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 4-4. Combined-stability index field form and ranking scheme.

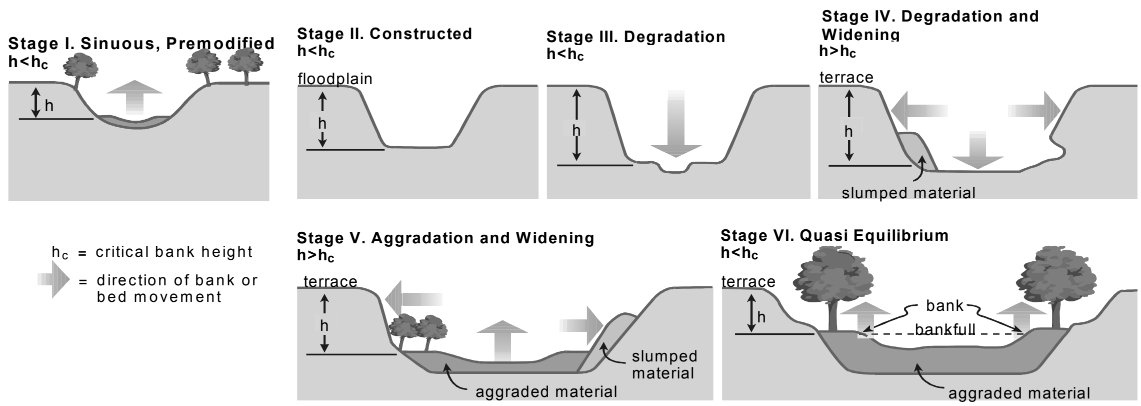

Figure 4-5. Six stages of channel evolution from Simon and Hupp (1986) and Simon (1989) identifying Stages IV and V as those dominated by bank widening.

4.5 Channel Changes With Time: Rates and Volumes of Streambank Erosion

Rates of bank erosion in the five streams ranged from net deposition of 51 m^3/y along Edgewood Creek to about 1860 m^3/y along the Washoe Meadows reach (by the golf course) of the Upper Truckee River (Table 4-2). Four of the five streams surveyed are net sinks for sediment with Edgewood and Logan House Creeks also showing net deposition on the channel banks. All of the streams with the exception of the Upper Truckee River are aggradational. Because different lengths of channel and time were considered in this analysis, data expressed in m^3/y/km are used to make comparisons between streams. Thus, Blackwood Creek provides roughly 14 times the amount of streambank sediment on an annual basis than General Creek; about 700% more fines per unit length of channel even though streambanks of General Creek contain, on average, more fine-grained material than do streambanks along Blackwood Creek (Table 4-2). This is significant because it quantifies the effects of disturbance on the magnitude of streambank erosion rates on the wetter, western side of the Lake Tahoe watershed.

Geomorphic assessments of 17 reaches over the lower 8.2 km of Blackwood Creek show that:

(1) except for the upstream-most site which is upstream of a headcut, 25-50% of the longitudinal extent of all assessed banks were unstable;
(2) there is a general trend of decreasing bank instability with distance upstream (Figure 4-6); and
(3) a knickpoint at about km 8.1 marks the headward advance of an instability moving through the Blackwood Creek network.

Points 2 and 3 above are typical of streams responding to disturbance. Combined, all of the evidence from Blackwood Creek, including the exceptionally high suspended-sediment yields suggests that the consistently high sediment loadings are the result of not only the gravel mining operations downstream but also land surface disturbance over 100 years ago. We speculate that alluvial valley fills dating from the period of intense logging operations provides the source of much of the sediment eroding from channel banks along Blackwood Creek.

Compare Figure (4-6) for Blackwood Creek, with RGA results from Logan House Creek, where extremely low sediment yields and net bank deposition have been calculated from past and present surveys (Figure 4-6), and the importance of streambank erosion in delivering suspended sediment can be appreciated.

Table 4-2. Results of analysis of historical and contemporary channel cross-section surveys for the five streams with historical data. Positive values denote erosion; negative values denote deposition.

Stream	Total (m^3/y)	Bank (m^3/y)	Bed (m^3/y)	Silt-clay in banks (%)	Bank erosion rate (m^3/y/km)	Bank erosion of fines (m^3/y)	Bank erosion of fines (m^3/y/km)
Blackwood	-413	1800	-2220	6	217	101	12.2
Edgewood	-78	-51	-28	2	-	-	-
General	-237	125	-362	10	14.6	13.0	1.5
Logan House	-21	-8	-13	-	-	-	-
Upper Truckee	2340	1860	476	14	645	261	90.3

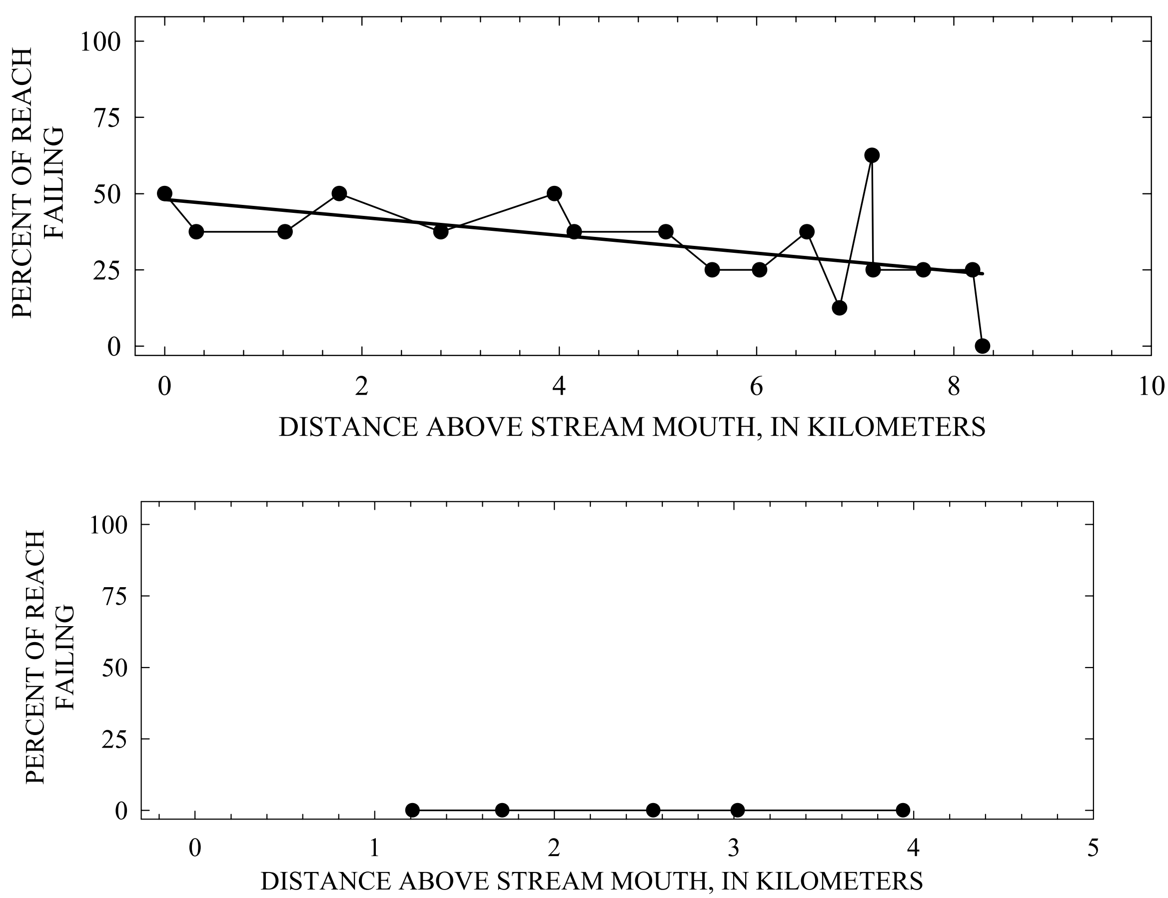

Figure 4-6. Percentage of left and right banks that are unstable along Blackwood Creek (upper) and along Logan House Creek (zero) (lower).

4.5.1 Upper Truckee River

Comparison of time-series cross sections indicates that the Upper Truckee River delivers about two times the amount of streambank sediment per river kilometer than Blackwood Creek. However, because streambanks along the Upper Truckee River tend to be more fine-grained (14%) then along Blackwood Creek (6%), the Upper Truckee produces 640% more fine-grained bank material (90 m^3/y/km) than Blackwood Creek (12.2 m^3/y/km) over the measured reaches. Although the matched cross sections on the Upper Truckee River represent only 2.9 km of a total study length of about 24 km, RGAs conducted along the entire 24 km length indicate that bank erosion is prevalent in all of the non-boulder reaches.

In the sinuous reaches of Washoe Meadows and further downstream, the outsides of meander bends are particularly active. This is evident from RGA data on the percent of each reach having failing banks (Figure 4-7). Here, the recurrence of 50% values reflect a geotechnically stable inside bend and an outside bend that is unstable along its entire length. Values of 0% failing reflect boulder reaches and other protected areas. Bank-erosion rates compared between 1992-1994 and 1997-2002 have increased 2 to 3 times, most likely a function of toe scour and lateral retreat of bank toes during the large January 1997 flow event. In fact, the 1997 surveys in the reach post-date the rain on snow event indicating that hydraulically-induced channel changes during the event resulted in geotechnical instabilities that have affected channel processes for at least the next five years. To place these results in a historical perspective, analysis of the lateral migration of this reach of river was conducted.

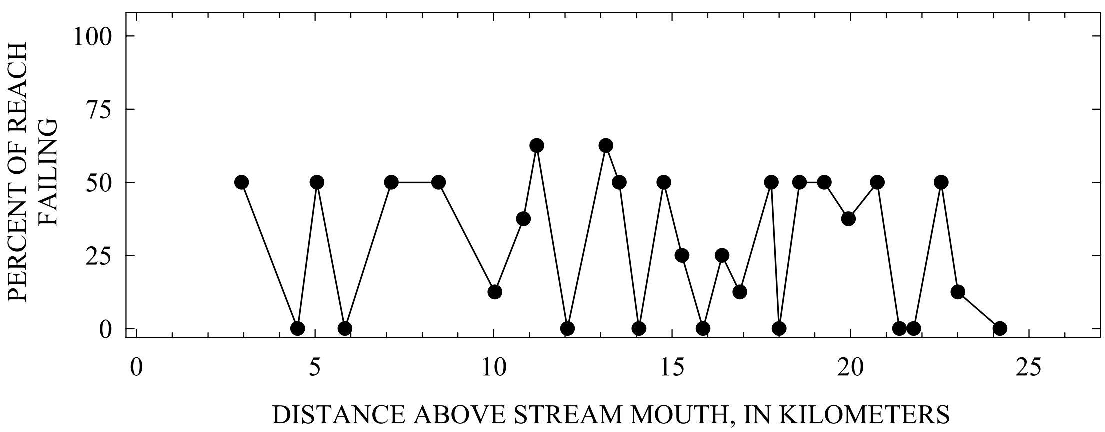

Figure 4.7. Percentage of left and right banks failing along the Upper Truckee River.

4.5.2 Data for Analysis of Channel Migration (1940-1994)

Channel centerlines of the Upper Truckee River were obtained from four sets of aerial photographs supplied by California State Parks: 1941, 1952, 1971 and 1994 in ArcView shape-file format (C. Walck, 2003, written commun.). Because the centerlines had different starting and ending points, upstream and downstream boundaries were established for the reach that was included in the four shapefiles. River centerlines were then cut at these points, isolating the common reach. The study reach extended from 1.7 km downstream of the first Highway 50 bridge (upstream boundary) to the second Highway 50 bridge (downstream boundary). This reach length following the valley profile was 3.07 km (the direct “as the crow flies” distance was

2.31 km). The downstream 73% of the reach runs through the Lake Tahoe Golf Course. Figure 4-8 illustrates the four channel centerlines.

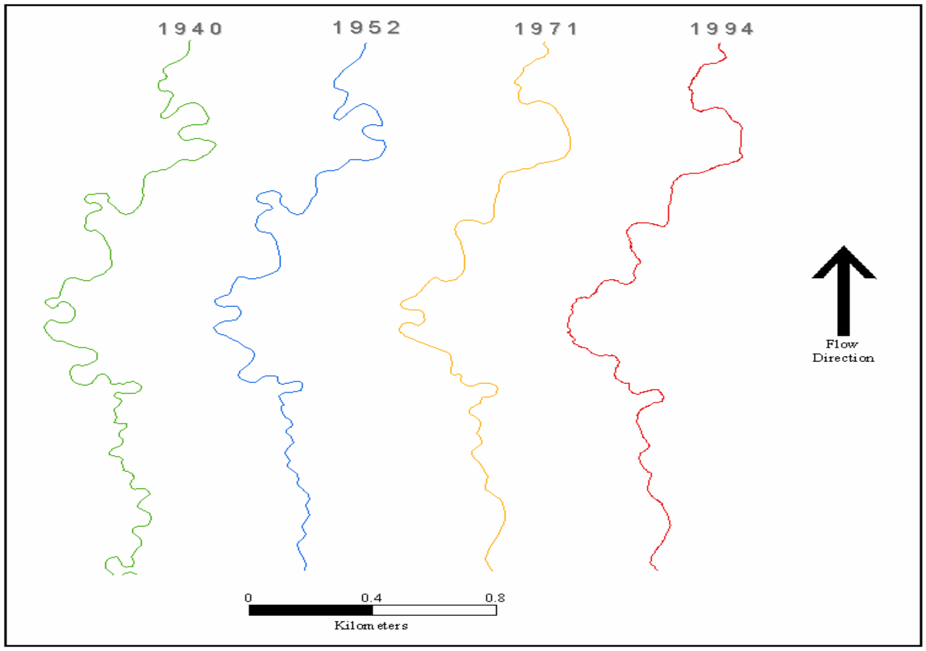

Figure 4-8. Successive centerlines of the Upper Truckee River, 1941 – 1994.

4.5.3 Analysis of Channel Lengths and Channel Activity

The lengths of the four cut-line coverages were calculated using ArcView. More detailed analysis was also performed for the section of the channel adjacent to the golf course and the remaining section upstream.

Channel activity is defined by Shields *et al.* (2000) as: *"the mean rate of lateral migration along a river reach in dimensions of length, per unit time" (pg. 58)*. Calculation of channel activity over various time periods enabled the historical stability of the Upper Truckee River to be quantified. The active area of the channel was computed for each temporally adjacent pair of channel centerlines. An ArcView extension was downloaded to converted polylines to polygons. This was utilized to create a polygon enclosing the area of channel between each pair of centerlines which had been worked; the three polygons are detailed in Table 4-3. The area of these polygons was divided by both the length of the valley length and the earlier centerline used to produce them. These values were subsequently divided by the period between the start and end points giving the channel-activity value. Figure 4-9 contains a map of the polygons generated by this centerline analysis, both individually and all superimposed onto a 1998 aerial photograph. Channel-activity values were also calculated for the golf course reach and remaining reach upstream of the golf course.