TAHOE TRANSPORTATION DISTRICT (TTD)
INCLINE VILLAGE MOBILITY COMMITTEE

Meeting Agenda

Incline Village Library **June 26, 2023**
845 Alder Avenue **5:30 p.m.**
Incline Village, NV

The Tahoe Transportation District Incline Village Mobility Committee meeting will be physically open to the public at the Incline Village Library. In accordance with California and Nevada law, Committee members may be teleconferencing into the meeting via GoToWebinar and in accordance with requirements under California Government Code section 54953(f). Members of the public may observe the meeting and submit comments in person at the above location or via GoToWebinar.

Committee members: Alexis Hill-Chair, Andy Chapman, Cindy Gustafson, Carole Black, John Crockett, Wendy Hummer

To register for the TTD Incline Village Mobility Committee Meeting go to:
https://attendee.gotowebinar.com/register/5111956544300620380

After registering, you will receive a confirmation email containing information about joining the webinar.

Members of the public may provide public comment by sending comments to the Clerk to the Board by email at jallen@tahoetransportation.org. Please note which agenda item the comment pertains to. Comments will be distributed at the meeting and attached to the minutes of the meeting. All comments should be a maximum of 500 words, which corresponds to approximately three minutes of speaking time. Comments for each agenda item should be submitted prior to the close of that agenda item.

Any member of the public who needs accommodations should email or call Judi Allen who will use her best efforts to provide reasonable accommodations to provide as much accessibility as possible, while also maintaining public safety in accordance with TTD's procedure for resolving reasonable accommodation requests. All reasonable accommodations offered will be listed on the TTD website at tahoetransportation.org.

All items on this agenda are action items unless otherwise noted. Items on the agenda may be taken out of order. The Committee may combine two or more items for consideration. The Committee may remove an item from the agenda or delay discussion relating to an item on the agenda at any time.

I. CALL TO ORDER AND ROLL CALL

A. Roll Call and Determination of Quorum
B. *For Possible Action:* Approval of Agenda for June 26, 2023
C. *For Possible Action:* Approval of Minutes of May 22, 2023 **Page #1**

II. PUBLIC INTEREST COMMENTS

All comments are to be limited to no more than three minutes per person for non-agendized items. Comments made cannot be acted upon or discussed at this meeting, but may be placed on a future agenda for consideration.

III. DISCUSSION ITEMS

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A. *For Possible Action:* Presentation and Discussion on Site Analysis, Project Concepts and Site Selection Process for the Incline Village Mobility Hub Project **75**

IV. DISTRICT MANAGER REPORT

V. COMMITTEE MEMBER REQUESTS AND COMMENTS

This portion of the agenda is for members to make requests for future agenda items or to make a brief report about personal activities without further deliberation by the committee, although any member may request an item to be placed on a future agenda in response to such remarks.

VI. PUBLIC INTEREST COMMENTS

All comments are to be limited to no more than three minutes per person for non-agendized items. Comments made cannot be acted upon or discussed at this meeting, but may be placed on a future agenda for consideration.

VII. ADJOURNMENT

COMPLIANCE WITH PUBLIC NOTICE REQUIREMENTS

This notice and agenda has been posted at the TTD office and at the Stateline, Nevada post office. The notice and agenda has also been posted at the North Tahoe Conference Center in Kings Beach, the Incline Village GID office and the North Tahoe Chamber of Commerce and on the TTD website: www.tahoetransportation.org.

For those individuals with a disability who require a modification or accommodation in order to participate in the public meeting, please contact Judi Allen at (775) 589-5502 or jallen@tahoetransportation.org.

Nevada Open Meeting Law Compliance

Written notice of this meeting has been given at least three working days before the meeting by posting a copy of this agenda at the principal office of TTD and at three other separate, prominent places within the jurisdiction of TTD not later than 9 a.m. of the third working day before the meeting.

Written notice of this meeting has been given by providing a copy of this agenda to any person who has requested notice of the meetings of the Committee. Such notice was delivered to the postal service used by the Committee not later than 9 a.m. of the third working day before the meeting for transmittal to the requester by regular mail, or if feasible for TTD and the requester has agreed to receive the public notice by electronic mail, transmitted to the requester by electronic mail sent not later than 9 a.m. of the third working day before the meeting.

Supporting materials were provided to any person requesting such materials and were made available to the requester at the time the material was provided to the members of the Committee or, if provided to the members of the Committee at the meeting, were made available to the requester at the meeting and are available on the TTD website: www.tahoetransportation.org. Please send requests for copies of supporting materials to Judi Allen at (775) 589-5502 or jallen@tahoetransportation.org.

TAHOE TRANSPORTATION DISTRICT
INCLINE VILLAGE MOBILITY
COMMITTEE MEETING MINUTES
May 22, 2023

Committee Members in Attendance:
Alexis Hill, Washoe County
Carole Black, Public Member (attended remotely)
Andy Chapman, TNT-TMA
John Crockett, Public Member
Wendy Hummer, Public Member

Committee Members Absent:
Cindy Gustafson, Placer County

Others in Attendance:
Carl Hasty, Tahoe Transportation District
George Fink, Tahoe Transportation District
Judi Allen, Tahoe Transportation District

I. CALL TO ORDER AND GENERAL MATTERS

A. Roll Call and Determination of Quorum
The meeting of the Committee was called to order by Ms. Hill at 5:33 p.m. at the Incline Village Library and via GoToWebinar. Roll call was taken and it was determined a quorum was in attendance for the Committee.

B. Approval of Agenda for May 22, 2023
Motion/second by Ms. Hummer/Mr. Crockett to approve the committee agenda for today's meeting. The motion passed unanimously.

C. Approval of Minutes for April 24, 2023
Motion/second by Mr. Chapman/Ms. Hummer to approve the committee minutes. Mr. Crockett abstained. The motion passed.

II. PUBLIC INTEREST COMMENTS

Carolyn Usinger asked who she needed to talk to regarding the red paint that is disintegrating on SR 28.

Diane Becker stated she feels there is a misuse of statistics in the report Incline Village Mobility Hub April 2023 Workshop Recap and hopes the Board won't be misled.

Doug Flaherty on behalf of Tahoe Clean Air.org is opposed to the OES site being considered or used as one of the alternative locations.

III. DISCUSSION ITEMS

A. Update on Implementation Efforts Underway Regarding the Nevada State Route 28 Multi-Modal Transportation Plan and the Regional Transportation Plan

Including Transit, Trails, Parking, and Mobility Hubs That Connect to Recreation, Commercial, and Residential Land Uses

Mr. Hasty reviewed this item. Ms. Black stated the need to look at the peak trip numbers, not the daily average trip numbers and that a mobility hub will increase congestion. Mr. Chapman mentioned the possible corridor entry fee and that revenue may help with the corridor segment.

Helen Neff suggested developing a reservation system for parking.

Doug Flaherty, Tahoe Clean Air.org, stated TTD's claims of trip reduction, getting people out of their cars, VMT claims, traffic reduction claims continue to be highly controversial, subjective, arbitrary, and capricious and the stated outcomes are highly uncertain.

Aaron Vanderpoole stated he doesn't understand people who do not understand that when you offer more amenities you bring more people and traffic and the plan doesn't make sense.

Doug Graham commented he was surprised to see Diamond Peak listed as an option for parking and was curious to see a comparative evaluation of those options.

Denise Davis asked if NDOT is the only organization allowed to have electronic signs along our roads and it would be helpful to have signage outside the basin and why we don't speak to our state legislature regarding the transit occupancy tax and should be able to use Incline's portion for Incline. She also stated she was told that East Shore Express riders are not counted in Sand Harbor's attendance counts.

Steve Dolan agreed with Mr. Vanderpoole and wants to see the infrastructure completed before developing the attractions.

Action Requested: For Information

B. Selection of Date for Next Public Workshop and Informational Briefing on Questionnaire and Workshop Input for the Incline Mobility Hub Project Concepts and Site Selection Process

Mr. Hasty reviewed this item. Ms. Black stated she feels the real results are not being shown, obfuscating the message and it has fallen short. Mr. Chapman feels there is an opportunity to clarify an amenity structure regardless of the location. Mr. Crockett asked when the complete responses to the questionnaire would be shown. Ms. Hill asked if another survey of missing pieces could be done. Ms. Black stated the need to see the raw data.

Helen Neff stated many people did not complete the survey as they thought it was stacked towards the OES and the TTD agenda and thinks there are things in the HDR Plan have not been addressed. She added the Incline bus stops are pathetic and should be upgraded.

Doug Flaherty stated transparency can do great things and there is a lack of transparency.

Aaron Vanderpoole stated he feels the survey lacks accountability and the amenities depends on the location. He also doesn't appreciate his train of thought being interrupted.

Carolyn Usinger thinks of mobility hubs as places for the homeless as they are in the Bay Area. She added there is no need for another survey or meeting, because Incline Village doesn't want it.

Theresa Paine lives three blocks from the OES and says a lot of the neighbors say it's unpopular to put the mobility hub there and there are lots of kids living across the street and there must be a better choice.

Ms. Hill stated the workshop will need to be redirected to talk about the vision and how the pieces fit together, as well as looking at opportunities for other locations.

Mr. Chapman feels there are five possible properties and the need to have the conversation of what would work at those properties.

Mr. Crockett noted the need to look at the viability of the other properties.

Mr. Chapman asked for the public's help in finding other possible properties.

Ms. Black thinks there are two areas on SR28 of federal land that may be possibilities and asked about using imminent domain.

Doug Flaherty asked how the location of a mobility hub could be transferred from the OES.

It was determined the next workshop will be Monday, August 14 from 4:00 p.m. to 7:00 p.m.

Action Requested: For Possible Action

IV. DISTRICT MANAGER REPORT

Mr. Hasty had nothing further to report.

V. COMMITTEE MEMBER REQUESTS AND COMMENTS

Ms. Black reviewed the documents she submitted as comments and requested data to be posted on the website.

Mr. Chapman noted TART Connect will be going to their summer schedule on June 23 and noted 80% of the riders are locals.

VI. PUBLIC INTEREST COMMENTS

Doug Flaherty stated he noticed a bias towards Ms. Black and you're bringing in heavy equipment to OES from the NDOT projects and asked how that is going without the proper permits.

Aaron Vanderpoole talked about transit and noise and the impact of soundscape on nature and he has almost been killed by e-bikes. He also suggested considering the Hyatt as a possible location.

Denise Davis looks forward to talking about other locations and take a look at the different use characteristics.

Helen Neff suggested looking at the transit center at the college at South Shore.

VII. ADJOURNMENT

The meeting adjourned at 8:03 p.m.

Respectfully Submitted:

Judi Allen
Executive Assistant
Clerk to the Board
Tahoe Transportation District

(The above meeting was recorded in its entirety, anyone wishing to listen to the aforementioned tapes, please contact Judi Allen, Clerk to the Board, (775) 589-5502.)

May 16, 2023

To: Chair Hill and Incline Village Mobility Hub Committee Members

Cc: C. Hasty, J. Allen, info@inclinevillagemobiltyhub.org

From: Helen Neff, Incline Village Resident

Dear Committee Members,

Please include this message as public comment for the May 22, 2023 Incline Village Mobility Hub Committee Meeting. This message has 3 parts: 1) Agenda Item III.B, 2) HDR Public Involvement Plan, and the 3) Washoe County Tahoe Transportation Plan. Questions are in **green text.**

1) AGENDA ITEM: III.B.

Attachment B

TTD Incline Village Mobility Hub Project Site Location and Amenities Community Input Summary

Per the summary, 345 surveys were completed. Of these, 104 specified a location within Incline Village which means 241 who did NOT specify a location within Incline Village. Thus, 70% of the people that responded did NOT specify a location in Incline Village. **Please include this point in your analysis and as well as the comments that were written under "other" for the location questions.**

This summary only addressed two of the survey questions: responses regarding the location of a Mobility Hub and the amenities. There were many other questions on the survey. I believe it is the intent of the committee to be transparent. **When will the replies to those questions be provided to the public?**

Attachment C

The recap of the April 20, 2023 Public Workshop is not clear on the use of stickers. Since 47 people signed in that would distribution of stickers was as follows: 141 purple (3 per attendee), 47 green and 47 red.

Of the 141 purple stickers, the report states that stickers were allocated to the listed possible amenities and that totals 32 purple stickers. The report goes on to say "*32 individuals created a section titled "none of the above" and added their stickers there."*

Each participant was given three purple stickers for amenities. **When the report says, "32 individuals created a section titled "none of the above"' and added their stickers there," do you mean to say that there were 32 stickers placed for "none of the above" or 96 (three x 32)? Please clarify the number of stickers actually placed on the "none of the above" part of the board.**

Just a suggestion for future workshops: schedule stickers or similar polling for AFTER the official presentation and accompanying public comment so that all views are heard before "votes" are taken.

2) HDR PUBLIC INVOLVEMENT PLAN

The HDR proposal that was discussed at the January 30, 2023 Incline Village Mobility Hub Meeting specifically detailed the *Public Involvement Plan*. Based on the response from the public at the April 20, 2023 workshop and the April 24, 2023 Incline Village Mobility Hub Meeting, it seems this would be a useful time for this committee to reexamine the proposal, specifically the following points in italic text (below):

Project Background:

- *Siting and designing a mobility hub should begin by identifying trips that can most effectively be replaced by new transportation services. The team is reviewing recent plans and identifying potential gaps for further data collection.*
- *After identifying these trips, outreach will be tailored specifically to the types of travelers accessing these origins and destinations. Public engagement will meaningfully consult a diversified set of stakeholders, including underserved populations, to determine the vision, desired transportation services, and proposed amenities.*

What trips have been identified as most effectively being replaced? How is outreach being tailored?

Public Involvement Goals and Objectives

The intended outcome of the public involvement process is to engage community members and stakeholders of Incline Village to obtain feedback and create a vision and project design for the Incline Village Mobility Hub Concept Plan. The following goals will be finalized in cooperation with the Tahoe Transportation District (TTD) and the Incline Village Mobility Committee. The desired goals and objectives are:

• Establish a data-informed public involvement approach

• Work with the community to obtain meaningful and collaborative public input leading to informed decisions that meet the community's needs through transparency, inclusivity, and a diverse audience.

• Incorporate public feedback into the official project record and consider all comments in the decision-making and design concept process

• Engage community leaders who can help the project team access hard-to-reach groups including seasonal residents, visitors, workforce, and minorities to understand their interests and priorities

• Identify potential services, amenities, and locations for the Incline Village mobility hub and communicate that it is a piece of the broader transit system for the Tahoe Basin.

What is the progress of each of these goals and objectives? Particularly in the area of transparency, incorporating all comments in the decision making (see survey comments, above) and accessing minorities to understand their interests and priorities?

Target Audiences

See list in the proposal.

What has been done to reach each of these target audiences? Especially "hard to reach" populations (other than translating the survey and flyer to Spanish, what was done to reach out to Latinos?).

Also, when/how was the Washoe County CAB engaged?

Key Community Ambassadors

Key Community Ambassadors The project team will enlist reputable and influential community ambassadors, including the Incline Village Mobility Committee, for the project to help disseminate project information, assist in educating the community, and encourage community engagement. They will be provided with information, including a survey, to disseminate to their organization's constituents.

How was this done? How was project information disseminated? How was the average citizen encouraged to engage? (That is, the person who does not regularly attend community meetings).

Outreach and Promotional Materials

*Promoting the project as "The People's Plan" can help develop collaboration and immediately promotes community collaboration for the future mobility hub services, amenities, and locations, **letting the community know that this project concept is being developed with their voice and feedback regarding priorities and needs as they relate to a mobility hub.** HDR will develop the following materials which will be distributed to the aforementioned stakeholder list and community ambassadors:*

• Project Fact Sheet/flyer promoting "The People's Plan"

This was/is a great tag line … what happened to using "The People's Plan" in promotional materials?

Specific Outreach

- Social Media – **what was done?** I saw nothing on the TTD Facebook page. Next Door posts were not by TTD or HDR but by individual citizens.
- E-Blasts – **what was sent and to whom?**
- Fact sheet/Informational Flyer: **I did not receive any notification from my HOA or my church (both on the stakeholder list). When I inquired, they said they had not received anything.**
- Mailer/Newspaper Advertising: **At this point, probably not worth pursuing.**

Public Engagement

• Incline Village Mobility Committee Meetings: HDR will actively participate and present at three Incline Village Mobility Committee meetings during the course of the project. HDR project manager or other staff should be available regularly to listen and answer questions at most committee meetings.

Since this proposal was presented at the January 30, 2023 Mobility Hub Committee meeting, what public meetings has HDR attended other than the public workshop on April 20, 2023?

Existing Mobility Hub Facilities

Also included in the Public Involvement Plan is Table 3-2: *Existing Mobility Hub Facilities*, showing photos of four different mobility hubs. The first example, Lake Tahoe Community College (LTCC) Mobility Hub, seems to be similar to what some of the speakers at the April 20 workshop were describing as a possible solution, located close to the East Shore Trail, to be used in conjunction with bus service from Reno, Carson City, and various California locations. Restrooms would need to be included.

Another example is the Tinloy Transit Center in Grass Valley, CA. Located close to downtown, it accommodates 4 small busses at the curb pullout, has 2 shelters, restrooms, and attractive landscaping. After a bit of controversy in the planning process, the final version is well accepted by residents and transit users. Note the name as a “transit center” rather than a “hub.”

Please include this type of facility as an option in future public discussion. Perhaps use the photo on a flyer or other promotional material.

3) <u>WASHOE COUNTY TAHOE TRANSPORTATION PLAN</u>

On a related note, Incline Village suffers from many transportation issues, as outlined in the recently adopted Washoe County Tahoe Transportation Plan. Bus stops are included. Many of our bus stops are woefully unmaintained and this discourages use.

At the intersection of SR28/Northwood/Southwood by the proposed Nine 47 Tahoe Condominium Development, the bus stop on the north side is simply a sign stuck in the ground. No pullout, no shelter, no pad, no ADA accommodation. Not even a bench. Please see photo.

The Washoe County Tahoe Transportation Plan recommends improvements for five bus stops within Incline Village but this one is not included in that list. There are others that are not listed that badly need upgrades as well.

Such lack of attention to the safety of current and potential transit users causes residents to pause and wonder why grand new transit facilities are being proposed when current basic bus stops are not being maintained and are not safe for users. Nor are they ADA compliant. This lack of care does not promote transit use.

Of course, the responsibility for bus stops falls on Washoe County, perhaps RTC and perhaps NDOT but as the leader for transportation in the Tahoe Basin (with a physical presence in the Tahoe Basin), it would seem logical that the Tahoe Transportation District, in the spirit of cooperation, should take steps to improve the unsafe, unattractive, deteriorating bus stops in Incline Village as a priority. This would seem a logical course of action.

As the Tahoe Transportation District website states: **The agency is responsible for facilitating and implementing safe, environmentally positive, multi-modal transportation plans, programs, and projects for the Lake Tahoe Basin, including transit operations.**

Thank you.

TAHOECLEANAIR.ORG

May 21, 2023

RE: Written Public Comment – Agenda Item II -TTD Incline Village Mobility Committee Meeting 5-22-23.

OES = Old Elementary School (used interchangeably as 771 Southwood Blvd, Incline Village, NV)
ESE = East Shore Express
TTD = Tahoe Transportation District
TRPA =Tahoe Regional Planning Agency
FTA = Federal Transit Administration
VMT = Vehicle Miles Traveled

Dear TTD Staff and TTD Mobility Hub Committee Members:

Please ensure that this written comment is made part of the record and the minutes regarding Agenda Item II - TTD Incline Village Mobility Hub Committee meeting 5-22-23.

This written Public Comment is being provided on behalf of TahoeCleanAir.org.

TahoeCleanAir.org is opposed to the OES site being considered or used as one of the **"alternative"** locations for a TTD mobility hub, and is opposed to its use in connection with the ESE for the following reasons:

TTD claims of trip reductions, getting people out of their cars, VMT claims, and traffic reduction claims, continue to be highly controversial, subjective, arbitrary, and capricious and TTD's stated outcomes highly uncertain. The TTD would require a "crystal ball" to make such claims.

Regarding TTD's consulting firm attempts to link hubs in Vail, CO, Sparks and Reno NV, these locations bare little or no relevance to the environmental protection, public safety and wildfire evacuation sensitivities of Incline Village and the Lake Tahoe Basin. This includes adding the significant and cumulative adverse environmental and safety peril impacts that a 365 day a year mobility hub will bring.

Further, the January 20, 2023, TTD *"Incline Village Mobility Hub Data Review and Context Draft Memorandum",* Table 3-1: "Screening Criteria Categories" are subjective, incomplete, arbitrary, capricious, and designed in favor of the TTDs relentless quest to construct a mobility hub at the OES site, of which is within and adjacent to a dense close in traffic safety peril neighborhood as well as an environmentally sensitive area.

As an example:

TTD and its consultants failed to provide an "Environmental Impact Score" within its "screening criteria list". This, to avoid a data driven analysis of past, current, and future cumulative environmental impacts in relation to all potential locations. This includes an analysis of direct or adjacent site locations that rest within or adjacent to any environmentally sensitive area. In the case of the OES site, as an example, an Environmental Impact Score would consider an analysis of the OES site and its impacts within and directly adjacent to the "Burnt Cedar and Wood Creek Watersheds". This includes Burnt Cedar creek itself, an ephemeral stream, which begins on OES property and drains ¼ mile directly into Lake Tahoe waters. How can the TTD ever claim that they are working to protect the environment and waters of Lake Tahoe when they fail to provide any reference whatsoever to an "Environmental Impact Score" for all possible Mobility Hub alternative sites.

Additionally, within the TTD Screening criteria, **Item 7: Road Safety Score** should be re-labeled **"Public Safety Score"** and placed at the top of the screening criteria list. This item should discuss data driven measurements of all site alternatives, including a comprehensive traffic study, access and egress analyses including slopes, neighborhood pedestrian impacts and safe wildfire evacuation, in connection with human and roadway overcapacity in densely populated neighborhoods, including stranded transit users during a wildfire.

Further, the deficiencies of the eight (8) draft screening criteria provided by TTD Staff for selection of an Incline Village Mobility Hub are discussed below with comments added in blue:

1. **Transit System Score** - Consider how well integrated the location is with respect to the existing transit network. Comment: The terms "well-integrated" and "existing transit needs" are subjective, arbitrary, and capricious in relation to the OES site. TTD fails to provide significant and substantial data indicating otherwise. 771 Southwood Blvd currently provides an unsafe short term seasonal East Shore Express service location which cannot be safely "well integrated" when it comes to the neighborhood public safety impacts, including safety perils for both users and the neighborhood during a wildfire evacuation, as well as the cumulative environmental degradation caused by a 365-day year-round, full mobility service hub.

2. **Transit Propensity Score** - Overlay various points of mobility data to understand locations with "high" mobility needs and potential transit demand. Comment: TTD fails to provide significant and substantial data demonstrating that 771 Southwood mobility needs are "high". The OES site currently provides an unsafe short term seasonal East Shore Express service location which cannot be safely "well integrated" when it comes to the neighborhood public safety and environmental impacts of the ESE or a 365-day year-round, mobility service hub. TTD has not provided substantial data to indicate a "high mobility need", confusing ESE ridership numbers, as being synonymous with year-round mobility hub demand. Data indicates that public transportation ridership choice is extremely low compared to other forms of transportation within the Lake Tahoe Basin.

3. **Recreational Access Score** - Consider the proximity a "high mobility need" and potential transit demands" ease of connection to recreational amenities for locals and visitors. Comment: The term "high mobility need" and "potential transit demand's", for locals and visitors is subjective, arbitrary, and capricious in connection with a 365-day year-round mobility hub at 771 Southwood Blvd. TTD fails to provide significant and substantial data indicating otherwise. TTD fails to provide significant data indicating that OES hub users will have "ease of connection" access to workable safe roadway by roadway evacuation route capability during a wildfire.

4. **Key Destination Score** - Examine the location's proximity and ease of connection to significant destinations, services, and activity centers. Comment: Any suggestion that a hub at the OES will promote the ease of connection to "significant destination", "services" and "activity centers" walking or access is subjective, arbitrary, and capricious and stated outcomes are highly unlikely. TTD fails to provide significant and substantial data indicating otherwise. TTD fails to provide significant data indicating that OES hub users will have access to workable safe roadway by roadway evacuation route capability nor emergency services during a wildfire.

5. **Walkability Score** - Analyze the extent of the surrounding sidewalk and trail networks connecting to the potential location. Comment: Any suggestion that a mobility hub geographically located at the OES will promote walking or trail use is subjective, arbitrary, and capricious and stated outcomes are highly unlikely. TTD fails to provide significant and substantial data indicating otherwise. TTD fails to provide significant data indicating that OES hub users, combining their use with walkability, will have access to workable safe roadway by roadway evacuation routes during a wildfire.

6. **Bikeability** Score - Analyze the extent of the surrounding bike network (on the street and multi-use trail) connecting to the potential location. Comment: Any suggestion that a hub geographically located at the OES will promote biking or trail use is subjective, arbitrary, and capricious and stated outcomes highly unlikely. TTD fails to provide significant and substantial data indicating otherwise. TTD fails to provide significant data indicating that OES hub users, combining their use with a bike network, will have access to workable roadway by roadway safe evacuation routes during a wildfire.

7. Road Safety Score - Examine crash data (or other relevant data) in proximity to mobility hub locations. Comment: As stated above, this screening criteria should be re-labeled "Public Safety Score." Crash data is only one piece of screening criteria regarding public safety. This item should be re-labeled **"Public Safety**

Score" and placed at the top of the screening criteria list. This item should discuss data driven measurements of all site alternatives, including a comprehensive traffic study, access and egress analyses including slopes, neighborhood pedestrian impacts and safe wildfire evacuation, in connection with human and roadway overcapacity in densely populated neighborhoods, including stranded transit users during a wildfire.

8. Property Size Score - The location meets the minimum square footage to accommodate the mobility hub program and allow for future growth. Comment: The reference to accommodating "future growth" is synonyms with TTD and TRPA creation of Lake Tahoe Basin overcapacity, thereby creating public safety perils caused by increased human and roadway overcapacity and is subjective, arbitrary, and capricious. TTD fails to provide significant and substantial data indicating otherwise.

Further, the original Federal Transit Authority (FTA) National Environmental Policy Act (NEPA) Protective Acquisition funding application submitted by NDOT and TTD, which granted a NEPA "Categorical Exclusion" (CE), in order for TTD to receive federal funding to purchase the OES property, was fundamentally flawed and misleading.

NDOT and TTD stated, as part of the original NEPA protective acquisition funding application and correspondence, that the "Acquisition or transfer of interest in the real property is 1) not within or adjacent to a recognized environmentally sensitive area and 2) the use of the property by the TTD would not result in a substantial change in the functional use of the property..."

1.. With regard to past and present "functional use" of the OES property:

In an original letter from NDOT to the FTA, seeking funding to secure the purchase of 771 Southwood Blvd funding, NDOT/TTD stated, "For the last nine years, Tahoe Transportation District has been using the Property for a seasonal transportation hub"… **when actually the past use of the property was that of a 10-year inactive school campus with 8 years of non-permitted TTD parking and a non-permitted bus TTD transit stop.**

The continued 8 yr. past illegal use of the 771 Southwood Blvd, by the TTD, is now substantiated as part of the record, via discussions between the TRPA and TTD Staff during the recent October 26, 2022, Incline Village residents TRPA Appeal of the Temporary Use Permit, as connected with the 2022-2023 East Shore Express operation.

2. Further, in order to receive FTA Protective Acquisition Funding approval, in its original 23 CFR 771.118 (C)(6) Categorical Exclusion Application and correspondence seeking federal funding, NDOT/TTD stated that the 771 Southwood property was not within or adjacent to a "recognized" environmentally sensitive area and therefore a Categorical Exclusion (CE) should be granted.

Per NEPA, CEs are actions that do not individually or cumulatively have significant environmental effects or impacts and are excluded from the requirement to prepare an environmental assessment (EA) or environmental impact statement (EIS) **when there are no "unusual circumstances"** (40 CFR 1508.4, 23 CFR 771.118). CEs are not exempt from NEPA.

However, NDOT and **TTD failed to inform the FTA**, in its original funding application that:

Lake Tahoe is listed under the Clean Water Act Section 303(d) as "impaired", which clearly represents an "unusual circumstance" with regard to the 771 Southwood property which is located on and adjacent to the environmentally sensitive Burnt Cedar and Wood Creek Watersheds.

While the recent good news headline regarding Tahoe's clarity is indeed good news, the UC Davis comments indicated, that this is a short-term window of improvement, and the degradation of Tahoe's clarity is expected to revert back to its 20-year history of degradation upon the expected return of the mysis shrimp. This means TTD and TRPA failures to protect Lake Tahoe will return.

The "impaired" water listing is due to three pollutants; nitrogen, phosphorus, and sediment, all of which are responsible for Lake Tahoe's deep water transparency loss.

It is evident that the OES property is the headwater property of a visible and "intervening" seasonal ephemeral stream recognized in sediment studies (Simon) and NDEP), as Burnt Cedar Creek. This visible "intervening" ephemeral stream deposits runoff sediment directly into the waters of Lake Tahoe within ¼ mile of the headwater property in question through a series of ditches and pipes, and of which stream, the Tahoe Regional Planning Agency has failed to adequately improve to prevent pollution runoff in order to help protect Lake Clarity.

The "intervening" ephemeral stream is within and adjacent to 1) the Lake Tahoe Burnt Cedar Creek Watershed and adjacent Wood Creek Watershed – see Simon – referencing Burnt Cedar and Wood Creek Watersheds) … Simon is also "recognized" in the Nevada Division of Environmental Protection – Final Lake Tahoe Total Maximum Daily – Report to the US EPA. Pages 7-5 and 7-6 and throughout**.** The "unusual circumstance" of Lake Tahoe being listed as "impaired" waters under the Clean Water Act Section 303(d) makes both of these watersheds "recognized" environmentally sensitive areas.

Further, the Burnt Cedar and Wood Creek watersheds, are "recognized" environmentally sensitive areas, since they **cumulatively**, along with all other Lake Tahoe watersheds add "impaired" 303(d) water listed sediment and pollutants to Lake Tahoe waters, and the issuance of a CE by the FTA allowing purchase of the 771 Southwood property, without investigating this unusual 303(d) circumstance, was not appropriate, and at minimum there should have been a publicly noticed Environmental Assessment (EA) process undertaken by the FTA to help determine the need for an Environmental Impact Statement.

TTD's stated need for a mobility hub at this location is subjective, arbitrary, and capricious, agenda driven and said need is not supported by substantial nor significant data.

The information provided below discusses the TTD 2022-2023 East Shore Express Temporary Permit process is germane and directly tied to the overall Mobility Hub process.

1. The TRPA granting of the 2022-2023 ESE Temporary Use Permit represented a "change in use" from the original 8-year use of the property, and such change in use was an intensification of use and was not based on fact but was arbitrary and capricious. The TRPA and TTD therefore violated NEPA when it intensified the use of 771 Southwood Blvd as part of a "special condition" attached to 2022-2023 ESE Temporary Use Permit without a NEPA Environmental review process.

TTD Staff Reports continue to state that "the service has been operating for a number of years on a less-formalized basis, of which is an obfuscation—vague and incomplete—since the past use of the property was that of a 10-year inactive school campus with 8 years of non-permitted TTD parking and a non-permitted bus TTD transit stop. "Less formalized" in this case means, "unpermitted."

The original TRPA Temporary Use Permit Application by the TTD requested the permit for the purpose of "Intercept Parking for East Shore Shuttle Service to SR 28 and Sand Harbor". However, TRPA arbitrarily and capriciously granted, without a request from the Applicant an intensified and expanded "change of use" from the property's past illegal use.

This was done by arbitrarily inserting a Special Condition, of which Special Conditions are normally considered "planning permissions" to mitigate or compensate for negative impacts. However, in the case of permit Special Condition 1, especially as it applies to 771 Southwood Blvd, TRPA arbitrarily and capriciously granted an intensified and expanded the "change of use". This act required TRPA and TTD to consult with the FTA which is the only agency with NEPA primacy in this particular case.

2.. During the Temporary Use Permit Process for the 2022-2023 ESE Operation TRPA Violated its own Chapter 6.2. JOINT ENVIRONMENTAL DOCUMENTS which states:

… the National Environmental Policy Act (NEPA) or other state or local environmental review, TRPA shall, whenever feasible, coordinate its environmental review process with the local, state, or Federal process. Coordination would include joint activities such as scoping, selection of consultants, notice, and concurrent comment periods.

Because the 771 Southwood property was purchased using FTA Federal funds via an application for funding in connection with a NEPA Categorical Exclusion (CE) Protective Property Acquisition request by the Nevada DOT on behalf of the TTD, the primacy for regulatory environmental review considerations rests with the FTA under NEPA.

Primary FTA primacy and reach is germane in this case since the TRPA staff arbitrarily created, and the TRPA Hearing Officer approved, a Special Use Permit "change of use" from that of an illegal use of operating without the required TRPA parking permits, to an intensified "use" of a **"Transit Station and Terminal."**

As explained by FTA's Mr. Ted Matley, in an email on June 7, 2021, "Change of Use" triggers an additional [required] review and determination under the National Environmental Policy Act (NEPA).

Matley goes on to comment:

"The Categorical Exclusion (CE) determination that FTA Region IX issued allows the project sponsor to purchase the property using Federal funds, should the project sponsor choose to do so. The FTA CE determination does not include approval for any future changes to, or development of, the property."

"If the property is purchased using Federal funds, or should Federal funds be proposed to fund the development of or change the use of the property, **an additional review and determination under the National Environmental Policy Act (NEPA)** is required to develop or change the use of the property. We have confirmed with the project sponsor that they understand the limitations of the current FTA CE determination and that any future action to develop the property or change the use will require additional NEPA analysis.

3. And finally, as currently written, the new and old TRPA "armchair" Environmental Checklists contained in various past TRPA and TTD ESE Staff reports are inadequate and a sham, designed to sidestep the identification and analysis of the true local community as well as basin wide cumulative impacts/effects of the ESE and all projects within the Lake Tahoe Basin.

In this case, the desktop environmental checklist failed to recognize that the site is within and adjacent to the recognized environmental sensitive areas of the Burnt Cedar and Wood Creek Watersheds and that Lake Tahoe is listed under the Clean Water Act Section 303(d) as "impaired" waters.

Further, for the most part, the subjective staff armchair conclusions within the Environmental Checklist are not based on substantial or significant evidence, are rather opinionated, arbitrary, and capricious, and continue to violate the Bi-State Compact requirements of Tahoe Basin equilibrium and harmony.

Sincerely,
Doug Flaherty, President
Tahoe Sierra Clean Air Coalition (DBA TahoeCleanAir.org)
A Nevada 501(c)(3) Non-Profit Corporation
774 Mays Blvd 10-124
Incline Village, NV 89451

TahoeCleanAir.org Organizational Purpose

Tahoe Sierra Clean Air Coalition (DBA TahoeCleanAir.Org) is a Nevada 501 (c) (3) non-profit corporation registered to do business in the State of California. Our organizational purpose extends beyond protecting clean air, and includes, among other purposes, protecting and preserving natural resources, including but not limited to clean air, clean water, including lake and stream clarity, soils, plants and vegetation, wildlife and wildlife habitat including wildlife corridors, fish and fish habitat, birds and bird migration, insects, forest and wilderness from adverse environmental impacts and the threat and potential of adverse environmental impacts, including cumulative adverse impacts, within the Nevada and California Sierra Range, and its foothill communities, with corporation/organization geographical purpose priority being that of the Lake Tahoe Basin. Our purpose further extends to all things incidental to supporting environmental impact assessments and studies, including the gathering of data necessary to analyze the cumulative adverse environmental, health and safety impacts from public and private projects inside and outside the Lake Tahoe Basin, and addressing and supporting safe and effective evacuation during wildfire. Our purpose further extends to supporting transparency in government to ensure that our purpose and all things incidental to our specific and primary purposes are achieved.

Estimates of Fine-Sediment Loadings to Lake Tahoe from Channel and Watershed Sources

Andrew Simon, USDA-Agricultural Research Service, National Sedimentation Laboratory, Oxford, MS 38655; asimon@ars.usda.gov

INTRODUCTION

Over the past 35 years, a trend of decreasing water clarity has been documented in Lake Tahoe, attributable in part to the delivery of fine-grained sediments emanating from upland and channel sources. The term *fine sediment* can be defined in several ways, with much of the confusion based on how the threshold diameter is defined. In sediment-transport analyses, fine sediment is generally considered to be those particles finer than 0.063mm whose transport is not a function of size and weight, but of availability to a flow. This threshold represents the distinction between sand- and silt-sized particles. Coarser sediments are hydraulically controlled with entrainment being function of the energy, stream power, or shear stress of the flow relative to the size and weight of the particle. With regards to lake clarity, however, it is the finest particles that are of the greatest interest because they tend to stay in suspension for extended periods of time. Thus, *fine sediment* can also be considered as those particles finer than 0.020 mm, representing the distinction between silt- and clay-sized particles.

Suspended-sediment-loadings to Lake Tahoe from selected watersheds were reported by Rowe *et al*. (2002) and by Simon *et al*. (2003). Both reports identified streams such as Blackwood, Trout, Third and Ward Creeks, and the Upper Truckee River as major contributors of suspended sediment. Using suspended-sediment particle-size data from the U.S. Geological Survey which distinguishes between particles coarser or finer than 0.063mm, Simon *et al*. (2003) provided initial estimates of fine-sediment loads (T/y) and yields ($T/y/km^2$) from 14 streams around the basin. This study also highlighted important distinctions in sediment production from different sides (quadrants) of the basin and from different sources. With extensive reconnaissance-level field work throughout the basin and by re-surveying monumented cross sections originally established in the 1980's (Hill *et al*. 1990), streambank erosion was identified as an important source of suspended sediment from several watersheds, including Blackwood and Ward Creeks, and the Upper Truckee River.

Estimates of fine-sediment loadings from all contributing watersheds and particularly from streambank sources are required to:

1. validate estimates of fine-sediment loadings being simulated by others using a watershed model, and
2. effectively simulate current and future water-clarity conditions in Lake Tahoe using a lake-clarity model.

The research undertaken and described in this report is only one of numerous projects being conducted by academic institutions, government agencies and private firms to improve knowledge about the causes and consequences of declining lake clarity. A synthesis of the products generated from all of this research and development of a TMDL for Lake Tahoe will rely heavily on numerical simulations of lake clarity being conducted by the University of

California, Davis. The reliability and of this modeling effort is, in part, a function of the quality of the data provided to the modelers from various sources. Data on flow and sediment inputs, and water temperature are critical.

Whereas most sediment-transport studies express loadings in units of mass (such as Megagrams or tonnes) or volume (such as cubic meters), the lake clarity model requires loadings in *numbers of particles*. An important data-collection program conducted by the University of California, Davis and the U.S. Geological Survey has recently provided fine particle-size data in the 0.005 – 0.020 mm (5-20 μm) range (Rabidoux, 2005). These data provide a means by which to calculate the number of particles in this important size class that is transported to Lake Tahoe from the sampled streams. The Rabidoux (2005) dataset, in combination with suspended-sediment transport relations, measured and simulated rates of streambank erosion, and semi-quantitative evaluations of the relative stability of stream channels throughout the basin (Simon et al. 2003) provide the means to estimate fine-sediment loadings from all watersheds draining to Lake Tahoe.

OBJECTIVES AND SCOPE

The overall objective of the research reported here was to determine the amount of fine sediment delivered to Lake Tahoe from each of the 63 contributing watersheds (Figure 1). Because the watershed modeling being conducted by others does not account for channel processes, a second critical objective was to provide estimates of stream-channel contributions, particularly fine sediment emanating from streambank erosion. This was also to be accomplished for each contributing watershed. More specifically, this study aimed to provide three forms of fine-sediment loadings data for each contributing stream in the Lake Tahoe Basin:

1. Average, annual fine-sediment (<0.063mm) loadings in tonnes per year (T/y);
2. Average, annual fine-sediment (<0.020mm) loadings in number of particles per year (*n*/y); and
3. Average, annual fine-sediment (<0.063mm) loadings in T/y from streambank erosion.

RESEARCH APPROACH

A large amount of useful data on flow, suspended sediment and channel characteristics were available from previous studies conducted in the Lake Tahoe Basin (Jorgensen *et al*. 1978; Hill *et al*., 1990; Nolan and Hill, 1991; Rowe *et al*, 2002; Simon *et al*. 2003; Rabidoux, 2005). Still, without resources to conduct detailed numerical simulations of channel processes for each stream as was done for the Upper Truckee River, and Ward and General Creeks (Simon *et al*. 2003), a combination of empirical methods were required to address the study objectives. An approach that was used successfully by Simon *et al*. (2003) to initially sort streams by similar basin characteristics was the concept of basin quadrants.

In the Lake Tahoe Basin, precipitation, geology, and other basin characteristics vary from one side of the lake to the other resulting in a broad range of sediment-transport rates. To partially account for these differences and to make interpretations of differences in suspended-sediment loads and yields to Lake Tahoe, watersheds were separated into the four principle directional quadrants; north, south, east, and west (Figure 2). Streams referred to as “northern” include First,

1 Tahoe State Park
2 Burton Creek
3 Barton Creek
4 Lake Forest Creek
5 Dollar Creek
6 Cedar Flats
7 Watson
8 Carnelian Bay Creek
9 Carnelian Canyon
10 Tahoe Vista
11 Griff Creek
12 Kings Beach
13 East Stateline Point
14 First Creek
15 Second Creek
16 Burnt Cedar Creek
17 Wood Creek
18 Third Creek
19 Incline Creek
20 Mill Creek
21 Tunnel Creek
22 Bonpland
23 Sand Harbor
24 Marlette Creek
25 Secret Harbor Creek
26 Bliss Creek
27 Deadman Point
28 Slaughter House
29 Glenbrook Creek
30 North Logan House Creek
31 Logan House Creek
32 Cave Rock
33 Lincoln Creek
34 Skyland
35 North Zephyr Creek
37 Zephyr Creek
38 Mcfaul Creek
39 Burke Creek
40 Edgewood Creek
41 Bijou Park
42 Bijou Creek
43 Trout Creek
44 Upper Truckee River
45 Camp Richardson
46 Taylor Creek
47 Tallac Creek
48 Cascade Creek
49 Eagle Creek
50 Bliss State Park
51 Rubicon Creek
52 Paradise Flat
53 Lonely Gulch Creek
54 Sierra Creek
55 Meeks
56 General Creek
57 Mkinney Creek
58 Quail Lake Creek
59 Homewood Creek
60 Madden Creek
61 Eagle Rock
62 Blackwood Creek
63 Ward Creek

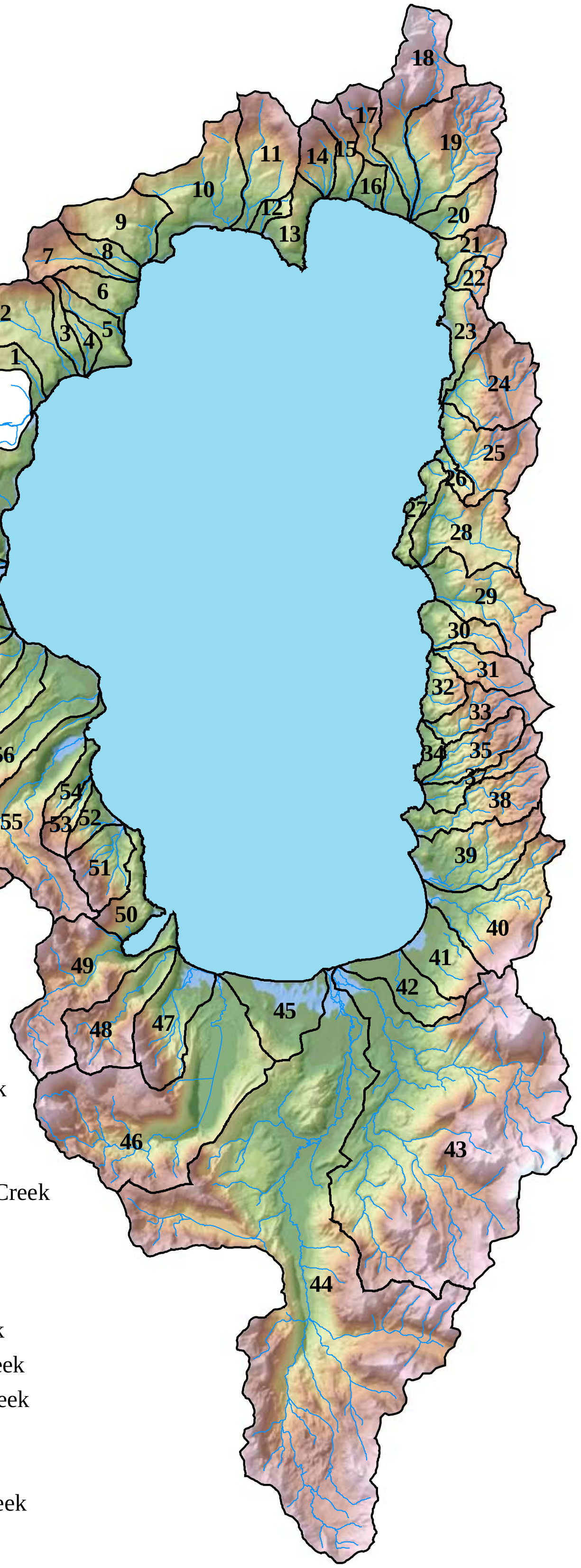

Figure 1. Map of the Lake Tahoe Basin showing the 63 watersheds draining to the lake.

Second, Third, and Incline Creeks. The major “southern” streams are the Upper Truckee River and Trout Creek. “Eastern” streams include Edgewood, Glenbrook and Logan House Creeks, while “western” streams include Blackwood, Ward, and General Creeks.

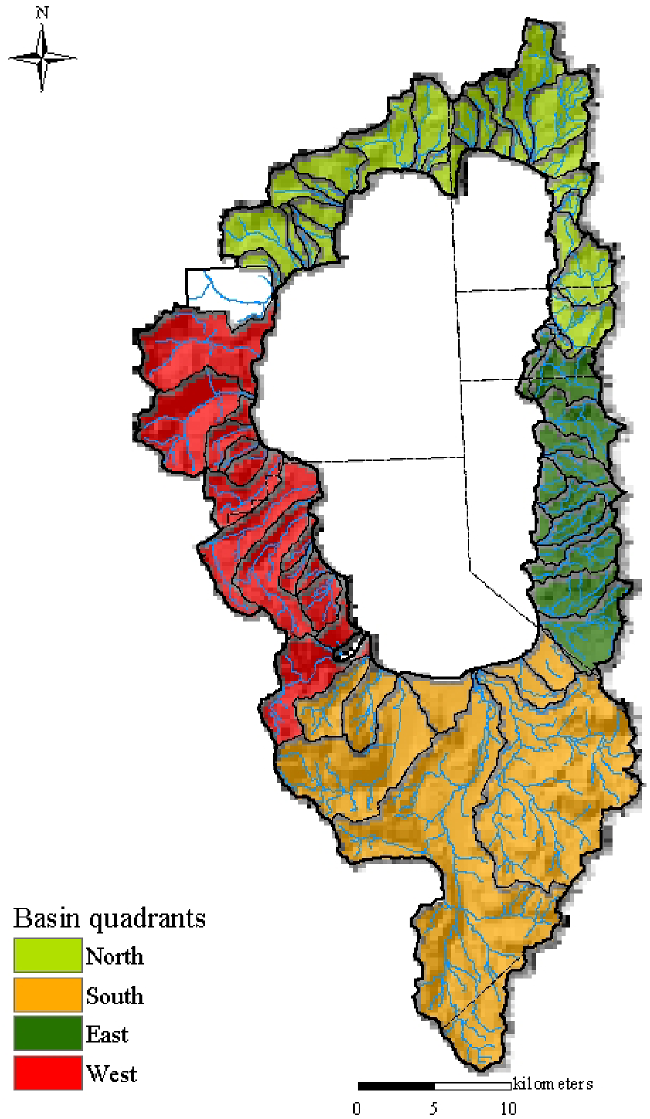

Figure 2. Map of the Lake Tahoe watershed showing designation of four basin quadrants.

Existing Suspended-Sediment Transport Data and Relations for Fine Sediment

Determination of fine-sediment (<0.063mm) loadings (in T/y) was straightforward for streams with historical flow, concentration, and particle size data. The methods employed, and results are presented and mapped in detail in Simon *et al*. (2003). Results for index sites are reproduced here in Table 1 with their period of record in Table 2. The concept of an index station is that sediment loadings and yields from a particular watershed to Lake Tahoe can be represented by sediment-transport data from a specific downstream location in that watershed. Selections of these stations were based on two criteria; (1) the station from a given stream with the longest period of record and, (2) the station had a downstream location. These stations were then used to interpret similarities and differences in sediment delivery to the lake.

Table 1- Annual fine-sediment loadings (<0.063mm) derived from measured data for index stations. (Modified from Simon *et al*., 2003). [1] = Data from Kroll (1976).

Stream	Station number	Annual Fine Load		Contribution of fines (%)	Years of data	Drainage Area (km^2)
		Average (tonnes)	Median (tonnes)			
UTR	10336610	1261	**1010**	44	24	142
Blackwood	10336660	1347	**846**	45	40	29.0
Trout	10336780	624	**462**	38	40	95.1
Ward	10336676	658	**412**	47	28	25.1
Third	10336698	462	**318**	31	26	15.7
Incline	10336700	320	**129**	67	17	18.1
General	10336645	69.2	**53.3**	29	20	19.3
Eagle[1]	10336630		**21.8**		3	20.4
Meeks[1]	10336640		**19.1**		3	22.2
Edgewood	103367585	12.9	**11.4**	59	11	8.1
Glenbrook	10336730	8.8	**7.0**	80	16	10.5
Quail Lake[1]	10336650		**3.2**		3	4.2
Dollar [1]	10336684		**2.6**		3	4.7
Logan House	10336740	3.5	**2.3**	75	17	5.4

Table 2. Period of record for index stations.

Stream	Station number	Basin quadrant	Distance above mouth (km)	Period of record (y)
Third	10336698	N	0.19	26
Incline	10336700	N	0.27	17
Trout	10336780	S	4.52	40
Upper Truckee	10336610	S	2.94	24
Edgewood	103367585	E	3.81	11
Glenbrook	10336730	E	0.04	16
Logan House	10336740	E	0.66	17
Eagle Rock	103367592	E	2.99	10
Blackwood	10336660	W	0.31	40
General	10336645	W	0.65	20
Ward	10336676	W	0.44	28

The rationale that was used to extrapolate suspended-sediment loadings from streams with measured data to streams without historical data was based on the concepts of basin quadrants and relative channel stability. The idea behind this approach was that streams exhibiting similar attributes of channel stability within a zone of similar precipitation, geology, land use and topographic characteristics would yield similar amounts of sediment per unit area. In contrast, stable and unstable streams from the same zone would have markedly different sediment yields.

Thus differences in stability can be used to differentiate suspended-sediment yields from similar areas, zones, or regions. This concept has been used successfully to determine “background” or “natural” rates of suspended-sediment transport rates, and to distinguish between stable and unstable streams for ecoregions across the United States (Simon *et al*., 2004). The techniques are being used by state agencies and others to develop TMDLs for sediment.

Because streams draining larger basin areas in a given quadrant and condition will tend to transport more sediment than smaller ones, loadings data were divided by basin area to establish fine-grained (<0.063mm) suspended-sediment yields (in T/y/km^2). The distribution of yield data (10th, 25th, 50th, 75th, and 90th percentiles) was then calculated by basin quadrant (Table 3).

Table 3- Distributions of annual fine-sediment (<0.063mm) yields (in T/y/km^2) for the four basin quadrants.

Percentiles (T/y/km^2)					**Quadrant**
10th	**25th**	**50th**	**75th**	**90th**	
0.46	0.55	0.70	1.05	1.26	E
1.87	3.83	7.10	13.65	17.58	N
5.12	5.45	6.00	6.55	6.88	S
0.81	0.91	1.93	13.0	18.95	W

Channel Conditions and Rapid Geomorphic Assessments

Evaluation of relative channel stability was accomplished using rapid geomorphic assessments (RGAs) of stream-channel conditions and identification of the dominant geomorphic processes, extent of channel instabilities, and stage of channel evolution (Simon and Hupp, 1986; Simon, 1989). As part of the RGA procedure, a semi-quantitative channel-stability index was modified to include potential side-slope erosion (combined-stability index) and calculated for hundreds of sites along the studied streams based on diagnostic criteria obtained during each RGA. In addition, samples of bed and bank material were obtained at all ground reconnaissance sites during the previous study (Simon *et al*. 2003) for determining the amount of fine-grained sediment (<0.063mm) in streambank materials (Figure 4).

Information from RGAs were supplemented by more detailed geomorphic evaluations conducted by Simon *et al*. (2003) where specific sources of fine-grained streambank materials were identified and sampled during stream walks. About 300 RGAs were conducted during 2002 and reported in Simon et al. (2003). An additional 53 RGAs were conducted in 2004 as part of this study to fill gaps in the data network.

Combined stability-index data collected during RGAs were averaged for each stream and sorted by basin quadrant (Table 4). The range and distribution of values were then calculated for each quadrant (Table 5).

COMBINED-STABILITY RANKING SCHEME

Station #__________________ **Station Description**___________________________________

Date _____________ **Crew** _______________ **Samples Taken**_________________________

Pictures (circle) U/S D/S X-section **Slope**__________ **Pattern:** Meandering / Straight / Braided

1. Primary bed material

Bedrock	Boulder/Cobble	Gravel	Sand	Silt Clay	
0	1	2	3	4	____

2. Bed/bank protection

Yes	No	(with)	1 bank protected	2 banks	
0	1		2	3	____

3. Degree of incision (Relative ele. Of "normal" low water; floodplain/terrace @ 100%)

0-10%	11-25%	26-50%	51-75%	76-100%	
4	3	2	1	0	____

4. Degree of constriction (Relative decrease in top-bank width from up to downstream)

0-10%	11-25%	26-50%	51-75%	76-100%	
0	1	2	3	4	____

5. Streambank erosion (Each bank)

	None	fluvial	mass wasting (failures)	
Left	0	1	2	____
Right	0	1	2	____

6. Streambank instability (Percent of each bank failing)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	0	0.5	1	1.5	2	____
Right	0	0.5	1	1.5	2	____

7. Established ripirian woody-vegetative cover (Each bank)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	2	1.5	1	0.5	0	____
Right	2	1.5	1	0.5	0	____

8. Occurrence of bank accretion (Percent of each bank with fluvial deposition)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	2	1.5	1	0.5	0	____
Right	2	1.5	1	0.5	0	____

9. Stage of channel evolution

I	II	III	IV	V	VI	
0	1	2	4	3	1.5	____

10. Condition of adjacent side slope (circle)

N/A	Bedrock	Boulders	Gravel-SP	Fines	
0	1	2	3	4	____

11. Percent of slope (length) contributing sediment

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	0	0.5	1	1.5	2	____
Right	0	0.5	1	1.5	2	____

12. Severity of side-slope erosion

None	Low	Moderate	High	
0	0.5	1.5	2	____

TOTAL ____

Figure 3. Combined-stability index field form and ranking scheme.

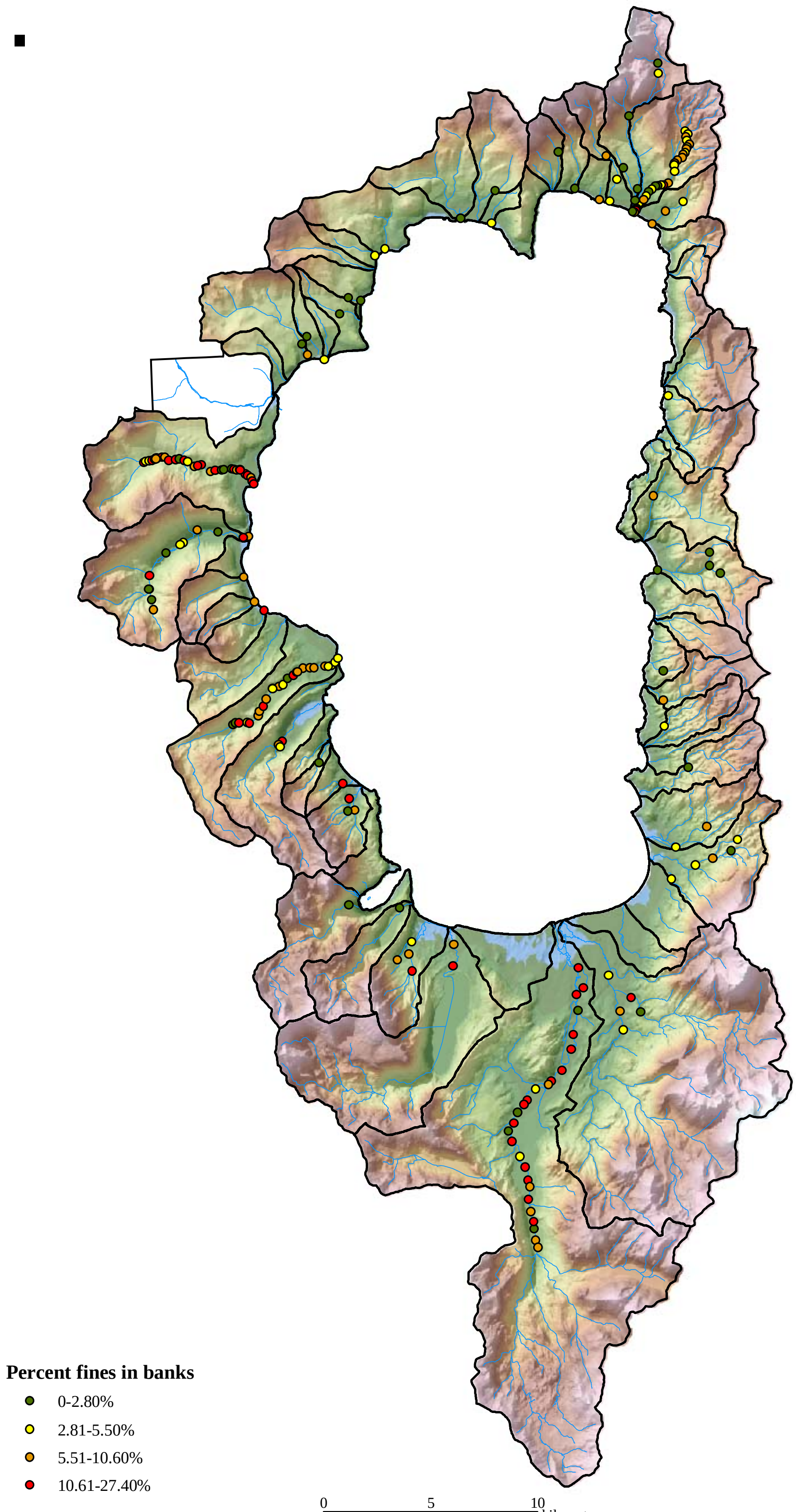

Figure 4. Spatial distribution of fine-grained (<0.063mm) bank materials.

Table 4- Average, combined-stability index for streams draining to Lake Tahoe. Values are based on criteria shown in Figure 3.

Watershed	Stream	Combined stability-index	Basin area $(km)^2$	Quadrant
39	Burke	10.0	12.8	E
32	Cave Rock	16.8	4.1	E
27	Dead Mans Point	13.5	3.5	E
40	**Edgewood**	17.8	17.2	E
29	**Glenbrook**	19.3	13.0	E
33	Lincoln	14.5	6.7	E
31	**Logan House**	12.9	5.6	E
38	McFaul	17.6	10.2	E
30	North Logan House	15.0	5.3	E
35	North Zephyr	16.3	6.8	E
	Skyland		2.0	E
28	Slaughterhouse	15.3	12.3	E
37	Zephyr	21.0	4.9	E
3	Barton	6.5	2.6	N
22	Bonpland	9.0	2.3	N
16	Burnt	16.3	2.3	N
2	Burton	9.1	14.8	N
8	Carnelian Bay	7.0	2.6	N
9	Carnelian Canyon	7.5	9.2	N
6	Cedar Flats	8.3	4.7	N
5	Dollar	6.5	4.7	N
	East Stateline Point		4.8	N
14	First	15.6	4.5	N
11	Griff	13.6	11.8	N
19	**Incline**	17.5	17.4	N
12	Kings Beach	14.5	1.6	N
4	Lake Forest	4.2	1.8	N
24	Marlette	21.8	11.3	N
20	Mill	17.3	12.4	N
	Sand Harbor		5.6	N
15	Second	19.1	4.8	N
25	Secret Harbour	12.2	11.1	N
1	Tahoe State Park	10.0	3.1	N
10	Tahoe Vista	11.4	15.5	N
18	**Third**	14.2	15.5	N
21	Tunnel	14.1	4.4	N
7	Watson	4.3	6.0	N
17	Wood	13.0	6.1	N
42	Bijou	11.7	7.3	S
41	Bijou Park	18.5	8.0	S
	Camp Richardson		10.1	S
48	Cascade	12.0	11.1	S
47	Tallac	8.4	11.9	S

46	Taylor	8.0	41.0	S
43	**Trout**	14.9	106.6	S
44	**Upper Truckee**	16.6	144.2	S
62	**Blackwood**	17.4	28.8	W
26	Bliss	14.0	1.6	W
50	Bliss State Park	5.5	5.4	W
49	**Eagle**	7.0	20.4	W
	Eagle Rock		2.1	W
45	**General**	16.1	23.3	W
59	Homewood	13.1	2.6	W
53	Lonely Gulch	8.3	2.8	W
60	Madden	9.3	5.9	W
57	McKinney	7.2	22.2	W
55	Meeks	13.0	5.7	W
52	Paradise Flat	18.0	2.9	W
58	Quail Lake	6.5	4.2	W
51	Rubicon	9.2	7.4	W
54	Sierra	6.0	3.1	W
63	**Ward**	13.9	34.2	W

Table 5- Distribution of average, combined stability-index by basin quadrant.

Combined stability-index percentiles					**Quadrant**
10th	**25th**	**50th**	**75th**	**90th**	
13.0	14.3	15.8	17.6	19.1	E
6.5	7.9	12.2	15.1	17.5	N
8.2	10.0	12.0	15.7	17.4	S
6.2	7.1	9.3	13.9	16.9	W

Estimates of Fine-Sediment Loadings: T/y <0.063 mm

Initial analysis of fine-sediment (<0.063 mm) loadings in T/y to Lake Tahoe from all 63 watersheds were conducted using the distributions of fine-sediment yields and the combined-stability index, and applied to streams with no historical loadings data. The procedure was:

1. Determine the average, combined stability index for the stream (Table 4);
2. Calculate the distribution of average values by basin quadrant (10th, 25th, 50th, 75th, and 90th) (Table 5);
3. For a given stream, use the appropriate percentile class based on the combined-stability index distribution, and apply to the same percentile of the distribution of fine-grained (<0.063mm) suspended-sediment yield (Table 3);
4. Obtain the fine-grained (<0.063mm) suspended-sediment yield from the table and multiply by basin area to obtain average, annual fine-sediment load in T/y.

On average, approximately 5,200 T/y of fine (<0.063 mm) sediment is delivered to Lake Tahoe from the 63 contributing watersheds. Loadings from the north, south and west quadrants are similar, with contributions representing 32%, 37% and 30%, respectively. Results are mapped in

Figures 5 and 6 showing annual fine-sediment loadings in T/y and percent contribution to the lake.

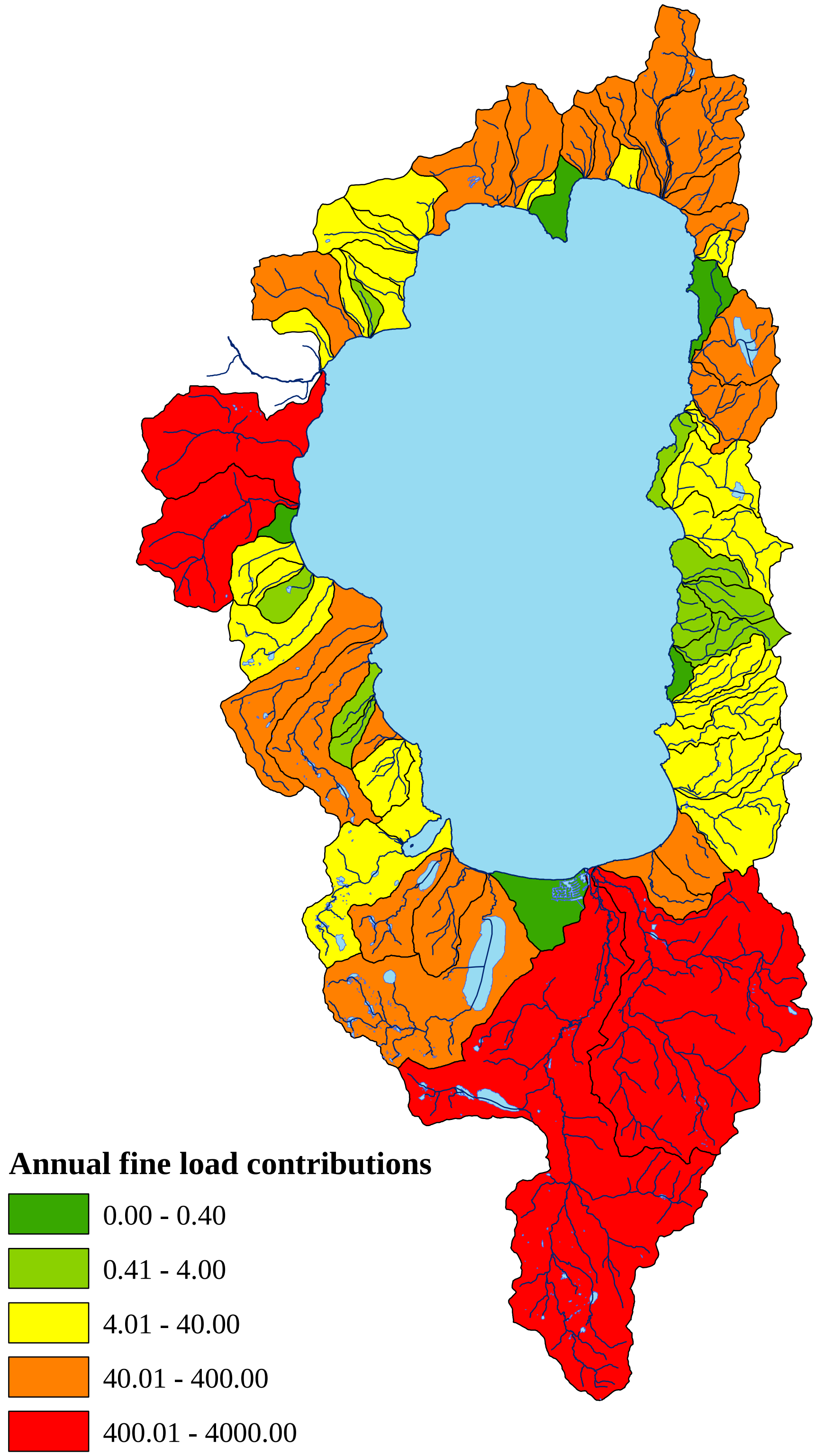

Figure 5. Median, annual contribution of fine sediment (<63um) in T/y.

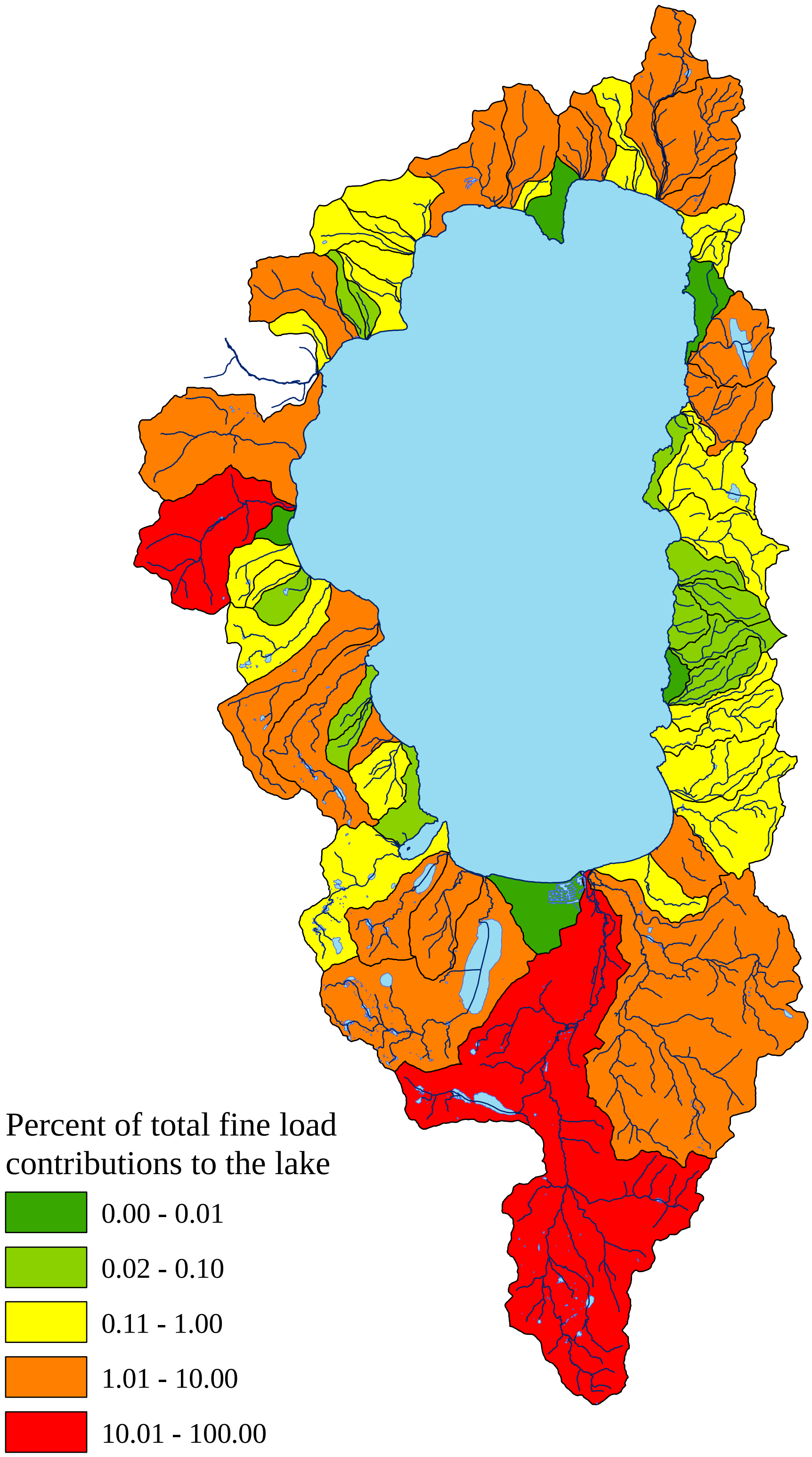

Figure 6. Percent of annual contribution of fine suspended sediment (<63um).

Estimates of Fine-Sediment Particle Flux: *n*/y <0.020 mm

The fundamental approach to developing estimates of basinwide fine-particle flux to Lake Tahoe were based on similar techniques to those used above. That is, using distributions of particle flux by basin quadrant from measured data and regression relations and then applying those relations to streams with no fine-particle flux data. Particle flux is defined as the product of the concentration of particles per volume of water times the flow rate:

$$n = C\,Q\,\alpha \qquad (1)$$

where n = particle flux, the number of particles per second; C = concentration in mg/l; Q = discharge in ft^3/s; and α = factor to convert from per milliliter to per ft^3.

Rabidoux (2005) used relations between flow discharge and particle flux to develop loadings estimates for sites with measured fine-particle data (Table 6).

Table 6- Sampling sites of water-sediment mixtures by U. California, Davis between 2002 and 2004 (Rabidoux, 2005). Note: * = additional samples taken at other sites along stream.

Stream	USGS station number	Number of samples
Blackwood Creek	10336660	71
Eagle Rock Creek	103367592	59
Edgewood Creek	10336760	62
General Creek	10336645	69
Glenwood Creek	10336730	59
Incline Creek*	10336700	73
Logan House Creek	10336740	59
Third Creek	10336698	72
Trout Creek*	10336790	65
Upper Truckee River*	10336610	72
Ward Creek	10336676	75

Preliminary analysis of relations between flow discharge and particle concentration in *n*/ml undertaken in this study using the same data set showed extremely low regression coefficients and flat regression slopes (Figure 7). An example of the regression for Blackwood Creek is shown in Figure 8. The lack of significant relations between concentration of fine particles and flow is not surprising given that particles finer than sand, and particularly those finer than silt, are not hydraulically controlled. Thus relations between particle flux and water discharge are almost akin to multiplying discharge by a constant particle concentration. This provides an explanation for the strength of the relations reported by Rabidoux (2005) (Figure 9).

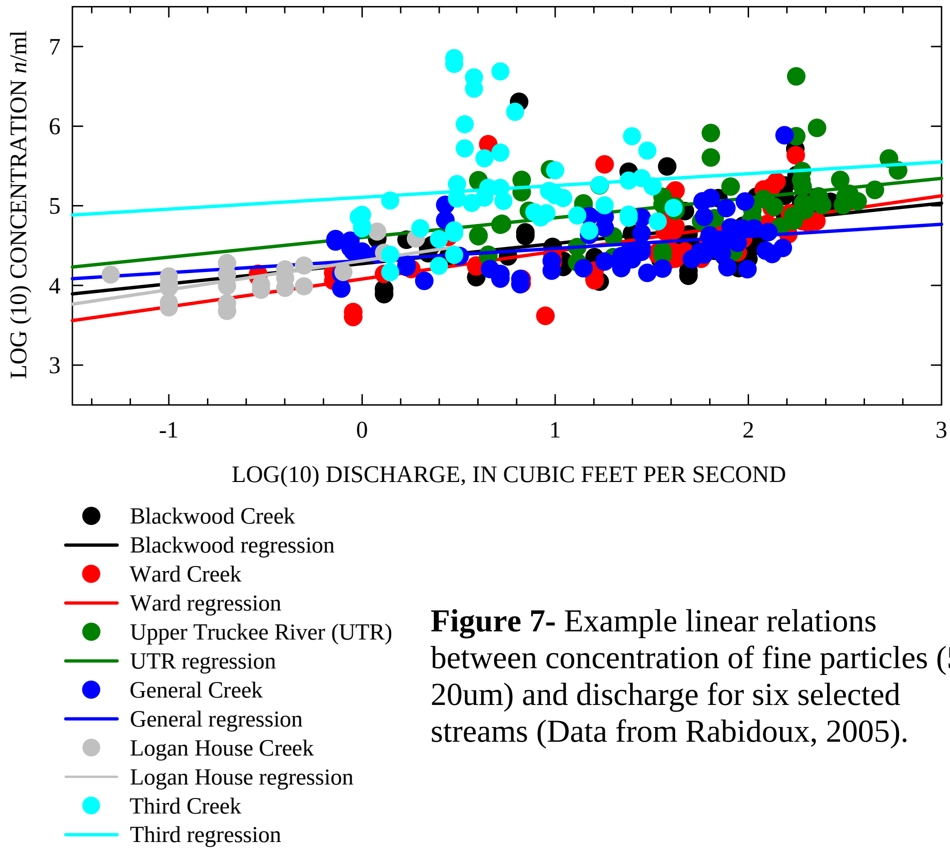

Figure 7- Example linear relations between concentration of fine particles (5-20um) and discharge for six selected streams (Data from Rabidoux, 2005).

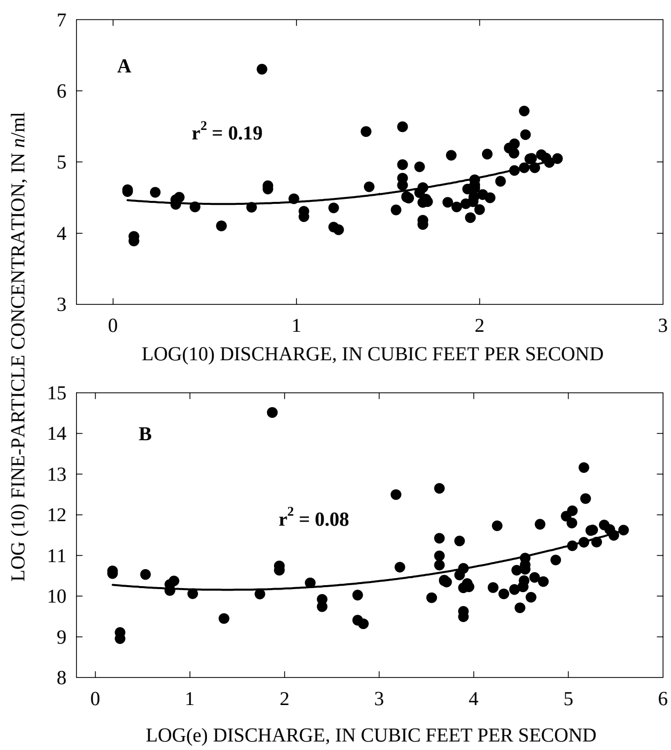

Figure 8. Example quadratic relations of fine-particle concentration (5-20μm) regressed against discharge for Blackwood Creek using data from Rabidoux (2005) and showing very low coefficients of determination between variables using log base 10 (A), and natural log (B).

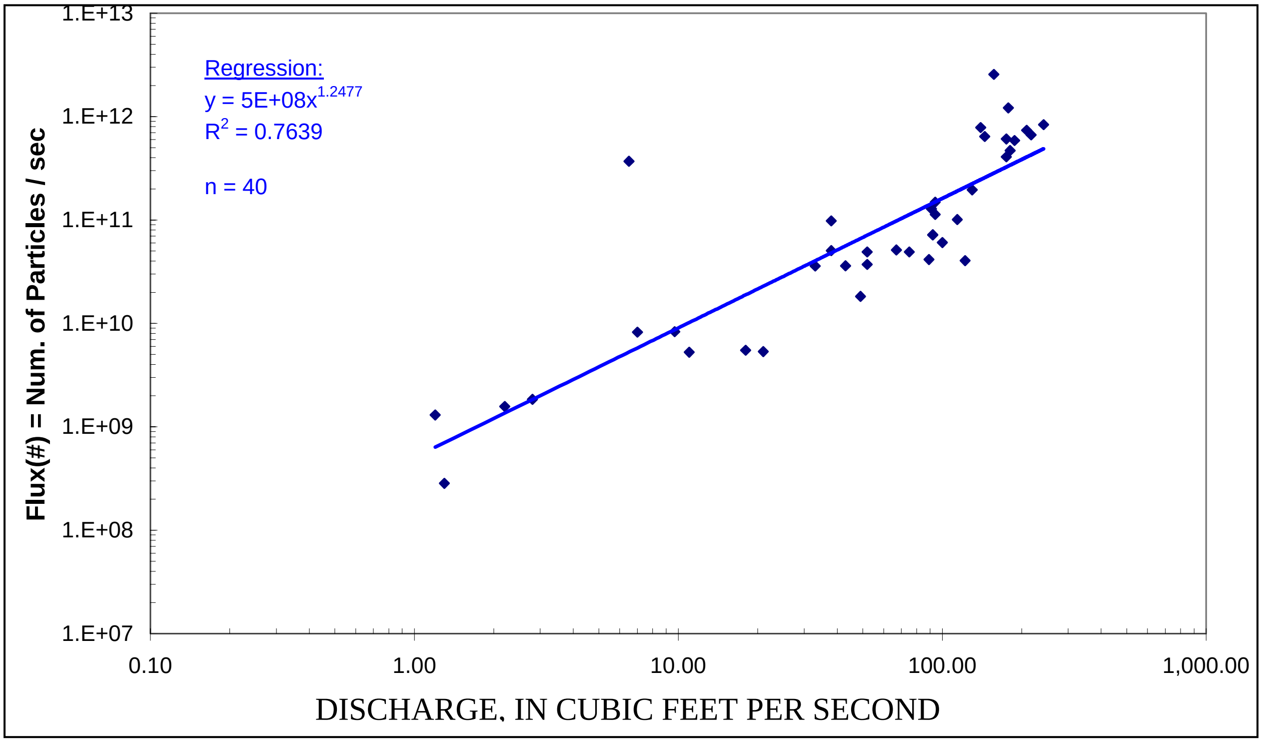

Figure 9- Relation between flow discharge and fine=particle (<0.020mm) flux for Blackwood Creek. Modified from written commun., A. Rabidoux (2005).

More meaningful relations for extrapolating annual particle flux (in *n*/y) were obtained by regressing total, suspended-sediment concentration (in mg/l) as analyzed by the USGS using conventional methods, with particle concentration of the 5 -20 µm fraction (in *n*/ml) analyzed using the Liquilaz instrument (Table 6). The improvement in r^2 values can be seen by comparing the values for the selected stations shown in Table 7. That the slope of the regression lines are significantly greater than 0.0 also attests to the improved viability of the regressions. Relations developed in log-log space for the 11 sites with particle flux data are shown in Figure 10. Regression of these two variables provides a functional link between the total mass of suspended-sediment transported at a given time and the number of particles in the 5 -20 µm fraction.

Table 7- Coefficients of determination (r^2-values) and regression slopes for relations between fine-particle (5-20µm) concentration and discharge (*Q*) and total suspended-sediment concentration (*C*) for selected stations. Note the improved relations for regressions of *n* with *C*.

Particle concentration (*n*) vs. *Q*			**Particle concentration (*n*) vs. *C***		
Stream	**r^2**	**Slope of regression**	**Stream**	**r^2**	**Slope of regression**
Blackwood	0.16	0.25	Blackwood	0.67	0.79
Ward	0.35	0.35	Ward	0.74	0.74
Upper Truckee	0.14	0.25	Upper Truckee	0.52	0.51
General	0.13	0.15	General	0.31	0.39
Logan House	0.40	0.36	Logan House	0.62	0.55
Third	0.01	0.15	Third	0.36	0.51

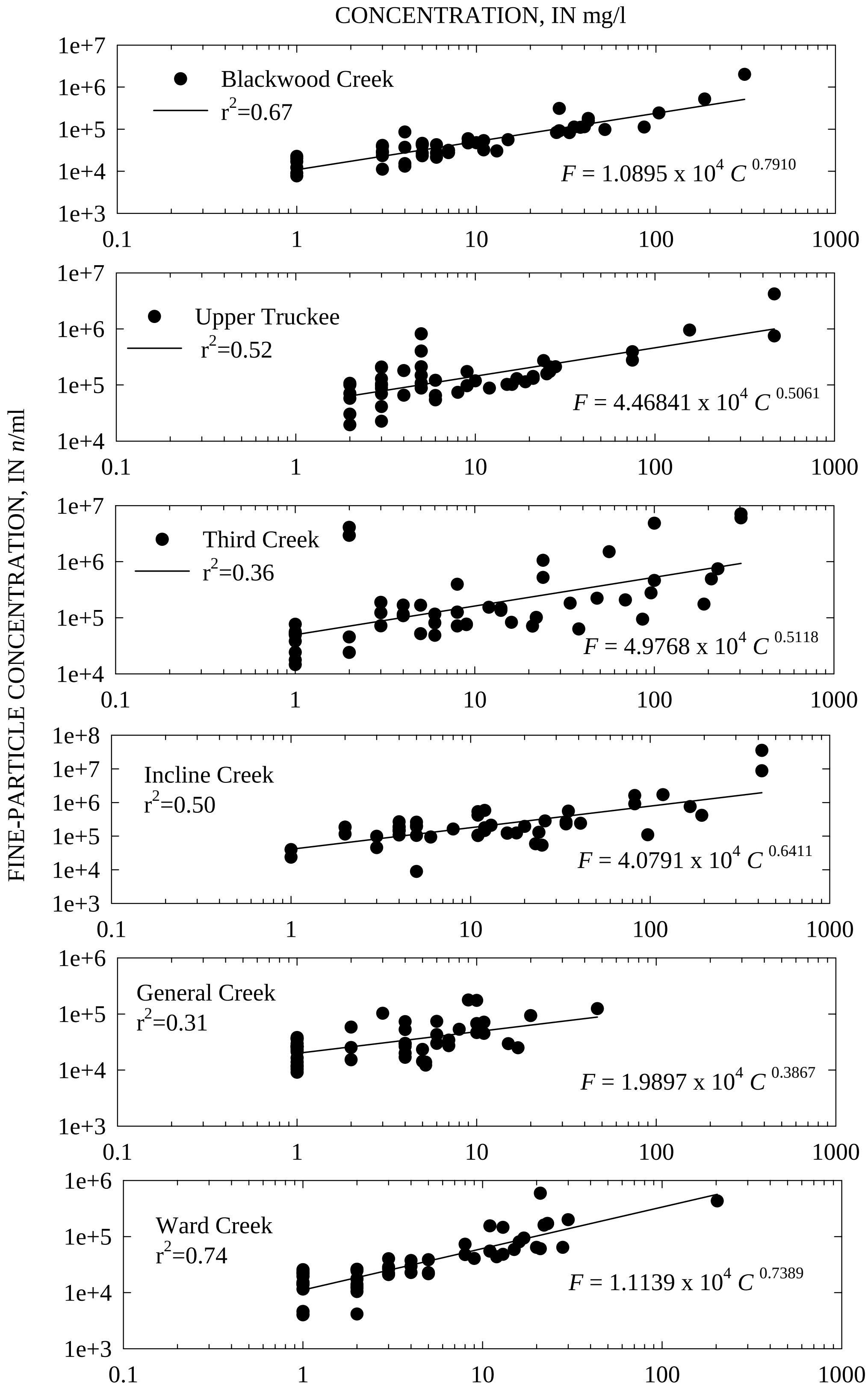

Figure 10- Regressions between fine-particle (5-20μm) concentration in *n*/ml and total, suspended-sediment concentration in mg/l.

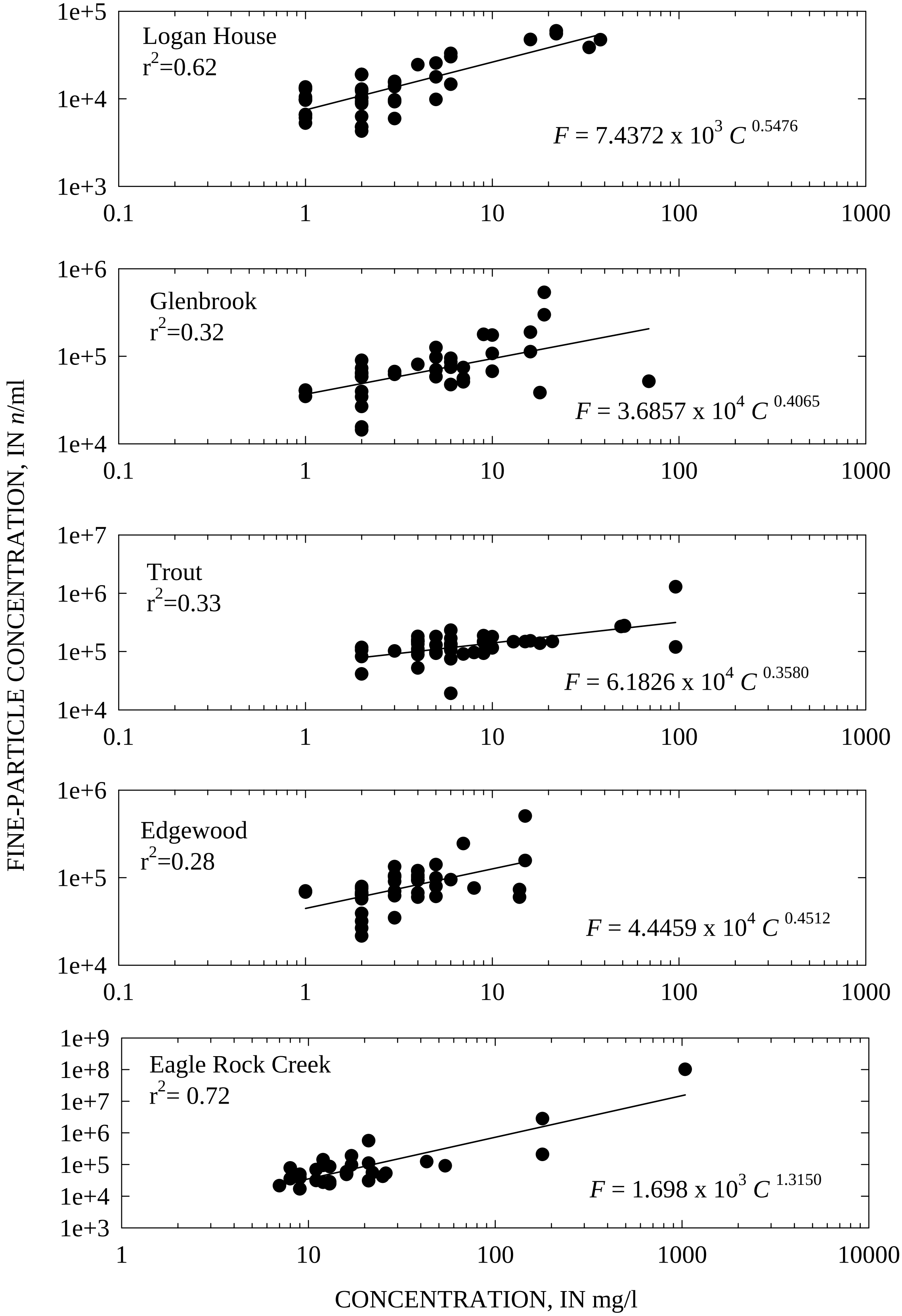

Figure 10- cont'd.

To obtain estimates of annual, fine-particle (5-20 μm) flux, the relations shown in Figure 10 were to be applied to total, suspended-sediment load data for each of the stations over their daily-values period of record. Thus, the daily suspended-sediment loads calculated in Simon *et al*. (2003) for the index stations were used. As it serves as a basis for annual flux estimates, a review of the procedures used in this earlier study to calculate daily loads is appropriate.

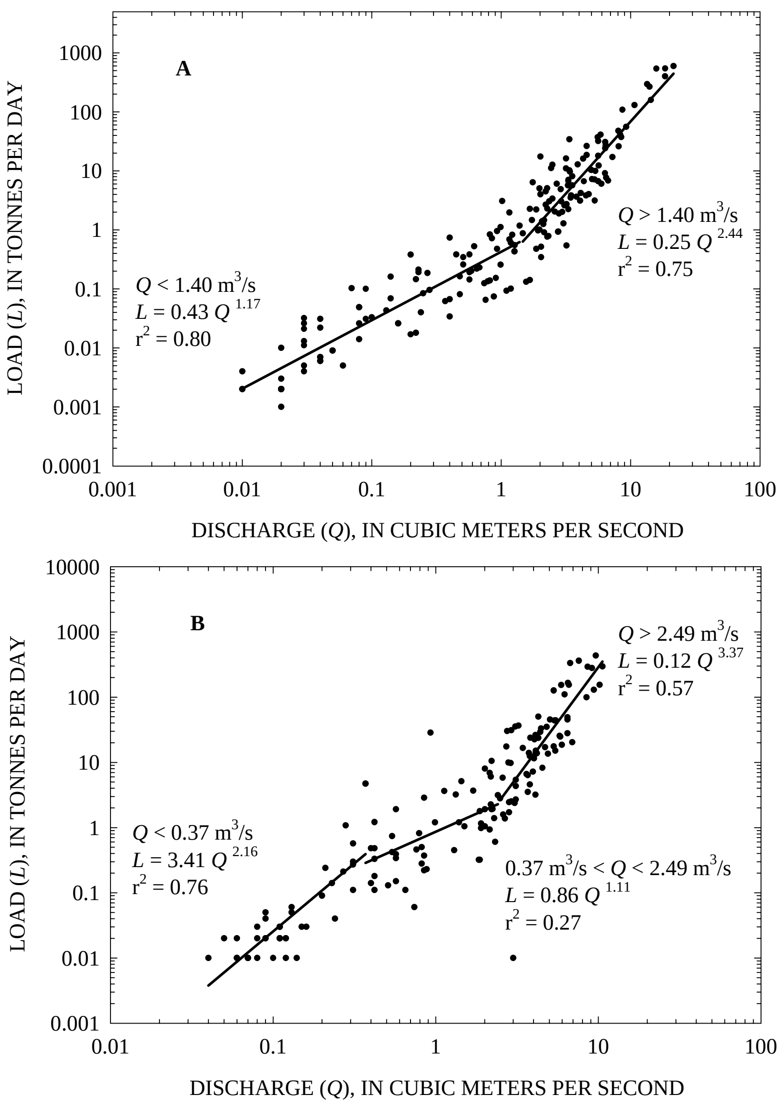

Figure 11. Example of two- and three-segment suspended-sediment rating relations for Blackwood Creek (A), and General Creek (B).

Daily suspended-sediment load data were calculated for each of the index stations from mean-daily flow data and the sediment-rating relations developed in Simon *et al*. (2003). These suspended-sediment transport ratings represent flow and concentration (or load) data collected over extended periods (up to 40 years; Table 2). In a number of cases, the transport relations were not represented by a single linear segment (in log-log space) but were split into several segments to appropriately represent the relation between flow and load over the range of possible discharges (Figure 11). In addition, rating relations for a given site displayed shifts with time, requiring different relations to be used for different time periods. These were generally split into pre- and post-1997, thus accounting for the effects of the large New Year's Day rainstorm in 1997 that created super-saturated snow packs and resulted in large runoff events throughout the Lake Tahoe Basin. Suspended-sediment loads resulting from this event were very high, representing the peak of record in some watersheds (Simon *et al*. 2003). A summary of the number and type of rating relations used to calculate daily, suspended-sediment loads from each of the index stations in shown in Table 8 while the pre- and post-1997 rating equations are shown in Tables 9 and 10, respectively..

Table 8- Number and type of suspended-sediment rating relations used to calculate mean-daily suspended-sediment loads.

Stream	Station	Data Period		Pre / Post 1997 data available ?	Number of Rating Sections: Pre 1997	Number of Rating Sections: Post 1997
		Flow	Suspended Sediment			
Blackwood	10336660	10/1/60-9/30/01	5/16/74-8/19/02	Y	3	3
Eagle Rock	103367592	11/18/89-9/30/00	11/2/89-9/13/02	Y	1	1
Edgewood	10336760	10/1/92-9/30/00	8/20/92-9/13/02	Y	1	1
General	10336645	7/7/80-9/30/01	4/30/81-9/19/02	Y	2	2
Glenbrook	10336730	10/1/71-9/30/00	10/18/71-9/13/02	Y	1	2
Incline	10336700	10/1/69-9/30/00	10/15/69-9/16/02	Y	1	1
Logan House	10336740	10/1/83-9/30/00	5/10/84-9/13/02	Y	2	2
Third	10336698	10/1/69-9/30/00	10/15/69-9/16/02	Y	1	1
Trout	10336790	10/1/71-9/30/92	3/4/72-9/11/02	Y	1	0
UTR	10336610	10/1/71-9/30/01	11/4/72-9/12/02	Y	1	1
Ward	10336676	10/1/72-9/30/01	12/20/72-9/19/02	Y	2	2

Table 9- Pre-1997 suspended-sediment rating relations used to calculate mean daily suspended-sediment loads.

Stream	Station	Rating Relations					
		Eq. 1	Eq. 1 limit	Eq. 2	Eq. 2 limit	Eq. 3	Eq. 3 limit
		(T)	(m^3/s)	(T)	(m^3/s)	(T)	(m^3/s)
Blackwood	10336660	$L = .07Q^{1.48}$	Q < 1.47	$L=1.15Q^{2.09}$	1.47 < Q < 10.62	$L =1.35Q^{2.18}$	Q > 10.6
Eagle Rock	103367592	$L = 9.3Q^{1.82}$	All flows				
Edgewood	10336760	$L=3.29Q^{1.84}$	All flows				
General	10336645	$L =.430Q^{1.17}$	Q < 1.40	$L =.248Q^{2.44}$	Q >1.40		
Glenbrook	10336730	$L =2.23Q^{1.34}$	All flows				
Incline	10336700	$L =26.6Q^{2.19}$	All flows				
Logan House	10336740	$L =1.35Q^{1.32}$	Q <0.038	$L= 30.3Q^{2.16}$	Q > 0.038cms		
Third	10336698	$L =38.6Q^{2.01}$	All flows				
Trout	10336790	$L =1.23Q^{1.61}$	All flows				
Trout	10336770	$L =1.96Q^{2.04}$	All flows				
UTR	10336610	$L =.991Q^{1.55}$	All flows				
Ward	10336676	$L =1.26Q^{1.43}$	Q < 2.00	$L =.404Q^{2.69}$	Q >2.00		

Table 10- Post-1997 suspended-sediment rating relations used to calculate mean-daily suspended-sediment loads.

Stream	Station	Rating Relations					
		Eq. 1	Eq. 1 limit	Eq. 2	Eq. 2 limit	Eq. 3	Eq. 3 limit
		(T)	(m^3/s)	(T)	(m^3/s)	(T)	(m^3/s)

Blackwood	10336660	$L=3.41Q^{2.16}$	$Q < 0.37$	$L = .865Q^{1.11}$	$0.37<Q<2.49$	$L= 0.12Q^{3.37}$	$Q > 2.49$
Eagle Rock	103367592	$L = .701Q^{1.05}$	All flows				
Edgewood	10336760	$L = 1.32Q^{1.57}$	All flows				
General	10336645	$L = .703Q^{1.48}$	$Q < 2.00$	$L = .232Q^{2.93}$	$Q > 2.00$		
Glenbrook	10336730	$L = 0.54Q^{1.08}$	$Q< 0.085$	$L = 0.27Q^{1.60}$	$Q > 0.085$		
Incline	10336700	$L = 3.70Q^{1.86}$	All flows				
Logan House	10336740	$L = 1.37Q^{1.39}$	$Q< 0.060$	$L = 118Q^{3.09}$	$Q > 0.060$		
Third	10336698	$L = 4.09Q^{1.94}$	All flows				
Trout	10336780	$L = 2.27Q^{1.87}$	All flows				
Trout	10336775	$L = .562Q^{1.81}$	All flows				
Trout	10336770	$L = .774Q^{1.81}$	All flows				
UTR	10336610	$L=.784Q^{1.33}$	All flows				
Ward	10336676	$L = .58Q^{1.41}$	$Q < 2.00$	$L = .158Q^{2.98}$	$2.0<Q<16.0$	Pre-1997 eq 2	$Q > 16.0$

The number of fine particles (5-20 μm) transported on a given day was thus calculated for each day at each index station based on the equations in Figure 10 transposed to relations between fine-particle flux (in *n*/d) and suspended-sediment load (in T/d) (Table 11). This was done because the daily, sediment loadings data sets from Simon *et al*. (2003) were expressed in T/d. Summing the daily values for each year provided an annual fine-particle flux for each year of record. An example from the Upper Truckee River (station 10336610) is shown in Table 12.

Table 11- Regression equations between fine-particle flux (in *n*/d) and suspended-sediment load (in T/d) used to calculate the daily and annual flux for each index station.

Stream	**Function**	**Basin Area (km^2)**	**Median Annual Flux**	**Median Annual-Flux Yield**
Trout Creek 10336790	$F = 1.3358 \times 10^{16} L^{0.6310}$	106.6	4.18E+18 (8.16E+18)[1]	4.00E+16 (8.59E+16)[1]
Glenbrook Creek 10336730	$F = 5.2060 \times 10^{15} L^{0.7632}$	13.0	1.03E+17	9.81E+15
Edgewood Creek 10336760	$F = 7.1390 \times 10^{15} L^{0.6894}$	17.2	4.67E+17	3.28E+16
Incline Creek 10336700	$F = 9.0419 \times 10^{15} L^{0.6834}$	17.4	2.42E+18	1.33E+17
Logan House Creek 10336740	$F = 1.4239 \times 10^{15} L^{0..8100}$	5.6	9.29E+15	1.72E+15
General Creek 10336645	$F = 1.3679 \times 10^{15} L^{0..7499}$	23.3	2.05E+17	1.06E+16
Third Creek 10336698	$F = 7.6192 \times 10^{15} L^{0.6174}$	15.5	3.37E+18	2.15E+17
Ward Creek 10336676	$F = 6.6512 \times 10^{15} L^{0.9080}$	34.2	4.56E+18	1.82E+17
Upper Truckee River 10336610	$F = 1.7579 \times 10^{16} L^{0.7141}$	144.2	1.93E+19	1.36E+17

Blackwood Creek 10336660	$F = 5.1054 \text{ x } 10^{15} L^{0.8126}$	28.8	5.44E+18	1.88E+17
Eagle Rock Creek 103367592	$F = 8.1701 \text{ x } 10^{15} L^{1.1836}$	1.53	1.74E+16	1.14E+16

F = fine-particle (0.5 – 20µm) flux, in number per day (*n*/d); *L* = suspended-sediment load in Tonnes per day (T/d).

[1] = Values calculated using flux-load relation from station 10336790 with flow and load data from 10336780.

Table 12- Calculation of annual fine-particle (<0.020mm) flux and flux yield for the Upper Truckee River (station 1033610)

Year	**Annual Load (T)**	**Yield (T/km^2)**	**Annual Flux (*n*)**	**Annual Flux Yield (*n*/y)**
1972	2370	16.67	1.93E+19	1.36E+17
1973	3325	23.38	2.40E+19	1.69E+17
1977	293	2.06	4.35E+18	3.06E+16
1981	1840	12.94	1.52E+19	1.07E+17
1982	7320	51.49	4.29E+19	3.02E+17
1983	8903	62.62	5.13E+19	3.61E+17
1984	4333	30.47	2.84E+19	2.00E+17
1985	1407	9.90	1.29E+19	9.08E+16
1986	5848	41.13	3.46E+19	2.44E+17
1987	641	4.51	7.16E+18	5.04E+16
1988	403	2.83	5.60E+18	3.94E+16
1989	2493	17.53	1.94E+19	1.37E+17
1990	755	5.31	8.34E+18	5.87E+16
1991	977	6.87	9.60E+18	6.76E+16
1992	516	3.63	6.49E+18	4.56E+16
1993	3965	27.89	2.72E+19	1.91E+17
1994	474	3.33	6.03E+18	4.24E+16
1995	8652	60.85	4.80E+19	3.38E+17
1996	5146	36.19	3.44E+19	2.42E+17
1997	2678	18.83	2.00E+19	1.41E+17
1998	2430	17.09	2.02E+19	1.42E+17
1999	2034	14.31	1.71E+19	1.20E+17
2000	1079	7.59	1.11E+19	7.78E+16
Mean	**2951**	**20.8**	**2.06E+19**	**1.45E+17**
Median	**2370**	**16.7**	**1.93E+19**	**1.36E+17**
Max	**8903**	**62.6**	**5.13E+19**	**3.61E+17**

To summarize, estimates of fine-sediment (<0.020 mm) flux in *n*/y from each index station were obtained using the following procedure.

1. Relations were developed between total, suspended-sediment concentration (in mg/l) and particle concentration (in *n*/ml) of the 5-20mm fraction (Figure 10);

2. Relations from (1) above, were converted to fine-particle concentration (in *n*/d) and suspended-sediment load (in T/d) (Table 11);
3. Particle flux in *n*/d were calculated for each day of historic flow record at each site from the equations in Table 11;
4. Data for each year were summed to obtain an annual value;
5. An average, annual value was calculated by summing the number of particles transported during each year of flow record, and dividing by the number of years (See Table 12); and
6. Average, annual particle flux (in *n*/y) was divided by basin area to obtain an average, annual particle-flux yield (in *n*/y/km^2).

The procedure for extrapolating average, annual fine-particle flux yield data to ungaged watersheds was accomplished by first sorting the average, annual values (in *n*/y/km^2) by basin quadrant and determining the distribution within each quadrant. As done previously, distributions for each quadrant were defined in terms of the 10th, 25th, 50th, 75th, and 90th percentiles. For a given stream, the correct quadrant and appropriate percentile class is selected based on the combined-stability index distribution (Table 5). That same quadrant, percentile class is then selected from the average, annual flux yield distribution in Table 13. By multiplying that value by the basin area (in km^2) the average, annual particle flux of the 5-20µm fraction (in *n*/y/km^2) was obtained.

Table 13- Distribution of average, annual flux yields in *n*/y/km^2 by basin quadrant.

Percentiles of average, annual flux yield in *n*/y/km^2					**Quadrant**
10th	**25th**	**50th**	**75th**	**90th**	
3.34E+15	5.77E+15	9.81E+15	2.13E+16	2.82E+16	E
1.41E+17	1.54E+17	1.74E+17	1.95E+17	2.07E+17	N
4.92E+16	6.30E+16	8.59E+16	1.11E+17	1.26E+17	S
4.49E+16	9.63E+16	1.82E+17	1.85E+17	1.87E+17	W

A summary of the results, using the above procedure is shown in Table 14. On average, a total of 7.79E+19 fine particles (<0.020 mm) are delivered to Lake Tahoe on an annual basis from the 63 contributing watersheds. The spatial distribution of fine-particle flux in *n*/y and the relative contribution (in percent) from each watershed are displayed in Figures 12 and 13, respectively.

Table 14- Summary of annual fine load (<0.063mm) and annual fine-particle flux (<0.020mm) for watersheds draining to Lake Tahoe.

Watershed	Stream name	Quadrant	Annual Fine Load (<63um) tonnes/y	% of Load (<63um)	% by Quadrant (<63um)	Annual Flux (0.5 - 20 um) number/y	% of Load (0.5 - 20 um)	% by Quadrant (0.5 - 20 um)
39	Burke	E	5.9	0.11		4.28E+16	0.05	
32	Cave Rock	E	3.5	0.07		6.12E+16	0.08	
27	Dead Mans Point	E	1.8	0.03		1.58E+16	0.02	
40	**Edgewood**	E	**11.4**	0.22		**4.67E+17**	0.60	
29	**Glenbrook**	E	**7.0**	0.13		**1.03E+17**	0.13	
33	Lincoln	E	3.7	0.07		3.84E+16	0.05	
31	**Logan House**	E	**2.3**	0.04		**9.29E+15**	0.01	
38	McFaul	E	10.7	0.21		2.17E+17	0.28	
30	North Logan House	E	3.3	0.06		4.12E+16	0.05	
35	North Zephyr	E	4.7	0.09		6.65E+16	0.09	
	Skyland	E	-	-		-	-	
28	Slaughterhouse	E	8.6	0.17		1.21E+17	0.15	
37	Zephyr	E	6.1	0.12	1.3	1.37E+17	0.18	1.7
3	Barton	N	4.9	0.09		3.70E+17	0.48	
22	Bonpland	N	8.7	0.17		3.49E+17	0.45	
16	Burnt	N	36.2	0.70		4.69E+17	0.60	
2	Burton	N	79.9	1.53		2.43E+18	3.12	
8	Carnelian Bay	N	7.8	0.15		1.16E+17	0.15	
9	Carnelian Canyon	N	35.4	0.68		1.42E+18	1.82	
6	Cedar Flats	N	18.0	0.35		7.23E+17	0.93	
5	Dollar	N	8.8	0.17		6.62E+17	0.85	
	East Stateline Point	N	-	-		-	-	
14	First	N	61.7	1.18		8.79E+17	1.13	
11	Griff	N	121	2.33		2.16E+18	2.78	
19	**Incline**	N	**129**	2.48		**1.63E+18**	2.09	
12	Kings Beach	N	22.4	0.43		3.02E+17	0.39	
4	Lake Forest	N	3.4	0.06		2.56E+17	0.33	
24	Marlette	N	199.2	3.83		2.34E+18	3.01	
20	Mill	N	218.8	4.20		2.57E+18	3.30	
	Sand Harbor	N		0.00		-	-	
15	Second	N	84.0	1.61		9.89E+17	1.27	
25	Secret Harbour	N	78.5	1.51		1.92E+18	2.47	
1	Tahoe State Park	N	8.8	0.17		5.14E+17	0.66	
10	Tahoe Vista	N	110	2.11		2.69E+18	3.46	
18	**Third**	N	318	6.11		3.37E+18	4.33	
21	Tunnel	N	44.2	0.85		8.13E+17	1.04	
7	Watson	N	11.2	0.22		8.49E+17	1.09	
17	Wood	N	43.5	0.83	31.8	1.07E+18	1.37	37.1
42	Bijou	S	43.9	0.84		6.28E+17	0.81	
41	Bijou Park	S	55.0	1.06		1.01E+18	1.29	
	Camp Richardson	S	-	-		-	-	
48	Cascade	S	66.8	1.28		9.57E+17	1.23	
47	Tallac	S	60.7	1.17		5.83E+17	0.75	
46	Taylor	S	210	4.03		2.01E+18	2.59	
43	**Trout**	S	**462**	8.87		**4.18E+18**	5.37	
44	**Upper Truckee**	S	**1010**	19.40	36.6	**1.93E+19**	24.8	36.8
62	**Blackwood**	W	**846**	16.25		**5.44E+18**	6.98	
26	Bliss	W	20.8	0.40		2.96E+17	0.38	
50	Bliss State Park	W	4.4	0.08		2.43E+17	0.31	
49	**Eagle**	W	**21.8**	0.42		1.96E+18	2.52	
	Eagle Rock	W	-	-		-	-	
45	**General**	W	**53.3**	1.02		**2.05E+17**	0.26	
59	Homewood	W	33.9	0.65		4.83E+17	0.62	
53	Lonely Gulch	W	3.9	0.08		3.92E+16	0.05	
60	Madden	W	11.4	0.22		1.07E+18	1.37	
57	McKinney	W	20.2	0.39		2.14E+18	2.74	
55	Meeks	W	73.8	1.42		2.55E+17	0.33	
52	Paradise Flat	W	54.3	1.04		5.35E+17	0.69	
58	Quail Lake	W	3.4	0.06		2.93E+17	0.38	
51	Rubicon	W	14.3	0.27		1.35E+18	1.73	
54	Sierra	W	2.5	0.05		1.38E+17	0.18	
63	**Ward**	W	**412**	7.91	30.3	**4.56E+18**	5.85	24.4
	Total		5206	100		7.79E+19	100	100

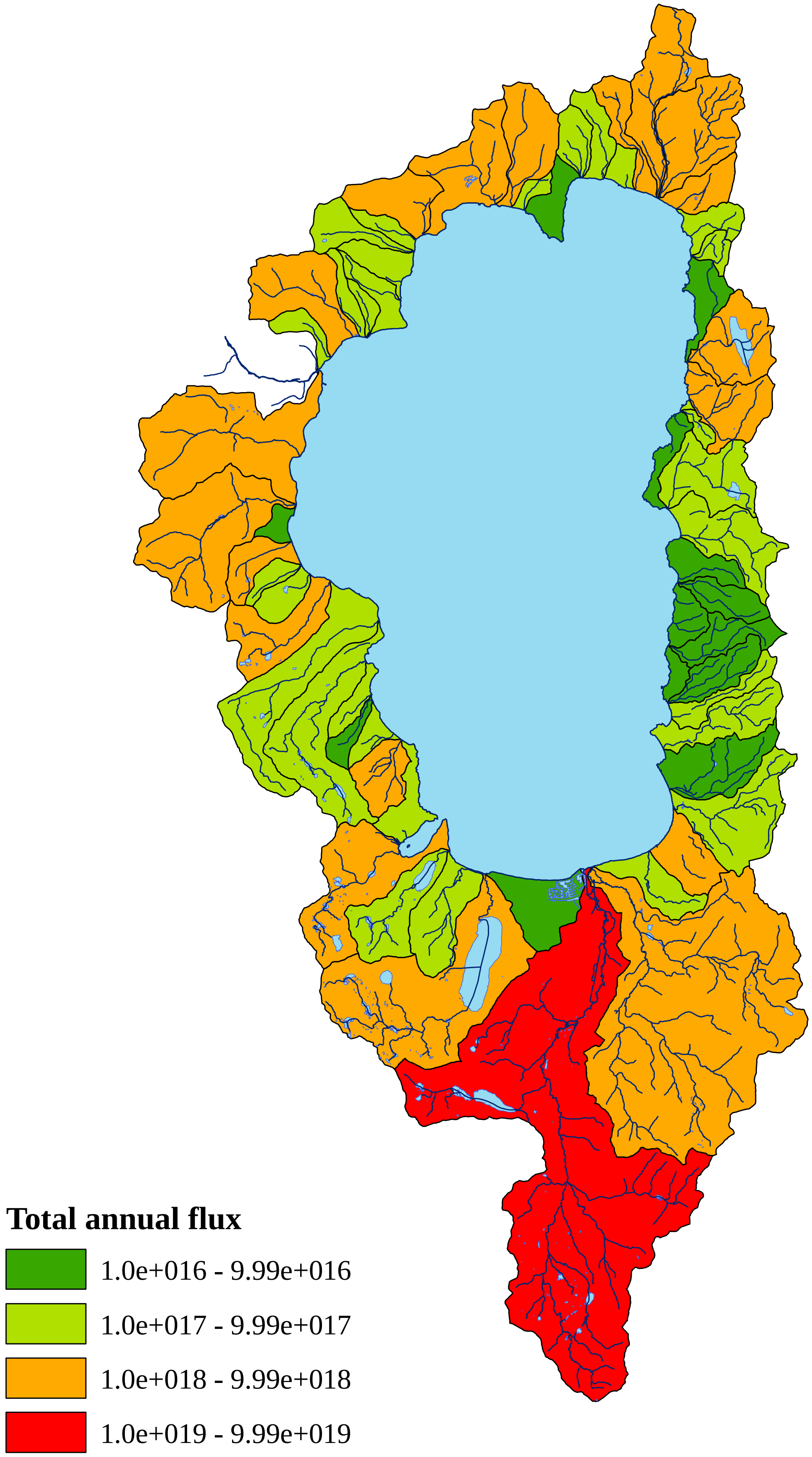

Figure 12. Median annual fine-particle flux (0.5 – 20 um) to Lake Tahoe, in *n*/y.

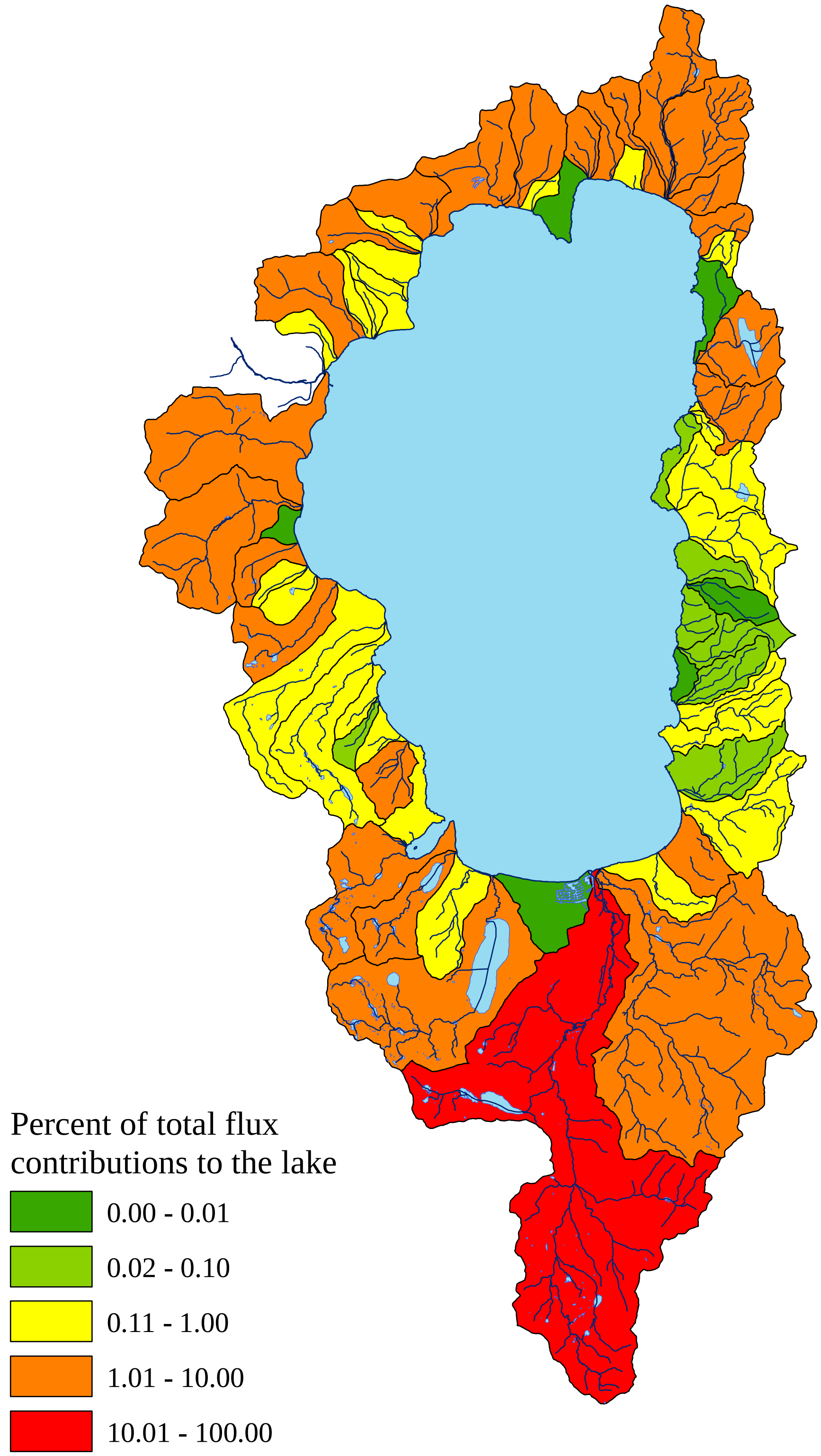

Figure 13. Percent contribution of annual fine-particle flux (0.5 – 20 um) to Lake Tahoe.

Estimates of Fine-Sediment Contributions from Streambank Erosion: <0.063 mm

Whereas estimates of fine-particle loadings and flux to Lake Tahoe relied on generating relations between total, suspended-sediment loadings and fine-particle loadings or flux from measured data at various index stations, estimates of fine-sediment contributions from streambank erosion presented a different challenge. In this case, the fine-particle loadings or flux measured at the index stations or estimated by the previously discussed procedures, represent fine-sediment loadings from all possible sources. This could include floodplains, slopes and channel beds and banks. Once again, in the absence of resources to perform deterministic, numerical simulations of all contributing streams, empirical procedures were utilized. In general, the technique to estimate basinwide fine-sediment contributions from streambank erosion relied on extrapolating rates of streambank erosion obtained from time-series measurements of monumented cross sections or from numerical simulations with the CONCEPTS channel evolution model (Nolan and Hill, 1991; Simon *et al*., 2003)

Availability of Data: Time-Series Cross Sections

Cross sections on Blackwood, General, Logan House, and Edgewood Creeks were monumented with metal fence posts and labeled with brass plates (Hill *et al*. 1990) by the U.S. Geological Survey in 1983 and 1984. Original survey notes were obtained from the USGS and new surveys were conducted at as many of these sites as could be located during the fall of 2002 and summer of 2004. Time-series cross sections of the Upper Truckee River were originally surveyed in 1992 and had been re-surveyed (2001 or 2002), thus providing a ten-year record of channel changes (C. Walck, 2003, written commun.). A summary of the historical cross-section data is provided in Table 15.

Table 15- Summary of historical cross-section data available for this study.

Stream	Date of first survey used	Number of sections matched	Total matched length (km)	Source of historical data
Blackwood	1983	17	8.3	USGS[1]
Edgewood	1983	23	5.6	USGS[1]
General	1983	12	8.5	USGS[1]
Logan House	1984	10	3.3	USGS[1]
Upper Truckee	1992	24	2.9	Calif. Parks[2]

[1] Data from K.M. Nolan (2003 written commun.)
[2] Data from C.M. Walck (2003 written commun.)

Calculation of Rates of Streambank Erosion

The change in cross-sectional area for a given time period was determined by overlaying time-series cross sections and calculating the area between the plotted lines. The location of the bank toe was determined for the original and 2002 surveyed sections and used to discriminate between erosion or deposition from the bed and banks. Examples are shown in Figure 14. Values between adjacent cross sections were averaged and then multiplied by the reach length to obtain a volume in m^3. Results are expressed as a rate (in m^3/y) and as a yield (in $m^3/y/km$ of channel length). The average percentage of fines determined from samples of bank material (Appendix B) was multiplied by the volume of material eroded from the channel banks to determine rates and yields of fine-grained materials delivered by streambank erosion. Because fines were not found in measurable quantities on streambeds, bed erosion was neglected as a contributor of fine sediments.

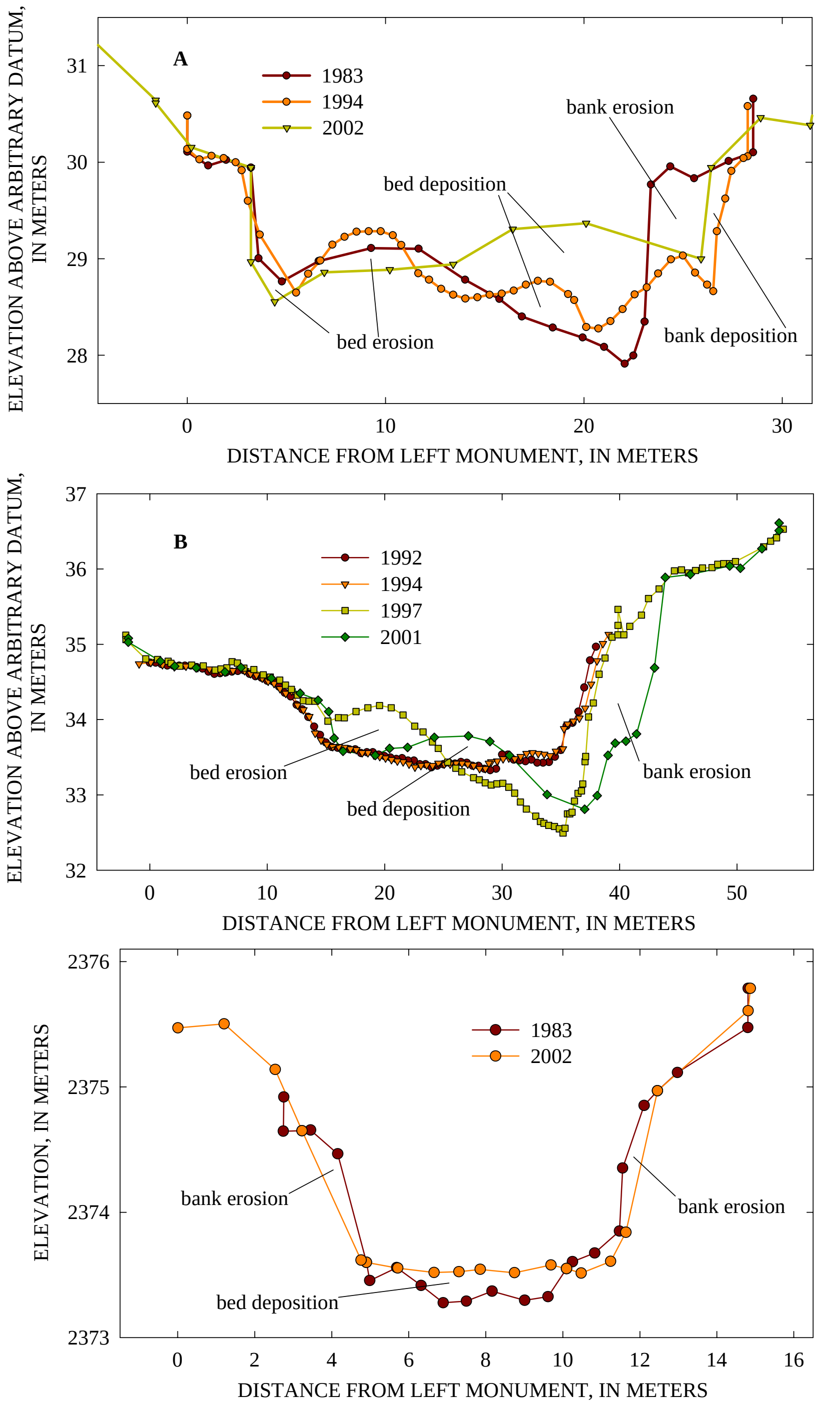

Figure 14. Examples of overlain surveys from Blackwood Creek (A), Upper Truckee River (B) and General Creek (C).

Simulations of Streambank Erosion

As part of a previous study, the deterministic, channel-evolution model CONCEPTS was used to simulate channel erosion and deposition along General and Ward Creeks and the Upper Truckee River (Simon *et al*., 2003). The CONCEPTS numerical model was used to simulate channel width adjustment by incorporating the fundamental physical processes responsible for bank retreat: (1) fluvial erosion or entrainment of bank-toe material by flow, and (2) bank mass failure due to gravity (Langendoen 2000). Required input data such as geotechnical shear strength, bank-toe erodibility and particle size distribution of bank materials were measured or sampled in the field (Simon *et al*., 2003). An example is shown in Figure 15.

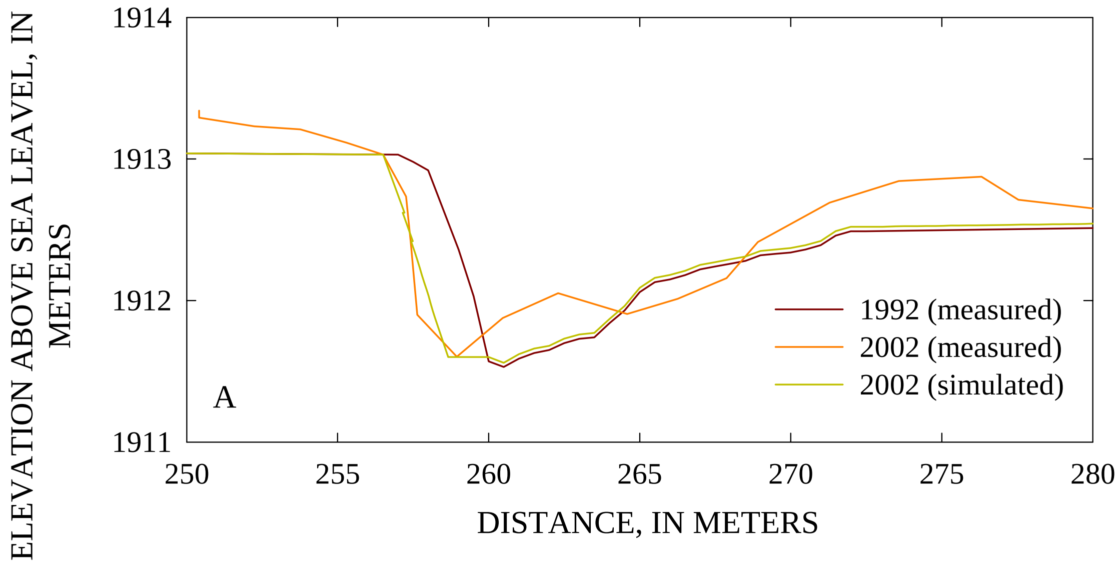

Figure 15- Example comparison of simulated and measured streambank erosion between 1992 and 2002 along the Upper Truckee River. Modified from Simon et al. (2003).

Unit rates of streambank erosion were derived from the numerical simulations by:

1. Calculating the area eroded in each cross section;
2. Taking the average eroded area between successive cross sections;
3. Multiplying by the distance between the midpoint of successive cross sections;
4. Dividing by the number of years of simulation to obtain a rate in m^3/y; and
5. Dividing by the total reach length to obtain a rate in m^3/y/km of channel.

This provided a unit streambank erosion rate in the same units as those calculated from time-series cross section calculations.

Extrapolation of Measured and Simulated Streambank Erosion Rates

To obtain the rate of streambank erosion of fine sediment (<0.063 mm) from the measured and simulated unit erosion rates, values were multiplied by the average percentage of silt-clay in the channel banks. The resulting rates of fine, streambank erosion are expressed in m^3/y/km and listed in Table 16.

Table 16- Measured and simulated average, annual rates of streambank erosion.

Stream	Bank composition (% finer 0.063 mm)*	Erosion rate (m^3/y/km)	Type of data	Source of data
Blackwood Creek	5.6	12.2	Measured	Simon *et al*. 2003
Edgewood Creek	4.9	0.09	Measured	Nolan and Hill, 1991
General Creek	7.4	0.92	Simulated	Simon *et al*. 2003
Logan House Creek	-	0.002	Measured	Nolan and Hill, 1991
Upper Truckee River	9.5	9.50	Simulated	Simon *et al*. 2003
Ward Creek	10.4	4.40	Simulated	Simon *et al*. 2003

* = Data from Simon *et al*. (2003)

To extrapolate this limited data set to the entire Lake Tahoe Basin, diagnostic information obtained during the RGAs were used. Question 6 of the RGA field form (Figure 3) describing relative bank instability as the percentage (longitudinally) of each side of the channel that has experienced recent mass failure was used. Observed conditions ranged from 0% (stable banks) to 100% where the entire reach contained failing streambanks. An example from Blackwood Creek shows the average, longitudinal extent of bank failures evaluated at 17 sites along the creek (Figure 16). Each bank was assigned a numerical value based on the extent of failures (Table 17). This value was termed the bank-stability index (I_B). The index attempts to synthesize more quantitative evaluations of streambank stability that might include parameters such as bank height, bank angle, geotechnical strength, and bank-toe erodibility. A summary of all field data is provided in Table 18 with the average I_B values for each stream, in Table 19.

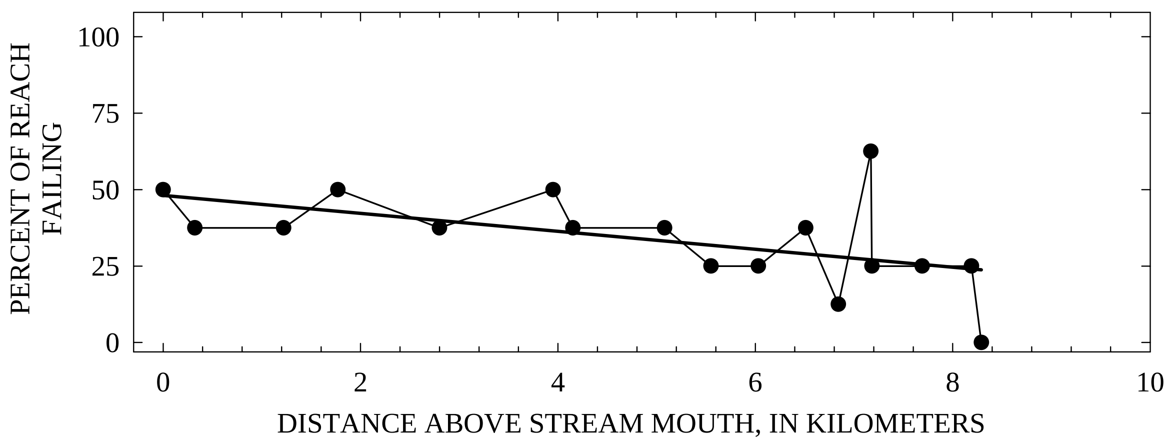

Figure 16. Observations of the extent of streambank instability along Blackwood Creek

Table 17- Assigned values for the bank-stability index (I_B) based on the percent of reach length with failing banks.

Criteria					
Percent of reach with failing banks*	0-10%	11-25%	26-50%	51-75%	76-100%
Assigned index value*	0	0.5	1.0	1.5	2.0
* = Evaluations and calculations are done for each bank and summed to obtain a value for the reach. A maximum value of 4.0, therefore, is possible for a reach.					

Table 18- Sites with field data used to calculate bank-stability index (I_B). rkm= distance above mouth in kilometers.

Basin	Stream	rkm	Streambank erosion, left	Streambank erosion, right	Streambank instability, left	Streambank instability, right
1	Tahoe State Park	0.019	None	None	0-10%	0-10%
1	Tahoe State Park	0.897	None	None	0-10%	0-10%
2	Burton Creek	0.255	Fluvial	None	26-50%	0-10%
2	Burton Creek	0.848	Fluvial	None	11-25%	0-10%
3	Barton Creek	0.408	None	None	0-10%	0-10%
3	Barton Creek	1.056	None	None	0-10%	0-10%
4	Lake Forest Creek	0.016	None	None	0-10%	0-10%
4	Lake Forest Creek	1.036				
4	Lake Forest Creek	1.847	None	None	0-10%	0-10%
5	Dollar Creek	0.305	Fluvial	None	11-25%	0-10%
5	Dollar Creek	1.217	None	None	0-10%	0-10%
6	Cedar Flats Creek	0.057	None	None	0-10%	0-10%
6	Cedar Flats Creek	0.672	Fluvial	Fluvial	11-25%	11-25%
7	Watson Creek	0.038	None	None	0-10%	0-10%
7	Watson Creek	1.113	None	None	0-10%	0-10%
8	Carnelian Bay Creek	0.114	None	None	0-10%	0-10%
9	Carnelian Canyon Creek	0.026	None	Fluvial	0-10%	0-10%
9	Carnelian Canyon Creek	1.303	None	None	0-10%	0-10%
9	Carnelian Canyon Creek	1.898	None	None	0-10%	0-10%
10	Tahoe Vista	0.113	None	None	0-10%	0-10%
10	Tahoe Vista	0.017	Fluvial	Fluvial	26-50%	11-25%
10	Tahoe Vista	1.270	None	None	0-10%	0-10%
10	Tahoe Vista	2.881	Mass Wasting	Mass Wasting	11-25%	11-25%
10	Tahoe Vista	2.324	Fluvial	Fluvial	0-10%	0-10%
11	Griff Creek	0.088	Fluvial	None	0-10%	0-10%
11	Griff Creek	0.945	Fluvial	Fluvial	11-25%	11-25%
11	Griff Creek	1.928	Fluvial	Fluvial	26-50%	26-50%
11	Griff Creek	3.064	Fluvial	Fluvial	0-10%	0-10%
11	Griff Creek	1.914	None	Fluvial	0-10%	0-10%
12	Kings Beach	0.083	Fluvial	Fluvial	0-10%	0-10%
14	First Creek	0.032	None	None	0-10%	0-10%
14	First Creek	0.251	Fluvial	Fluvial	0-10%	0-10%
14	First Creek	0.778	Fluvial	Fluvial	0-10%	0-10%
14	First Creek	1.920	None	None	0-10%	0-10%

14	First Creek	1.920	Fluvial	Mass Wasting	11-25%	51-75%
15	Second Creek	0.177	Mass Wasting	Mass Wasting	11-25%	26-50%
15	Second Creek	1.192	Fluvial	None	0-10%	0-10%
16	Burnt Creek	0.128	Mass Wasting	Fluvial	11-25%	11-25%
16	Burnt Creek	1.250	Fluvial	Fluvial	11-25%	11-25%
16	Burnt Creek	2.171	Fluvial	Fluvial	11-25%	0-10%
17	Wood Creek	0.060	None	None	0-10%	0-10%
18	Third Creek	0.045	Mass Wasting	Fluvial	11-25%	0-10%
18	Third Creek	0.587	Fluvial	Fluvial	11-25%	0-10%
18	Third Creek	1.152	Fluvial	None	0-10%	0-10%
18	Third Creek	2.974	Fluvial	Fluvial	0-10%	11-25%
18	Third Creek	4.870	Fluvial	None	11-25%	0-10%
18	Third Creek	7.610	Fluvial	Fluvial	11-25%	11-25%
18	Third Creek	8.099	Fluvial	Fluvial	11-25%	11-25%
18	Third Creek	2.312	Fluvial	Fluvial	11-25%	26-50%
19	Incline	5.690	None	None	0-10%	0-10%
19	Incline	5.607	None	None	0-10%	0-10%
19	Incline	5.442	None	None	11-25%	11-25%
19	Incline	5.393	None	None	0-10%	0-10%
19	Incline	5.224	None	Fluvial	11-25%	0-10%
19	Incline	5.040	None	None	0-10%	0-10%
19	Incline	4.809	Mass Wasting	Mass Wasting	76-100%	76-100%
19	Incline	4.637	Fluvial	None	0-10%	0-10%
19	Incline	4.526	Fluvial	None	0-10%	0-10%
19	Incline	4.339	Fluvial	Fluvial	0-10%	0-10%
19	Incline	4.218	Fluvial	None	0-10%	0-10%
19	Incline	4.052	Fluvial	Fluvial	0-10%	0-10%
19	Incline	3.778	Fluvial	Fluvial	0-10%	0-10%
19	Incline	3.537	None	None	0-10%	0-10%
19	Incline	3.527	None	None	11-25%	11-25%
19	Incline	3.419	None	Fluvial	0-10%	11-25%
19	Incline	3.399	None	Fluvial	0-10%	11-25%
19	Incline	3.050	Fluvial	Fluvial	0-10%	0-10%
19	Incline	2.407	Fluvial	Fluvial	0-10%	0-10%
19	Incline	2.169	Fluvial	Fluvial	11-25%	0-10%
19	Incline	2.055	None	Fluvial	0-10%	11-25%
19	Incline	1.901	Fluvial	Fluvial	51-75%	11-25%
19	Incline	1.773	Fluvial	Fluvial	0-10%	0-10%
19	Incline	1.607	None	None	0-10%	0-10%
19	Incline	1.552	Fluvial	Fluvial	0-10%	0-10%
19	Incline	1.316	Fluvial	Fluvial	0-10%	11-25%

19	Incline	1.218	None	None	0-10%	0-10%
19	Incline	1.082	Fluvial	Fluvial	0-10%	0-10%
19	Incline	0.849	Fluvial	Fluvial	0-10%	0-10%
19	Incline	0.717	Fluvial	Fluvial	0-10%	0-10%
19	Incline	0.568	None	Fluvial	0-10%	11-25%
19	Incline	0.404	Fluvial	None	26-50%	0-10%
19	Incline	0.264	Fluvial	Fluvial	51-75%	11-25%
19	Incline	0.212	None	Fluvial	0-10%	51-75%
19	Incline	0.164	Mass Wasting	Fluvial	76-100%	11-25%
19	Incline	0.045	Fluvial	None	0-10%	0-10%
20	Mill Creek	0.012	Fluvial	Fluvial	11-25%	11-25%
20	Mill Creek	0.889	None	None	0-10%	0-10%
20	Mill Creek	1.896	None	None	0-10%	0-10%
21	Tunnel Creek	0.066	Fluvial	Fluvial	0-10%	0-10%
21	Tunnel Creek	1.223	None	None	0-10%	0-10%
22	Bonpland	0.071	None	None	0-10%	0-10%
24	Marlette Creek	0.014	Fluvial	Fluvial	0-10%	0-10%
24	Marlette Creek	0.916	Fluvial	Fluvial	0-10%	11-25%
24	Marlette Creek	1.279	Fluvial	Fluvial	26-50%	11-25%
25	Secret Harbour	0.204	None	None	0-10%	0-10%
25	Secret Harbour	0.546	Fluvial	Fluvial	0-10%	11-25%
25	Secret Harbour	0.037	None	None	0-10%	0-10%
25	Secret Harbour	1.268	None	None	0-10%	0-10%
26	Bliss Creek	0.386	Fluvial	Fluvial	11-25%	11-25%
26	Bliss Creek	1.197	None	None	0-10%	0-10%
27	Dead Mans Point	0.043	None	None	0-10%	0-10%
27	Dead Mans Point	0.591	None	None	0-10%	0-10%
28	Slaughterhouse	0.231	None	None	0-10%	0-10%
28	Slaughterhouse	2.245	Fluvial	Fluvial	11-25%	11-25%
28	Slaughterhouse	4.510	None	None	0-10%	0-10%
29	Glenbrook Creek	0.030	None	Fluvial	0-10%	0-10%
29	Glenbrook Creek	0.765	None	Fluvial	0-10%	11-25%
29	Glenbrook Creek	2.700	Fluvial	Fluvial	11-25%	11-25%
29	Glenbrook Creek	3.216	Mass Wasting	Mass Wasting	26-50%	26-50%
29	Glenbrook Creek	3.348	Fluvial	Fluvial	0-10%	0-10%
30	North Logan House Creek	0.483	Fluvial	Fluvial	0-10%	0-10%
31	Logan House Creek	3.94	None	None	0-10%	0-10%
31	Logan House Creek	3.02	None	None	0-10%	0-10%
31	Logan House Creek	2.55	None	None	0-10%	0-10%
31	Logan House Creek	1.71	None	None	0-10%	0-10%
31	Logan House Creek	1.21	None	None	0-10%	0-10%

32	Cave Rock	0.189	None	None	0-10%	0-10%
32	Cave Rock	0.087	None	None	0-10%	0-10%
32	Cave Rock	0.893	Fluvial	Fluvial	0-10%	0-10%
33	Lincoln Creek	0.219	Fluvial	Fluvial	0-10%	0-10%
33	Lincoln Creek	1.195	Fluvial	Fluvial	11-25%	11-25%
35	North Zephyr Creek	0.284	Fluvial	Fluvial	0-10%	0-10%
35	North Zephyr Creek	1.263	Mass Wasting	Fluvial	0-10%	0-10%
35	North Zephyr Creek	1.593	Mass Wasting	Fluvial	11-25%	11-25%
37	Zephyr Creek	0.131	Fluvial	Fluvial	0-10%	0-10%
37	Zephyr Creek	0.993	Fluvial	Mass Wasting	11-25%	11-25%
38	McFaul Creek	0.520	Mass Wasting	Fluvial	11-25%	11-25%
38	McFaul Creek	1.691	Fluvial	Fluvial	0-10%	0-10%
38	McFaul Creek	3.226	Mass Wasting	Mass Wasting	0-10%	11-25%
39	Burke Creek	0.135	Fluvial	Fluvial	0-10%	0-10%
39	Burke Creek	1.579	Fluvial	Fluvial	0-10%	0-10%
39	Burke Creek	3.200	None	None	0-10%	0-10%
39	Burke Creek	3.212	Fluvial	None	0-10%	0-10%
39	Burke Creek	3.580	Fluvial	Fluvial	11-25%	11-25%
39	Burke Creek	4.128	None	None	0-10%	0-10%
39	Burke Creek	6.247	None	None	0-10%	0-10%
40	Edgewood Creek	7.220	None	None	0-10%	0-10%
40	Edgewood Creek	7.210	Mass Wasting	Fluvial	51-75%	11-25%
40	Edgewood Creek	7.230	Fluvial	Fluvial	0-10%	0-10%
40	Edgewood Creek	6.410	None	Fluvial	0-10%	0-10%
40	Edgewood Creek	6.220	None	None	0-10%	0-10%
40	Edgewood Creek	6.150	Fluvial	Fluvial	11-25%	11-25%
40	Edgewood Creek	5.620	Fluvial	Fluvial	26-50%	11-25%
40	Edgewood Creek	4.960	Fluvial	Fluvial	0-10%	0-10%
40	Edgewood Creek	3.830	Fluvial	Fluvial	11-25%	11-25%
40	Edgewood Creek	3.090	Mass Wasting	Fluvial	26-50%	11-25%
40	Edgewood Creek	1.200	Fluvial	Fluvial	0-10%	0-10%
40	Edgewood Creek	0.200	None	None	0-10%	0-10%
41	Bijou Park	1.317	Fluvial	Fluvial	0-10%	0-10%
41	Bijou Park	1.884	Fluvial	Fluvial	11-25%	0-10%
42	Bijou Creek	0.543	Fluvial	None	0-10%	0-10%
42	Bijou Creek	2.162	None	None	0-10%	0-10%
42	Bijou Creek	3.442	None	None	0-10%	0-10%
43	Trout Creek	1.454	None	None	0-10%	0-10%
43	Trout Creek	2.485	Fluvial	Fluvial	11-25%	0-10%
43	Trout Creek	4.711	Fluvial	Fluvial	0-10%	0-10%
43	Trout Creek	7.047	Mass Wasting	Fluvial	26-50%	0-10%

43	Trout Creek	6.516	Fluvial	Mass Wasting	11-25%	26-50%
43	Trout Creek	7.473	Fluvial	Mass Wasting	0-10%	11-25%
43	Trout Creek	8.127	Fluvial	Fluvial	0-10%	0-10%
44	Upper Truckee	24.187	Fluvial	Fluvial	0-10%	0-10%
44	Upper Truckee	23.009	None	Fluvial	0-10%	11-25%
44	Upper Truckee	22.538	None	Mass Wasting	0-10%	76-100%
44	Upper Truckee	21.769	Mass Wasting	None	0-10%	0-10%
44	Upper Truckee	21.369	Fluvial	Fluvial	0-10%	0-10%
44	Upper Truckee	20.749	Mass Wasting	Mass Wasting	51-75%	11-25%
44	Upper Truckee	19.940	Mass Wasting	Fluvial	51-75%	0-10%
44	Upper Truckee	19.261	Fluvial	Mass Wasting	11-25%	51-75%
44	Upper Truckee	18.5731	None	Mass Wasting	0-10%	76-100%
44	Upper Truckee	17.999	Fluvial	Fluvial	0-10%	0-10%
44	Upper Truckee	17.779	None	Mass Wasting	0-10%	76-100%
44	Upper Truckee	16.898	Fluvial	Fluvial	11-25%	0-10%
44	Upper Truckee	16.40	Fluvial	Fluvial	11-25%	11-25%
44	Upper Truckee	15.870	None	None	0-10%	0-10%
44	Upper Truckee	15.277	None	Fluvial	0-10%	26-50%
44	Upper Truckee	14.768	None	Mass Wasting	0-10%	76-100%
44	Upper Truckee	14.071	Fluvial	None	0-10%	0-10%
44	Upper Truckee	13.519	None	Mass Wasting	0-10%	76-100%
44	Upper Truckee	13.146	Mass Wasting	Mass Wasting	51-75%	26-50%
44	Upper Truckee	12.070	None	Mass Wasting	0-10%	0-10%
44	Upper Truckee	11.207	Fluvial	Mass Wasting	26-50%	51-75%
44	Upper Truckee	10.838	Mass Wasting	Fluvial	51-75%	0-10%
44	Upper Truckee	10.037	None	Fluvial	0-10%	11-25%
44	Upper Truckee	8.455	None	Mass Wasting	0-10%	76-100%
44	Upper Truckee	7.137	None	Mass Wasting	0-10%	76-100%
44	Upper Truckee	5.837	None	None	0-10%	0-10%
44	Upper Truckee	5.055	Fluvial	Mass Wasting	26-50%	26-50%
44	Upper Truckee	4.511	Fluvial	Fluvial	0-10%	0-10%
44	Upper Truckee	2.941	Mass Wasting	None	51-75%	11-25%
46	Taylor Creek	0.903	Fluvial	None	11-25%	0-10%
46	Taylor Creek	2.328	Fluvial	None	11-25%	0-10%
47	Tallac Creek	1.374	Fluvial	None	26-50%	0-10%
47	Tallac Creek	2.202	Fluvial	None	11-25%	0-10%
47	Tallac Creek	2.546	None	None	0-10%	0-10%
47	Tallac Creek	3.053	None	None	0-10%	0-10%
47	Tallac Creek	2.948	None	None	0-10%	0-10%
48	Cascade Creek	0.693	None	None	0-10%	0-10%
49	Eagle Creek	0.584	None	None	0-10%	0-10%

50	Bliss State Park	0.410	None	None	0-10%	0-10%
51	Rubicon Creek	0.919	None	None	0-10%	0-10%
51	Rubicon Creek	1.271	Fluvial	Fluvial	11-25%	11-25%
51	Rubicon Creek	1.596	Fluvial	Fluvial	0-10%	0-10%
51	Rubicon Creek	1.707	None	None	0-10%	0-10%
51	Rubicon Creek	2.113	None	None	0-10%	0-10%
52	Paradise Flat	0.624	Fluvial	Fluvial	11-25%	0-10%
53	Lonely Gulch Creek	0.807	None	None	0-10%	0-10%
53	Lonely Gulch Creek	1.236	None	None	0-10%	0-10%
54	Sierra creek	0.885	None	None	0-10%	0-10%
55	Meeks Creek	1.226	None	None	0-10%	11-25%
55	Meeks Creek	3.149	Fluvial	None	11-25%	0-10%
55	Meeks Creek	3.499	None	Fluvial	0-10%	26-50%
55	Meeks Creek	3.496	Fluvial	None	11-25%	11-25%
56	General	6.800	None	Fluvial	0-10%	0-10%
56	General	6.660	None	Fluvial	0-10%	0-10%
56	General	6.500	None	Fluvial	0-10%	11-25%
56	General	6.060	None	Fluvial	0-10%	11-25%
56	General	5.900	None	Fluvial	0-10%	26-50%
56	General	5.330	Fluvial	Fluvial	11-25%	11-25%
56	General	5.250	Fluvial	Fluvial	11-25%	11-25%
56	General	5.050	Fluvial	Fluvial	0-10%	11-25%
56	General	4.730	None	Mass Wasting	0-10%	11-25%
56	General	4.210	None	Fluvial	0-10%	0-10%
56	General	3.620	Fluvial	None	0-10%	0-10%
56	General	3.600	Fluvial	Mass Wasting	0-10%	26-50%
56	General	3.590	Fluvial	Fluvial	0-10%	11-25%
56	General	3.250	Fluvial	Mass Wasting	0-10%	76-100%
56	General	2.970	None	None	0-10%	0-10%
56	General	2.580	Fluvial	Mass Wasting	0-10%	51-75%
56	General	2.200	None	Mass Wasting	0-10%	76-100%
56	General	1.940	None	Fluvial	0-10%	26-50%
56	General	1.930	Fluvial	Fluvial	0-10%	0-10%
56	General	1.540	None	Mass Wasting	0-10%	51-75%
56	General	1.170	None	Mass Wasting	0-10%	11-25%
56	General	0.950	Fluvial	Mass Wasting	11-25%	76-100%
56	General	0.890	Fluvial	Mass Wasting	0-10%	11-25%
56	General	0.710	None	Fluvial	0-10%	11-25%
56	General	0.570	None	None	0-10%	0-10%
56	General	0.300	None	Fluvial	0-10%	0-10%
56	General	0.010	Mass Wasting	None	26-50%	0-10%

56	General	8.077	None	None	0-10%	0-10%
57	General		Fluvial	None	0-10%	0-10%
57	McKinney Creek	0.276	None	None	0-10%	0-10%
57	McKinney Creek	1.248	None	None	0-10%	0-10%
58	Quail Lane Creek	0.024	None	None	0-10%	0-10%
58	Quail Lane Creek	0.212	None	None	0-10%	0-10%
59	Homewood Creek	0.094	Fluvial	Fluvial	11-25%	11-25%
59	Homewood Creek	0.407	Fluvial	Fluvial	11-25%	11-25%
60	Madden Creek	0.097	None	None	0-10%	0-10%
62	Blackwood Creek	8.290	None	None	0-10%	0-10%
62	Blackwood Creek	8.190	Fluvial	None	0-10%	26-50%
62	Blackwood Creek	7.690	Fluvial	Fluvial	11-25%	11-25%
62	Blackwood Creek	7.180	Fluvial	Fluvial	11-25%	11-25%
62	Blackwood Creek	7.170	Fluvial	Mass Wasting	11-25%	76-100%
62	Blackwood Creek	6.840	None	Mass Wasting	0-10%	11-25%
62	Blackwood Creek	6.510	None	Mass Wasting	0-10%	51-75%
62	Blackwood Creek	5.550	None	Fluvial	0-10%	26-50%
62	Blackwood Creek	6.030	None	Mass Wasting	0-10%	26-50%
62	Blackwood Creek	5.080	None	Mass Wasting	0-10%	51-75%
62	Blackwood Creek	4.150	Fluvial	Fluvial	26-50%	11-25%
62	Blackwood Creek	3.950	None	Mass Wasting	0-10%	76-100%
62	Blackwood Creek	2.800	Mass Wasting	None	51-75%	0-10%
62	Blackwood Creek	1.970	Fluvial	Mass Wasting	26-50%	11-25%
62	Blackwood Creek	1.770	Fluvial	Mass Wasting	11-25%	51-75%
62	Blackwood Creek	0.320	Mass Wasting	None	51-75%	0-10%
62	Blackwood Creek	0.000	None	None	26-50%	26-50%
63	Ward	6.553	None	Fluvial	0-10%	26-50%
63	Ward	6.455	Fluvial	Fluvial	0-10%	11-25%
63	Ward	6.416	None	None	0-10%	0-10%
63	Ward	6.270	None	Fluvial	0-10%	11-25%
63	Ward	6.167	Fluvial	None	11-25%	0-10%
63	Ward	6.102	Fluvial	None	11-25%	0-10%
63	Ward	5.938	None	Mass Wasting	0-10%	76-100%
63	Ward	5.868	None	Fluvial	0-10%	0-10%
63	Ward	5.805	Fluvial	Fluvial	0-10%	11-25%
63	Ward	5.526	Fluvial	Fluvial	11-25%	0-10%
63	Ward	5.360	None	Fluvial	0-10%	26-50%
63	Ward	5.124	Fluvial	Mass Wasting	0-10%	26-50%
63	Ward	4.740	None	Mass Wasting	0-10%	76-100%
63	Ward	4.522	Fluvial	Fluvial	11-25%	11-25%
63	Ward	4.250	Mass Wasting	None	26-50%	0-10%

63	Ward	4.059	Fluvial	Fluvial	11-25%	11-25%
63	Ward	3.641	Mass Wasting	Fluvial	51-75%	26-50%
63	Ward	3.506	Fluvial	Mass Wasting	11-25%	51-75%
63	Ward	3.279	None	Mass Wasting	0-10%	0-10%
63	Ward	2.639	None	Fluvial	0-10%	0-10%
63	Ward	2.382	Fluvial	Mass Wasting	11-25%	51-75%
63	Ward	2.084	Fluvial	Fluvial	0-10%	0-10%
63	Ward	1.971	Fluvial	Fluvial	0-10%	0-10%
63	Ward	1.545	Fluvial	Fluvial	0-10%	0-10%
63	Ward	1.417	Mass Wasting	Fluvial	26-50%	0-10%
63	Ward	1.292	None	Mass Wasting	0-10%	51-75%
63	Ward	1.140	None	Fluvial	0-10%	11-25%
63	Ward	1.125	Mass Wasting	Fluvial	26-50%	0-10%
63	Ward	1.110	Fluvial	Fluvial	26-50%	0-10%
63	Ward	0.778	Mass Wasting	Fluvial	51-75%	11-25%
63	Ward	0.629	Fluvial	Mass Wasting	0-10%	26-50%
63	Ward	0.505	None	Fluvial	0-10%	11-25%
63	Ward	0.435	Mass Wasting	Mass Wasting	76-100%	11-25%
63	Ward	0.254	Mass Wasting	Fluvial	26-50%	26-50%
63	Ward	0.093	None	None	0-10%	0-10%

Table 19- Average bank-stability index for each stream based on summing the index value for each site visited an dividing by the number of sites (Table 18).

Watershed	Stream	Average Bank-Stability Index
1	Tahoe State Park	0.000
2	Burton Creek	0.400
3	Barton Creek	0.000
4	Lake Forest Creek	0.000
5	Dollar Creek	0.250
6	Cedar Flats Creek	0.500
7	Watson Creek	0.000
8	Carnelian Bay Creek	0.000
9	Carnelian Canyon Creek	0.000
10	Tahoe Vista	0.400
11	Griff Creek	0.600
12	Kings Beach	0.000
14	First Creek	0.400
15	Second Creek	0.375
16	Burnt Creek	0.830
17	Wood Creek	0.000
18	Third Creek	0.750
19	Incline	0.514
20	Mill Creek	0.333
21	Tunnel Creek	0.000
22	Bonpland	0.000
24	Marlette Creek	0.830
25	Secret Harbour	0.125
26	Bliss Creek	0.500
27	Dead Mans Point	0.000
28	Slaughterhouse	0.333
29	Glenbrook Creek	0.600
30	North Logan House Creek	0.000
31	Logan House Creek	0.000
32	Cave Rock	0.000
33	Lincoln Creek	0.000
35	North Zephyr Creek	0.333
37	Zephyr Creek	0.500
38	McFaul Creek	0.500

39	Burke Creek	0.143
40	Edgewood Creek	0.583
41	Bijou Park	0.250
42	Bijou Creek	0.000
43	Trout Creek	0.500
44	Upper Truckee	1.120
46	Taylor Creek	0.500
47	Tallac Creek	0.300
48	Cascade Creek	0.000
49	Eagle Creek	0.000
50	Bliss State Park	0.000
51	Rubicon Creek	0.400
52	Paradise Flat	0.500
53	Lonely Gulch Creek	0.000
54	Sierra Creek	0.000
55	Meeks Creek	0.750
56	General	0.670
57	McKinney Creek	0.000
58	Quail Lane Creek	0.000
59	Homewood Creek	0.167
60	Madden Creek	0.000
62	Blackwood Creek	1.353
63	Ward	0.929

Relation between Bank-Stability Index (I_B) and Streambank Erosion Rate

With an average bank-stability index (I_B) calculated for each stream from observed conditions, a relation between this parameter and measured streambank erosion rates was required for extrapolation to streams without measured data. Using data from the six streams with measured or simulated data (Table 16) a regression was performed using a sigmoidal 3-parameter equation based on the general shape of the relation (Figure 17). This equation takes the general form:

$$y = \frac{a}{1 + e^{-\frac{(x - x_0)}{b}}} \qquad (2)$$

and yields the following relation ($r^2 = 0.99$):

$$E_r = \frac{12.6939}{1 + e^{-\frac{(I_B - 1.0217)}{0.1129}}} \qquad (3)$$

where E_r = erosion rate of fine (<0.063mm) bank sediment in m^3/y/km of channel; I_B = average bank-stability index (percent of reach length with failing banks)

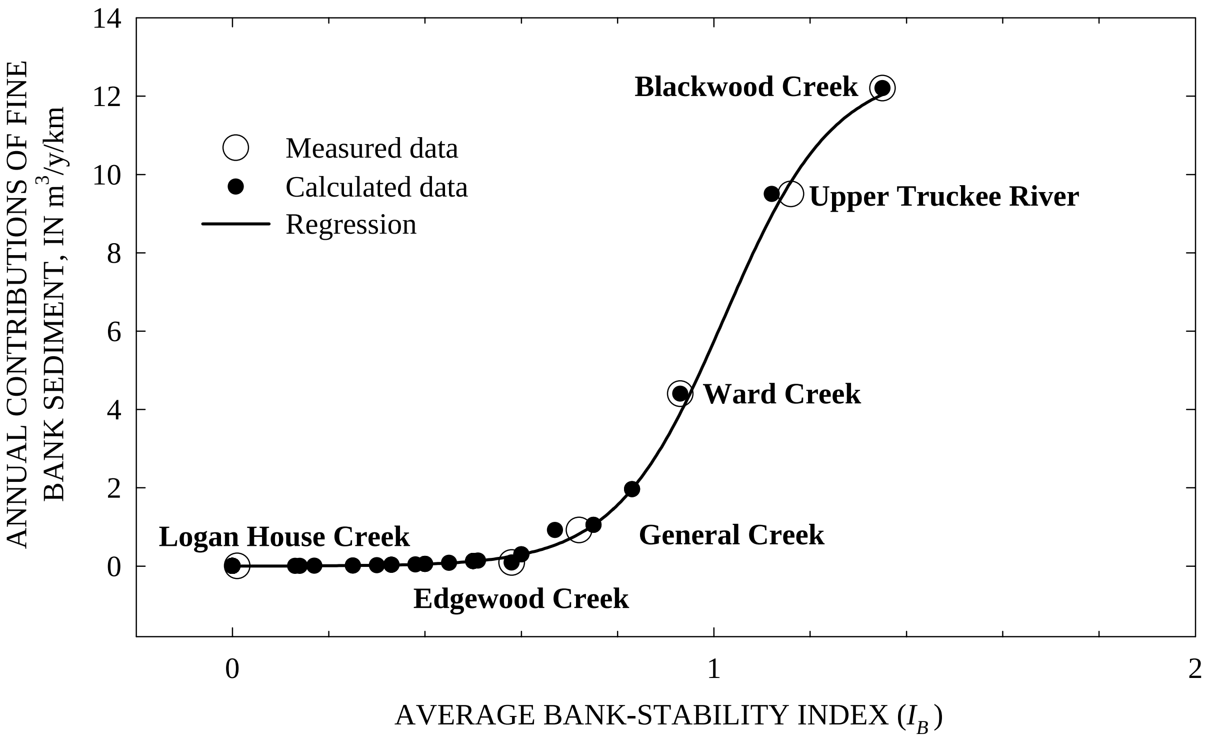

Figure 17- Relation between average, annual streambank erosion rates and average bank-stability index (I_B). Regression is a 3-parameter sigmoidal equation; r^2 = 0.99.

Unit Streambank Erosion Rate. An erosion rate for each stream was obtained by substituting the stream's value into the above regression equation (eq. 3) to provide an average, annual erosion rate of fine (<0.063mm) sediment per unit length of channel (Table 20). This unit, streambank erosion rate, expressed in m^3/y/km, can be used to differentiate those streams with the most actively eroding banks, and ones where streambank stabilization measures may be considered appropriate (Figure 18). Blackwood Creek manifests the highest streambank erosion rates per unit length of channel (12.2 m^3/y/km) followed by the Upper Truckee River (9.5 m^3/y/km) and Ward Creek (4.4 m^3/y/km), respectively.

Streambank Erosion Rate. The average, annual volume (in m^3) of streambank erosion for each stream was then determined by multiplying the unit streambank erosion rate (Table 20) by the total length of main channels as calculated by Jorgensen *et al*. (1978). Modifications were made to some of these reported lengths based on tributary contributions and contributing areas. These are shaded in yellow in Table 21. The volume of fine sediment (<0.063 mm) eroded from streambanks was converted to kilonewtons by multiplying by an average bulk unit weight of 17.3 kN/m^3, and then to metric tonnes (T).

Table 20- Average, annual bank-erosion rates of fines (<0.063mm) per kilometer of main-stem channel length for streams draining to Lake Tahoe.		
Watershed	**Stream**	**Erosion rate (m^3/y/km)**
1	Tahoe State Park	0.001491
2	Burton Creek	0.051325
3	Barton Creek	0.001491
4	Lake Forest Creek	0.001491
5	Dollar Creek	0.013634
6	Cedar Flats Creek	0.123740
7	Watson Creek	0.001491
8	Carnelian Bay Creek	0.001491
9	Carnelian Canyon Creek	0.001491
10	Tahoe Vista	0.051325
11	Griff Creek	0.295931
12	Kings Beach	0.001491
14	First Creek	0.051325
15	Second Creek	0.041164
16	Burnt Creek	1.964148
17	Wood Creek	0.001491
18	Third Creek	1.049460
19	Incline	0.139760
20	Mill Creek	0.028405
21	Tunnel Creek	0.001491
22	Bonpland	0.001491
24	Marlette Creek	1.964148
25	Secret Harbour	0.004509
26	Bliss Creek	0.123740
27	Dead Mans Point	0.001491
28	Slaughterhouse	0.028405
29	Glenbrook Creek	0.295931
30	North Logan House Creek	0.001491
31	Logan House Creek	0.001491
32	Cave Rock	0.001491
33	Lincoln Creek	0.001491
35	North Zephyr Creek	0.028488
37	Zephyr Creek	0.123740
38	McFaul Creek	0.123740

39	Burke Creek	0.005281
40	Edgewood Creek	0.090000
41	Bijou Park	0.013634
42	Bijou Creek	0.001491
43	Trout Creek	0..123740
44	Upper Truckee	9.500000
46	Taylor Creek	0.123740
47	Tallac Creek	0.021217
48	Cascade Creek	0.001491
49	Eagle Creek	0.001491
50	Bliss State Park	0.001491
51	Rubicon Creek	0.051325
52	Paradise Flat	0.123740
53	Lonely Gulch Creek	0.001491
54	Sierra Creek	0.001491
55	Meeks Creek	1.049460
56	General	0.920000
57	McKinney Creek	0.001491
58	Quail Lane Creek	0.001491
59	Homewood Creek	0.006523
60	Madden Creek	0.001491
62	Blackwood Creek	12.200000
63	Ward	4.400000

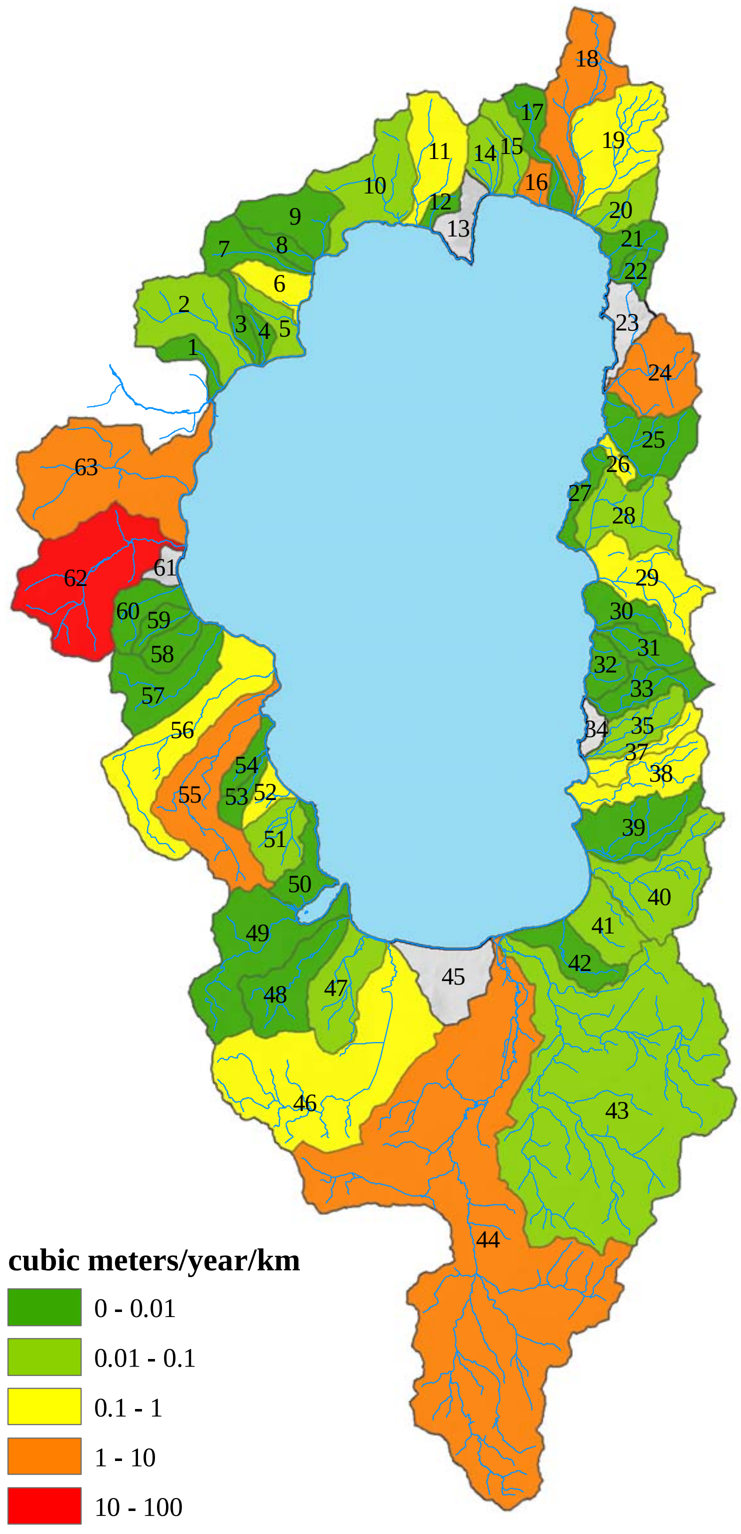

Figure 18- Unit volume of fine-sediment (<0.063mm) contributions from streambank erosion per kilometer of main channels. Gray shading indicates no data available.

Table 21- Stream lengths as reported by Jorgensen *et al*. (1978) with modifications (shaded in yellow) to account for tributaries and, in some cases, reduced contributing areas.

Watershed	Stream	Length (mi)	Length (km)
1	Tahoe State Park		2.430
2	Burton Creek	6.220	10.008
3	Barton Creek		2.470
4	Lake Forest Creek	2.000	3.218
5	Dollar Creek	2.880	4.634
6	Cedar Flats Creek	0.570	0.917
7	Watson Creek	3.320	5.342
8	Carnelian Bay Creek	1.940	3.121
9	Carnelian Canyon Creek	2.800	4.505
10	Tahoe Vista	5.910	9.509
11	Griff Creek	5.780	9.300
12	Kings Beach	1.880	3.025
14	First Creek	4.340	6.983
15	Second Creek	3.040	4.891
16	Burnt Creek		0.700
17	Wood Creek	3.940	6.339
18	Third Creek	10.550	16.975
19	Incline	11.910	19.163
20	Mill Creek	4.462	7.180
21	Tunnel Creek	2.040	3.282
22	Bonpland	1.960	3.154
24	Marlette Creek	3.440	5.535
25	Secret Harbour	4.950	7.965
26	Bliss Creek	1.520	2.446
27	Dead Mans Point		1.500
28	Slaughterhouse	7.000	11.263
29	Glenbrook Creek	3.920	6.307
30	North Logan House Creek	2.530	4.071
31	Logan House Creek	3.300	5.310
32	Cave Rock	2.570	4.135
33	Lincoln Creek	6.140	9.879
35	North Zephyr Creek	6.750	10.861
37	Zephyr Creek	4.040	6.500
38	McFaul Creek	8.050	12.952
39	Burke Creek	7.850	12.631

41	Bijou Park		5.940
42	Bijou Creek	3.330	5.358
43	Trout Creek	31.540	50.748
44	Upper Truckee	24.900	40.064
46	Taylor Creek	11.000	17.699
47	Tallac Creek	6.910	11.118
48	Cascade Creek	4.730	7.611
49	Eagle Creek	5.820	9.364
50	Bliss State Park		0.850
51	Rubicon Creek	5.400	8.689
52	Paradise Flat	2.050	3.298
53	Lonely Gulch Creek	2.180	3.508
54	Sierra Creek	1.350	2.172
55	Meeks Creek	4.500	7.241
56	General	9.170	14.755
57	McKinney Creek	5.750	9.252
58	Quail Lane Creek	1.850	2.977
59	Homewood Creek	2.100	3.379
60	Madden Creek	3.070	4.940
62	Blackwood Creek	12.700	20.434
63	Ward	8.670	13.950

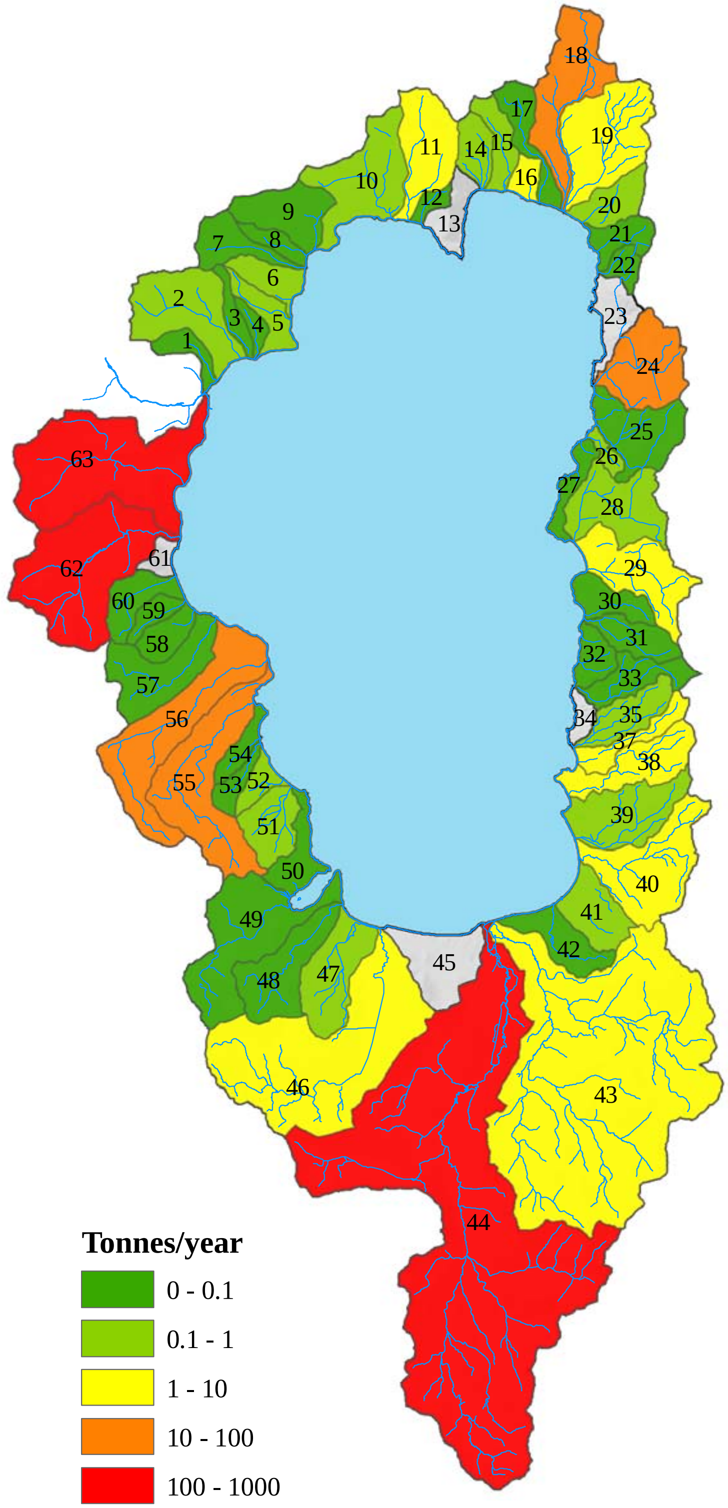

Figure 19- Loadings of fine sediment (<0.063mm) from streambank erosion. Gray shading indicates no data available.

Fine-Sediment Loadings from Streambank Erosion

Using the above procedures, average, annual erosion and delivery of fine sediment to Lake Tahoe were calculated for each stream. Resulting values are summarized in Table 22 and mapped in Figure 19. Summing the values calculated for each of the 63 watersheds gives an annual, average of 1305 T/y of fine (<0.063 mm) sediment delivered to Lake Tahoe from streambank erosion. From what has been learned in this and previous studies, it is no surprise that the three largest contributors of fine, streambank sediment are the Upper Truckee River (639 T/y), Blackwood Creek (431 T/y), and Ward Creek (104 T/y) (Figure 20).

About 25% of the fine sediment delivered to the lake emanates from streambank erosion when compared to the total fine-loadings calculated in this report (5206 T/y). In fact, about 20% of all fine sediment delivered to Lake Tahoe comes from the banks of the Upper Truckee River and Blackwood Creek. If Ward Creek is included, this figure becomes 22%. This is shown most clearly in Figure 20b and helps to emphasize the potential importance of concentrating bank-stabilization efforts in these watersheds.

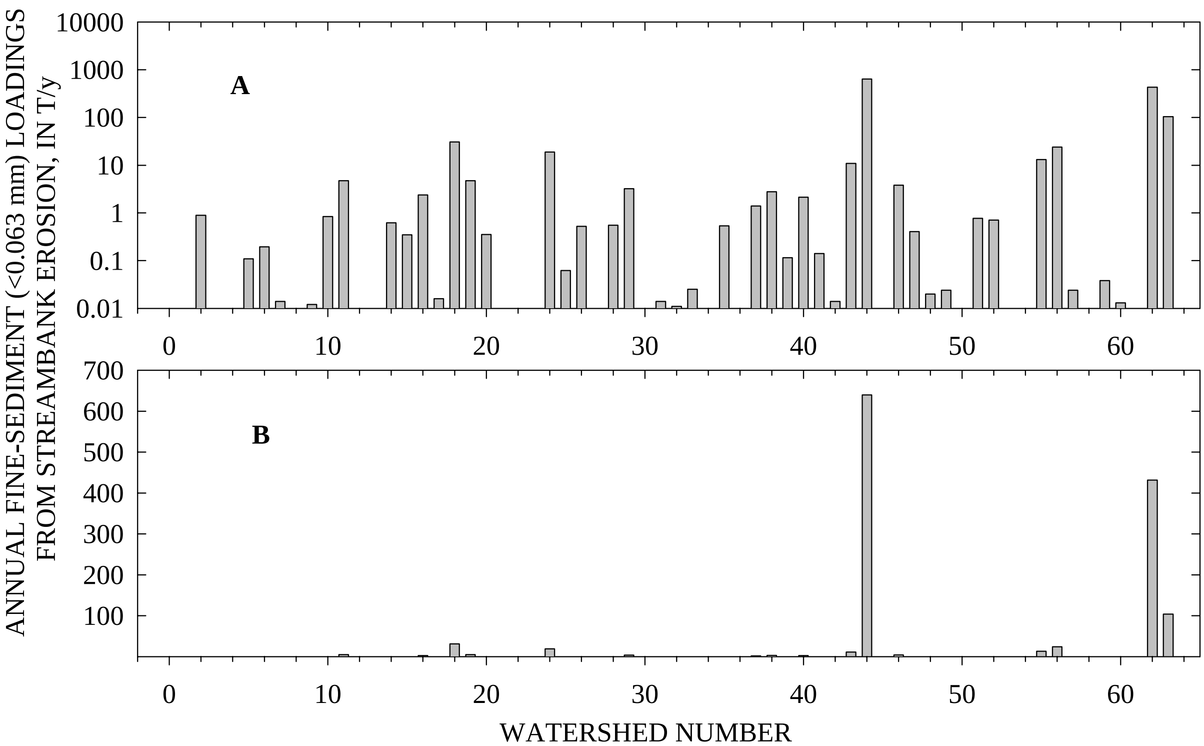

Figure 20- Annual, fine-sediment (0.063 mm) loadings in tonnes per year from streambank erosion plotted with $\log_{10}$ scale (A) and arithmetic scale (B). Note the relatively large contributions from the Upper Truckee River (#44), Blackwood Creek (#62), and Ward Creek (#63).

Table 22- Average, annual bank-erosion rates of fines (<0.063mm) for streams draining to Lake Tahoe.		
Watershed	**Creek Name**	**T/y**
1	Tahoe State Park	**0.006**
2	Burton Creek	**0.889**
3	Barton Creek	**0.006**
4	Lake Forest Creek	**0.008**
5	Dollar Creek	**0.109**
6	Cedar Flats Creek	**0.196**
7	Watson Creek	**0.014**
8	Carnelian Bay Creek	**0.008**
9	Carnelian Canyon Creek	**0.012**
10	Tahoe Vista	**0.844**
11	Griff Creek	**4.76**
12	Kings Beach	**0.008**
14	First Creek	**0.620**
15	Second Creek	**0.348**
16	Burnt Creek	**2.38**
17	Wood Creek	**0.016**
18	Third Creek	**30.8**
19	Incline	**4.72**
20	Mill Creek	**0.353**
21	Tunnel Creek	**0.008**
22	Bonpland	**0.008**
24	Marlette Creek	**18.8**
25	Secret Harbour	**0.062**
26	Bliss Creek	**0.524**
27	Dead Mans Point	**0.004**
28	Slaughterhouse	**0.553**
29	Glenbrook Creek	**3.23**
30	North Logan House Creek	**0.010**
31	Logan House Creek	**0.014**
32	Cave Rock	**0.011**
33	Lincoln Creek	**0.025**
35	North Zephyr Creek	**0.535**
37	Zephyr Creek	**1.39**
38	McFaul Creek	**2.77**
39	Burke Creek	**0.115**
40	Edgewood Creek	**2.14**
41	Bijou Park	**0.140**
42	Bijou Creek	**0.014**

43	Trout Creek	**10.9**
44	Upper Truckee	**639**
46	Taylor Creek	**3.79**
47	Tallac Creek	**0.408**
48	Cascade Creek	**0.020**
49	Eagle Creek	**0.024**
50	Bliss State Park	**0.002**
51	Rubicon Creek	**0.771**
52	Paradise Flat	**0.706**
53	Lonely Gulch Creek	**0.009**
54	Sierra Creek	**0.006**
55	Meeks Creek	**13.1**
56	General	**23.9**
57	McKinney Creek	**0.024**
58	Quail Lake Creek	**0.008**
59	Homewood Creek	**0.038**
60	Madden Creek	**0.013**
62	Blackwood Creek	**431**
63	Ward	**104**
	Total	**1305**

The relative importance of fine-sediment erosion from streambanks was calculated by comparing average, annual loadings of fine, streambank sediment to total, fine sediment from all sources for the nine watersheds where fine loads had been calculated from measured data in Simon *et al*., (2003). For these streams, values range from 63% for the Upper Truckee River to 2.4% for Trout Creek (Table 23). It is interesting that the maximum and minimum values occur in adjacent watersheds within the same basin quadrant (South), indicating that anthropogenic disturbances to the channels of the Upper Truckee River have played an important role in destabilizing streambanks and creating conditions where streambanks have become the dominant source of fine sediment. The relatively low value for Third Creek (10%) suggests that the dominant sources of fine sediments in this basin are probably the steep, bare upland slopes and urbanized areas. The low percentage for Incline Creek (3.6%) is probably attributable to greater contributions from urban areas compared to streambanks.

Table 23 – Comparison between measured, median annual fine-sediment (<0.063 mm) loadings (From Simon *et al*., 2003) and estimated, fine-grained (<0.063 mm) loadings from streambanks.

Stream	**Fine load, all sources (T/y)**	**Fine load, streambanks (T/y)**	**Fine-grained contribution from streambanks (%)**
Upper Truckee River	1010	639	63
Blackwood Creek	846	431	51
Ward Creek	412	104	25
Third Creek	318	30.8	10
General Creek	53	23.9	45

Trout Creek	462	10.9	2.4
Incline Creek	129	4.7	3.6
Glenbrook Creek	7.0	3.2	46
Edgewood Creek	11.4	2.1	18

A broader comparison of the relative importance of streambank erosion compared to all other sources of fine sediment in each of the 63 basins was made by comparing fine-sediment loadings estimates from all sources (Table 14 and Figure 5) with those solely from streambanks (Table 22 and Figure 19). Results are shown graphically by watershed number (Figure 21) and spatially (Figure 22).

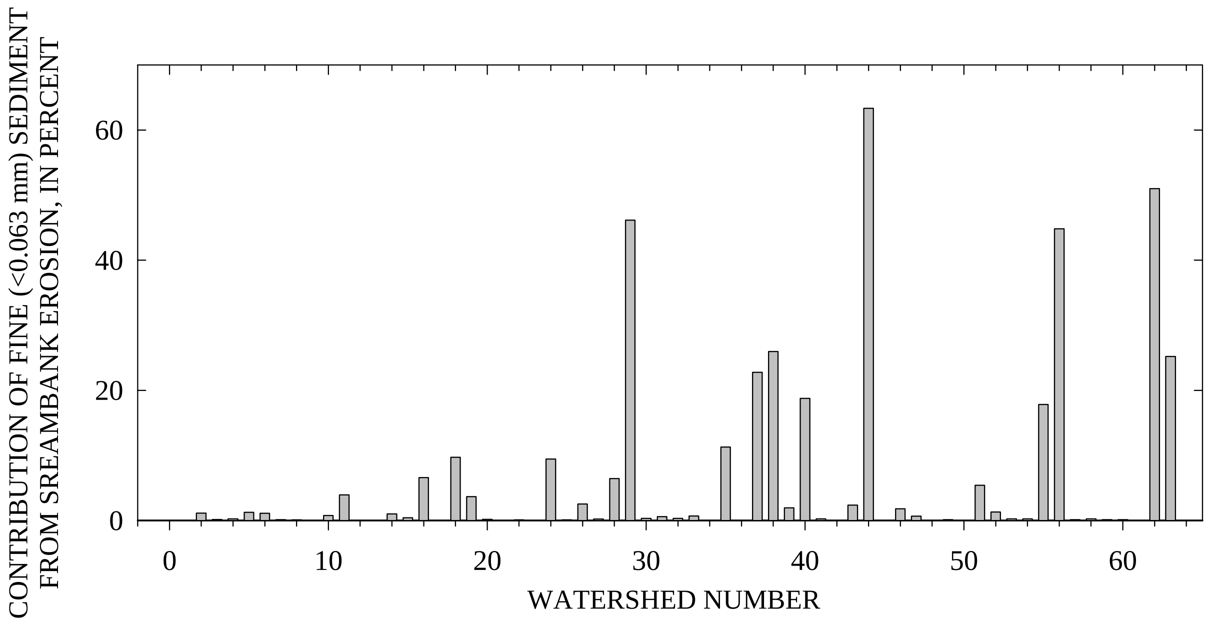

Figure 21- Contribution of fine (<0.063 mm) sediment from streambank erosion relative to all sources within each watershed.

SUMMARY AND CONCLUSIONS

The delivery of fine-grained sediment from tributary basins is listed as a major cause of water-clarity deterioration in Lake Tahoe. Efforts to control the discharge of fine sediment to the lake require knowledge of the volumes, rates and sources of this material. Similarly, use of a lake-clarity model to predict future clarity conditions and the effectiveness of management alternatives also require these types of data. The research described in this report used combinations of field-based observations of channel and bank stability with measured and simulated data on fine-sediment loadings to estimate fine-sediment loadings from un-monitored basins throughout the Lake Tahoe Basin. Loadings were expressed in the conventional format of mass per unit time (tonnes per year) but also in the number of particles finer than 20 μm, the latter for use in a lake-clarity model operated by the University of California, Davis.

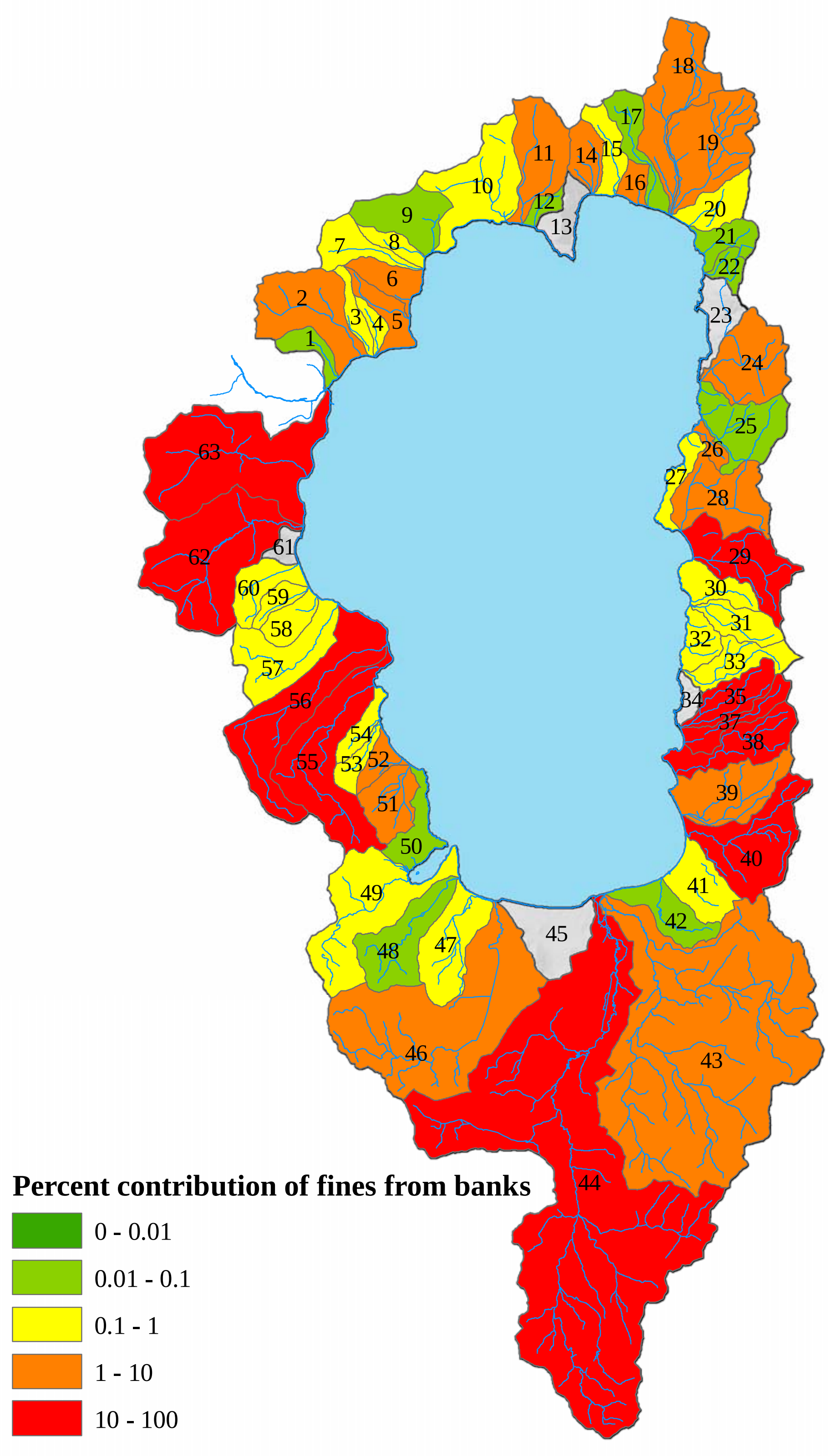

Figure 22- Contribution of fine (<0.063 mm) sediment from streambanks compared to all other sources within a given watershed.

Three types of fine-sediment loadings estimates have been provided for each of the 63 contributing watersheds in both tabular and graphical form:

1. Average, annual fine-sediment (<0.063 mm) loadings in tonnes per year (T/y);
2. Average, annual fine-sediment (<0.020 mm) loadings in number of particles per year (*n*/y); and
3. Average, annual fine-sediment (<0.063 mm) loadings in T/y from streambank erosion.

Fine-sediment (<0.063) loadings (in T/y) for each un-monitored watershed were based on extrapolating relations between distributions of a combined-stability index and measured fine yields (T/y/km^2) within each basin quadrant. The greatest contributors happened to be those with measured data, not requiring extrapolation. In descending order they are: Upper Truckee River (1010 T/y), Blackwood Creek (846 T/y), Trout Creek (462 T/y) and Ward Creek (412 T/y). Summing the values from all 63 contributing watersheds provided an average, annual estimate of fine-sediment (<0.063 mm) loadings to the lake of 5,206 T/y.

Fine-sediment (<0.063 mm) loadings in tonnes per year had to be converted to loadings expressed number of particles per year finer than 0.020 mm for use in the lake-clarity model. This was accomplished using data from Rabidoux (2005) by establishing relations between total suspended-sediment concentration (in mg/l) and the concentration of the 5-20 μm fraction in number per milliliter. Resulting data were converted to mean-daily and then annual values using suspended-sediment rating relations from Simon *et al*., (2003). A total of 7.79E+19 particles in the 5-20 μm fraction were calculated to enter Lake Tahoe in an average year with the Upper Truckee River accounting for almost 25% of the total. Contributions from Blackwood, Ward, Trout, and Third Creeks account for another 23% of these very fine particles. Thus, these five streams making up about 40% of the basin area, account for almost 50% of all fine-sediment loadings to the lake.

Contributions of fine sediment from streambank erosion was estimated by developing empirical relations between measured or simulated bank-erosion rates (adjusted for the content of silt and clay in the bank material) with a field-based measure of the extent of bank instability along given reaches and streams. Measured, unit values of fine sediment (<0.063 mm) erosion rates ranged from 12.2 m^3/y/km for Blackwood Creek to 0.002 m^3/y/km for Logan House Creek. Multiplying by the length of main channels in the watershed produced estimates of fine-sediment streambank erosion for each of the watersheds in tonnes per year. Summing the values for all of the 63 contributing watersheds provided an average, annual fine-sediment loading from streambank erosion of 1,305 T/y. This represents about 25% of the average, annual fine-sediment load delivered to the lake from all sources. The two largest contributors, the Upper Truckee River (639 T/y) and Blackwood Creek (431 T/y), account for slightly more than 80% of all fines emanating from streambanks, representing about 20% of fine sediment delivered to Lake Tahoe from all sources.

Extrapolations of fine-sediment loadings to the un-monitored watersheds are based on documented empirical relations yet contain a significant amount of uncertainty. Except for those values derived directly from measured data, reported results should be considered as estimates.

ACKNOWLEDGMENTS

The research reported here was funded by the Tahoe Research Group at the University of California, Davis, Nevada Department of the Environmental Protection, and the Lahontan Regional Water Quality Control Board. Special thanks go to John Reuter, Jason Kuchnicki and Dave Roberts for navigating through the contracting complexities to make this project a reality. To Brian Bell, Mark Griffith, Danny and Lauren Klimetz of the USDA-ARS National Sedimentation Laboratory for very long days in the field and long nights working up data. And last but not least to Dixon's and the band of minstrels that make it all fun. This work could not have been completed without your help.

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From: Aaron
To: Judi Allen; Cindy.Gustafson; Alexis; Carole Black; jcrockett@washoecounty.us; andy@gotahoe.com; info@inclinevillagemobilityhub.org
Subject: TTD Incline Mobility Committee Meeting May 22nd 2023
Date: Sunday, May 21, 2023 6:10:54 PM

Dear Judi Allen,

Please include this for tomorrow's TTD meeting Agenda Item II

Dear Tahoe Transportation District (TTD),

The vast overwhelming majority (LANDSLIDE voice) of Incline Village has made it loud and clear what their stance is regarding the Incline Village mobility hub but I still don't feel like the committee is hearing us. For those that didn't attend the workshop, it couldn't be more clear after about 2 dozen people, 100% that spoke, spoke out against OES! For those that did attend the workshop, were you at the same workshop as me? If TTD is hearing the public as they claim to say they are hearing them, TTD should immediately start the process of selling the Old Elementary School (OES) site on Southwood BLVD to new owners. TTD should cash that check they made in this deal and move on. Once TTD does that, then the Incline Village population as a whole might be able to start giving more positive feedback and energy, and everyone can actually make some multi-party progress toward transportation solutions. I still don't understand why it is so difficult to understand that you don't fix transportation problems by creating more supply, more cars driving, and reduced housing, instead of addressing needs directly. Agencies need to come together at this realization if they truly want to fix growth problems of the region.

Unless TTD starts the process of selling the OES, I don't see how anything can come from future public engagement workshop meetings or outreach because you have lost community support. Continuing to repeat the same mantra to us for 2-3 years is insulting.

Serving on such committees is no small thing, you have future generations of humans and wildlife in your hands. Please consider if you are appropriately trained in holistic sustainability and whole systems before choosing to fill such a position. Life, decisions and projects are not a silo in any one field. Impacts are cumulative, often indirect and broad reaching; be it making an economic decision/policy, a social decision/policy, an infrastructure decision/policy, a safety decision/policy, an environmental/wildlife decision/policy or others. I say this because I do not see big picture or systems thinking anywhere the direction we are headed. I am also seeing some representing themselves in their own silo. I give my thanks to Carol Black and support what she said and her presentation at the last committee meeting. She clearly has put some effort into this and it's appreciated.

Sincerely,

Aaron Vanderpool

806 Oriole Way

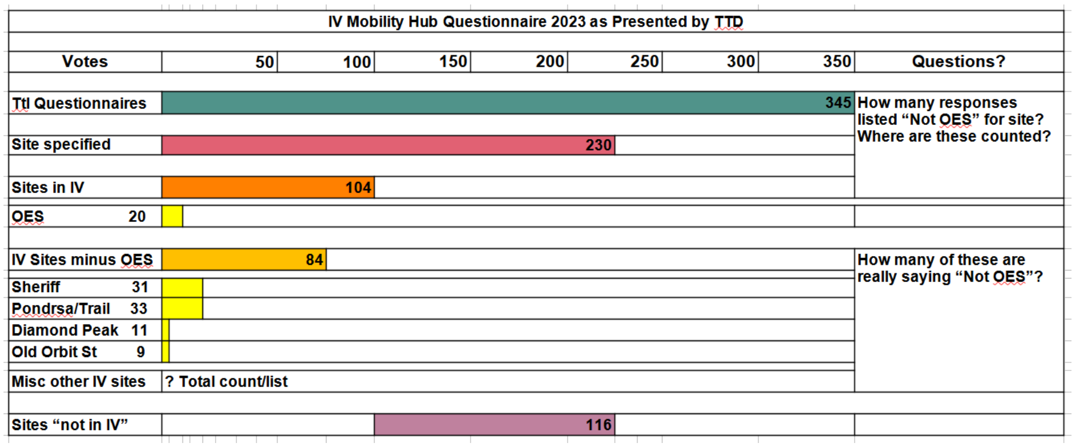
Incline Village, NV

Committee Member Comment, Incline Village Mobility Hub Committee Mtg May 22, 2023
Agenda Item III B, *Submitted by Carole Black, Committee member and Incline Village resident*

These comments relate to the reports re Mobility Hub Questionnaire and Mobility Hub Workshop #1. I request that planning for Mobility Hub Workshop #2 be deferred until after all info & possible remedial steps re concepts/process [e.g., Mobility Hub or Transit Center(s)] are shared, and reviewed/discussed in committee.

1. **Mobility Hub Questionnaire Results**: the presented report highlights results which appear to have been obtained/reported in a manner which may distort the underlying message from responders as follows:

1a. **Site Preferences: Staff report concludes that the OES was the second most preferred site in Incline Village dismissing the fact that the overwhelming number of responders by various means voted for "elsewhere." Another view: Only 20/345 = 5.8% favored OES – not exactly a resounding endorsement!** I am also aware that some individuals may have simply entered "Not OES" but do not see this captured anywhere.



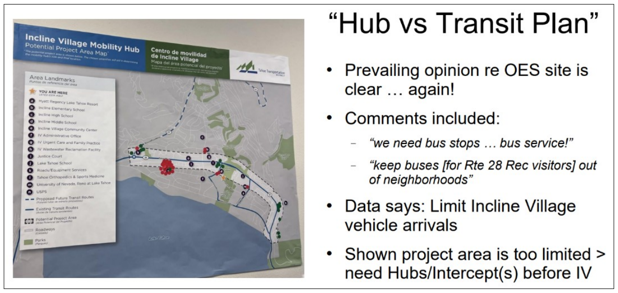
1b. **Amenities: By not separating Transit Services** (fundamental purpose of a Hub or Transit Center) **from Amenities** (optional niceties)**, the "Amenities" section of the questionnaire delivers results which do not address/prioritize transit needs at the expense of a distracting laundry list of optional items.**

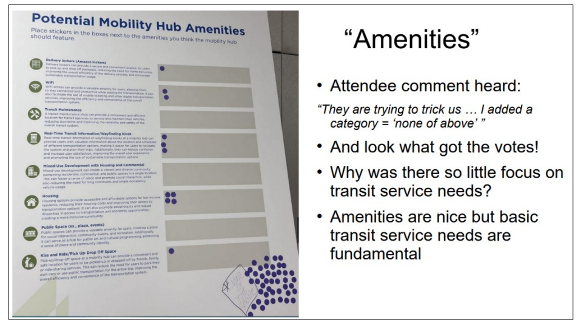
Certainly restrooms could be considered required. But other items listed are ancillary and/or distractions from major issues to be considered for an improved transportation service. Others can readily be delivered elsewhere. And some relevant items such as closing current Bus Service schedule gaps were not even asked.

Some literature does support the concept of "Transit Oriented Development" including "mixed use." But housing, when included, seems to be recommended for siting within ~ 1/4 mile of a transit center, but not within or immediately adjacent. Other recommendations include limiting parking to encourage transit use and diagrams of bus drop off/ pick up routing which avoids residential areas.

"Amenities" Questionnaire Section	
Item = Transit Service	**Votes**
Way-finding/Schedules	84
Indoor waiting/seating	66
Bus transfers	?
Bus service gaps closed	?
Micro-transit connection	?
Item = Amenity	**Votes**
Restrooms	128
Mixed Use	86
Public space	77
Wifi*	59
Coffee shop	40
Information booth	39
Affordable Housing	27
Parking*	?
Bike racks*	?
Bike/minor supply storage	?
Misc: dog park, bike rental, boat storage, strong security, grocery options, affordable gas (1 vote each)	
** Possibly considered "Services"?*	

2. **Workshop Summary and Results:** The Workshop summary similarly fails to emphasize the level of community engagement & overwhelming audience message sent. Apparently 47 people signed in but not clear of total actual attendee #. The simplest way to summarize what I heard and saw is with two slides previously submitted by me to this committee (*snapshots and pic are from news article as cited in prior public comment by me*):





While these may not be the final results (as end of workshop boards were not made available), the themes I believe are clear and do not appear materially changed:

> With respect to preferred site, message is clear: “Not OES”!
> With respect to “Amenities” preferences, presented report results are confusing, possibly incorrect. Each person received several dots. Report says 30+ people voted for the audience-added “none of above” option but correct number is unclear. I counted 44 stickers in “none” corner above but can’t tell how many stickers each respondent placed. This may have changed by evening end but, even so, relating sticker count to people # would be impossible. **Nonetheless the message seems clear > forget most optional stuff; focus on planning viable transit/traffic programs (hopefully with restrooms)!**

In addition, public comments (?18) apparently overwhelmingly opposed the OES site – I have had community requests for transcriptions and/or posted recordings. Where/when available? And then there’s a “picture worth 1000 words” (*also from news report*):

Thus I ask ... **When can this committee expect to see proposals for transit services? Road safety data requires vehicle intercepts before IV** for Rte 28 Corridor site overflow traffic & **Public has been clear** re preferences for IV:

- **Transit Center approach** with transit transfers and safe waiting area w/transit info
- **Transit to meet passenger needs re service levels/timing**
- **Skip added “fluff amenities” except restrooms,** perhaps wifi, ?possibly bike racks

Not discussed but a community concern > **affordable housing** is a challenge and considered for OES site in the past. Yet co-location with a surface transit center, especially bus traffic, does not appear to be a preferred approach.

With these baseline assumptions, TTD staff and consultants should be able to develop some draft models w/site requirement estimates/options to present for committee discussion in the next couple of meetings. **And after that would the time to plan workshop #2 for further community input re feasible, specific siting options!**

Committee Member Recommendation 1: IV Mobility Hub Committee May, 2023 *by Carole Black IV Resident/Committee Member*

Incoming Traffic Solution is Essential … and IV Hub will not Fix This!

This analysis is based only on Sand Harbor usage using reported 2022 volumes^ and assumes that what I have been told about parking spaces is correct (450 used), then each space turns over approx 4x/day & assumes that data includes the Shakespeare volume. If not, estimates below are low.

The reported numbers indicate an average vehicle occupancy of 2.8 which is about what has been quoted in past for individual vehicles. This does not include the IV vehicles for the ESE volume which at busy times is several hundred/day (≥ 500). And 500/2.8 avg people/vehicle > 178 ESE vehicles/day.

So in July we would be looking at the following estimate for vehicles passing along IVCB Rte 28 with occupants headed for Sand Harbor::
- Vehicles arriving at Sand Harbor = 1800/day
- Subtract 270 (est. ~ 15% of cars to Sand Harbor from south*) = 1530
- Add 180 (vehicles stopping in IV to board ESE)

- - > Net is approx. 1710 vehicles arriving and leaving through IV each day for busy season Sand Harbor use!

Sand Harbor Impact Estimate = 1700+ vehicles and 3400+ vehicle trips on busy season IVCB roads/day:

Near/In IV Impacted area:	Vehicles/day	Vehicle trips/day	Notes
Total: Incline Village (Rte 28)	1710	3420	*Excludes trips by residents with Senior parking passes (for Shakespeare which are apparently not counted); ? re all Shakespeare*
Crystal Bay > IV (Rte 28)*	1026	2052	
Rte 431 to IV*	685	1390	
** assumes distribution of arrival directions for vehicles at Sand Harbor mimics arrival sources for ESE riders*			

Sand Harbor 2022 visitor volume thus accounted for ~ 50% of busy season overage trips on Rte 28^^
& this doesn't include separate vehicle arrivals/vehicle trips for Tahoe East Shore Trail^^^

>> TTD/TRPA should not increase ESE trips this coming summer? This will only increase total excessive trips in an area with existing safety challenges!^^^^ **In an evacuation, what would happen**???

>> IV Hub will not improve and may worsen this picture unless all arriving Rte 28 corridor volume without on-corridor parking is intercepted prior to IVCB. This also applies to new SLT Event Center traffic.

>> **Transit service to IVCB needs to expand service hours.** Current TART Mainline NV avg = 74 passengers/day with gap 9-11am; last trip of day departs IV at 4:30pm: **not great for beach, events, commute!**

>> **Excess Vehicle Crashes along Rte 28 are a known issue ... What about TES Trail safety?** See pic:
https://travelnevada.com/outdoor-recreation/tahoe-east-shore-trail/

Notes:

^ Sand Harbor reported usage:

SAND HARBOR VISITOR COUNT - SUMMER 2022				
Month	Total Visitors	Total Vehicles	Ave Daily Visitors	Ave Daily Vehicle
May	41,662	17,541	1,344	566
June	79,800	29,329	2,660	978
July	155,128	55,855	5,004	1,802
Aug	139,789	44,769	4,509	1,444
Sept	45,587	23,191	1,520	773

^^ NDOT counts on Rte 28 between CB and IV during July averaged 18,368/day in 2021. In the recent WC Transportation Study the typical capacity listed for a two-lane rural highway is 13,900 vehicles/day. So that roadway segment is running ~ 4,468 trips/day over capacity

^^^ Tahoe East Shore Trail is reported to have accommodated 1850 one-way trips during July 2020 which would have required ~ 330 vehicles and a total # of vehicle arrival/departure trips = 660 and ESE accommodated approximately 500-550 passengers/day

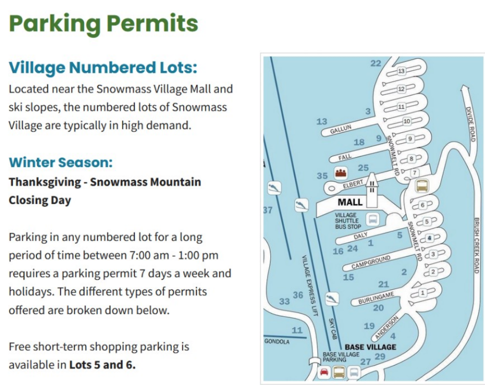
^^^^ Copied from recent WC Transportation report:

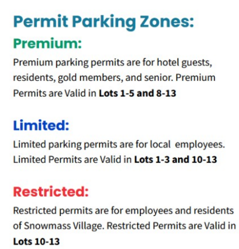
> Safety
>
> Between 2015 and 2019 there were a total of 554 crashes in the Incline Village and Crystal Bay areas. Of these, two were fatal, eight resulted in severe injuries, and 136 resulted in non-severe injuries. The remaining crashes were classified as property damage only. Exhibit 2-6 shows the density crashes experienced in Incline Village and Crystal Bay during this time period. Higher concentrations crashes occurred on the segment of SR 28 between Incline Village and Crystal Bay, including half of the crashes

Committee Member Recommendation II. IV Mobility Hub Committee 5.21.2023:
THIS COULD WORK: Prior transit w/Village Transit Hub or Hubs for transfers locally -
Summary of Snowmass, CO Ski Season Transit and Parking*

> Town area shuttle and Regional buses serving intercept lots and town center: Annual ridership >1 million.
> Free Parking by permit in town (limited to purchased permits for residents, local lodging guests, employees; and at limited short term shopping spots)
> Free Parking at 2 Intercept Lots outside of the town/ski area (~5mi and ~3mi) with Transit Centers

Ski Season Permit Parking: permits are purchased





With the huge ridership volume the area is currently outgrowing the existing Transit Centers and there is proposed a larger central transit center for both local shuttle and regional bus transit use which would be able to co-locate up to 7 buses, with amenities limited to way-finding, bathrooms, ?wifi. The proposed project was recently deferred because of concerns about construction interfering with local businesses. [Note that there is in addition limited, pricey day visitor (skier) parking at Base Village.]

With access off of Rte 28 or 431 away from residential areas and pre- IVCB remote intercepts, I believe this type of approach (with boarding in IVCB for Rte 28 Corridor sites limited to residents, local lodging guests and all others only with proof of IV arrival by transit) could work in IVCB area … Suggest a working session with consultants to review data/community feedback and brainstorm viable program options in order to build location requirement specs to facilitate site option review. There are, for example, 2 parcels on Rte 28 about to be re-assigned – might one/both of these work for a Transit Center? (And, as an aside, some sort of permit program for parking within IV overall might also be considered but this may fall in WC realm?}
** Ref: Snowmass related internet sites*

MEMORANDUM

Date: June 14, 2023

To: Tahoe Transportation District (TTD) Incline Village Mobility Committee

From: TTD Staff – Carl Hasty, District Manager

Subject: Presentation and Discussion on Site Analysis, Project Concepts and Site Selection Process for the Incline Village Mobility Hub Project

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Action Requested:
It is requested the Committee hear the presentation on sites being assessed and project concept progress being prepared for the August 14th workshop and provide input.

Fiscal Analysis:
All expenditures associated with this item for the fiscal year are in the approved FY23 budget, with $200,000 allocated for Professional Services and $13,000 for staff time or potential budget amendments for potential out of scope services. Staff time is currently being billed to Transit. Funding sources include $202,350 of Surface Transportation Block Grant funds and $10,650 in Transportation Development Act funds. The HDR agreement is for $200,000. The additional funds currently set aside will be needed for the mailers, phone line, and other items as outlined in the plan.

Work Program Impact:
All work associated with this effort is captured under respective elements of the approved FY23 work program and is included in the FY24 work program, with corresponding allotted staff time. This project aligns with TTD's Strategic Goal SG-3 - Increase the connectivity and reliability of a regional multi-modal transit system around the Basin.

Background:
At the May 2023 meeting, the Committee reviewed and discussed the community input for sites within Incline for a mobility hub location and ideas on amenities or co-location ideas. The Committee also discussed that many of those who provided input also opposed the idea of a mobility hub within Incline. The Committee also selected August 14th as the date for the next workshop to share with the public possible site locations and project concept(s) for input.

Discussion:
The workshop on August 14th will be to inform and engage the community on mobility hub concepts and potential locations.

Attachment A is the updated schedule for the plan and public process, including committee meetings and planning workshops. Attachment B is the location map noting sites that have been identified for consideration within Incline Village. The Incline area is not the only community or location identified for a mobility hub. Additional mobility hub areas have been identified in the region to compliment an Incline connection, including at the intersection of US 50 and State Route (SR) 28, Kings Beach, Truckee, US 50 in Carson City, and other locations at the south end of Lake Tahoe, as part of a larger transit network to provide community connections and transfer points to people traveling to destinations within and outside of Lake Tahoe.

Staff and the consultant team will present work to date on the locations for Committee and public input.

Additional Information:
If you have any questions or comments regarding this item, please contact Carl Hasty at (775) 589-5501 or chasty@tahoetransportation.org.

Attachments:

A. Updated Work Schedule
B. Location Map of Sites for Assessment

CH/ja AGENDA ITEM:.III.A.

TTD Incline Village Mobility Hub Schedule DRAFT

October 2022	HDR Planning Work Initiated
*February 27, 2023 - IVMC Meeting	TTD presents planning schedule overview
*March 6-20, 2023	TTD conducts In-Person Questionnaire Outreach
*March 20 – April 3, 2023	TTD posts informational flyers within the community and conducts information drops at key community locations
~~*March - IVMC Meeting~~	~~TTD presents an update on the Questionnaire and Preliminary Workshop Materials~~ *Mtg cancelled due to lack of quorum*
April 20, 2023	First Public Workshop, 4:30 p.m. – 7 p.m. with a presentation at 5:30 p.m. at Parasol
April 30, 2023	Questionnaire closes
May 2023	Review Community Feedback
*May 29, 2023 - IVMC Meeting	TTD presents Workshop and Questionnaire Feedback Summary
June 2023	Develop Site Suitability Assessment and Concept Plans
*June 26 - IVMC Meeting	TTD presents Preliminary Site Assessment Update
July 31	Committee Meeting
August 14	Second Public Workshop
*August - IVMC Meeting	TTD presents Preliminary Plan Recommendations and Draft Preferred Mobility Hub Concept for Comment
September 2023	Final Mobility Hub Plan
Sept. or Oct. - IVMC Meeting	HDR presents Draft Plan for Recommendation to the TTD Board
December TTD Board	Mobility Hub Plan

*TTD will execute these deliverables, as they are not included in consultant's scope.

**All dates and information are subject to change.

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