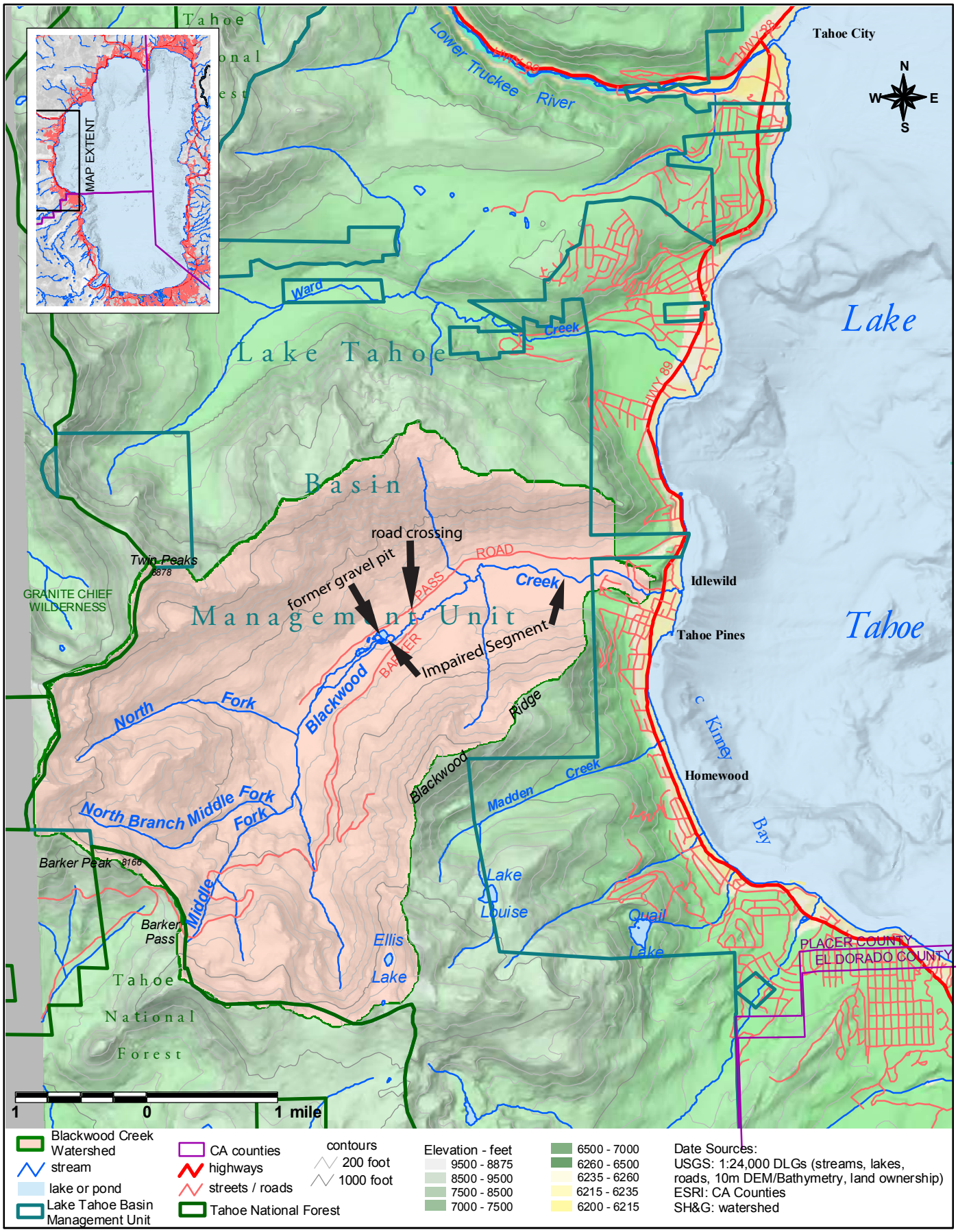
# FIGURES

**Figure 1**

Blackwood Creek Watershed Location Map

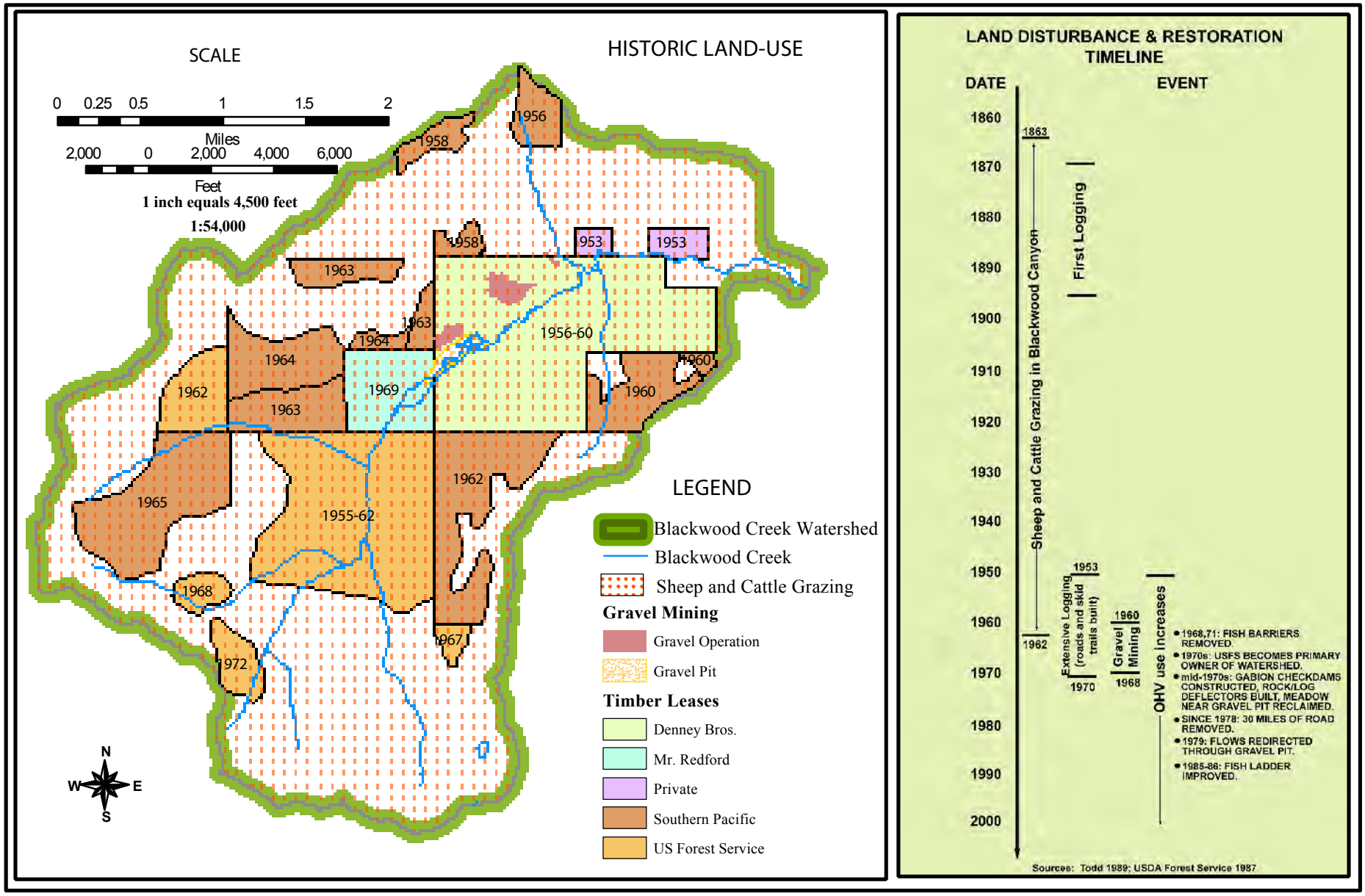
[Figure modified from Swanson (2003)]



# Figure 2

Historic Land Use in Blackwood Creek Watershed

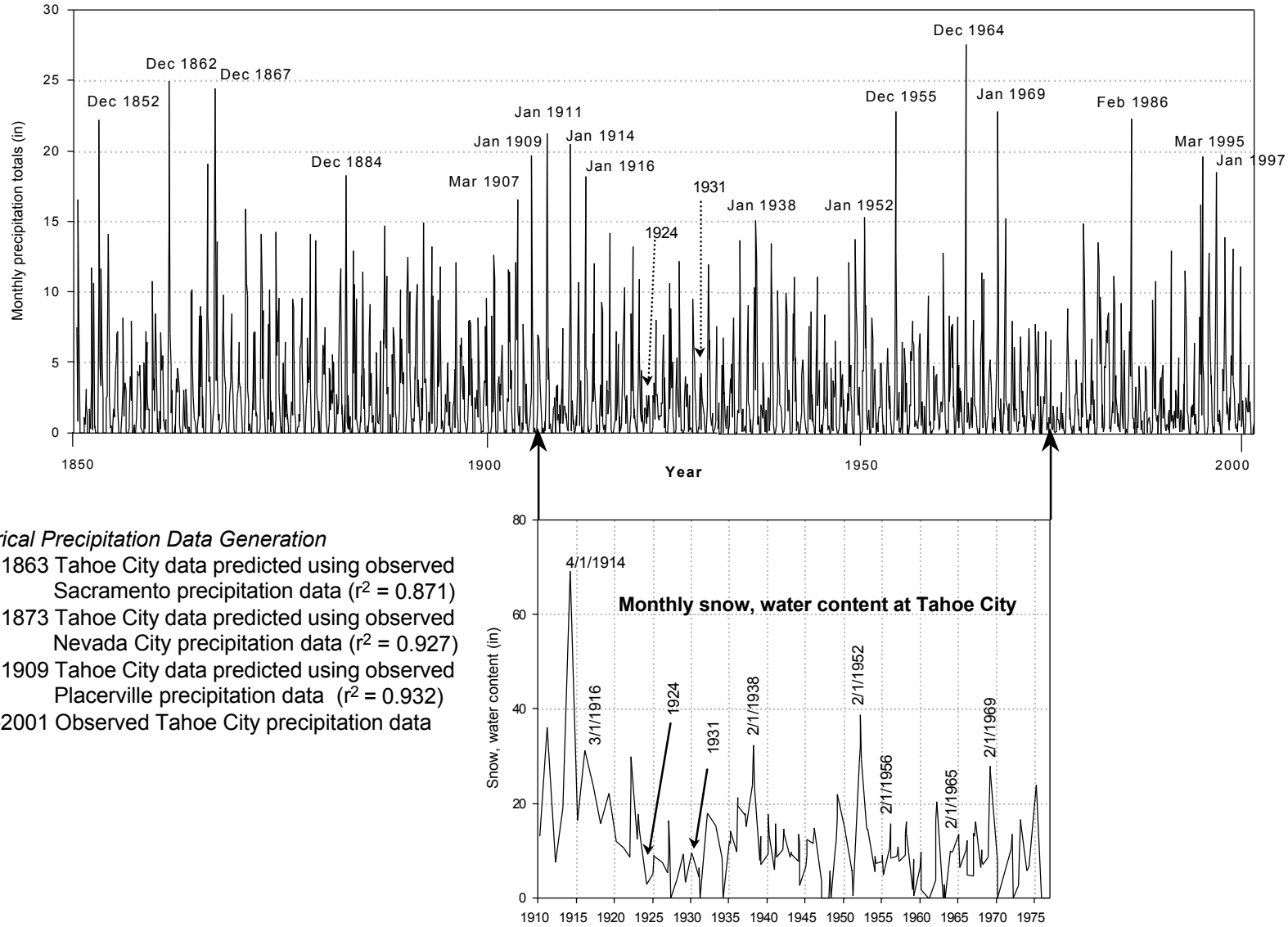
[Figure modified from Swanson (2003)]



# Figure 3

Summary of Monthly Tahoe City Precipitation Values, 1850 - 2001

[Figure from Swanson (2003)]




*Historical Precipitation Data Generation*

1850-1863 Tahoe City data predicted using observed Sacramento precipitation data ($r^2 = 0.871$)

1864-1873 Tahoe City data predicted using observed Nevada City precipitation data ($r^2 = 0.927$)

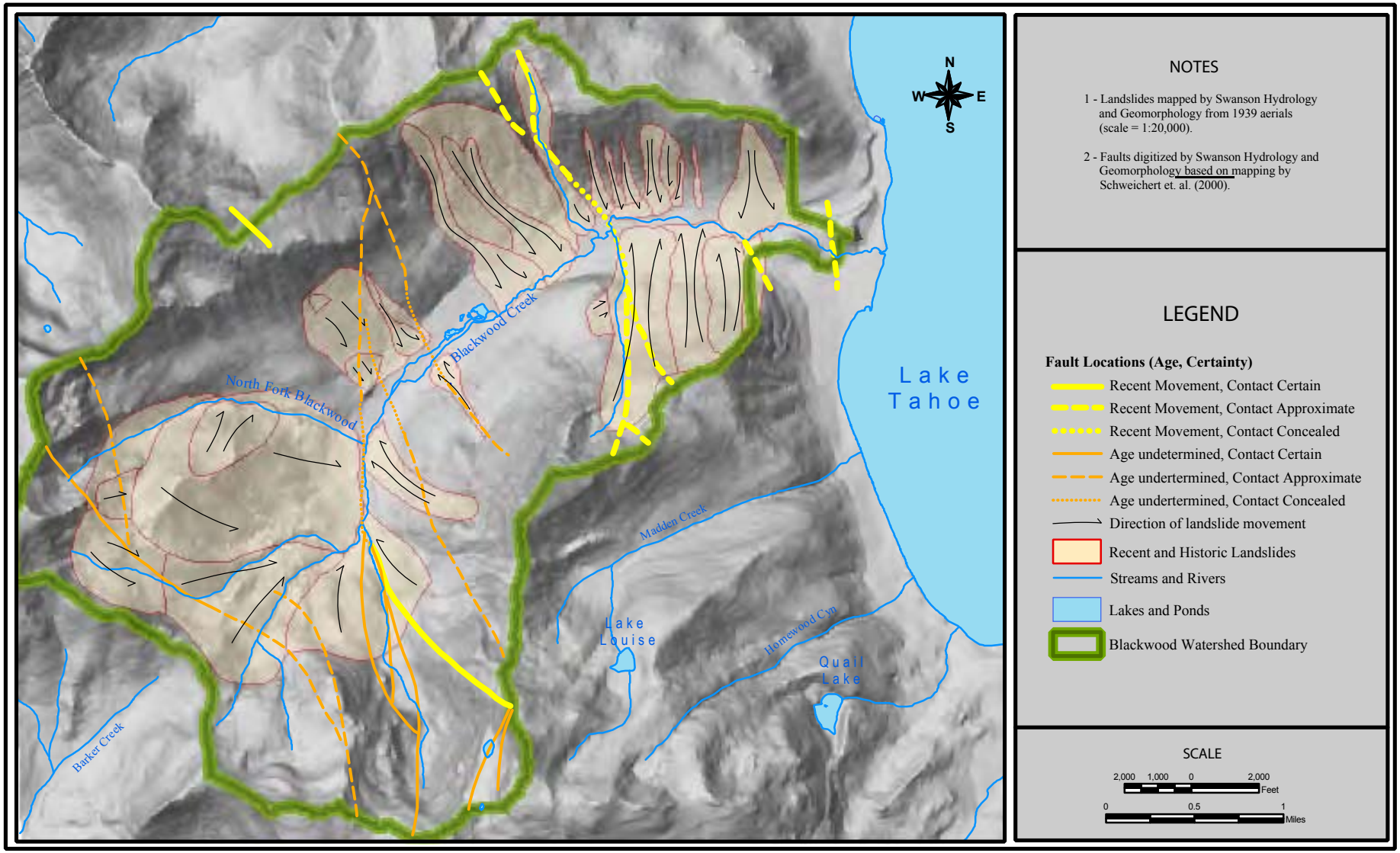
1874-1909 Tahoe City data predicted using observed Placerville precipitation data ($r^2 = 0.932$)

1910-2001 Observed Tahoe City precipitation data

# Figure 4

Landslides and Faulting in Blackwood Watershed

[Figure modified from Swanson (2003)]



# Figure 5

Profile of Blackwood Creek and Tributaries

[Figure modified from Swanson (2003)]

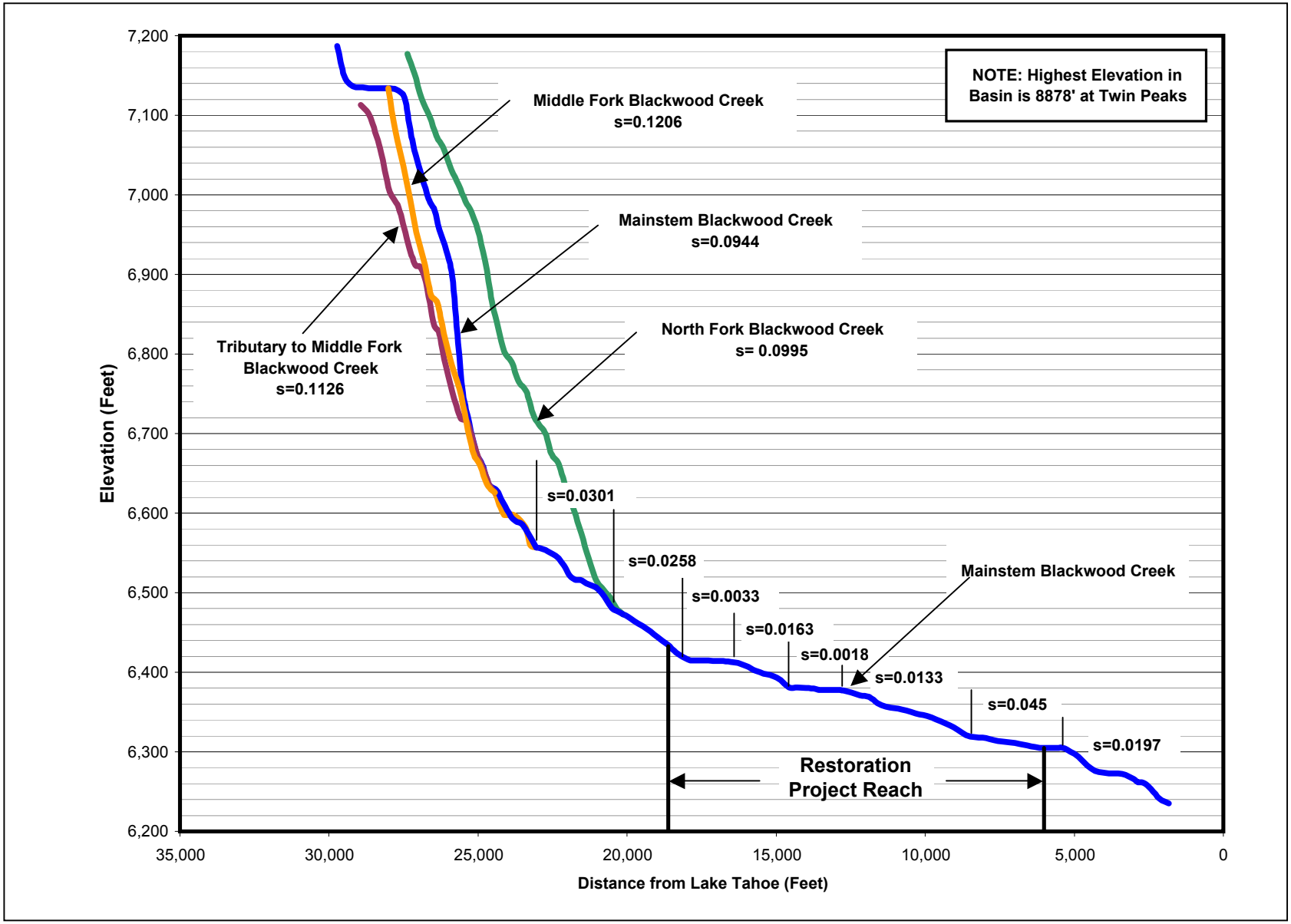


**Figure 6**

Mean Daily Flows in Blackwood Creek, Water Years 1961 - 2006

[Data from USGS: Site 10336660]

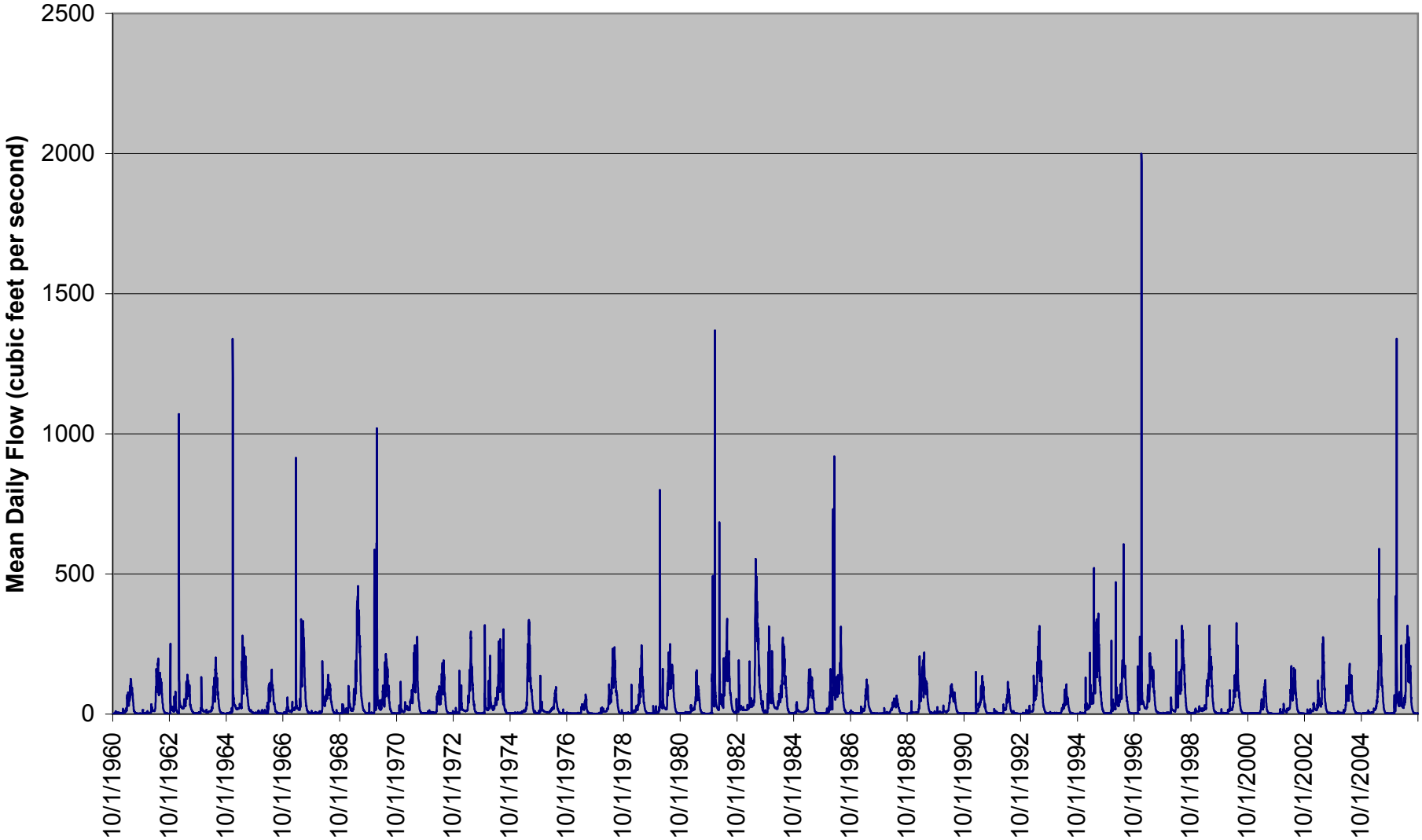


**Figure 7**
Frequency of Suspended Sediment Analyses Versus Flow Quartile
[Data from USGS: Site 10336660]
[Suspended Sediment Data Collected from 1974 to 2004]

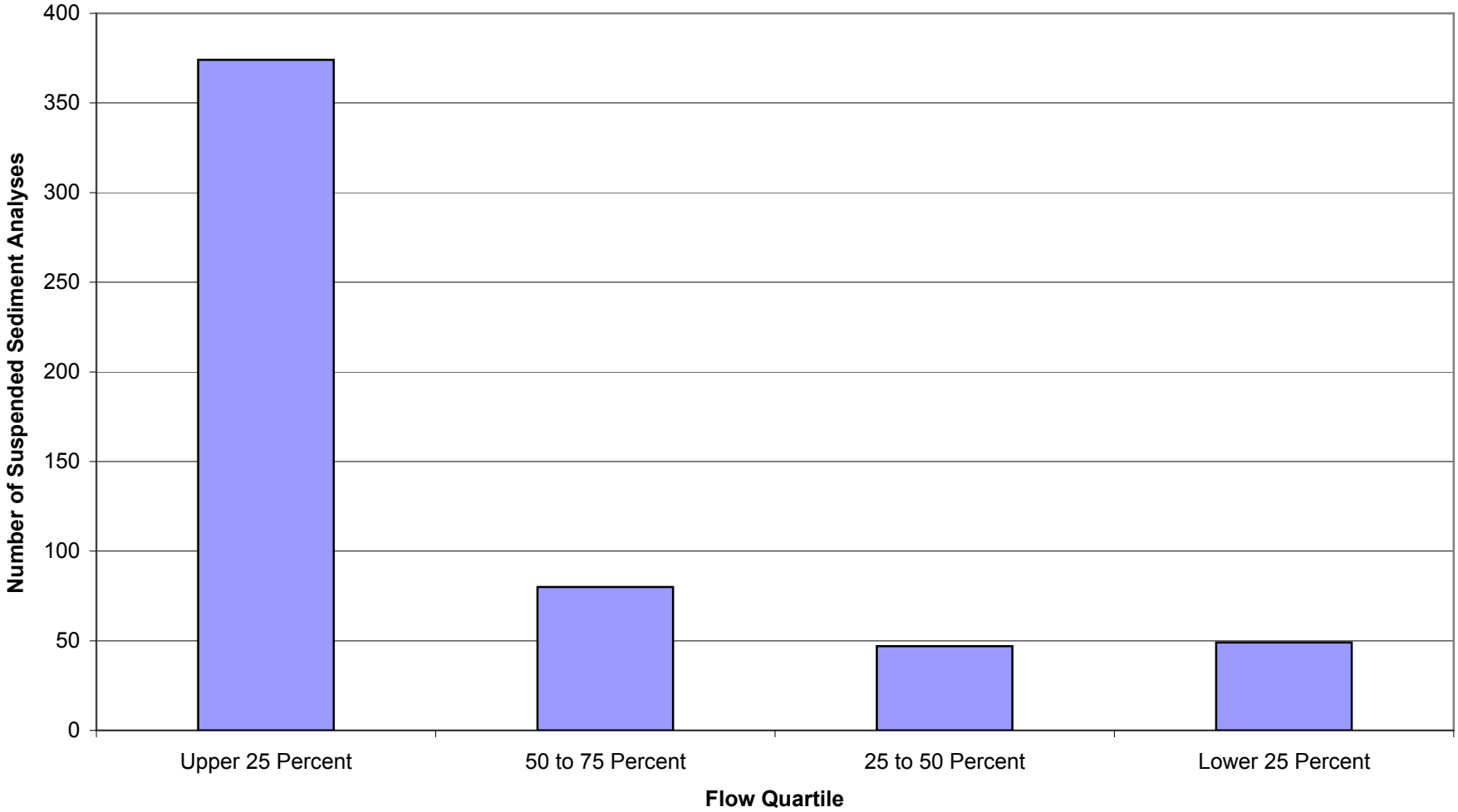


**Figure 8**

Frequency of Suspended Sediment Analyses Versus Month

[Data from USGS: Site 10336660]

[Suspended Sediment Data Collected from 1974 to 2004]

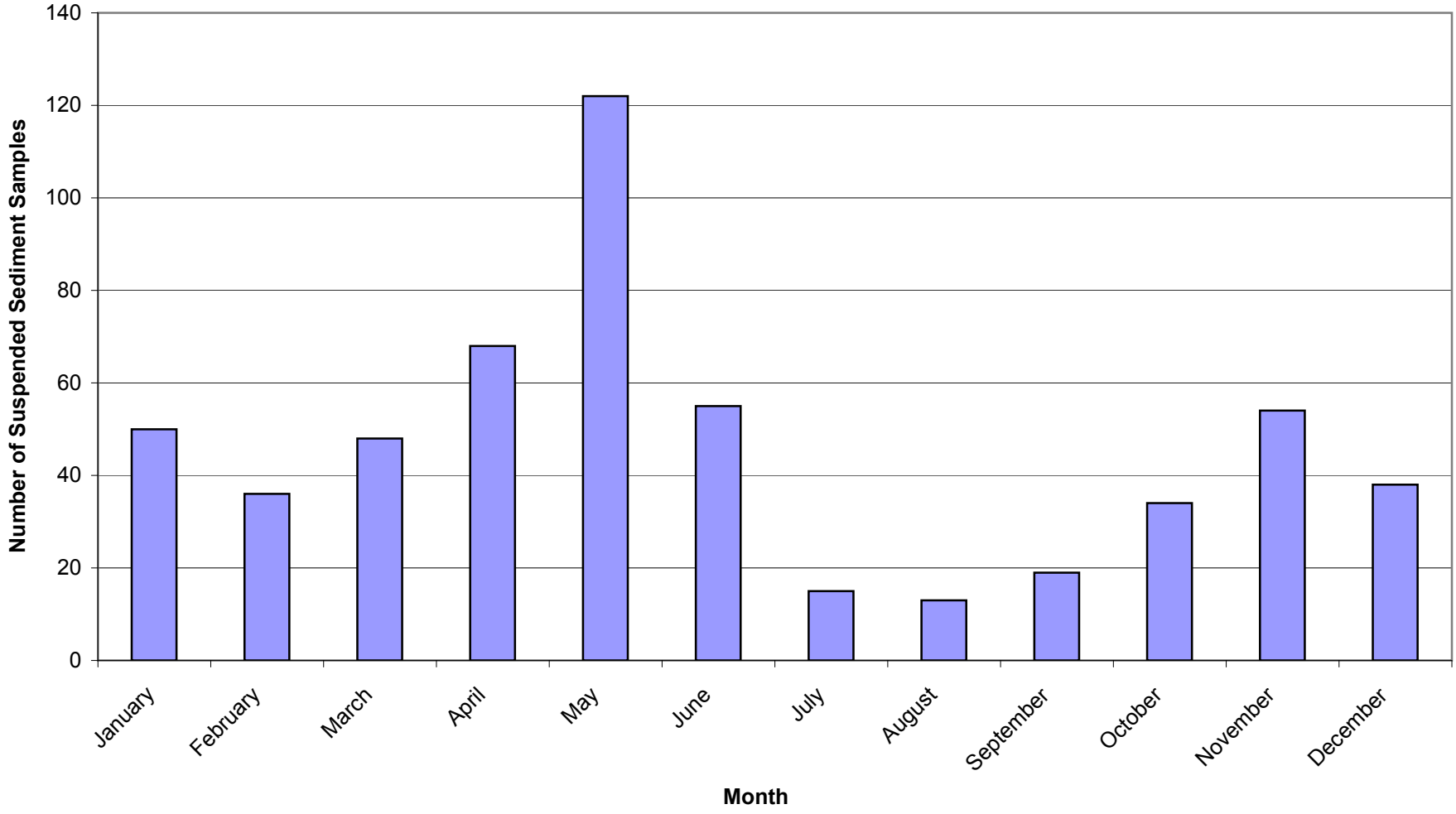
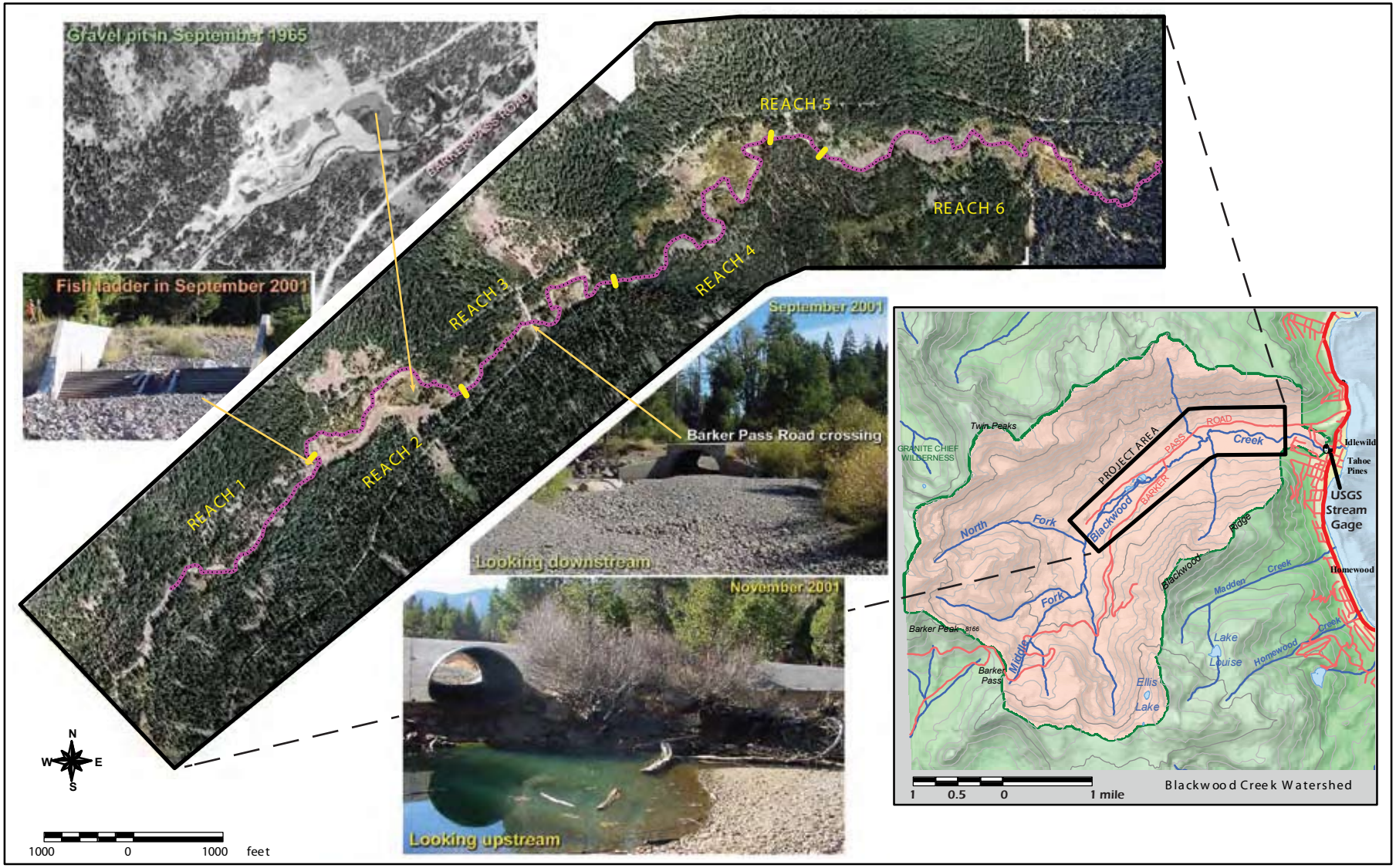


**Figure 9**

Former Gravel Pit, Former Fish Ladder,
Former Low Water Crossing, and Designated Reach Breaks
[Figure modified from Swanson (2003)]



# Figure 10

Historic and Current Channel Patterns of Blackwood Creek

[Figure modified from Swanson (2003)]

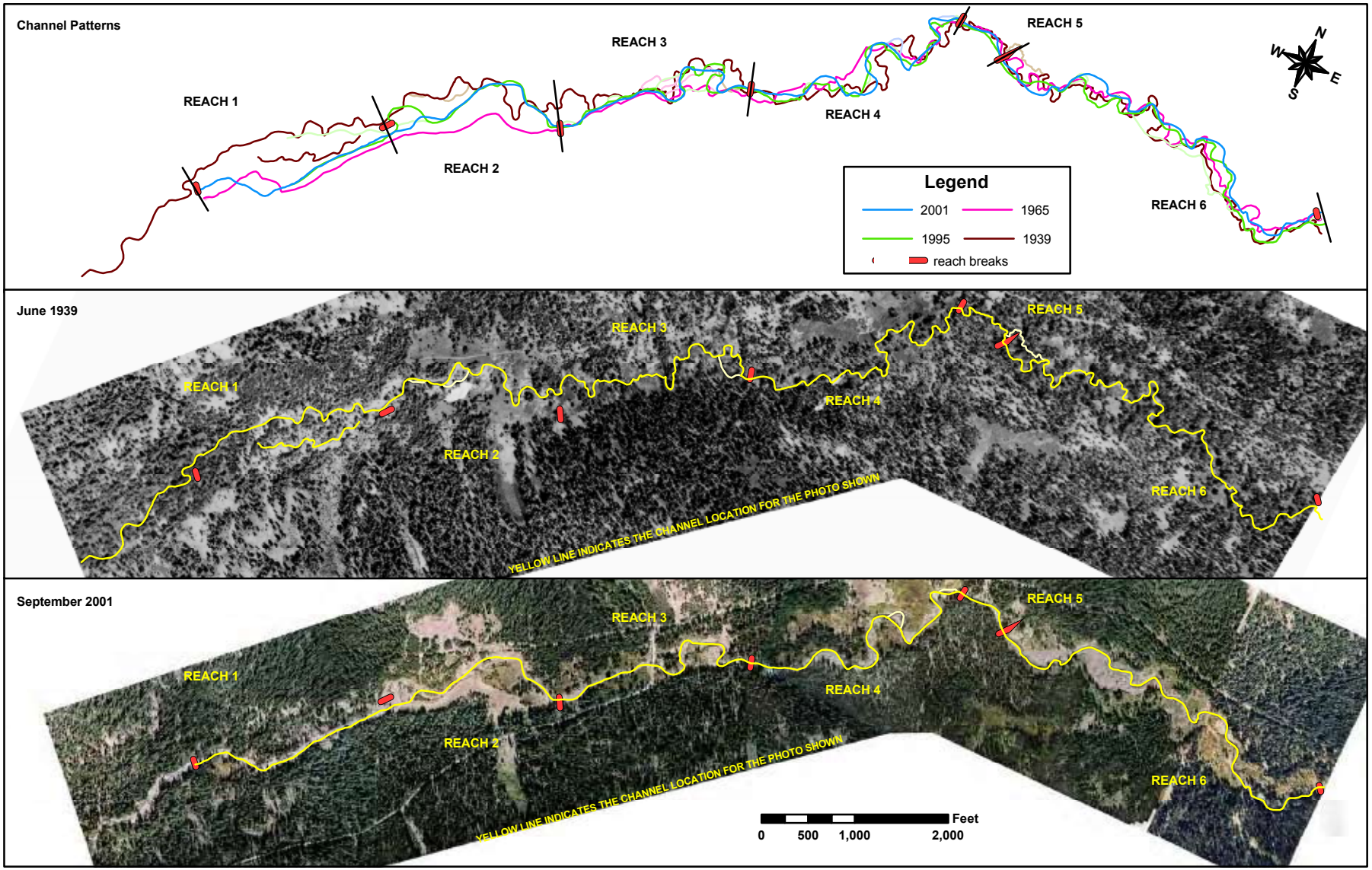


**Figure 11**

Gravel Pit Operations and Diversion Channel

[Source: Department of Fish and Game Files]

Photo Dated August 4, 1960

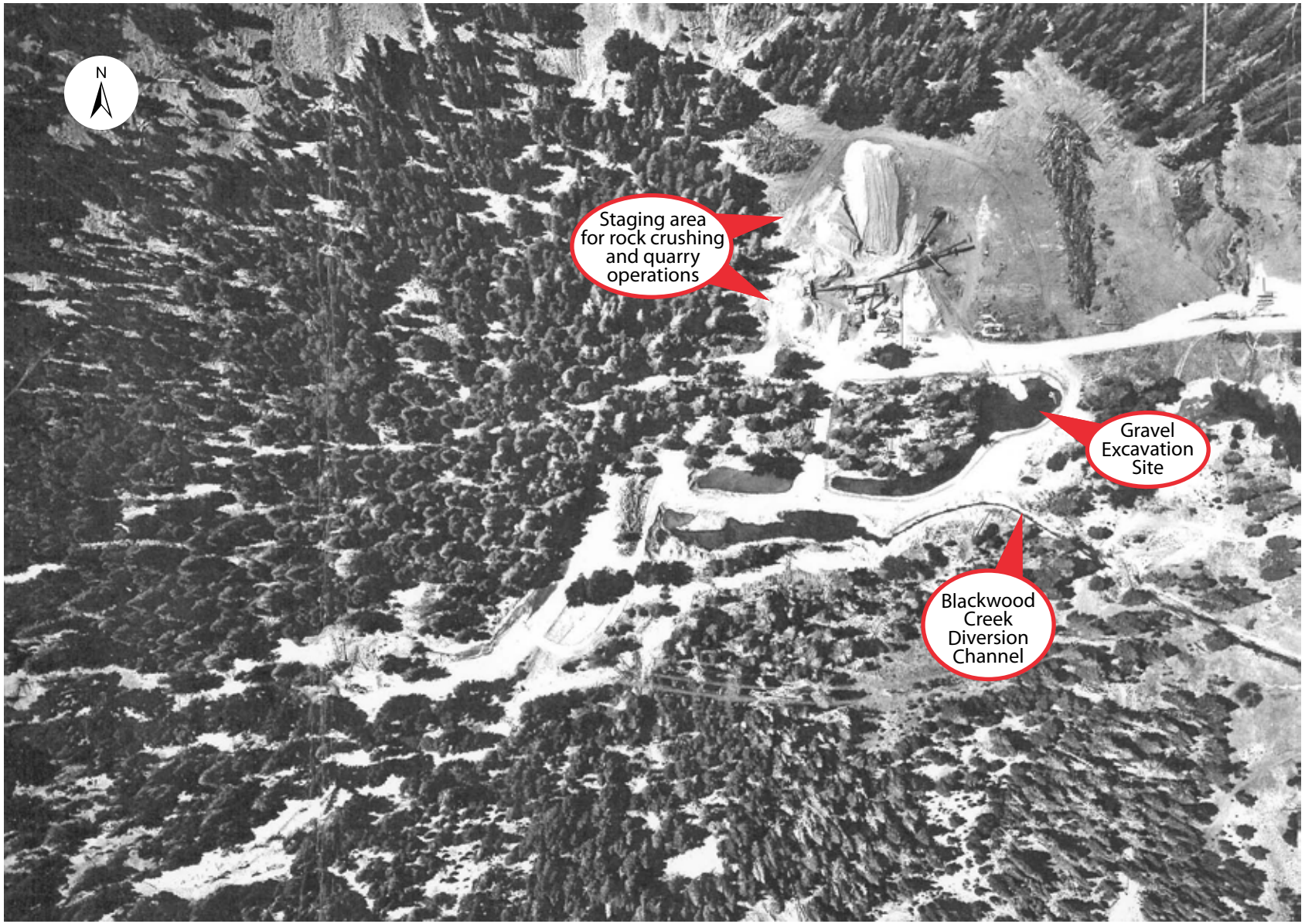
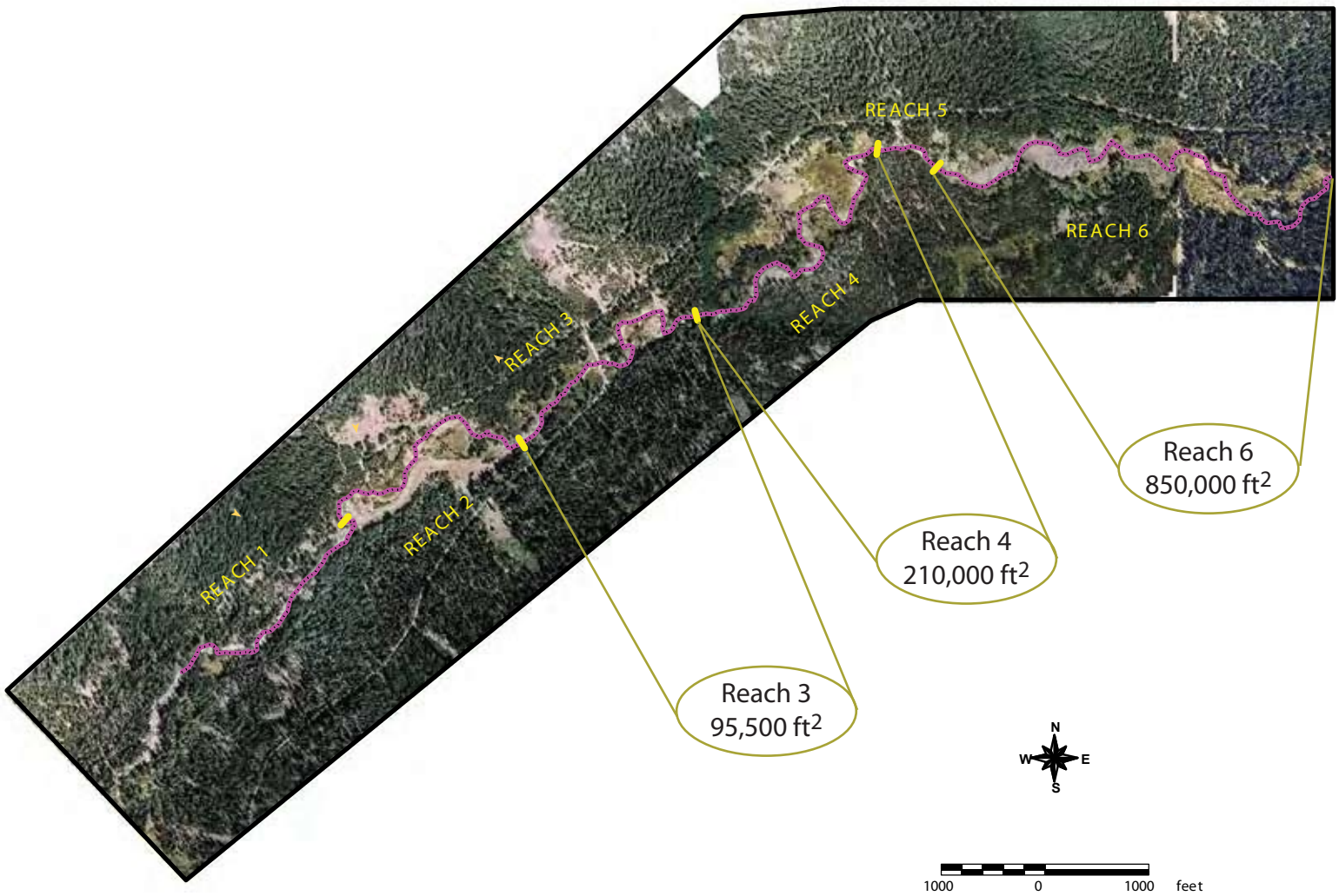


**Figure 12**
Location and Estimates of Excess Bedded Sediment
[Figure modified from Swanson (2003)]



## ATTACHMENT 3:

## WATER BOARD STAFF RESPONSES TO PUBLIC REVIEW COMMENTS

**Public Comments and Board Staff Responses**
**Blackwood Bedded Sediment TMDL Public Review Draft Staff Report**

Public comments are paraphrased below in italics. Board staff comments follow in plain text. Original comments are attached.

**1. Comments from Craig Oerhli, USFS**

[Note that Mr. Oerhli reviewed a pre-public review draft of the Staff Report. Therefore referenced page numbers may not correspond to the public review draft document.]

*1b. Page 1-1, 5th paragraph: note that restoration activities will remove or sculpt coarse floodplain deposits.*

The text states "... by removing or stabilizing large areas of excessive bedded sediment that are impairing channel form and function in Blackwood Creek." Staff believes this is accurate. No change has been made to the report.

*1c. Page 2-1 (problem statement): change the word aggraded to incised.*

Incorporated. Staff considers the inset gravel terraces to be deposits of coarse sediment and, therefore, aggradations. However, we understand the stream channel has been incised and will revise the text.

*1d. Page 2-1: Regarding logging disturbance, note the occurrence of logging on the floodplain and how that led to floodplain instability through removal of natural floodplain roughness. We feel this is an important element in the destabilization of Blackwood Creek.*

Incorporated. Staff concur that cumulative impacts are important in the degradation of Blackwood Creek. We expanded on the concept that the gravel pit and diversion channel were placed into an already fragile setting. This revision is located in section 2.4.3.

*1e. Logging history: logging occurred throughout the watershed in the 50-60s not just north fork.*

Incorporated.

*1f. Page 2-10: I wanted to point out that the 90th percentile flow (107 CFS) is less than 50% of predicted bankfull discharge. Flows at this stage are flowing over the gravel-cobble bed and generally not at a stage where they are attacking the terraces and mobilizing fine sediment. This may be a factor as to why we are not violating suspended sediment concentration standards.*

Comment noted.

*1g. Page 2-11: The data suggest that it is the larger flow events that generate most of the fine sediment erosion and subsequent transport to Lake Tahoe.*

Comment noted. Staff agrees with your interpretation; the sediment rating curves indicate the same result. However, this TMDL is for bedded sediment, which was identified as violating water quality objectives in a portion of Blackwood Creek. The TMDL requires reduction in the identified pollutant, bedded sediment, to a level that will meet the objectives and restore beneficial uses affected by the pollutant. Fine sediment transport to Lake Tahoe is a subject for the Lake Tahoe sediment and nutrient TMDL, and is not relevant for this instream bedded sediment TMDL.

*1h. Simon's work shows that Blackwood has a large fine sediment load (2$^{nd}$ highest in the Tahoe Basin) yet the suspended sediment concentration data doesn't violate water quality standards.*

Staff concludes that Blackwood is one of the highest producers of fine sediment in the Tahoe Basin because it has a relatively large drainage area (the third largest in the Tahoe Basin) with correspondingly large mean daily flows, and the watershed is dominated by volcanic geologic. Volcanic rocks tend to be easily eroded and produce fine sediment when eroded.

Based on work by Simon and others before him, Staff expected the analysis of suspended sediment concentrations (SSCs) in Blackwood Creek to indicate that the 90$^{th}$ percentile, 60 mg/L WQO was not being attained. However, the data did not confirm our hypothesis. In addition to Blackwood Creek meeting the SSC water quality objective, staff did not find clear reference to instream impairment from fine sediment.

*1i. Page 2-11, 2.4.1: I would call the coarse sediment terraces inset terraces. Also, significant erosion probably doesn't occur until flows get beyond the Q5 event (flood recurrence interval of 5 years). The bankfull channel (bed and banks) is composed of gravel and cobble carved through large gravel-cobble bars.*

Incorporated. Staff emphasized that Blackwood Creek has lost its resiliency to withstand large flows, and that significant erosion now occurs during these high flow events. These changes are in section 2.4.3.

*1j. Page 4-4, 1$^{st}$ paragraph: I would consider the gravel bars to be the pollutant generator in that their lack of mobility encourages flows to attack and erode terraces at flows beyond Q5 (Q5 flows are significantly larger than 90$^{th}$ percentile flows).*

Comment noted. For the purposes of the Blackwood Bedded Sediment TMDL, the material in the gravel bars is considered the pollutant.

*1k.: While Oehrli based thickness of bedded sediment deposits on channel bar height, actual thickness will be measured in the field in the near future. We may want to refine these estimates once we get a better idea of thickness.*

Comment noted. Staff understands that these are estimates. The load estimates calculated from the channel bar thickness give a relative sense of the in-channel improvements needed to protect water quality and beneficial uses. The TMDL will rely on targets of sinuosity, vegetation, and bank stability to track progress.

*1l. Page 5-2, 1st paragraph: I would also mention continuing water quality monitoring at USGS gage, and that it may take some time to see a response.*

Comment noted. The TMDL relies on targets (sinuosity, vegetation, and bank stability) to track progress. It does not rely on water quality monitoring as the USGS does not monitor bedded sediment loads at that station. We agree that it will take years to see desired responses in the TMDL targets.

**ORIGINAL COMMENTS**
Blackwood Bedded Sediment TMDL
Craig Oerhli, USFS Fluvial Hydrologist

My general comment is that this very good piece of work – I appreciate that the writing is so good!

1. Page 1-1- 5th paragraph – make note that remove and sculpt coarse floodplain deposits that will remain– or something like that.
2. Page 2-1 –problem statement- change the word aggraded to incised
3. Page 2-1 – logging disturbance- make note of the logging on the floodplain and how that relates to floodplain instability through removal of natural floodplain roughness elements-this we feel is big reason why blackwoods current condition is what it is.
4. Logging history ---Logging occurred throughout the watershed in the 50-60s not just north fork.
5. Page 2-10 – need to note that the 90th percentile flow (107 CFS) is less than 50% of predicted bankfull discharge. Flows at this stage are flowing over the gravel – cobble bed and generally not at a stage where they are attacking the terraces and mobilizing fine sediment. – perhaps this is a factor as to why we are not busting ssc standards.
6. Page 2-11 – need to note that it is the larger events generate most of the fine sediment erosion and subsequent transport to the lake – that's what the data is suggests to me.
7. May also want to note that Simons work shows that blackwood has a large fine sediment load (2nd highest in the basin) yet the data doesn't show that busting water quality standards – someone might question that.
8. Page 2-11- 2.4.1 – I would call out the coarse sediment terraces as inset terraces. Also not that significant erosion probably doesn't occur until flows get beyond the Q5 event – the bankfull channel (bed and banks) is composed of gravel and cobble carved through big coarse gravel cobble bars.
9. Page 4-4 1st paragraph – I would consider the gravel bars are the pollutant generator in that their lack of mobility encourages flows to attack and erode terraces at flows beyond Q5 (significantly beyond 90th percentile flows).
10. Oehrli based thickness on channel bar height – we will verify actual thinknesses shortly. We may want to refine these estimates once we get a better idea of thicknesses.
11. Page 5-2 1st paragraph – I would make mention of continuing water quality monitoring at USGS gage-it may take sometime to see a response.