l_{pre} w_{pre} e_{pre}}{t_{pre}} \Delta \tau \qquad \text{(E4)}$$

where w_{pre} is the width of the channel pre-restoration, e_{pre} is the vertical erosion that caused channel entrenchment, t_{pre} is the time span over which the pre-restoration incision occurred, and ρ_b is the bulk density of the channel material. The advantage of this approach is that it allows rapid calculation of the sediment-load reduction as a result of reduced channel erosion without relying on parameters that can be difficult to quantify. Disadvantages include 1) that it does not allow for changes in lithology, particularly from armoring banks during restoration, 2) that it does not distinguish between bank and bed erosion, and 3) the precise rate of pre-restoration erosion may be unknown.

Intermediate Approach. The Simple Approach can be made more realistic by including water discharge data to determine water depth and the frequency of occurrence for the range of discharge conditions (Figure 4.3), and by including separate coefficients that relate shear stress to incision (k_1) and bank erosion (k_2) (Figure 4.4):

$$\Delta E = \rho_b \sum_{i=Q_{min}}^{Q_{max}} \left[k_1 \left(\tau_{post,i} l_{post} w_{post} - \tau_{pre,i} l_{pre} w_{pre} \right) + k_2 \left(\tau_{post,i} l_{post} h_{post} - \tau_{pre,i} l_{pre} h_{pre} \right) \right] t_i \qquad \text{(E5)}$$

where post- and pre-restoration parameters are denoted with "pre" and "post" subscripts, τ_i is shear stress at a given discharge *i*, *l* is channel length, *w* is channel width, *h* is bank height, and t_i is the expected amount of time that a given discharge *i* occurs over the relevant study period. This approach has the advantage of a more realistic expression of channel conditions while remaining relatively simple to calculate. Scaling of coefficients *k* can be found in previous studies (e.g., Simon, 2008; Simon et al., 2000). The disadvantage is that the modeled water flow is not two-dimensional, and therefore changing shear stress around meanders is not incorporated into this approach. Moreover, layered bank stratigraphy is not considered here. However, layered bank stratigraphy can be considered using the Bank Stability and Toe Erosion Model (BSTEM) to calculate erosion rates for particular discharge conditions. BSTEM has been applied to Trout Creek (V. Mahaceck, pers. comm.) and could be implemented as part of an Intermediate Approach for channel erosion.

Complex Approach. Two-dimensional models of channel erosion can be developed using HEC-GeoRAS output to determine two-dimensional distribution of shear stress, which can then be related to channel erosion as discussed above, allowing more realistic modeling of channel erosion around meander bends (Figure 4.5). As noted above, we have begun to build a HEC-GeoRAS model for the post-restoration reach of Trout Creek to assess the strengths and limitations of HEC-GeoRAS in assessing channel erosion. Alternatively, a CONservational Channel Evolution and Pollutant Transport System (CONCEPTS) model could be developed, and has already been done to a limited extent for Trout Creek and other Tahoe streams by E. Langendoen (pers. comm.). As with the Complex Approach for floodplain deposition, the necessary data inputs can be overwhelming for projects with limited budgets, and the data inputs for completed projects may be unobtainable for pre-restoration conditions and for potential future projects must be estimated for post-restoration conditions.

2.4 ASSESSMENT OF MODEL APPROACHES

2NDNATURE will develop examples of the SLRT for the range of approaches presented above, producing two types of results: 1) an estimate of the water quality benefits of Trout Creek restoration, and 2) a comparison of the model approaches used. The models assessed will include:

Table 2. Summary of methodologies to be developed and/or assessed for SLRT recommendations.

Model	Floodplain Retention	Channel Erosion
2N Simple Approach	X	X
2N Intermediate Approach	X	X
2N Complex Approach (HEC-geoRAS)	X	X
Modified BreZo (UC-Davis)	X	
CONCEPTS		X
BSTEM		X

Two fundamental questions that will be addressed are whether additional complexity (and associated costs) improves accuracy of the models, and which types of field data are needed to implement and validate the models. For each model, we will assess:

- Cost and level of expertise necessary to implement the model
- Performance of the model, including validating the model results and assessing the types of output that the model produces
- Parameters needed to implement the model and relative costs/complexity to obtain
- Parameters that model results are sensitive to
- Appropriate uses of the model, focusing on strengths and weaknesses of each approach

A detailed assessment of each SLRT model will be a valuable product and will inform our recommendations on how to standardize how water quality benefits of stream restoration projects are estimated in context of the Lake Tahoe TMDL.

For Trout Creek, model implementation requires compilation of data previously collected pre- and post-restoration, and additional field data that the 2NDNATURE team will collect as part of this research project. Model validation requires field samples and observations when floodplain inundation occurs. It is possible that floodplain inundation will not occur during the study period of WYs 2010-2011 and existing data and assumptions will be have to be more intensively leveraged In Chapter 3, we detail Trout Creek data already assembled by the 2NDNATURE team and provide an example of the simple approach SLRT for Trout Creek. In Chapter 4, we outline our data collection strategy for Trout Creek, with explicit recognition that the exact strategy will depend on the discharge conditions during the research timeline.

CHAPTER 3 - TROUT CREEK CASE STUDY

Water was first introduced to 3 km of constructed new channel in the Trout Creek restored reach in October 2001. Restoration goals included increasing overbank flow and sediment deposition, and creating wetland habitat adjacent to the channel (Haen Engineering, 1998). Channels were designed to have overbank flow at discharge levels greater than 70 cfs upstream of the Cold Creek confluence and 90 cfs below Cold Creek (Watershed Restoration Associates, 2000). Sinuosity of the channel as a result of restoration has increased and the slope has decreased from the addition of meander bends. Floodplain vegetation was restored by salvaging pre-project sod and plants, as well as scattering seeds of native riparian plants (Haen Engineering, 1998). Impacts to streamflow and groundwater as a result of the restoration project was studied by Tague et al. (2008); however, improvements to water quality have not been systematically assessed to determine if the restoration project has accomplished pre-project goals.

3.1 AVAILABLE TROUT CREEK DATA

This document summarizes the proposed approaches to the SLRT model, thereby identifying specific data requirements from Trout Creek to serve as the case study. This SLRT model will provide an estimate of water quality benefits from the Trout Creek restoration project. It will also demonstrate methods to determine water quality impacts of future stream restoration projects, including specific recommendations for the type of data to collect pre- and post-project to constrain the SLRT model.

Meeting research objectives require a compilation of a variety of existing and future data from the restored reach of Trout Creek. The research will include integration of existing pre- and post-project data obtained from the restored reach by others specifically from Trout Creek, as well as data generated over the 2010 and 2011 water years by the 2NDNATURE team. The 2NDNATURE team is continuing to obtain and compile existing datasets and sources. The current list of data and sources obtained is outlined in Table 3.

We have begun to compile and mine existing data for historic cross-sections (cross section data, bankfull survey), floodplain and channel conditions (pebble counts, pool/riffle info, soil data) and constraints on the relationship between water discharge and stage, TSS, and FSP. The majority of data obtained represents post-restoration conditions. We currently believe that the most relevant existing data with respect to the SLRT development are:

- Calculations of pre- and post-restoration probability of overbank flow during project design phase (Haen Engineering, 1998)
- Pre-project topography and cross-sections (HydroScience and Swanson Hydrology + Geomorphology, 1997)
- Pre-project characteristics of stream channel and floodplain (Haen Engineering, 1998)
- Post-project floodplain topography (Stephen Andrews, unpublished data 2008)
- Post-project characteristics of stream channel (Swanson Hydrology + Geomorphology, 2004)
- Post-project characteristics of floodplain (Tague et al., 2008)
- Post-project calculations of channel erosion using CONCEPTS (E. Langendoen, pers. comm.)
- The relevant USGS streamflow and water quality data available for Trout Creek gauging stations (Table 4)

To build upon existing data, 2NDNATURE data collection will include repeat channel cross-sections; continuous stage measurements to document extent, duration and frequency of post-project overbank flow; measurements of floodplain sedimentation during overbank events; measurements of upstream and downstream water quality during overbank events; and standardized observations of stream channel and floodplain factors that affect sediment generation and retention within the reach.

Table 3. Summary of acquired existing data for Trout Creek

Type	Report	Source	Data Available	Data Collection Dates	Attribute Class[1]	Pre-project	Post-project
Geomorphic Data	No report available at this time	Scott Carroll	XS data	2001-2003	Channel/Floodplain Relationship Channel Stability		X
	Trout Creek Meadow Restoration, 2001-2003 Geomorphic Monitoring	Swanson Hydrology + Geomorphology	Pebble Counts	2001-2003			X
			XS Data	2001-2003			X
			Longitudinal Profiles	2001-2003			X
			Pool/Riffle Info	2001-2003			X
			Stream Stage Data	2001-2003			X
			Bankfull Survey (Wetted Perimeter)	1997		X	
Soil Data	Trout Creek Restoration and Wildlife Habitat Enhancement Project - Water Quality Monitoring Report	E. Langendoen/NSL	PSD, physical data	2008			X
		DRI	PSD/ Grain size data	Dates of Sample (?)			
Surface Water Quality Data		DRI	SW Nutrient Data (TSS, turbidity, TKN, PO4, OPO4, NO3, Ec) at 3 stations.	8/4/00-7/30/02 (grab samples)	Downstream Water Quality	X	X
Groundwater Data		Scott Carroll/CTC/CSLT	Spot measurements, elevations, and graphs of MW at transects 1-6.	1999-2003	Channel/Floodplain Relationship	X	X
		DRI	GW Nutrient Data (EC, TKN, PO4, TPsol) for monitoring wells (transects 1-6)	2001-2002			X
Vegetation Data	Trout Creek Restoration and Wildlife Habitat Enhancement Project -Baseline Vegetation Report, 2001	Julie Etra/Western Botanicals	Plant Species, Average Cover %, Frequency %, Relative Vegetation Cover % used in reporting baseline data in 2001	2001	Floodplain Vegetation Community Condition Streambank Vegetation Community Condition		X
Streamflow and Groundwater Data	Effect of geomorphic channel restoration on streamflow and groundwater in snowmelt dominated watershed	Christina Tague, Scott Valentine	No raw data	1999-2000, 2001-2004	Channel/Floodplain Relationship	X	X
Topography Data	None	Swanson Hydrology + Geomorphology, (Stephen Andrews)	GPS point data	1997, (2008)	Channel/Floodplain Relationship	X	X
Aerial Images	NAIP, ICONOS	USFS	Images	1989, 2002	Floodplain Vegetation Community Condition Streambank Vegetation Community Condition	X	X

[1] Relevant attribute class indicated per the terms and definitions developed within the Riparian Ecosystem Restoration Effectiveness Framework (2NDNATURE, 2010).

The U.S. Geological Survey (USGS) has long-term stream gages upstream and downstream of the study site. Those data, summarized below (Table 4), provide important data to calculate the frequency of particular water discharge magnitudes on Trout Creek and on the relationship between TSS and FSP loads and water discharge.

Table 4. Available USGS stream gage data relevant to Trout Creek restored reach.

USGS Stream Gage ID#	Location	Water discharge	Suspended sediment concentration	% fines (<63 µm)
10336775	Upstream at Pioneer Trail	Daily average 6/1/90-9/30/08; Grab samples 8/24/89-9/3/08 (n=479)	Spot samples 8/24/89-9/3/08 (n=412)	Spot samples 3/4/91-5/14/88 (n=9)
10336780	Downstream at Martin Ave.	Daily average 10/1/60-9/30/08; Grab samples 11/9/73-6/28/02 (n=129)	Daily average 10/1/73-9/30/88; Grab samples 11/9/73-6/28/02 (n=113)	Grab samples 11/9/73-5/14/88 (n=109)
10336790	Downstream at Lake Tahoe Blvd.	Daily average 10/1/71-9/30/92; Grab samples 3/4/72-9/3/08 (n=476)	Grab samples 3/4/72-9/3/08 (n=459)	Grab samples 3/4/72-5/21/08 (n=49)
10336778	Cold Creek at Pioneer Trail	Daily average 6/26/01-9/30/03; Grab samples 8/24/89-10/7/04 (n=8)	Grab samples 8/24/89-6/4/03 (n=2)	No grab samples

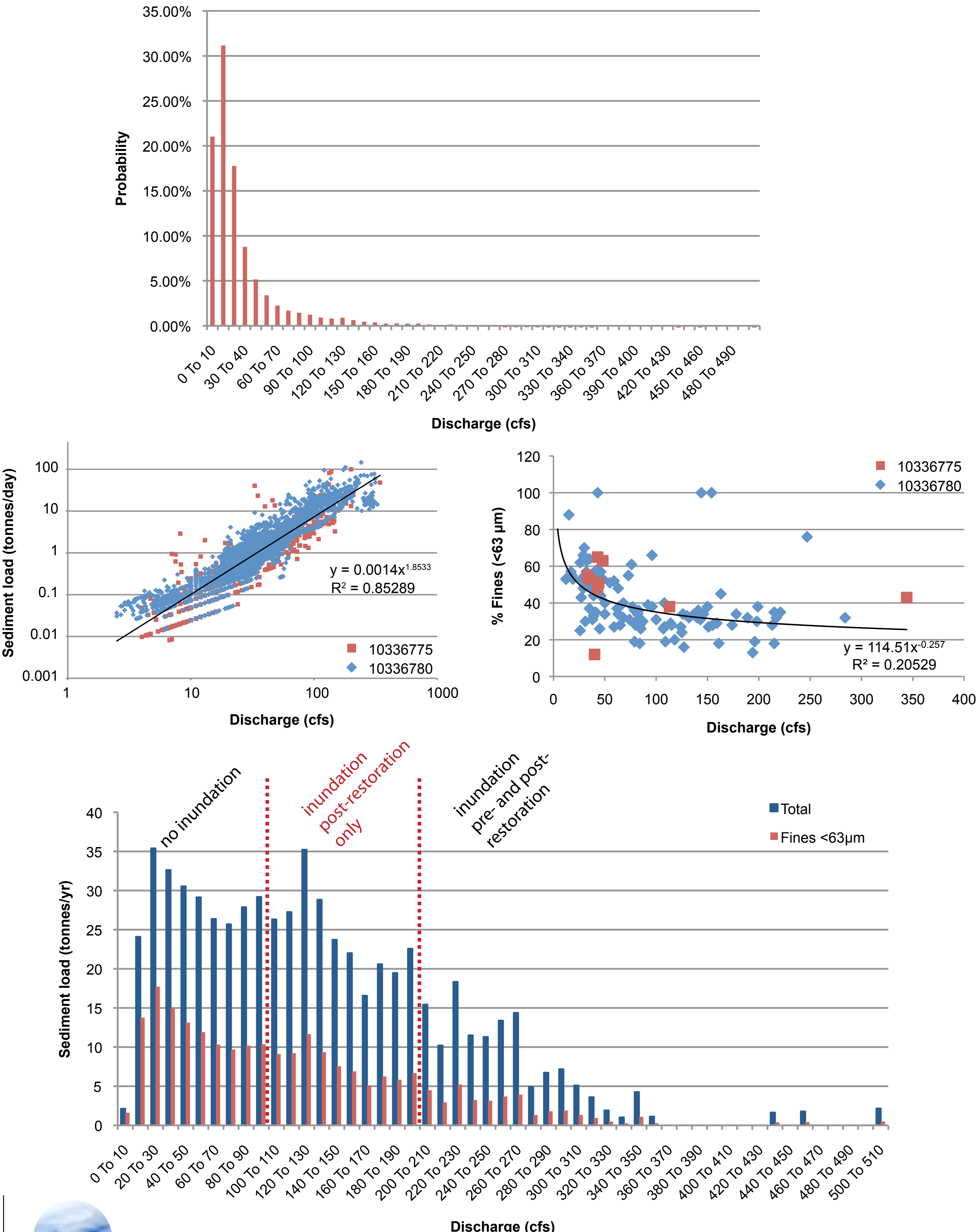
Because Cold Creek joins Trout Creek within the study area, no single USGS discharge value is representative of the entire reach. Therefore, we will consider both gage 10336780 and gage 10336775 to determine flooding probability, suspended sediment load, and fine sediment load. Gage 10336790, downstream on Trout Creek, and gage 10336778, upstream on Cold Creek, may provide additional constraints.

3.2 INITIAL SIMPLE APPROACH SLRT CALCULATION

The proposed SLRT simple approach can actually be applied to Trout Creek using existing data to provide an estimate of the average annual total and fine sediment (<63 µm) as a result of the restoration. Note that the USGS gage does not include fine sediment particle data for Trout Creek (<16 µm). From USGS data, we can provide initial estimates of the water quality benefits of the Trout Creek restoration project following the *Simple Approach* methodology outlined above (Equation 1). For floodplain deposition, the data allow us to determine the probability of daily discharge to exceed bankfull conditions, the sediment load values at different discharge conditions, and the fine sediment (<63 µm) values as a function of water discharge (Figure 5). By adding the sediment load for discharge values greater than bankfull discharge, these data allow us an evaluation of the maximum suspended sediment that can be deposited on the floodplain. Given the daily probability of overbank flow pre-project of ~0.75% and post-project of ~9% (Haen Engineering, 1998), the corresponding TSS and fine sediment (<63 µm) values from USGS data, we calculate the average annual delivery of suspended sediment to the floodplain is presented in Table 5.

Table 5. Floodplain sediment retention benefit for Trout Creek restored reach using the simple SLRT approach.

Trout Creek status	TSS retained on floodplain (tonnes/yr)	Fine sediment (<63 µm) retained on floodplain (tonnes/yr)
Pre restoration	135	35
Post restoration	460	145
Pollutant Retention Benefit	**325**	**110**



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USGS STREAM GAGE DATA FOR TROUT CREEK

FIGURE 5

This is equivalent to an additional ~0.5 mm/yr of sediment accumulation across the entire floodplain of the restored reach (2000 m long and 150 m wide). This estimate is consistent with total sedimentation rates of 0.5-2 mm/yr determined from soil cores of Trout Creek's downstream marsh and of Pope Marsh to the west (cf., Stubblefield et al., 2006).

In order to implement the proposed Intermediate Approach SLRT for floodplain deposition, we would incorporate measurements of floodplain area, roughness, and soil type to establish a sediment-retention parameter that would allow us to calculate the percent of this sediment that is retained on the floodplain. We also need to obtain FSP data from a variety of stream discharge conditions within Trout Creek to better inform our assumptions of generation, fate and transport of sediment particles finer than 16 µm.

For channel erosion, the existing Trout Creek data allow an initial estimate of the reduction in shear stress needed in the Simple Approach model (Equations 3 and 4). A calculation of the change in shear stress pre- to post-project within the channel, given measurements of pre- and post-project changes in channel slope and depth, provides an estimate of potential changes in sediment production from channel erosion. Given a pre-project water depth of 2 m at channel capacity, a slope of 0.003, and a length of 2700 m; and a post-project water depth of 1 m at channel capacity, a slope of 0.002, and a length of 3400 m; we calculate a decrease in the average shear stress of 50% as a result of the restoration project. Channel erosion rates pre-project are difficult to estimate precisely, but reasonable values estimated from the restoration design documentation (Haen Engineering, 1998) are a channel length of 2700 m, channel width of 5 m, and vertical incision of 1 m over 150 years. Assuming a bulk density of 2000 kg/m^3 and 30% fines <63 µm (E. Langendoen, unpublished data), we find that average annual sediment production by channel erosion is presented in Table 6.

Table 6. Stream channel sediment generation reduction for Trout Creek restored reach using the simple SLRT approach.

Trout Creek status	TSS generated from channel erosion (tonnes/yr)	Fine sediment (<63 µm) generated from channel erosion (tonnes/yr)
Pre restoration	180	55
Post restoration	90	23
Pollutant Source Reduction	**90**	**22**

In order to implement the proposed Intermediate Approach SLRT for floodplain deposition, we would incorporate the full distribution of water discharge conditions observed, the relationship between depth and water discharge pre- and post-project, and separate parameters for stream bank and bed erosion based on channel and bank properties.

Combining both increased floodplain retention and decrease channel erosion estimates results in the overall average annual load reduction estimate as a result of Trout Creek restoration (Table 7).

Table 7. Estimated average annual load reduction as a result of Trout Creek restoration using the simple SLRT approach.

System process improving downstream water quality	**TSS (tonnes/yr)**	**Fine sediment (< 63 µm) (tonnes/yr)**	**Fine sediment particle (<16 µm) assuming 20% of 63 µm (tonnes/yr)**
Increased floodplain retention	325	110	
Decreased channel erosion	90	22	
Average annual load reduction	**415**	**132**	**26**

For comparison, Simon (2008) calculates that Trout Creek delivers 462 tonnes/yr of fine sediment <63 µm to Lake Tahoe (we use a different rating curve than Simon (2008) to relate FSP to water discharge, and calculate 230 tonnes/yr of fine sediment <63 µm). Using the particle-size distribution for non-urban land-uses presented in the TMDL technical report (Lahontan Water Quality Control Board and Nevada Division of Environmental Protection, 2009), which states that 20% of the <63-µm fraction is <16 µm, the FSP reduction for Trout Creek is on the order of 26 tonnes/yr.

3.3 ASSESSMENT OF SIMPLE APPROACH SLRT CALCULATION

The Simple Approach SLRT for Trout Creek provides us with an example for the assessment that will be completed all of the SLRT models considered (see section 2.4 for assessment description).

Cost and level of expertise necessary to implement the model. The Simple Approach presented above is relatively inexpensive because it relies on USGS data and field data collected in association with the stream restoration project. The expertise needed is minimal, with specific skills needed in accessing, managing and interpreting USGS time series data.

Performance of the model. The SLRT produces the appropriate output needed to assess load reductions in tonnes/year. The validation of the model results requires field data proposed as part of our Data Collection Strategy (Chapter 4).

Parameters needed to implement the model. The data needed to constrain model parameters are USGS stream gage data, grab samples of TSS and FSP at different water discharge conditions, pre-restoration channel erosion rates, and changes to channel morphology associated with restoration.

Parameters that model results are sensitive to. The model output is sensitive to a few parameters that need particular attention in the data collection and interpretation. Calculation of floodplain deposition requires knowledge of the duration of floodplain inundation in an average year, generally calculated in HEC-RAS during restoration planning. The deposition of FSP on the floodplain also requires data to constrain the relationship between FSP and discharge, a possible gap in knowledge for many streams because USGS samples are commonly analyzed for fines <63 µm whereas FSP is defined as fines <16 µm. Likewise, the FSP concentration of bank and channel materials must be constrained for accurate calculation of the contribution to the FSP load by channel erosion. Field samples should be able to fill any FSP data gaps. Finally, the channel erosion reduction depends on knowledge of the pre-project erosion rate, which may be unknown or may have varied historically.

Appropriate uses of the model. Given the relatively simple implementation and direct calculation of water quality benefits, we recommend that the Simple Approach be applicable in two contexts: initial planning when prioritizing projects based on expected water quality benefit, and initial comparison of the long-term sediment load reduction versus short-term environmental impacts of stream restoration.

SLRT validation may demonstrate that the Simple Approach produces sufficiently accurate results to be applied more broadly. However, we currently consider the Simple Approach as a back-of-the-envelop calculation, and recommend that it be used in contexts when order-of-magnitude precision is appropriate.

CHAPTER 4 - DATA COLLECTION STRATEGY

4.1 GENERAL APPROACH

Our initial estimates for the Simple Approach provide important scaling of the water quality benefit of the restoration project. The research team suspects that a version of the Intermediate or Complex Approaches presented will improve our confidence in estimates of sediment load reduction benefits of stream restoration projects, but more data are needed for model implementation and validation. Using the available resources, the research team will complete the following data collection efforts in WY2010 and WY2011 within the Trout Creek reach:

- Floodplain characterization to develop a reasonable approach to estimate a retention coefficient for TSS and FSP delivered to the floodplain
- Upstream and downstream measurements of TSS and FSP load during spring snowmelt to improve the current sediment budget for the restored reach
- Repeat channel cross-sections to document channel erosion and bank properties to improve our ability to estimate sediment generation from channel erosion

The goal of the field research is to characterize current conditions of the Trout Creek channel and floodplain, and to provide sampling constraints on floodplain deposition and channel erosion. The data collection success will be inherently limited by the hydrologic conditions in the upcoming water years and the actual occurrence of overbank conditions at Trout Creek during the spring discharge peaks. Our approach is flexible and will rely upon cost effective instrumentation to be installed prior to spring conditions to save resources if overbank flow conditions do not occur. However, if flooding does occur, efforts to obtain data using field observations and measurements, grab sampling and GPS mapping will be intensive to ensure as much relevant data as possible is gained from the site during and following overbank conditions. If spring 2010 results in a significant flooding event, data collection resources may be exhausted to obtain valuable data and thus the potential evaluations in 2011 may be scaled accordingly.

The data collection parameters implemented to characterize Trout Creek will be a combination of:

- Simple measurements and standardized observations,
- Fluvial geomorphic topography and morphology characteristics, and
- A set of hydrologic and water quality measurements that are repeated numerous times either during or post-floodplain inundation as appropriate.

Specific data needs are:

- Cross-section surveys of the channel and floodplain,
- Qualitative observations of stream channel and floodplain characteristics, including stratigraphy, topographic complexity and vegetation coverage,
- Water level stage records to ground-truth HEC-RAS modeling results,
- Measurements of water quality upstream and downstream of site (using turbidity and grab sampling) at a range of water discharge conditions, and
- Measurements of floodplain inundation duration, distribution and retention following overbank events.

- Measurement of floodplain sediment distribution, deposition and retention distribution following overbank events.

Cross-sections. Cross-sections exist but do not extend across the floodplain. 2NDNATURE will utilize topographic mapping efforts by UC Davis researcher Stephen Andrews to collect valley-wide cross-sections in GIS to constrain channel and floodplain geometry. We will also perform bank-to-bank cross-section surveys to replicate historic cross-section measurements where necessary within the project reach. Because cross-sections have been completed in 2008 for the Trout Creek study area (E. Langeodoen, pers. comm.), cross-sections will only be repeated by the research team if high-discharge events occur in 2010-2011.

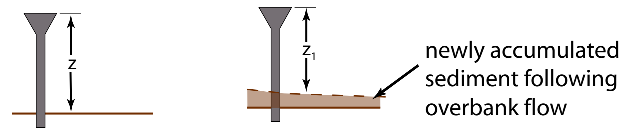
Channel and floodplain characteristics. Particular attention will be made to determining repeatable methods to characterize the topographic roughness and other factors that enhance total and fine sediment retention on the floodplain. Characteristics will include soil type, horizontal and vertical vegetation density and distribution, topographic complexity and other key characteristics. The floodplain evaluations will also be used to establish estimates of the critical depth that separates treated flow and bypass flow, the stage above which volumes are no longer experiencing a water quality benefit (following the Pollutant Load Reduction Model definition (Northwest Hydraulic Consultants et al., 2009)). Channel observations will be based on the protocols and parameters outlined by the Rapid Geomorphic Assessments of stream channel conditions and identification of the dominant geomorphic processes, extent of channel instabilities, and stage of channel evolution (Simon, 2008). These observations will take place at channel cross-sections that have been monitored since 2001.

Stage recordings. Three stage recorders (Figure 1) were installed in September 2009 and will log stream stage on 30 minute intervals through spring 2011.

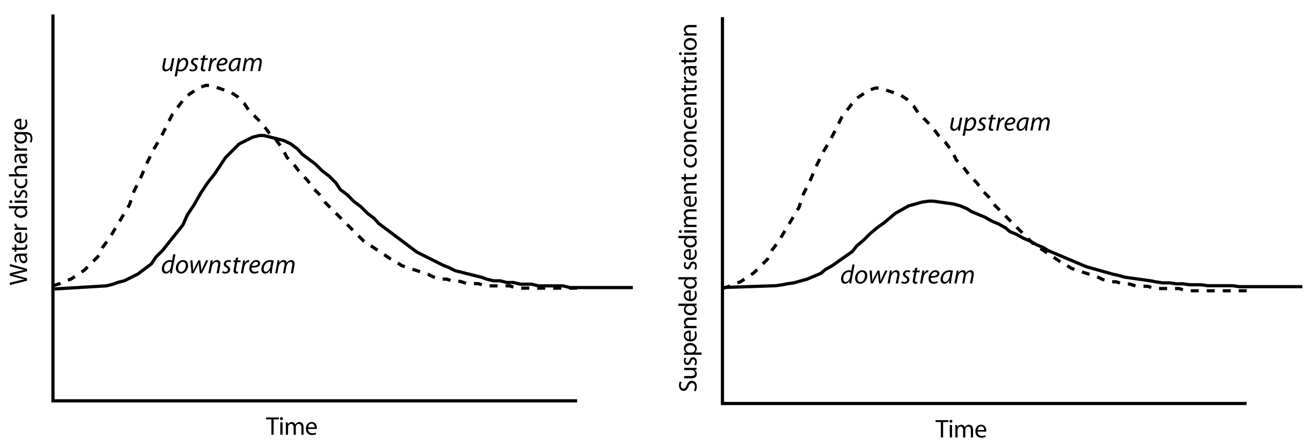
Water quality measurements. The USGS has collected grab samples upstream and downstream of the study area, but sampling immediately downstream of the area ended in 2001 (Table 4). 2NDNATURE will follow USGS protocols (available at http://water.usgs.gov/owq/Fieldprocedures.html) to collect grab samples at the USGS sites during elevated stage conditions in an effort to sample a range of discharge conditions. Samples will be submitted to WETLAB for TSS and grain-size analysis (10, 16, 63, 100, 1000 µm % finer by mass) per the analytical protocols outlined in Protocol A. If inundation occurs, upstream samples on Trout and Cold creeks can be considered "untreated" inputs to the site, while downstream samples reflect "treated" outputs (Figure 6). Three automated turbidity meters will be installed and operated during Spring 2010 at the USGS stream gage locations on Trout and Cold creeks (Figure 1) to provide turbidity time-series records. Strategic grab sampling to sample a range of hydrologic conditions using the real-time USGS website (http://waterdata.usgs.gov/ca/nwis/rt) will allow the development a rating curve to convert turbidity to TSS and FSP concentrations. The frequency of water sampling at the site will be driven by the hydrologic conditions and will increase to daily if overbank conditions occur at the site. The sample sites will be reestablished in early spring 2011 if remaining resources are available and had not been expended in 2010.

Floodplain deposition evaluations. In an effort to greatly improve our understanding of water and sediment retention on the floodplain, should overbank conditions occur; intensive field measurements and observations will be conducted on the Trout Creek floodplain. We plan to collaborate with the research team from University of California, Davis, led by Dr. Geoffrey Schladow and others, including graduate student Stephen Andrews. This group has already deployed low-cost, passive floodplain samplers to measure floodplain deposition as part of a SNPLMA-funded project that began in 2009. In consultation with these researchers, we will install 15 - 2ft rebar sediment pins (Figure 6) along 8 valley-wide transects to ensure proper coverage of four targeted sites: at the

Sediment Pin



- Pins sunk 1-2' into ground to prevent issues due to scour.
- Pin locations and elevations are surveyed and fixed.
- Following an inundation event, height from pin head to floodplain surface (z_1) is measured.
- Difference in height measurements ($z-z_1$) is the depth of newly accumulated sediments due to overbank flow.
- Provides simple calculation of volume of floodplain sediment deposition.



Water quality sampling: Two types of data will be collected to document water quality effects of Trout Creek restoration. Sediment pins (top panel) will be deployed in numerous locations across the floodplain. Sediment accumulation will be surveyed if floodplain inundation occurs during the study period. To develop a sediment budget for the study reach, USGS gages will be used to document water discharge upstream and downstream while suspended sediment samples will be collected upstream and downstream of the restored reach (including sampling of Cold Creek) to document any reduction in suspended sediment and water through floodplain retention (bottom panel).

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FLOODPLAIN AND WATER SAMPLING

FIGURE 6

upstream end of the study area, upstream of the Cold Creek confluence, downstream of the Cold Creek confluence, and at the downstream end of the study area. Transects will align with existing cross-sections within the project reach. The pins will be placed when lake level snow has receded, but upper elevation snowmelt has yet to peak. Pins will placed at equal intervals across each transect and locations identified using GPS and will demark future observation locations.

Intensive field evaluations of the floodplain will ensue if overbank flow occurs during the spring 2010 snow melt. Immediately following floodwater recession, sediment pins will be re-located and changes in grade elevations will be measured and recorded. Grab sediment samples will be collected from newly deposited sediment and submitted to the laboratory for grain size distribution analysis as appropriate. Field personnel will conduct systematic surveys of the 8 transects by recording attributes that effect floodplain sediment distribution that are within a 5 foot radius of each sediment pin. These attributes include: dominant vegetation, vegetation height (average and maximum), vegetation density (high, moderate or low), water retention depth, peak flow indicators and sediment transport indicators. The result of the floodplain deposition evaluations will include a map of the spatial distribution of floodplain deposits across each transect and a calculation of the sediment retention volume caused by the overbank conditions. These data will then be used to systematically evaluate characteristics of the floodplain that tend to enhance sediment retention relative to other areas, thereby improving our understanding of critical factors necessary to improve the assumptions and inputs to the SLRT.

California Rapid Assessment Module (CRAM) (if completed): The existing CRAM riverine module (http://www.cramwetlands.org/) will be applied to a selection of stream reaches within the Lake Tahoe Basin. The 2NDNATURE team is familiar with CRAM and has a number of CRAM trained team members. Trained 2NDNATURE personnel will be accompanied by Cara Clark of Moss Landing Marine Laboratory (a CRAM trainer) to perform the CRAM evaluations of the selected sites. This will ensure valid CRAM results from the selected sites. The two major goals of the pilot effort will be to evaluate the ability of CRAM to discern pre- post- project effects and evaluate the ability of CRAM to detect large differences in assumed disturbance and SEZ health. The basic study design will include the following:

1. CRAM will be applied pre- and post- project to at least 2 completed projects. Pre-conditions will be based on existing data sets (topography, vegetation surveys). Trout Creek, Angora Creek, and Cookhouse Meadow are all possible restoration sites for evaluations. By including other restoration projects, the Trout CRAM results will be have more context.
2. CRAM will also be applied to up to 4 other SEZs that have not been restored that represent a range of expected SEZ condition. For instance, low-gradient fine substrate SEZs assumed to be highly disturbed (Upper Truckee River), and 2 SEZs thought to be relatively undisturbed (Trout Creek upstream of project area, Angora upstream of project area.)

4.2 DATA MANAGEMENT

All data collected under this Characterization Plan will be managed in a digital Microsoft (MS) Access relational database (07-555.accdb). Field site observations will be recorded on pre-printed data sheets, entered into Palm Pilots during all sampling and instrument maintenance activities, and/or into a Trimble GPS data dictionary. Upon return to the office, all data will go through our Quality Assurance/Quality Control (QA/QC) procedure to ensure accuracy and completeness, and then integrated into the project-specific MS Access database. Instrument downloads will be corrected for barometric pressure as necessary, checked for inaccuracies, and calibrated to the relevant spot measurements prior to database entry (see Protocols). Results of lab analyses will be submitted electronically by the laboratory, checked for data quality and completeness, verified against the chain of custody record, and then entered into the database. This database will be available on the 2NDNATURE ftp site (ftp://www.2ndnatureinc.com/2ndnature) and updated quarterly.

CHAPTER 5 - REFERENCES

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APPENDIX A. PROTOCOLS

PROTOCOL A. SAMPLE ANALYSES AND DELIVERY

All water samples collected in the field will be submitted to WETLab for TSS (mg/L) and Particle Size Distribution [PSD] (% by mass for the following particle sizes: <10 µm, <16 µm, <63 µm, <100 µm and <1000 µm) analysis. TSS analyses are performed by WETLab (see Appendix C for WETLab standard operating procedures); PSD analysis is subcontracted to Desert Research Institute (DRI) and conducted using the laser optical backscatter (Saturn Digisizer 5200).

All water samples will be properly labeled (see Protocols B), placed on ice, and submitted with the proper chain of custody forms (see Appendix B) to WETLab by field personnel within the proper holding times (Table A.1). Field quality control samples will include field blanks and composite replicate samples (described above). Lab quality control samples will include method blanks, matrix spikes, laboratory duplicates and external standards (Table A.2).

All sediment samples collected in the field will be submitted to Cooper Testing Laboratory for particle grain size distribution analysis. Samples are submitted with the proper chain of custody forms (see Appendix B). A minimum mass of 50 grams (approximately 30 mL) is required for proper analysis. The particle-size analysis of soils (ASTM D 422-63) includes a combination of sieves (for particles >75µm) and a hydrometer (particles <75µm). The resulting data is presented as the sample % finer than the following approximate particle sizes: 9.5mm (3/8in sieve), 4.76mm (sieve #4), 1.00mm, 50µm, 35µm, 23µm, 13µm, 9µm, and 6µm.

Table A.1. Analytical Laboratory Sample Requirements per Analysis Type.

Type	Laboratory	Analysis	Analysis Method	Detection Limit	Sample Volume (ml)	Sample Bottle Type	Holding Time	Preservation Method
Water	WETLab	Total Suspended Sediment (TSS)	EPA 160.2	1 mg/L	300ml	HDPE	7 days	On ice (4^{o}C)
Water	WETLab	Particle Size Distribution (PSD)	Saturn Digisizer 5200	n/a	<600ml	HDPE	28 days	On ice (4^{o}C)
Sediment	Cooper Testing	Particle Size Distribution (PSD)	ASTM D 422-63	~6.6 µm	~30mL (50g)	Ziploc	N/A	N/A

Table A.2. Type and frequency of QA/QC samples.

Sample Type	Sample Frequency
Field Blank	One per event – hold for analysis pending analytical results
Composite Replicate	One per event per 3 sites – rotate sampling site
Method Blank	One per event – rotate sampling site
Matrix Spike	One per run for each analyte
Analytic Duplicate	One per run for each analyte
Analytic Blank	One per run for each analyte
External Standard	One per run for each analyte

PROTOCOL B. WATER AND SEDIMENT SAMPLE LABELS

All samples submitted to the appropriate laboratory must be clearly and consistently labeled to ensure no data is lost due to poor sample handling. All samples collected must be labeled with the following information. The same information must be simultaneously entered onto the chain of custody to ensure reliable sample tracking.

Sample Labeling	*Example*
Site Location: A	Site Location: Trout Ck at Martin Ave.
Sample Type: B	Sample Type: SFC
Rep #: C	Rep #:
Date: D	Date: 041510
Time collected: E	Time collected: 1400

Example label indicates a surface water grab sample was taken by at the USGS gage on Trout Creek at Martin Ave. May 15, 2010 at 14:00.

A: Site location (refer to Figure 1)

<u>Surface Water:</u>	<u>Floodplain Sediments:</u>
Trout Ck at PT (Pioneer Trail)	Sediment Pin ID
Trout Ck at MA (Martin Ave)	
Cold Ck at PT (Pioneer Trail)	

B: Sample Type

SFC: surface water grab sample

SED: floodplain sediment sample

C: Bottle or rep #

If replicates are taken from the surface water grab, indicate the replicate number here.

D: Date of collection

E: Time of collection

PROTOCOL C. SURFACE WATER GRAB SAMPLE

Logistics

The goal of this sampling effort is to obtain a series of grab water samples at two discrete locations on Trout Creek and one on Cold Creek. The sampling locations are (see figure1):

- Trout Creek at Pioneer Trail, USGS Gage #10336775 (Site ID:TCPT)
- Cold Creek at Pioneer Trail, USGS Gage #10336778 (Site ID:CCPT)
- Trout Creek at Martin Ave, USGS Gage #10336775 (Site ID:TCMA)

Sampling coordination with 2NDNATURE will be every morning at 09:30. 2NDNATURE's contacts are:

- Tashi MacMillen tashi@2ndnaturellc.com 831-239-1645
- Brian Spear brian@2ndnaturellc.com 831-512-7937
- 2NDNATURE main office 831-426-9119

California Tahoe Conservancy (CTC) contact is:

- Scott Carroll scarroll@tahoe.ca.gov 530-543-6062

Target sample collection over the season is based on the flow at the USGS gage on Trout Creek at Pioneer Trail (TCPT). The target sample distribution is:

- Every 20cfs when flow< 80cfs
- Every 10cfs when flow> 80cfs
- Digital sample logs will be used to keep track of flows sampled and those remaining throughout the targeted snow melt events

All 3 locations should be sampled on each sampling date within 1.5 hours of arriving at the first site in this order:

- Trout Creek at Pioneer Trail (TCPT)
- Cold Creek at Pioneer Trail (CCPT)
- Trout Creek at Martin Ave (TCMA)

Triplicates will be collected every 3rd sampling effort. The site where triplicates will be collected should rotate each time triplicates are collected in sequential order. 2NDNATURE and CTC will coordinate triplicate collection.

Sampling

Bring this equipment into the field:

- 6 clean 2L HDPE bottles with blank labels
- Sharpies and Ballpoint pens
- Digital camera
- Surface Sampler
- Cooler with **ice**
- Trout Creek Grab Water Sample field datasheet (Appendix B)
- Chain of custody forms (Appendix B)
- Protocol C. Surface Water Grab Sample (this sheet)
- Protocol B. Water and Sediment Sample Labels

1. Sample Collection
    a. Arrive at site (TCPT)
    b. Record USGS staff plate reading
    c. Take 3 photos of the stream. Repeat in same location each visit
    d. Secure a clean 2L HDPE bottle to the end of the surface sampler, using the radiator clamps.

e. Rinse bottle 3 times with undisturbed water 5 ft downstream of the sampling site
f. Extend the sampler to its full length.
g. Carefully place sampler into the streamflow as close to the location of the turbidity probe as flows will allow without disturbing probe. Position opening of bottle upside down and quickly move bottle as close to turbidity probe as possible. Turn bottle opening upstream, careful not to disturb turbidity probe
h. When bottle is filled, turn bottle so that it is upright and slowly pull sampler back to the bank. Note: Once the sampler is full the pole becomes less steady. Take care not to lose sampler.

2. Cap Sample
    a. Immediately cap the bottle upon retrieval at bank
    b. Loosen radiator clamps and remove bottle
    c. Dry off bottle and label it according to Protocol B
    d. Complete Trout Creek Grab Water Sample datasheet (Appendix B) before leaving site
    e. Place sample(s) in cooler on **ice**
    f. Go to next site and repeat

Return to office

1. Complete chain of custody forms (Appendix B: Field Datasheets)
2. Place samples in office refrigerator (2-6° C) if to be held overnight
3. Transfer sample to WETLAB
    a. Coordinate with Western Environmental Testing Laboratory (WETLAB) to have samples picked up within 5 days of collection. As of April 2010 WETLAB picks up samples in South Lake Tahoe on Tuesdays and some Wednesdays. Set a schedule with WETLAB to insure sample collection is predictable and seamless.
        - WETLAB
          Sparks Office
          475 E. Greg St, Suite 119
          Sparks, NV 89431
          Monday – Friday
          8:00 am – 6:00 pm
          (775) 355-0202 - Phone
          (775) 355-0817 – Fax
4. Transfer all information from field datasheet to digital file (troutcreek_date_SFC_samples.xlsx) Example troutcreek_20100613_SFC_samples.xlsx is for samples collected on June 13, 2010
5. Record USGS data
    a. Record flow and staff plate reading for TCPT and TCMA from USGS website into field datasheet. Record the reading for the time each sample was collected.
    TCPT (USGS Gage #10336775)
    http://waterdata.usgs.gov/nwis/uv/?site_no=10336775&agency_cd=USGS
    TCMA (USGS Gage #10336780)
    http://waterdata.usgs.gov/nwis/uv/?site_no=10336780&
    There is no CCPT USGS Gage -- leave blank
6. Coordination with 2NDNATURE for digital files
    a. Save file with date
    b. E-mail updated digital file to Tashi MacMillen daily (tashi@2ndnaturellc.com).

PROTOCOL D. SEDIMENT GRAB SAMPLE

1. Sample Collection
   a. Secure a clean small Ziploc® or similar plastic bag to transport and store each sediment grab sample.
   b. Clean metal scoop.
   c. Use the metal scoop to collect deposited floodplain sediments using a single long, even scrape, trying to sample down to vegetation barrier. Total volume must exceed 30 mL for particle size distribution analysis. Attempt to remove obvious debris and vegetation litter, while maintaining sediment integrity.
   d. Label sediment grab sample according to protocols below.
   e. Store and deliver sample for analysis according to Protocol A.

PROTOCOL E. FLOODPLAIN TRANSECT SETUP

Installation of 8 transects with 15 pins (120 pins total).

1. In office:
    a. Determine locations of desired 8 transects and calculate total length using GIS or map interpretation.
    b. Determine general sediment pin locations along transect by dividing 15 pins by total length of transect.
    c. Apply a transect ID starting with the most Southern transect as T1 and increase northward up to T8.
    d. Apply a pin ID starting with the most leftward pin as #1 and increasing along transect. These will be labeled in the field as TRANSECT ID – PIN ID (ex T1-1).
2. In field:
    a. Install left transect benchmark at desired location.
    b. Locate sediment pin location using the pacing determined in the office.
    c. At specified location, insert rebar stake halfway into floodplain, keeping the pin as close to vertical as possible.
    d. Use GPS to capture precise coordinates for future relocating and label sediment pin with scheme outlined above. Mark pins with colored flagging and spray paint.
    e. Using ruler/yard stick/stadia rod, measure the distance from the top of the pin to the floodplain surface. Be sure ruler does not sink into floodplain sediments.
    f. Record value in GPS data dictionary/field datasheet along with other information such as: date, time, field personnel, pin ID#, GPS coordinates. Note any additional field details as necessary.

PROTOCOL F. FLOODPLAIN TRANSECT SURVEY

Transect measurements

a. Pre Field needs:
    i. Charge GPS device and upload data dictionary (Trout_floodplain.ddf)
b. Transect measurements:
    i. Start transect on left valley benchmark.
    ii. Use GPS to establish and relocate sediment pins along each transect, using field map and relocation information (paces).
    iii. Sediment Pins
        1. Check pins for possible disturbance. *Note any possible disturbances in field notebook*, but do not move pin unless you are unable to resurvey it at that time.
        2. Using ruler/yard stick/stadia rod, measure the distance from the top of the pin to the floodplain surface on the left side. Be sure ruler does not sink into floodplain sediments.
        3. *Record value in GPS data dictionary/field datasheet*, noting date, time, field personnel, pin ID#, etc. Note any field details as necessary.
    iv. Floodplain Characteristics
        1. Using the GPS data dictionary file, estimate the following parameters within a 10 ft radius of sediment pin:
            - Dominant vegetation type (i.e. none, grass, forbs, sedge, juncus, willow)
            - Vegetation density (high, moderate, low)
            - Vegetation height (average)
            - Vegetation height (maximum)
            - Water retention depth (if standing water)
            - Maximum flow indicator height above ground (i.e. grass on willow branches)
            - Sediment indicator height above ground (i.e. sediment stain on vegetation stalk)
    v. If new sediment is present collect a sediment sample as outline in Protocol D.
    vi. Verify all pins within transect were relocated. Then continue to next transect.
c. Data Download:
    i. Download GPS data using Trimble GPS Pathfinder Office software.
    ii. Correct GPS locations.
    iii. Export to GIS shapefile following the naming scheme (Trout_YYMMDD.shp).
d. Data Management:
    i. Data exported to GIS can be used to store data spatially.
    ii. Table can be exported from GIS to be imported to project database.

PROTOCOL G. CROSS SECTION SURVEYS

Consult Map and/or Table for cross-section locations.

Cross Section Set-Up:

1. For consistency, have 0’ be on the LB side.
2. Secure survey tape to both cross section endpoint monuments.
3. Check that the length of XS is consistent with Sampling Plan information.
4. Set up transit in location where it is possible to see entire cross section and benchmarks.

Surveying the Cross Section:

1. Start at the cross section monument, placing stadia rod on the top of the pin/screw. Make sure that the pin is secure and does not move up and down.
2. From there get a reading at least every 1’ (include every break in slope). *Record all data points and notes in field notebook.*
3. Survey each edge of water and thalweg, noting locations.
4. In the active channel, readings every 3-4’ are okay.
5. At the locations of at-grade passive sampler, note cross section distance of edge of sampler, then place the stadia in the center of the grate for a reading (again noting cross section distance). If the passive sampler is not directly on the cross section, note the horizontal distance from the center of the grate to the survey tape.
6. Include benchmark height in the survey.

PROTOCOL H. IN-SITU LEVELTROLL/BAROTROLL DOWNLOAD PROCEDURE

Bring this equipment:

- Charged computer with extra battery
- Extra adaptor port, with 9-pin serial port
- Instrument cable
- A/C adapter to run computer off car, if necessary.
- Wrench (w/ warm water during winter)

Tasks to do:

1. Download data
    a. Clean off instrument. Remove debris, organisms from around the probes.
    b. Connect instrument to cable to computer.
    c. Open Win-Situ 5 Software – if no response, check cables assuring there is a tight connection with the computer.
    d. If device is still not connecting click on “Preferences” on the top toolbar and select “Comm Settings.” Select 9600 Baud rate and then click ok. The instrument should connect at this Baud rate. Once the connection between the computer and instrument is made change the Baud rate back to 57600.
    e. Instrument should appear under connection. In bottom right corner the two plugs inserted into each other indicates a connection.
    f. Click on Logging icon, second from left. Window will show active log indicated by an icon of a man jogging. You must stop the active log in order to download the data. Right click and select “Stop.” Right click again and select “Download,” choose to download all data.
    g. View data to assure that instrument was working correctly and collected data for the full duration and collected all the required parameters during the deployment.
    h. Downloaded data will be saved to “My Data.” To access data, click on View and select “My Data.” Right click the recently downloaded file, and select “Export to Csv.” Select the file under the “Exported Data” File and in the window to the right the location of the file on the C drive will be indicated.
    i. Check details on Instrument – Battery Capacity and Storage Capacity in the upper right corner. Record these values in the field log. If battery capacity is low, the instrument will need to be sent back to In-situ.
2. Start new test.
    a. To start new test, old test must be deleted. Right-click old test and choose Delete. This is why it is imperative that you check that gage has downloaded correctly and data is saved!! Deleting this should also clear out the data storage capacity.
    b. Right-click Tests and choose “New”. Wizard will take you through the set-up. If you are unsure of any of the settings, go to the data fi le just downloaded. Beginning lines give description of setup, including mode, reference depths, and sampling intervals. When setting up both Level and BaroTrolls, it is best to have them recording at same interval with same start times. One note on programming the BaroTroll - sometimes it will reset the default values in the wizard. The details of the next instrument you download after the BaroTroll will need to be adjusted to the normal default values.
    c. When finished, double check details to make sure test will begin. If you chose a manual start, do not forget to start test before disconnecting.
    d. Once you’ve convinced yourself that recording will happen, click on the icon in the right corner to disconnect the instrument and exit Win-Situ software.

PROTOCOL I. YSI TURBIDITY PROBE OPERATION AND DOWNLOAD

Bring this equipment:

- Charged computer plus extra battery
- Adapter port with 9-pin serial port.
- Instrument cable
- AA batteries
- DO membrane kit (sanding disks, membranes, solution, extra o-rings).
- Pipe wrench to open casings.
- Fresh water, calibration cup.
- A/C adapter to run computer off car, if necessary.
- Stadia rod, or something to measure water depth.
- ORP Calibration Bag – pH7, pH4, beakers, quinhydrone, wooden sticks
- Extra O-rings, O-ring lube
- DI Water

Tasks to do:

1. Download data:
   a. Clean off instrument. Remove debris, organisms from around the probes.
   b. Connect instrument to cable to computer.
   c. Open Ecowatch – if no response check cables, change batteries in YSI.
   d. Click on Sonde Icon. At #, type menu.
   e. Menu – Status (#4) – Make sure logging status active, battery not dead, date/time are correct.
   f. Menu – Run (#1) – Unattended Sample (#2). Stop Logging.
   g. Menu – File (#3) – Upload (#2) – Choose File – Proceed – Comma & '' Delimited. Make sure File transfer happens uninterrupted. Try not to let computer go to sleep.
2. Check data:
   a. When d/l successful, go to my computer – program files – ecowwin – data. Open file. Make sure data goes to current date/time, data is consistent/reasonable (especially depth and DO). If it looks that file didn't completely transfer, go to Menu – File – View File. Choose file and make sure data is complete there. If it is, d/l again and make sure computer stays awake. If it isn't, batteries probably died. Data is lost.
   b. Check DO, depth, ORP and battery level on uploaded file. See below for instructions.
3. Start new unattended sample:
   a. Once everything is okay, go to Menu – Run – Unattended Sample. Create new file name (SiteDate, ex VG050505), record on 30-minute intervals, double-check it will start sampling in less than 30 minutes (A), choose C – Start Logging.
   b. Go to Menu – Status – Check at logging status is active, for peace of mind.
   c. Disconnect everything and put instrument back in casing.
4. Check DO membrane on 600XLM:
   a. Always recalibrate DO probe after download. Watch the readings for 1 minute. If DO is consistently near 100% and not jumping around, then everything is okay. If not, see below.
   b. If DO is jumping around or not consistently near 100%, the probe is not shiny silver and gold, or the membrane is torn, the probe needs to be serviced.

   c. Remove membrane. Using sanding disk, scrape off grime – always sand in parallel direction to gold stripe.
   d. Rinse off with solution, add solution to probe, reapply new membrane and o-ring – avoiding air bubbles under membrane. This is a pain – good luck.
   e. Now you have to re-calibrate it. Probe is supposed to equilibrate in oxygen saturated water for 10 minutes before calibration, but it is fine to keep it in air to calibrate. Menu – Calibrate (#2) – DO% (#2). Follow instructions. Want the DO value to stabilize before hitting enter.

5. Check depth readings:
   a. Use stadia rod to measure water depth at site installation.
   b. Check depth data from downloaded file. Should be comparable to stadia rod measurement. Log both stadia depth and instrument reading.
   c. Always calibrate depth after download. Menu – Calibrate – Depth. Follow instructions. Usually calibrate it out of water, at O ft depth, so it knows what atmospheric pressure is. Want the depth value to stabilize before hitting enter.
6. Check battery level:
   a. At Menu – Status – Battery Level, make sure battery voltage will last until next site visit. Fully charged batteries are 6.2 volts and last for 45 days of sampling (at 30-minute intervals). Use best judgment, or if unsure, change batteries.
   b. Check Menu – Status – Battery Level to make sure new batteries are not duds.
7. Check all O-rings (sensor probes, battery compartment):
   a. Clean off any excess dirt with Kim wipe, paper towel, etc.
   b. Check o-rings for nicks, scrapes, damage.
   c. If o-ring needs to be replaced (b/c of damage or excess dirt), make sure new o-ring is clean. Apply small amount of lube to all of o-ring and then put on new o-ring. Apply a small amount of lube to outside of o-ring. Make sure your hands are relatively clean during all of this.
8. Check ORP data on 600XLM:
   a. If data looks to be changing erratically or is inconsistent with DO numbers (if site is consistently anoxic, ORP values should be decreasing to negative values – should not be doing that if oxygen is present), ORP should be recalibrated.
   b. You'll need the ORP calibration bag with pH4 and pH7 standard buffers, quinhydrone, long wooden sticks, DI water, and 3 plastic beakers.
   c. Fill one beaker with DI water, fill another with 0.5 oz pH7, third with 0.5 oz pH4.
   d. To both pH solutions, add quinhydrone. Use wooden stick to collect as much quinhydrone that will stay on .25 inch of stick.
   e. Stir quinhydrone into solution. Small amount MUST stay undissolved – add more until this happens.
   f. Go to Menu – Run – Discrete Sample – Start Sampling. **DO NOT OPEN A FILE.
   g. Rinse ORP probe in DI water and pat dry. Put in pH7 solution and wait 30-60 seconds for stabilized readings and note reading on instrument log. Should be +/- 15 mV from +96mV (20^{o} C), +90mV (25^{o} C), +83mV (30^{o} C).
   h. Rinse probe in DI and pat dry. Put in pH4 solution and wait 30-60 for stabilized reading. Note on log. Reading should be between 170mV and 185mV higher than pH7 reading.

i. If the readings are not within these ranges, probe needs is coated and needs to be cleaned. Start by gently cleaning with tissue/cloth. If that doesn't work, it is going to involve soaking it in some solution known to dissolve whatever is coating the probe. That will involve more research.
j. If readings are within ranges, probe is calibrated. No need to change anything. Double-check that under Menu-Run-Discrete Sample it says Open a file. If it says Close File, choose that. The instrument cannot run an unattended sample when a discrete file is open.

PROTOCOL J. TURBIDITY METER - LAMOTTE 2020E

Bring the Black LaMotte 2020e impact case. Make sure it includes:

- LaMotte 2020e turbidity meter, color grey
- 0.0 NTU standard. 60 ml bottle
- 1.0 NTU standard. 60 ml bottle
- 10.0 NTU standard. 60 ml bottle
- Extra nine-volt battery
- 0.0 NTU sample tube of standard
- 1.0 NTU sample tube of standard
- Non-cotton cleaning cloth
- User Manual, quick start guide, and 0-1 NTU Testing Guide

1. Bring sample bottles back to lab from field. Turbidity testing should occur immediately after returning from the field.
2. Place turbidity meter in clean area where there is no potential to damage/scratch glass tubes used for sampling.
3. Take field sample bottle from cooler; gently shake and invert sample bottle.
4. Carefully transfer sample from field bottle to sample tube. Use the sample tube labeled **high** for samples projected to be >200 NTU and **low** for samples <200 NTU.
    a. Hold neck of sample tube with cloth; be careful not the touch glass with fingers.
    b. Rinse sample tube with DI water. Repeat 3 times.
    c. Pour sample water from field bottle into sample tube and back into field sample bottle. Repeat 3 times.
    d. Hold neck of sample tube. Dry sample tube with cloth.
5. Analyze sample
    a. Turn meter **on** (meter should be calibrated with 1 NTU standard, see user manual for calibration)
    b. Select **measure**
    c. Select **turbidity**
    d. Hold blank (0.0 NTU sample tube) by neck and dry tube
        i. Make sure the single squared-off notch on the black positioning ring aligns with the vertical, white indexing line printed on the sample tube.
    e. Insert blank into the chamber
        i. Make sure the single squared-off notch aligns with the grey arrow on the top of the turbidity meter. The sample tube should fit smoothly into the notch.
    f. Close lid
    g. Select **scan blank**
    h. Remove blank from chamber. Place in foam insert inside the impact case
    i. Insert clean, dry sample tube into chamber
        i. Make sure the single squared-off notch aligns with the grey arrow on the top of the turbidity meter. The sample tube should fit smoothly into the notch.
    j. Close lid
    k. Select **scan sample**
    l. Record results
        i. Note if result is NTU or FAU.

APPENDIX B. FIELD DATASHEETS

Trout Creek Grab Water Sample

Floodplain Transect Survey

Cross Section Surveys

In-Situ Instrument Log

Chain of Custody

Trout Creek Grab Water Sample - Field

Site ID	Date	Time	Triplicate?	Field Staff Plate (ft)	Turbidity	Photos Taken (✓)	Notes

Digital file name is troutcreek_date_SFC_samples.xlsx

Example troutcreek_20100613_SFC_samples.xlsx is for samples collected on June 13, 2010

Floodplain Transect Survey

Date ____________

Time ____________

Personnel ___________________________

Transect ID	Pin ID	Height (in)	Dominant Veg Type*	Veg Density (H,M,L)	Avg Veg Height (ft)	Max Veg Height (ft)	Water Retention Depth (in)	Max Flow Indicator Height (in)	Max Sed Indicator Height (in)	Sed Sample (ml)	Notes:

* None, grass, forbs, sedge, juncus, willow, etc.

CROSS SECTION SURVEYS

XS ____________________
Date ____________________
Time ____________________
Personnel ____________________

LB Pin Distance* ____________________
RB Pin Distance ____________________
XS Total Distance ____________________
Benchmark ID ____________________
Benchmark Height ____________________
*Start survey tape at left bank.

Distance (ft)	Height (ft)	Description	Elevation (if known)

IN-SITU WATER INSTRUMENT CHECKLIST - PLEASE FILL OUT EVERY TIME INSTRUMENT IS SERVICED / DOWNLOADED / CHECKED / ETC.

Date	Time	Site	Personnel	Staff Plate	Gage	File Extracted	Data OK	Battery			New Test				Notes
								Capacity	Changed?	New Capacity	Name	Interval	Mode	Start Time	
					mini / baro / level										
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2NDNATURE

500 Seabright Ave #205, Santa Cruz, CA 95062
t 831.426.9119 f 831.421.9023
www.2ndnaturellc.com

CHAIN OF CUSTODY RECORD

PROJECT NAME AND JOB #: ______________________

SEND CERTIFIED RESULTS TO: ______________________

ELECTRONIC DELIVERABLE FORMAT: **YES** **NO**

Sampler: ______________________

Date: ______________________

LABORATORY: ______________________

TURNAROUND TIME: Standard 24hr Rush 48hr Rush 72hr Rush

GLOBAL I.D.: ______________________

Sample Identification	Sample Date	Time Sampled	Sample Filtered?	SAMPLE CONTAINERS					REQUESTED ANALYSIS										
				30 mL Poly Bottles	250 mL Poly Bottles	2.5L bottle	Other	Composite Samples?	Chlorophyll	Nutrients								Sediment	
										Filtered						Totals		TSS	Grain Size (fractions)
										NO_x^-	NO_2^-	NH_4^+	SRP	DP	DKN	TKN	TP		

RELEASED BY:	Date & Time		RECEIVED BY:	Date & Time	SAMPLE CONDITION (circle one)		
1.		→			Ambient	Refrigerated	Ice
2.		→			Ambient	Refrigerated	Ice
3.		→			Ambient	Refrigerated	Ice
4.		→			Ambient	Refrigerated	Ice
5.		→			Ambient	Refrigerated	Ice

NOTES:

APPENDIX C. WETLAB STANDARD OPERATING PROCEDURES

Attached as separate document due to length: **Appendix C: WetLab SOP.pdf**

APPENDIX D. TAC MEETING MARCH 18, 2010: MEETING REPORT

Meeting Report:
SLRT & Trout Creek Characterization
TAC Meeting #1

Date:	March 18, 2010
Time:	9:00am – 12:00pm
Location:	Lahontan Main Conference Room
Correspondence List:	Craig Oehrli, Theresa Loupe-NA (LTBMU); Cyndie Walck (CA Parks); Hannah Schembri, Bob Larsen (Lahontan); Matt Weld-NA (Waterways); Scott Carroll (CTC); Scott Frazier (TRPA); Jonathan Long (PSW); Stan Hill-NA (CSLT); Jason Kuchnicki-NA (NDEP); Jack Landy (EPA); Matt Kiesse (River Run); Catherine Riihimaki (Drew University); Nicole Beck, Brian Spear (2N); Jeremy Sokulsky (Environmental Incentives (EI)); [NA = Not Attending]
Facilitator:	Chad Praul (EI)

MEETING OBJECTIVES

1. Ensure TAC understanding of research scope, timing and intended products
2. Improve research team awareness of TAC needs from this study
3. Gain specific feedback on:
    a. Research scope and objectives
    b. Stream Load Reduction Tool (SLRT)
    c. Trout Creek Data Collection Strategy

CONTENT

Content presented at the meeting is available as a pdf on the project file sharing site at:
http://2ndnature.centraldesktop.com/2nfilesharing/doc/5277931/w-SlrttroutCreek

DECISIONS

1. The TAC agreed with the three objectives of the research and prioritization of those objectives based on the opportunity to collect over-bank flows during spring snowmelt runoff. (7 of 7 TAC members voting to agree) The objectives, as presented in the meeting in order of priority, were:

Research Objectives

a. Create and assess a range of methods to quantify WQ benefits and create a Stream Load Reduction Tool (SLRT)
   - Trout Creek case study

b. Inform inputs and validate outputs of SLRT through
   - Synthesizing existing data
   - Collecting new data from Trout Creek – Water Years 2010-11

c. Apply the riverine module of CRAM to Trout Creek

2. The TAC debated the need for California Rapid Assessment Methodology (CRAM) evaluation and decided to delay the potential implementation of the proposed CRAM effort until the summer of 2011. (6 of 7 TAC members voting to delay, 1 abstention)
    a. The TAC did not want CRAM evaluations completely removed from consideration by the research team. (0 of 7 TAC members voting for removal)

ACTION ITEMS

1. TAC members can submit written comments on the Draft Characterization Plan until March 26. The research team will incorporate comments and finalize the Characterization Plan in the first weeks of April.
2. TAC members are asked to submit any additional Trout Creek reports or data that they may have. Please check the list of reports the team is currently using on p. 14 of the Draft Characterization Plan. The team will check with Russ Wigart for additional data.
3. The research team will provide the TAC with a status update of data obtained and resources remaining in November 2010 and provide recommendations on WY2011 data collection strategy as well as the potential for CRAM evaluations in 2011.
4. Additional next steps were presented in the following slide (updated since meeting):

Trout Creek Characterization Plan

Future Steps	Dates
2010	
TAC	
• Submit any further comments on Char. Plan	• March 26
Project Team	
• Revise Characterization Plan	• April
• Deploy field instrumentation on Trout Creek	• April - May
• Collect spring runoff data	• May – June
• Check resource status with TAC	• November
2011	
• Collect spring runoff data*	
• Analyze existing and new data	• April
• Refine SLRT Methods	• July
• Complete CRAM field evaluations*	• August-September
• Draft main deliverables	• December
2012	
• TAC Meeting #2	• January
• Revise deliverables	• February

*subject to stream overbank conditions, resource availability and TAC recommendation

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5.

TAC POINTS AND QUESTIONS

SLRT Methods Development

1. TAC members asked if the SLRT methodology will address streams of higher gradient than Trout Creek such as Ward and General Creeks. The research team believes that the methodologies will likely be adaptable to different fluvial geomorphic settings, regardless of geologic differences.
2. It is important to be sure that bank stability enhancements are understood to allow for channel movement and erosion representative of pre-settlement processes. This is in contrast to considering it a strict “source control” for sediment. The research team supports the ecological process approach to

restoration it should remain a priority. The SLRT will allow restoration practitioners to quantify the pollutant load reduction expected from successful and desired stream restoration efforts.

3. The TAC is generally happy with the models that will be evaluated for the "complex" approach, but did suggest that the team evaluate the Rosgen rapid assessment protocol to see where it could be used. This is important because some project implementers are using this protocol to evaluate SEZ conditions.
4. Regulatory TAC members felt that the "Simple" approach to load estimation is very valuable for some of their needs. This approach would be useful for environmental documentation- specifically, comparing the short-term load increases due to construction to the long term benefit of the project. It is important to note that several of the current assumptions of this approach are in need of validation (e.g. 100% retention of sediment in the floodplain).
5. Use of LIDAR or other remote sensing techniques was mentioned, but the project team noted that accuracy of geomorphic survey is not a limiting factor whereas the models are very sensitive to other parameters such as "retention coefficients."

Trout Creek Data Collection Strategy

6. The TAC supported the allocation of significant resources during WY2010 should overbank flows occur, which may result in reduced field and data collection opportunities in WY2011. This approach will allow the research team to take full advantage of overbank flow opportunities which have been limited in the last few years.
7. The SLRT and Trout data collection strategy will focus primarily on fine sediment pollutants such as Fine Sediment Particles < 16 microns (FSP) and Total Suspended Sediment (TSS)- labs will conduct grain-size analysis of field samples. Field samples will not be analyzed for nutrient concentrations during this research effort. However, the research team will use the large nutrient dataset obtained by the USGS over many years to infer SRP and TP loads as resources allow.
8. Some TAC members mentioned an interest in meadow infill rates based on stream deposition, but this suggestion was also noted to be non-critical for the current effort.
    a. There was discussion that some evidence points to an approximate meadow infill rate of 0.5 mm/year.
9. TAC members suggested focusing on depressions in the Trout Creek floodplain- some data does exist for these depressions and these will be evaluated during field efforts.
10. The research team feels that it will be possible to do an "ok" job of synthesizing pre-project conditions for Trout Creek due to existing reports and research team experience with the project area.

CRAM Evaluation

11. Should the CRAM evaluation be conducted, the results will provide a simple ecosystem characterization rather than outputs that can be used to quantify water quality benefits.
12. Some TAC members felt that a quick evaluation of CRAM would potentially lead in the wrong direction and thought that a complete project focused directly on this topic would be needed.

AGENDA ; MARCH 18, 2010

(Repeated here for contextual reference)

Time	Description	Presenter
9:00	Introduce research goals and timeframe	Chad
9:15	Research focus and needs	Nicole
9:45	Outline concepts for Stream Load Reduction Tool (SLRT) • Explain general approaches • Gain initial TAC response	Catherine
10:50	Break	
11:00	Present and discuss Trout Creek data collection strategy • Purpose and approach • Consider the benefits and tradeoffs of doing a CRAM evaluation • Gather TAC input and comments	Nicole
11:30	Prioritize and confirm research outcomes and deliverables	Nicole/Chad
11:50	Next steps	Chad
12:00	Depart	