EDGEWOOD CREEK
WATERSHED ASSESSMENT

TECH MEMO II

FINAL DRAFT

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EDGEWOOD CREEK WATERSHED ASSESSMENT
TECH MEMO II

EXECUTIVE SUMMARY

Edgewood Creek drains an area of about 6.6 square miles at its mouth. The watershed lies predominantly within Douglas County, Nevada, with a small upper portion within California (see Figure 1). The land within the watershed has a variety of uses including the Stateline Casino area, Edgewood Golf Course, Heavenly Ski Resort, interstate highway, local roads, utility right-of-way corridors, residential neighborhoods and state and federal land. The objective of the Edgewood Creek Watershed Assessment, funded by the State of Nevada, specifically the Nevada Tahoe Resource Team, is to fully evaluate the watershed in regards to stream morphology, fish and aquatic habitat, terrestrial wildlife and vegetation, and erosion hazards/sediment supply**. The ultimate goal of the project is to propose potential Environmental Improvement Projects (EIP's) in order to maximize restoration of Edgewood Creek and its tributaries and to enhance the watershed for all the stakeholders.**

The goal of Phase II of the Edgewood Creek Watershed Assessment is to collect and analyze field data within the watershed to fully characterize the hydrology, geomorphology, water quality, terrestrial wildlife, aquatic habitat, and sediment supply/erosion potential of the watershed.

Phase II Tech Memo includes the methods used in field data collection, a description of the data and an analysis and discussion of the results for each discipline of the study. A brief synopsis of the findings is as follows.

Preliminary GIS Files and Database

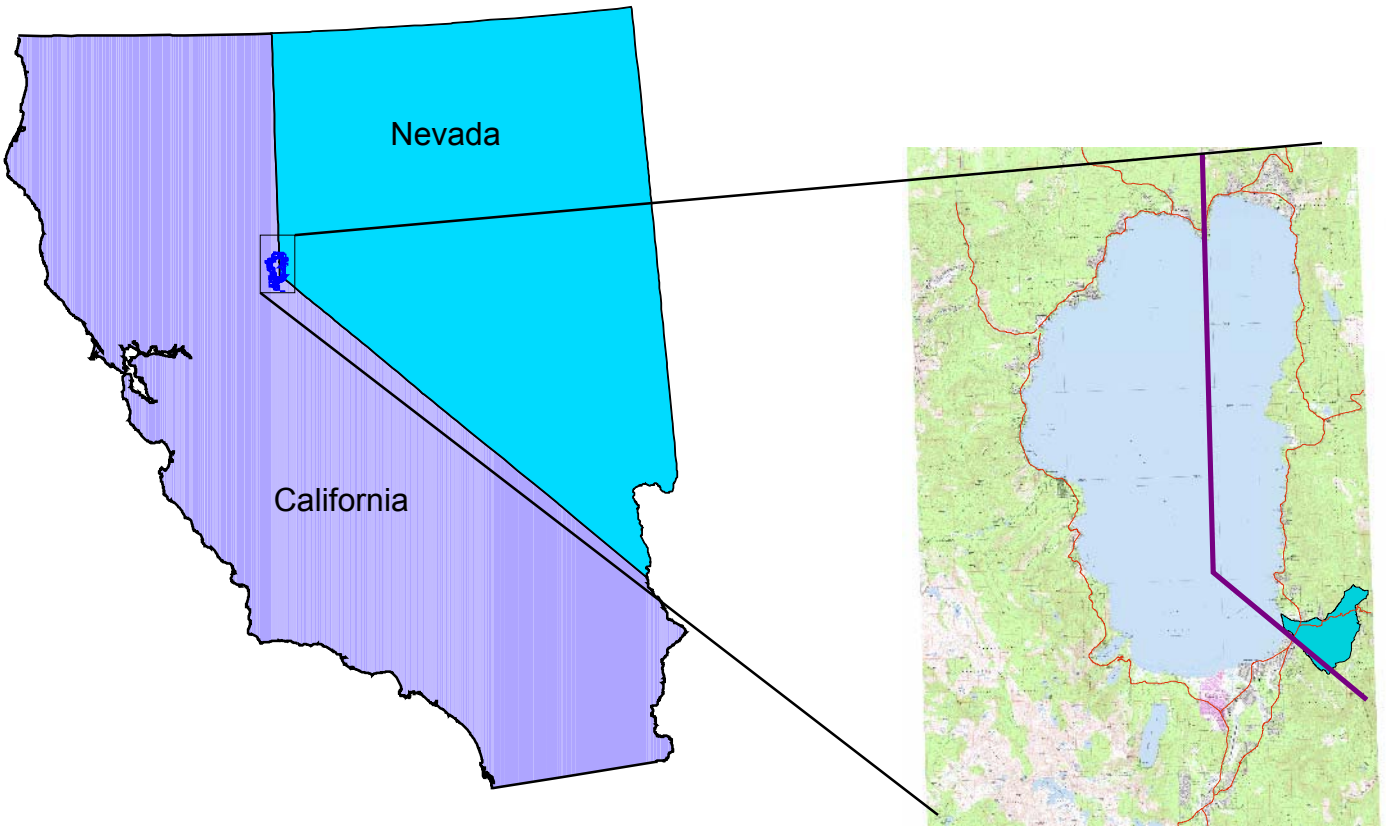
The GIS database has been augmented with all field data collected in Phase II of the assessment. Much of these data are represented in figures throughout the report.

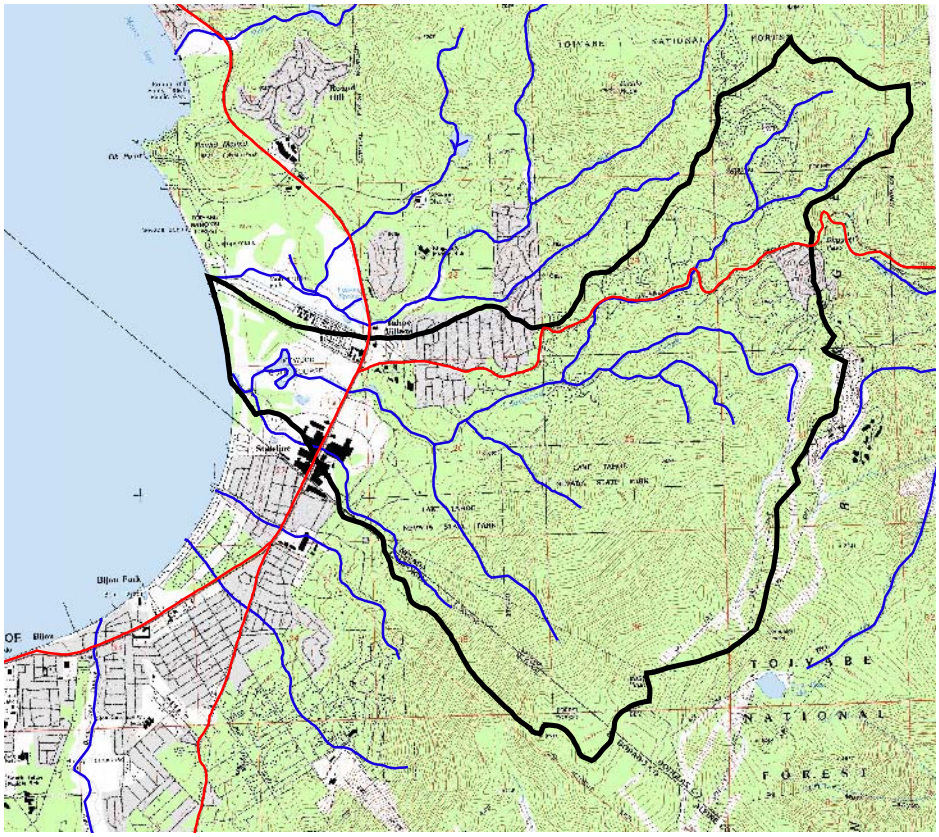
Watershed History and Preliminary Archeology

No additional data has been collected for watershed history and archeology.

Channel and Bank Stability

In the last 20 years, significant amounts of data have been collected and analyzed to characterize the sediment supply and channel morphology of Edgewood Creek and its tributaries. These data generally describe that runoff in the watershed, characterized by low magnitude peak event, along with the watershed's highly erodible soils and urbanization, have caused hillslope erosion and significant sediment delivery to the channels. The streams in the lower watershed have experienced aggradation and may experience loss of stability if additional aggradation continues. The focus of Phase II data collection is to characterize the channel at a reach scale and identify the current level of disturbance and the disturbances' impact on the physical and biological function of each reach.





Legend

- Major Roadway
- Edgewood Watershed
- Streams

NTS

Edgewood Creek Integrated Watershed Assessment Team	Edgewood Creek Site Map	Figure 1

Phase II primarily consisted of a comprehensive walk-through of all primary channels in the watershed and collection of additional field data to better understand stream corridor conditions and provide the necessary information to develop recommendations. Collected field data included longitudinal profiles, cross-sections, and pebble counts at two reference and two disturbed channel sections and bed sediment samples at selected historic USGS monitoring sites. The bed samples were used to understand the relationship between upland erosion from roads and stream channel conditions. Bed samples were also analyzed for mineralogical composition to assess the degree to which road abrasive may be impacting stream channels.

Overall, stream channels in the watershed are in relatively good condition in terms of channel and bank stability. Excessive erosion in the watershed is primarily derived from upland sources such as roads and gullies. Localized headcutting and areas of episodic downcutting and aggradation were observed in the watershed. The biggest impacts to channel stability or function are in areas where direct modifications have been made to the channel. Channel functionality has been minimized in areas that have experienced complete channel realignment, including Edgewood Golf Course and the Heavenly Valley Ski area parking lot. Channel instability has occurred at channelized sections such as the reach of the North Fork that runs along Kingsbury Grade and a portion of the mainstem along Crestview Drive. The most intact reference reach is located at the upstream end of the Park Cattle Company (PCC) Property. This site consists of a mountain meadow with a well-developed riparian corridor and intact channel morphology.

Sediment samples collected throughout the watershed suggest little bed composition changes since USGS surveys in the mid-1980's, except at one location downstream of the mainstem and North Fork confluence where the percentage of fine sediment increased. Bed material throughout Edgewood Creek is dominated by sand-sized particles. This is likely the natural condition since the watershed primarily consists of decomposed granite. It appears that in certain reaches road abrasives of volcanic origin make up a significant percentage of the bed material. This may have water quality implications in Lake Tahoe since some of this fine-grained material may be carried as suspended sediment to the lake.

Water Quality

Direct field observations and historical data concerning water quality were analyzed in the context of the potential impacts to aquatic habitat conditions. Water quality appears to be impacted by changes to morphology; alteration of riparian vegetation; in-stream ponds and sediment basins; the frequency and extent of maintenance activities; discharge of high Iron water of unknown origin; and the discharge of potentially untreated storm water from roadways.

Fisheries and Aquatic Habitat

Most of the mainstem of Edgewood Creek and the lower portion of the main tributaries were surveyed to assess the condition of fish and aquatic habitat. In addition, more detailed data were collected at two reaches, one undisturbed and one highly modified, to further assess habitat condition. The major findings were:

Although much of the watershed was disturbed by historic roading and logging, most of the channel has stabilized.

- A natural barrier about one mile upstream from Lake Tahoe blocks fish passage.
- Several man-made barriers to fish passage occur in the lower mile of the stream.
- The channel in the lower portion of the watershed has been extensively modified by human activities.
- Channel improvements could expand riparian vegetation and provide additional habitat for fish and wildlife.

Riparian/Upland Vegetation and Habitat

The majority of riparian vegetation, with the exception of heavily developed areas, is dense, thriving, and intact with reproduction occurring in numerous woody and herbaceous species. There is enormous potential for natural recruitment of native plants if disturbance occurs, as with restoration projects. Introduced cultivars, such as erosion control species, are mostly confined and do not appear to be invasive or problematic at the current time. Noxious weeds were also only found in disturbed, isolated areas to date. Some old growth conifers, including Jeffrey and sugar pines, as well as cottonwoods, occur in the watershed. Conifers occur adjacent to various sections of channel in the upper watershed where they have occurred historically. In the lower watershed, conifers also occur adjacent to channels but are not out-competing riparian vegetation at the current time.

Tahoe yellow cress, an Endangered species, occurs at the outlet of Edgewood Creek. No other sensitive species were located, and habitat is limited.

Terrestrial Wildlife

The existing wildlife surveys and delineations within the watershed have determined that there is habitat for and/or occurrences of willow flycatcher, marten, mule deer, waterfowl, northern Goshawk, and pacific tree frog. Phase II included field surveys to verify habitat delineations and to assess the presence/absence of additional vertebrate terrestrial species. It also included further analyses of existing data and identification of trends, forest characterization and management activities.

Land Use/Upland Watershed

An analysis of the conditions of the roadways and water quality infrastructure within the watershed was completed with the collection of field data and GIS analysis. All roadway shoulders, cut-slopes and roadside channels were field surveyed. The road-induced sediment production was then mapped on a sub-watershed basis and was compared to the locations of sediment traps and basins to identify potential areas where erosion control projects would be most effective.

Modifications to water quality infrastructure, especially to some of the subdivision sediment basins is recommended. Continued and aggressive maintenance of water quality infrastructure on State Route 207 and Highway 50 West is also recommended. Continuing stabilization and revegetation, where possible, is desirable. Road abrasive application practices should be reviewed. Placement of appropriate BMPs on dirt roads and roadside ditches is necessary.

1.0 GIS FILES AND DATABASE

Significant data was added to the GIS database for Phase II. These include the drainage direction of all public roadways; the location and length of roadway cut-slopes, shoulders and roadside channels; and the location of all sediment traps and basins. In addition, all existing culverts and potential source areas of sediment and erosion were mapped within the GIS database.

2.0 CHANNEL AND BANK STABILITY REPORT

2.1 Introduction

The primary objective of the Stream Corridor Assessment portion of Phase II of the Edgewood Creek Watershed Assessment is to gain more insight into the health of the stream corridor and assess the hydrologic and geomorphic function of the channel in terms of its ability to support functional wetland and aquatic ecosystems. Our primary approach to assessing the question of whether Edgewood Creek is a proper functioning stream system was to conduct a thorough walk-through of the primary stream channels and, based on the results, collect focused field data to characterize the problems and provide a basis for future restoration work.

Our fieldwork in Phase II consisted of the following elements:

- Detailed stream corridor walk-through survey,
- Detailed channel condition surveys at two sites: impacted and reference,
- Grain-size and mineralogical analysis from road features and streams, and
- Analysis of impacts of road-based sediment input on stream channel conditions.

In our proposed fieldwork plan, described in Technical Memorandum No. 1, we outlined an approach to reoccupy and resurvey reach segments and cross-sections established by the U.S. Geological Survey in the mid-1980s. To reoccupy the previously established sites, precise locations of cross-section and reach endpoints are necessary, along with the raw survey data. To obtain the data, we contacted personnel at the USGS who were directly involved in the original survey. Unfortunately, the information required to reconstruct these surveys was not easily available. Reoccupation of the original survey monuments would likely require direct participation of USGS staff, which is beyond the scope and time limits set by this project.

Given these constraints, we focused on information readily available from the original USGS report that would be valuable to repeat. As it turns out, our initial stream corridor walk-through suggested that the information gained by repeating the USGS surveys, such as the extent of channel downcutting, aggradation, and bank erosion, would not provide the level of information that would be required to assess channel function and potential impacts.

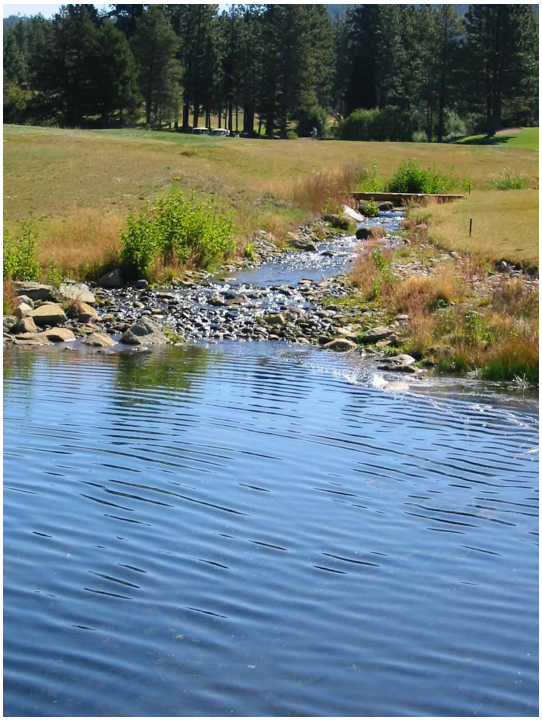
2.2 Detailed Stream Corridor Walk-through Survey

All reaches defined in Figure 2.1, as well as the lower portions of the major tributaries, were walked by a fluvial geomorphologist and a fisheries biologist. The walk-through survey was necessary to identify important channel features, assess the source and impact of erosion, determine precise locations where more detailed survey work would be conducted, and identify potential water quality impacts. Important channel features were mapped on a 1:24,000 USGS quadrangle map with additional use of an aerial photo basemap. The features identified during the survey are shown in Figure 2.2.

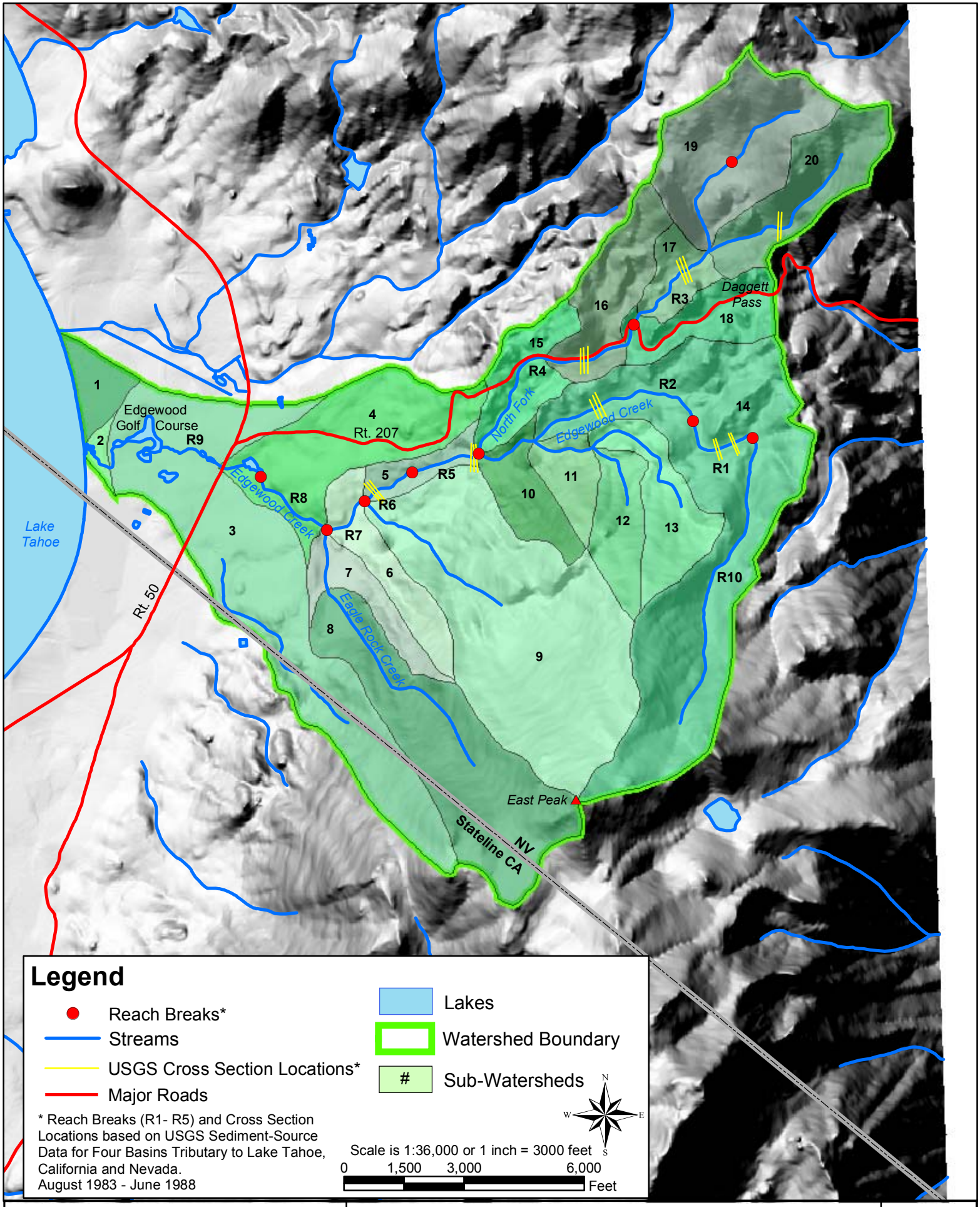
The following is a discussion of the results of the walk-through survey, by reach number, identified in Figure 2.1. Reach numbers are not ordered from downstream to upstream and are not necessarily sequential since they were initially based on USGS reach numbers.

Reach 9 – Mouth of Edgewood Creek to Friday Station Pond
The lower portion of Edgewood Creek, downstream of Highway 50, flows through Edgewood Golf Course. This reach has been completely modified from its original condition through channel realignment, integration of a series of ponds, and construction of a diversion system.

A series of ponds have been constructed through the golf course, the largest of which provides a storage reservoir for irrigation. Construction of the pond system has significantly shortened the length of stream habitat through the golf course. Channel stability along the golf course stream has been improved in the last ten years, though the reconstructed channel segments are not necessarily corollaries of the stream system that originally existed. Prior to these improvements, the channel was essentially an irrigation ditch through the golf course. Historically, this segment of creek was part of an extensive meadow with a meandering channel. By reconstructing the channel in-line with the pond system and reducing the natural meander pattern of the channel it was necessary to construct high gradient channel segments to account for the required drop in elevation from Highway 50 to the mouth.



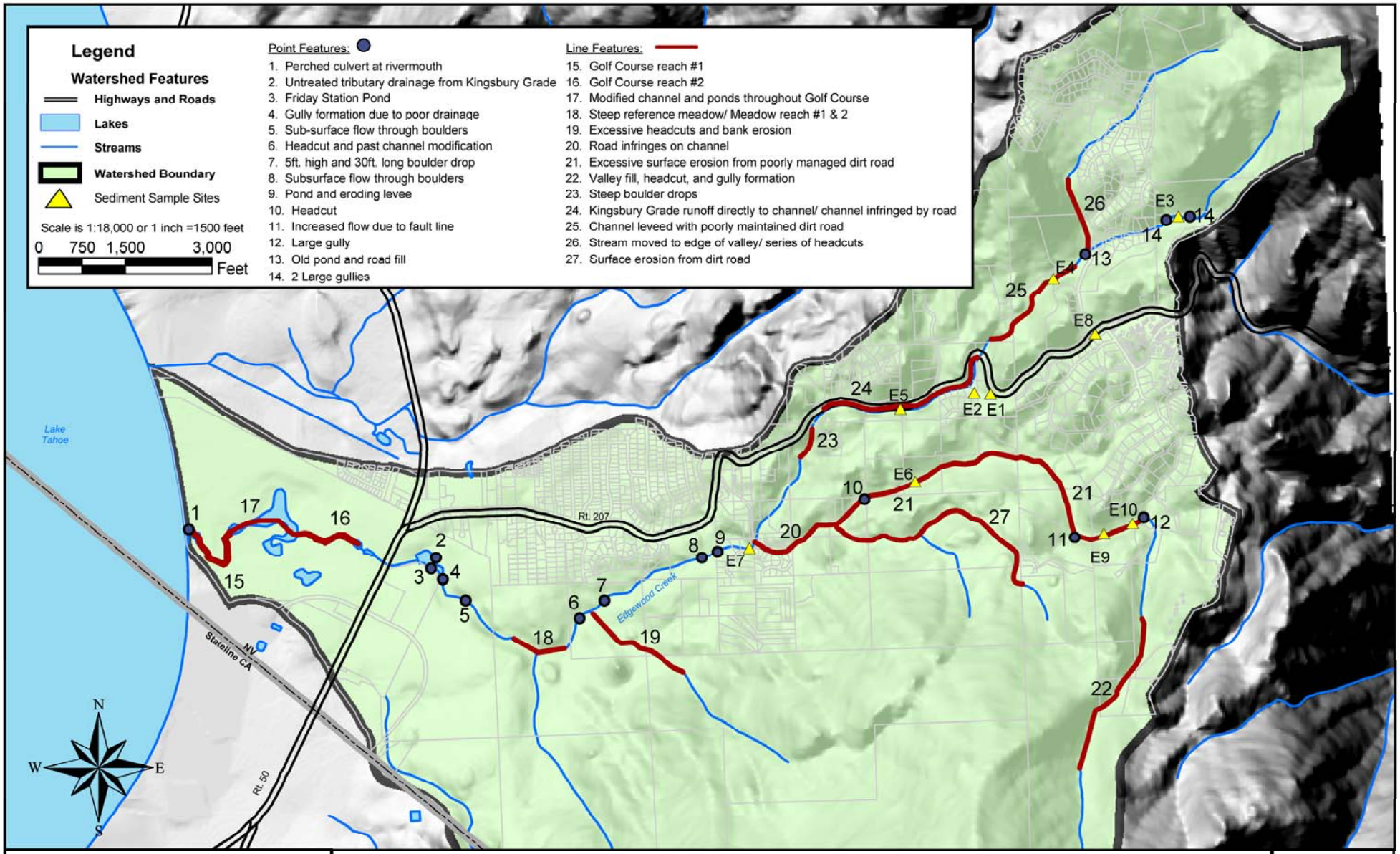
Reconstructed stream channel entering a pond on Edgewood Golf Course.



Edgewood Creek Integrated Watershed Assessment Team

Edgewood Creek Watershed
Sub-Watersheds and Reach Breaks

Figure 2.1



Edgewood Creek Integrated Watershed Assessment Team

Edgewood Creek Watershed
Stream Corridor Walk-Through Survey - Identified Watershed Features

Figure 2.2

Approximately 500 feet upstream of the Highway 50 crossing an earthen dam impounds approximately 500 lineal feet of Edgewood Creek and a small tributary entering from the vicinity of lower Kingsbury. The earthen dam has a valve release at the bottom. Recent beaver activity in the pond, known as Friday Station Pond, has blocked the outlet works, prompting Park Cattle Company (PCC) staff to close the release valve and allow water to go over the spillway. Although there are large rocks in the spillway channel, it is a potential erosion area in the event of high winter or spring flows.

Given the size of Friday Station Pond and its location in the lower watershed of Edgewood Creek and at the confluence of the mainstem and a tributary draining Lower Kingsbury, it is likely that all of the bedload and a portion of the suspended load are trapped within the impoundment. Consequently, Friday Station Pond acts as a large sediment basin that reduces the overall sediment load that is delivered to Lake Tahoe. The degree to which the Pond is a sediment trap for finer-grained material that may be impacting water clarity in Lake Tahoe would need to be studied further. Such a program should focus on suspended material entering and leaving the Pond. The trap efficiency of the Pond may differ depending on whether water is released through the release valves or the spillway.

Just upstream of the pond, irrigation drainage from the meadow to the south has formed several large gullies in the south slope above Edgewood Creek. An old flume diversion is found on the south bank of the creek in this area. The gullies cut across the flume, which probably supplied water to the station. Past attempts have been made to arrest the erosion through drainage modification with little success. The gullies continue to be a problematic sediment source.

Gullies forming due to concentrated surface flow just upstream of Friday Station Pond.

Reach 8 – Friday Station Pond to Eagle Rock Creek
Approximately 500 feet upstream of Friday Station Pond, Edgewood Creek passes through a jumble of large boulders that appear to be part of a morainal deposit. The stream goes subsurface for several hundred feet and is likely to do this even during high flow events. There are no alluvial deposits on the surface of the boulders.

A relatively undisturbed meadow is found on PCC property upstream of the boulder cascades. The meadow is a good example of the interaction between channel morphology, riparian vegetation, and woody debris accumulations. The stream has extensive riparian vegetation and a low width to depth ratio. There is evidence of a lot of historic beaver activity in the meadow. A significant tributary enters from the south and was investigated a short distance upstream. Both the mainstem and the tributary appear relatively stable with no significant erosion problems noted. The upstream end of the tributary was affected by the Gondola Fire (Summer, 2002) and should be monitored in the future in terms of any potential impact to the meadow. Monitoring should occur following significant runoff events to determine the potential impacts of increased sediment input on channel conditions.

Reach 7 - Eagle Rock Creek to unnamed southern tributary
Along a chain link fence at the upstream end of PCC property the stream has been channelized and straightened. Some minor bank erosion and a two-foot high headcut were observed at this location, although heavy riparian growth has stabilized the bank and channel. The entire area upstream of the fenceline appears to have been disturbed. A report by Ted Frantz (1982), former fisheries biologist with NDOW, suggests that some stream rehabilitation work took place in the 1970's. We identified ground evidence to suggest the channel may have been diverted in the past.

A tributary enters from the south through this reach. We walked approximately 1000 feet of the tributary channel and identified portions that were highly entrenched with unstable banks and a series of headcuts. TRPA staff identified this tributary as an area that should receive future restoration. It is unclear at this point what has caused the instability though it is likely a legacy affect from extensive logging that occurred in the 50's and 60's. In some areas, despite a wide SEZ, the channel is cutting directly into the hillslope and is likely to be an area of high sediment production under high flow conditions.

Reach 6 – Southern tributary to Palisades Rock Formation
This segment of stream is in relatively good condition. The most significant impact noted through this reach relates to existing crossings that are most likely related to historic logging crossing. A steep boulder drop occurs just upstream of the southern tributary. At the upstream end of this reach, the channel goes subsurface under large boulders. This feature occurs in conjunction with the Palisades Rock formations. No significant bank erosion or channel instability was noted through this reach.

Reach 5 – Palisades Rock Formation to Palisades/Crestview Drive road crossing
Most of the channel through this reach is in fairly good condition, though impacts of past logging and road development are apparent. Past logging impacts have resulted in even aged and closely

spaced stands of trees and a lack of tree diversity. A couple of headcuts were seen through the reach but riparian vegetation is extensive, stabilizing the channel and banks. Mature alder and aspen can be seen growing at the water surface in some locations suggesting that the reach is experiencing periods of episodic channel downcutting followed by aggradation.

Approximately ¼ mile downstream of Palisades/Crestview Drive there is a large pond on the north side of the creek. We were unable to locate the source of water for the pond. It is extensively bermed along the south side to separate the pond from Edgewood Creek. The berm is constructed of sandy material and is actively eroding. Immediately downstream of Palisades/Crestview Drive there is a USGS gauging station. Frantz (1982) noted that this portion of the channel had been highly disturbed by development activity. Some of this disturbance was still visible during our visit. Although the stream has obviously been channelized, subsequent colonization by riparian vegetation has stabilized it. Some minor bank erosion is apparent.

Pond adjacent to Edgewood Creek located approximately ¼ mile downstream of Palisades/Crestview Road. A levee separates the pond from the stream channel. The levee toe is actively eroding, contributing sediment directly to the channel.

Reach 1 and 2 – North Fork confluence to Boulder Lodge Parking Lot

Edgewood Drive, a paved two-lane residential street, runs directly parallel to the channel upstream of the crossing for several hundred feet. There are currently no stormwater treatment BMPs on the road, and both road runoff and sand from adjacent cut slopes and road shoulders directly enter the channel. Although the stream has been moved to the edge of the valley to make room for the road, subsequent colonization of riparian vegetation has allowed for a stable channel to form. Some minor eroding banks and a few small headcuts are apparent through this section.

Near the confluence with a small tributary, Edgewood Drive changes into a dirt road on Forest Service land (this dirt road appears to be an access route for Douglas County utilities) that runs parallel to Edgewood Creek all the way up to the Boulder Lodge Parking Lot. The road

impinges directly on the channel in some locations and is a source of direct sediment input into Edgewood Creek. The Forest Service road is in need of maintenance and installation of road BMPs to reduce visible gullying and flow concentration. There does not appear to be any drainage control associated with the road. Spur roads and shortcutting have caused extensive erosion, especially in the upper portions of the road near the Boulder Parking Lot.

Reach 10 - Boulder Parking Lot to Edgewood Creek headwaters

The area around the Boulder Parking Lot and upstream to the ski run are highly disturbed. The parking lot has filled a significant portion of channel. Extensive iron precipitation was noticed in this area, the source of which is unclear at this time. Higher iron concentrations in the vicinity may be a result of the fill material. The iron issue is discussed more extensively in the Water Quality section of this report. This issue will require future investigation.

Access road along Reach 2 of Edgewood Creek. The road impinges on the creek and captures drainage, resulting in gully formation and direct delivery of sediment to the stream channel. Probably a sewer utility road on USFS and others property.

Upstream of the Boulder Parking Lot, Edgewood Creek has been highly modified. It appears that the valley has been completely modified through a cut and fill process that has flattened out the ski run area. The stream channel and banks have been unable to recover from these impacts due to a policy of riparian vegetation removal that appears to occur annually as part of a special use permit with the Forest Service. Without mature riparian vegetation to support banks, the channel has become braided with a series of headcuts propagating upstream. The result is an unstable channel with extensive downcutting and bank erosion. This area is a significant source of sediment to Edgewood Creek. Two riparian zone wells directly adjacent to the creek are also present. The discharge pipes from these wells are in the SEZ and are probably affecting water quality and recruitment of riparian vegetation.

Edgewood Creek has been highly modified through Reach 10. Cut and fill of the valley and annual removal of riparian vegetation has resulted in the formation of localized gullies. During spring snowmelt, it is likely that high sediment loads are delivered downstream

Reach 4 – North Fork from Palisades/Crestview crossing to Kingsbury Grade
In the lower portions of this reach, downstream of where the creek meets Kingsbury Grade, the channel was probably disturbed by logging and road development. Subsequent riparian colonization has stabilized the channel, though some minor headcutting and bank instability remain. Like other areas, this reach also shows evidence of extensive incision followed by aggradation.

Before reaching Kingsbury Grade, the stream channel steepens considerably with the bed consisting primarily of cobble and boulder material. The gradient through this section was likely modified so the creek would match the elevation and gradient of Kingsbury Grade. Flow upstream of this point becomes intermittent. The North Fork then flows parallel to Kingsbury Grade for approximately 3,000 feet. The channel through this section is not well defined and most likely is aggrading due to impacts from Kingsbury Grade, such as channelization. The creek essentially functions like a roadside ditch with sand and road runoff entering the channel directly.

Reach 3 – North Fork from Kingsbury crossing to the headwaters
This reach is intermittent from the Kingsbury crossing upstream to a small tributary that enters from the east. A Forest Service road runs parallel to the stream through this section. The road is poorly maintained and can contribute sand directly to the stream channel. It appears an old levee was constructed at one point to separate the road from the stream channel. It is likely the stream was moved to one side of the valley to accommodate the road.

The Forest Service Road crosses the North Fork on earthen fill near the confluence with a small tributary that enters from the east. The earthen fill may have historically been part of a dam and pond facility related to the logging industry. Upstream of the filled road crossing the stream is channelized in a narrow channel on the northwest side of the valley. The banks are actively eroding in this area. TRPA staff previously identified this area as a potential EIP (Larry Benoit, personal communication). Upstream of the pond area the gradient of the valley increases. The channel is highly entrenched and eroding, suggesting that the area is in the process of adjusting to a disturbance.

Upstream of the high gradient area, in the vicinity of Brautovich Park, the valley widens and the stream flattens out. The channel through this area is poorly defined and is experiencing deposition and aggradation through an extensive willow thicket. Upstream of this area, the channel steepens. The location of the channel was not obvious and likely is piped and culverted through various neighborhoods.

The North Fork tributary, entering from the east, is a small, ephemeral drainage. The tributary runs along residential streets and through sediment traps and ponds before reaching the North Fork. Upstream of the residential area, a newly constructed sediment basin collects drainage from two heavily eroding gullies. These gullies were monumented and surveyed as part of the USGS study. Previous attempts to stabilize these gullies through the use of gabion check dams have only been temporary solutions. The gullies appear to be actively eroding, though how often they carry flowing water is unknown. Recreational use in this area may be exacerbating the problem. Future repairs of these gullies should consider the hydrologic regime, upstream and downstream impacts and the possibility of an installed grade control structure or energy dissipater being outflanked as a result of bank erosion or woody debris input.

Two gullies on a tributary to the North Fork. A sediment basin has recently been constructed to reduce sediment delivery downstream. Though this is a step in the right direction, this approach will not reduce erosion occurring at the head of each gully and will require long-term maintenance of the sediment basin

2.3 Channel Morphology Surveys

2.3.1 Overview

Edgewood Creek can be generally characterized as a stream with a stair-stepped morphology along the longitudinal profile. This morphological condition is produced by valley constrictions or hard points, such as moraine deposits, that control the overall grade of the stream (Grant and Swanson, 1995; Dvorsky, 2000). Upstream of these controls, sediment storage occurs resulting in lower gradient, meandering reaches similar to the meadow located at the upstream end of the PCC Property. It is in these reaches where wide riparian canopies develop, providing important habitat for terrestrial and aquatic organisms. These areas are also ideal locations for human development since they are wide and flat.

One of the most impacted meadow reaches on Edgewood Creek occurs through the Edgewood Creek Golf Course. This reach has been completely modified by pond development and channel realignment. In order to understand the degree to which this meadow reach is impacted and assess the future restoration potential, we conducted geomorphic surveys at two locations through the Golf Course and two locations in the upper meadow (PCC Meadow). The upper meadow is meant to represent a reference, or undisturbed, condition. Though some historic impact probably occurred, the upper meadow appears to be resilient and provides good riparian and aquatic habitat opportunities.

2.3.2 Methods

Two representative stream segments, or reaches, were selected in Edgewood Golf Course and the PCC Meadow. At each reach a level and rod were used to survey longitudinal profiles and cross-sections. Each reach used an arbitrary benchmark of 100 feet. The longitudinal profile was measured in order to determine average bed slope and to depict overall bed variability related to pool and riffle morphology. Cross-sections were surveyed to understand morphological characteristics of the channel such as width to depth ratio. Along each reach, a pebble count, consisting of approximately 100 measurements, was conducted to characterize bed substrate conditions (Wolman, 1954). Edge of riparian vegetation was also noted in the survey if it fell within the cross-section survey area, otherwise it was estimated.

The width to depth ratio is typically calculated by measuring the width of the channel at an estimated bankfull elevation divided by the average bankfull depth. Since the reaches surveyed through Edgewood Golf Course are constructed channels, indicators often used to estimate bankfull during low flow conditions would not be present since the channel has yet to, and may not ever, adjust to the prevailing hydrologic conditions found in the watershed. To maintain consistency between survey methods in the Golf Course reaches with those in the Meadow reaches, the width to depth ratio was calculated based on water surface elevations occurring at the time of the survey.

2.3.3 Results and Discussion

The results of the longitudinal profile survey, cross-sections and pebble counts are presented in Table 2.1 and Figures 2.3 to 2.7. Meadow Reaches 1 and 2 have the classic characteristics of a

mountain meadow stream. These characteristics include a moderate gradient, slight entrenchment, very low width to depth ratios, and high channel sinuosity (Rosgen, 1996). These channels are also considered to be extremely stable, when morphologic characteristics are maintained. They are also highly sensitive to disturbance, resulting in rapid channel adjustment within a relatively short period of time.

Table 2.1: Summary of geomorphic survey results for Edgewood Golf Course and Park Cattle Meadow reaches.

Site	Mean Riparian Width	Mean Width to Depth Ratio	Average Bed Slope	Rosgen Channel Type	Notes
Golf Course #1	62.3	7.97	0.24%	E5	Very low gradient
Golf Course #2	17.8	15.38	2.65%	B3	
Meadow Reach #1	75+	8.93	2.14%	E5	Beaver dam affects gradient
Meadow Reach #2	75+	5.12	1.19%	E5	Best reference segment

The constructed Golf Course channels do not necessarily replicate the historic conditions and therefore do not provide the appropriate function that creates habitat for terrestrial and aquatic organisms. Golf Course 2 mimics a Rosgen B channel, which is more characteristic of a narrow, moderately steep valley than a meadow stream. Golf Course 1 is a more appropriate morphology to replicate in a meadow setting though the gradient appears to be too low, potentially resulting in backwatering of important riffle habitat.

The results observed in the longitudinal profiles and cross-sections are mirrored in the pebble count results. Substrate grain-size distributions in Edgewood Creek are dominated by sand-sized particles. At Golf Course 2, cobble dominates the bed. Though this may benefit aquatic insect production, a lack of gravel sized bed material may inhibit fish spawning potential.

2.4 Grain Size and Mineralogical Analysis and Comparison to Road Conditions

2.4.1 Overview

The USGS conducted grain-size sampling in the mid-1980s at cross-section monitoring sites (Hill et. al., 1990). The sampling consisted of pebble counts (1983 and 1984) and sieved bed material samples (1987). Our approach was to repeat grain-size sampling at selected sites in the Edgewood Creek Watershed with the purpose of determining the degree to which bed conditions have changed over the last 15 to 20 years. Additionally, this data is used to assess bed substrate conditions in relation to sediment input from roads and other disturbed land surfaces and determine the origin of the material (e.g. – native material, imported road abrasives). Material origin is important when trying to understand sediment contributions to Lake Tahoe. Imported road abrasives may have a significant, long-term impact on water clarity in Lake Tahoe if the road abrasives contain dispersive clays and stay suspended in the water column, bypassing sediment control structures and ponds.

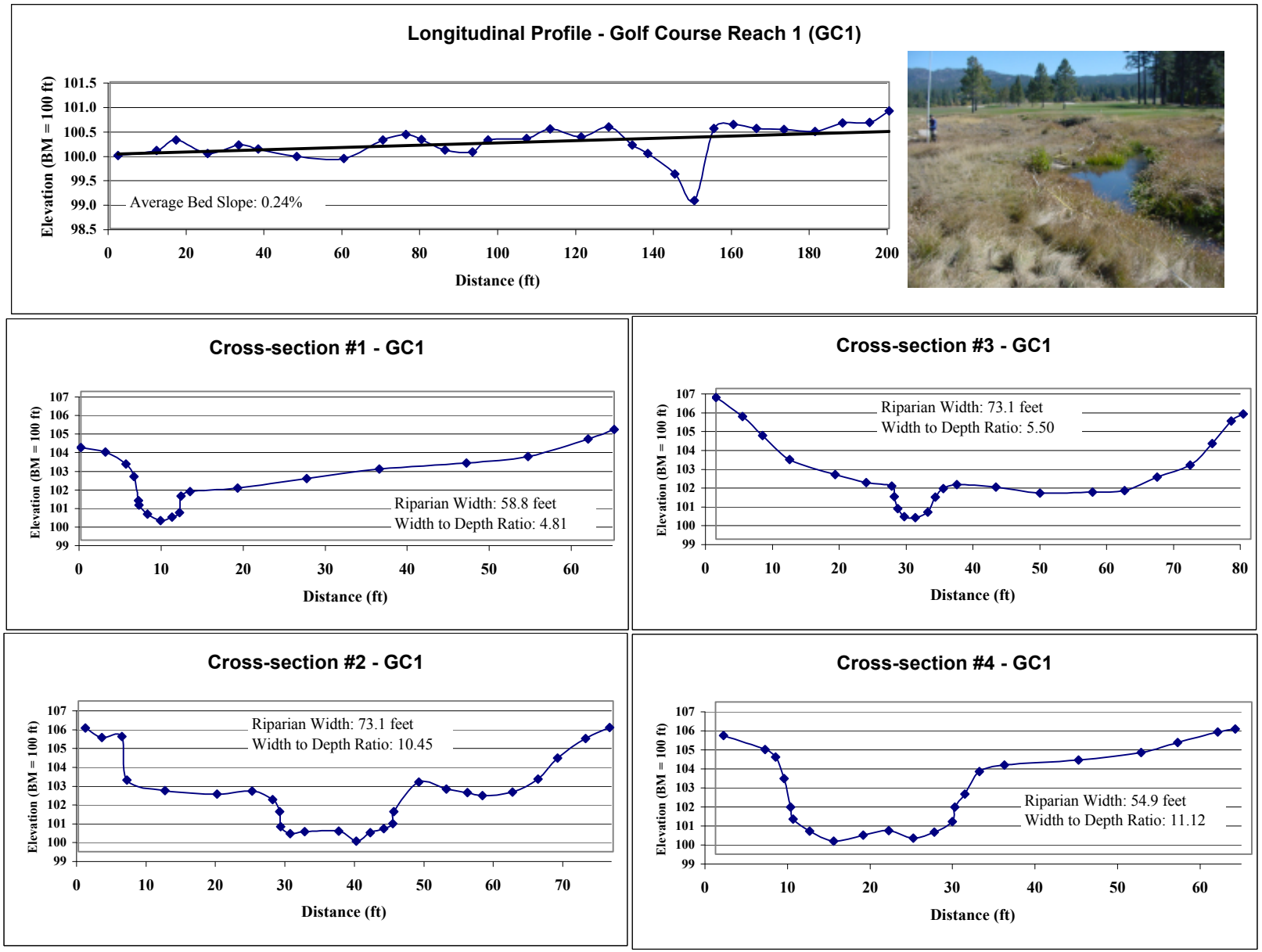


Figure 2.3: Long profile and cross-section geometry for a disturbed meadow reach (Golf Course Reach #1) at Edgewood Golf Course. This site consists of a highly modified channel. Riparian width was calculated as the edge of the maintained fairway turf grass. The width to depth ratio was calculated as wetted width to wetted depth since bankfull indicators were not apparent since modifications to this channel were recent.

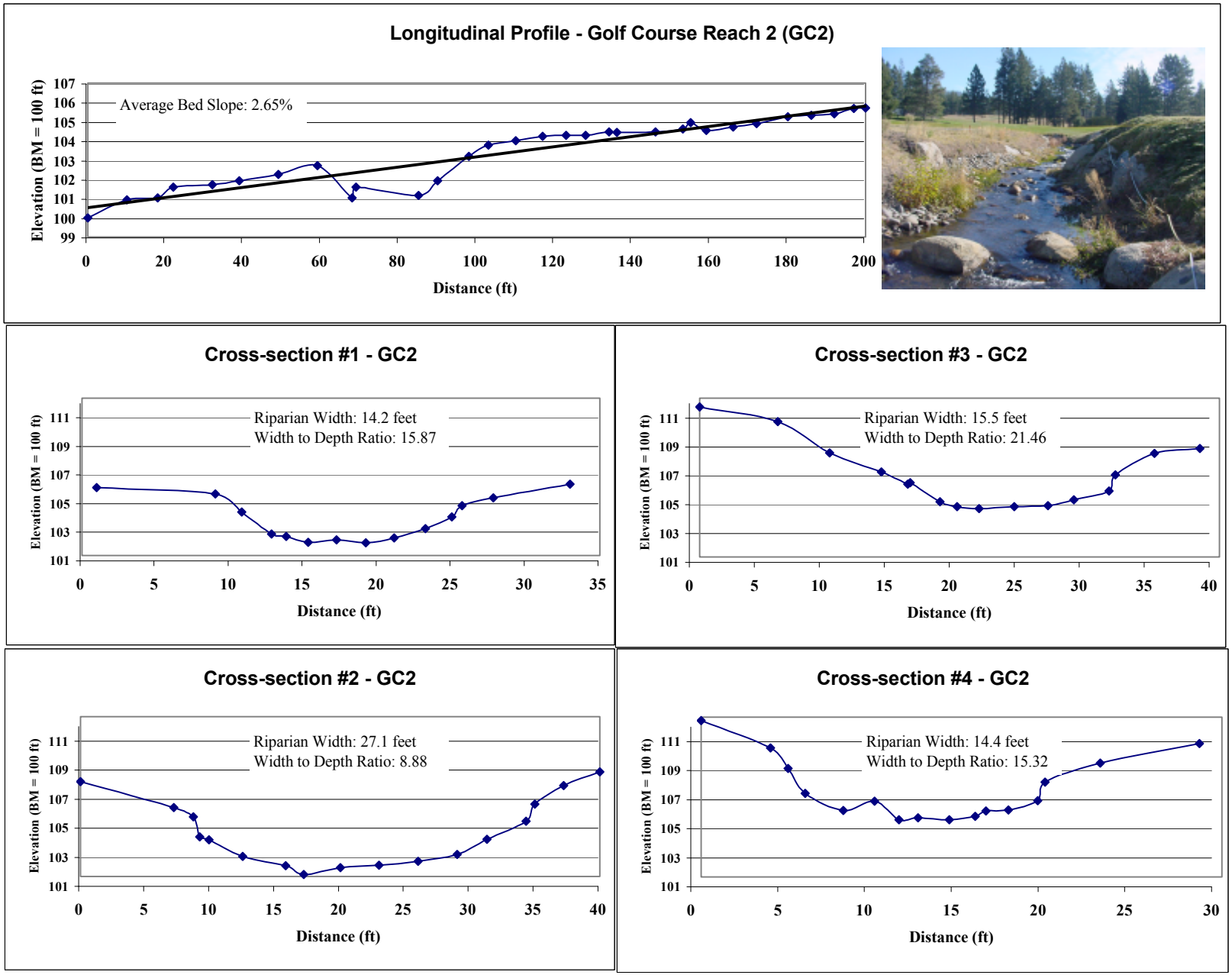


Figure 2.4: Long profile and cross-section geometry for a disturbed meadow reach (Golf Course Reach #2) at Edgewood Golf Course. This site consists of a highly modified channel. Riparian width was calculated as the edge of the maintained fairway turf grass. The width to depth ratio was calculated as wetted width to wetted depth since bankfull indicators were not apparent since modifications to this channel were recent.

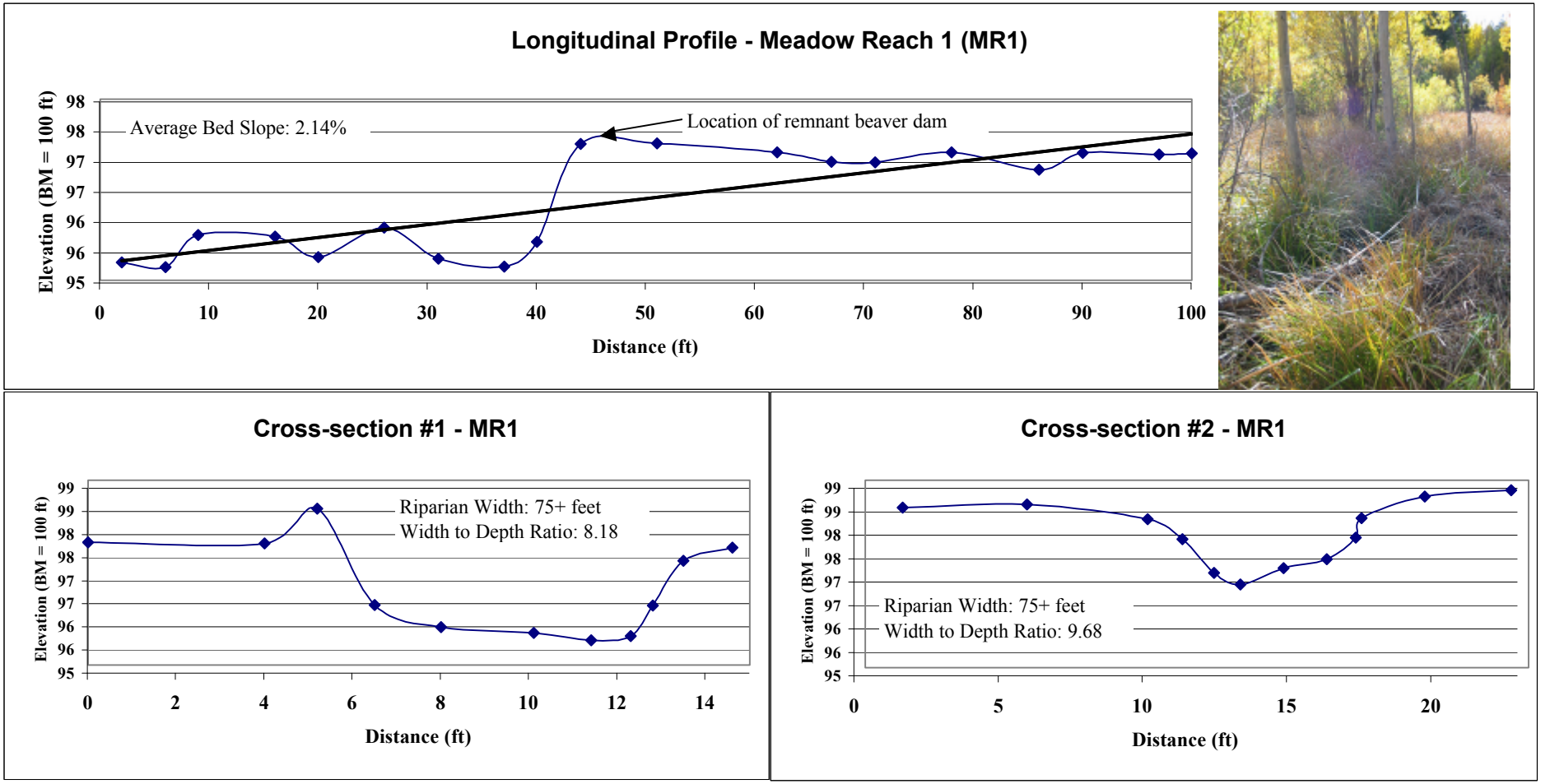


Figure 2.5: Long profile and cross-section geometry for a reference meadow reach (Meadow Reach #1) located at the upstream end of Park Cattle Company property. This site consists of a steep meadow in good condition. Riparian width was estimated based on vegetation type (i.e. - edge of coniferous forest). The width to depth ratio was calculated as wetted width to wetted depth to maintain consistency with the Edgewood Gold Course reaches.

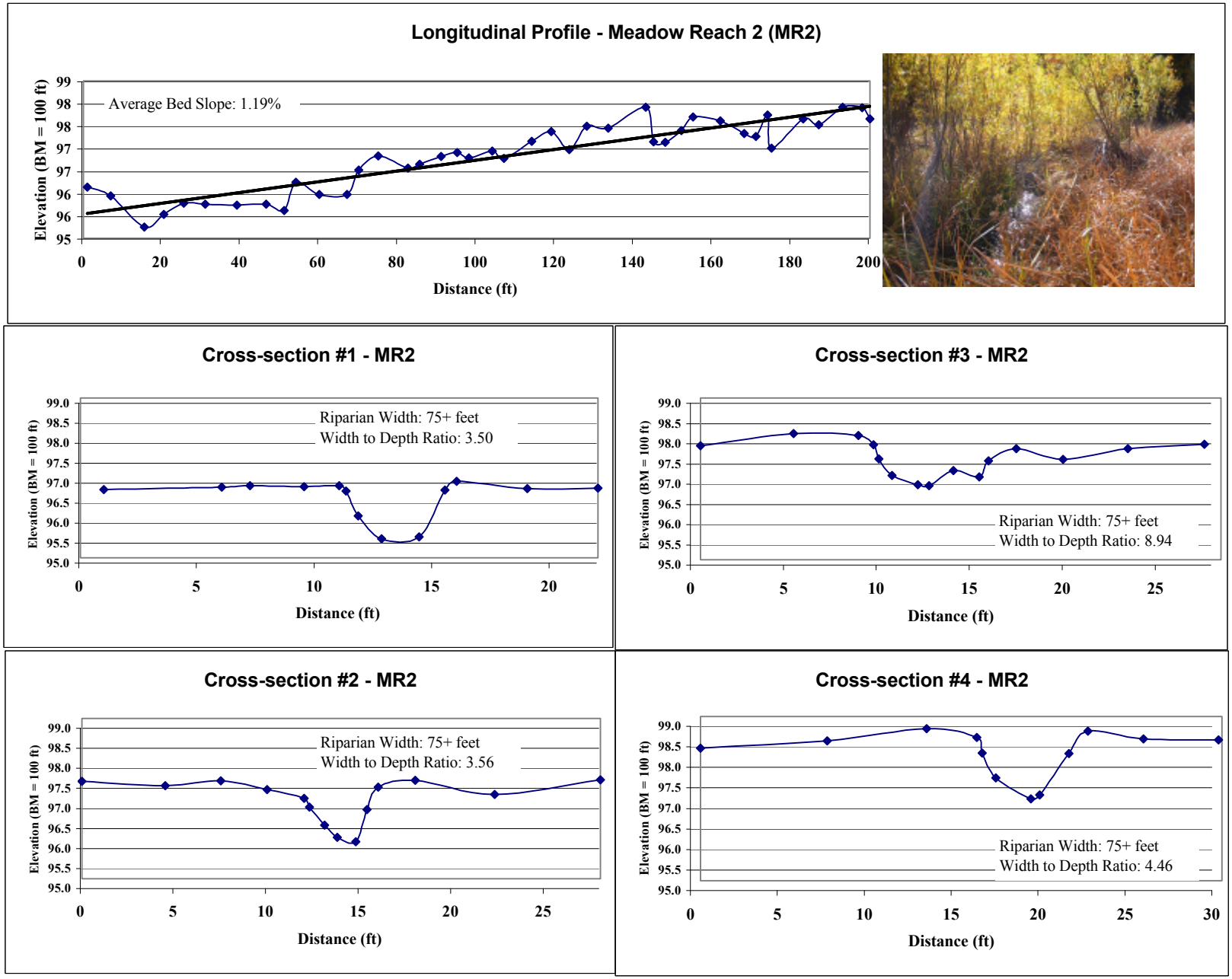


Figure 2.6: Long profile and cross-section geometry for a reference meadow reach (Meadow Reach #2) located at the upstream end of Park Cattle Company property. This site consists of a steep meadow in good condition. Riparian width was estimated based on vegetation type (i.e. - edge of coniferous forest). The width to depth ratio was calculated as wetted width to wetted depth to maintain consistency with the Edgewood Gold Course reaches.

Station	D84 (mm)	D50 (mm)	D16 (mm)	% Finer							
				Sand (0-2mm)	Very Fine Gravel (2-4mm)	Fine Gravel (4-8mm)	Medium Gravel (8-16mm)	Coarse Gravel (16-32mm)	Very Coarse Gravel (32-64mm)	Small/Medium Gravel (64-128mm)	Large Gravel (>128mm)
Golf Course #2	106	90	57	0	0	0	3	6	13	73	5
Golf Course #1	21	10	1	42	0	1	14	25	1	6	1
Meadow Reaches	17	1	1	67	14	18	1	0	0	0	0

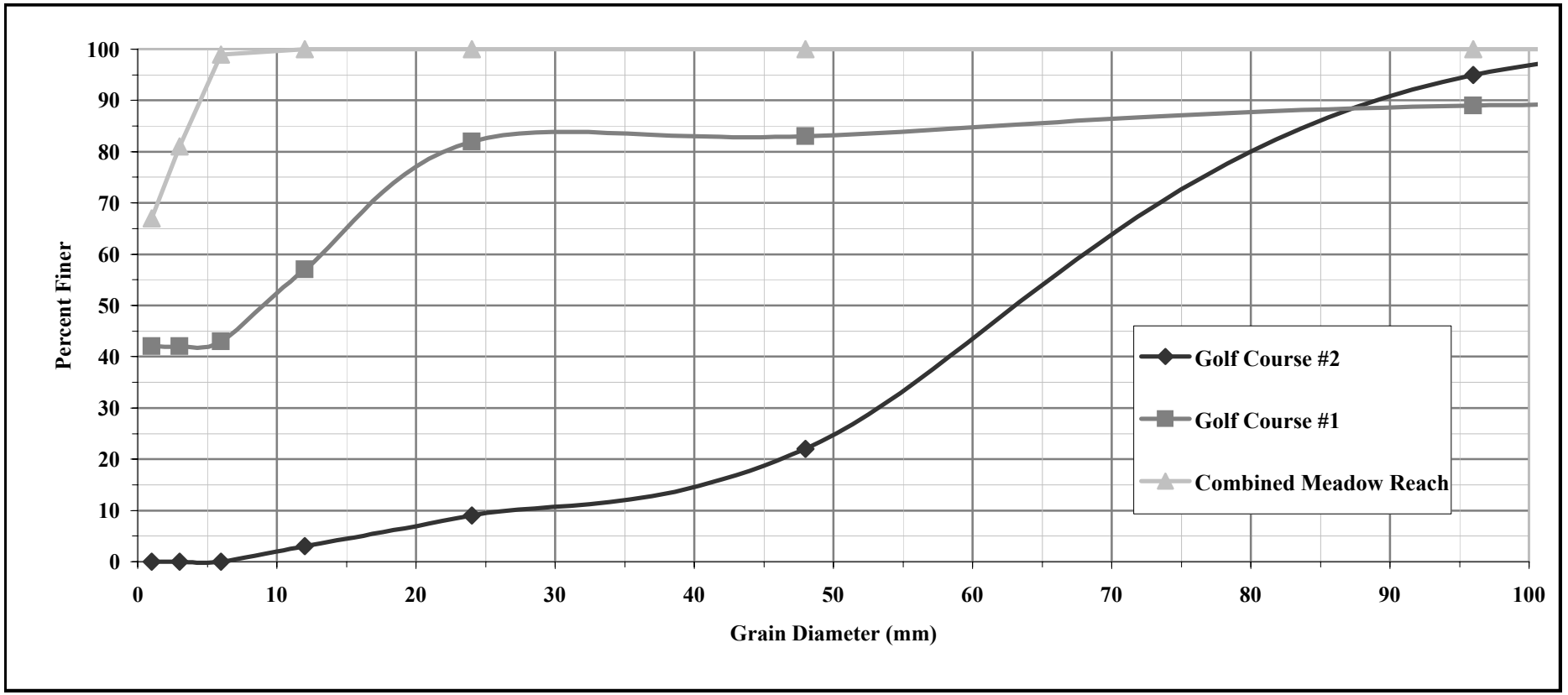


Figure 2.7: Pebble count results for Edgewood Golf Course and Park Cattle Company study reaches. Constructed channels on the golf course have coarser bed material due to importation of material and reductions in bedload due to the Friday Station Pond.

2.4.2 Methods

Bed material samples were collected at 8 sites along Edgewood Creek with two additional samples collected at sediment basins that capture runoff from Kingsbury Grade. Samples were collected using a shovel on depositional features, such as bar formations, adjacent to the wetted channel. Depositional features were chosen since they represent grain sizes that are being transported during a high flow event. The drawback of this approach is that the USGS sampling method did not appear to use the same criteria. Sampling by the USGS, as described in the 1990 report, was conducted via pebble counts and bulk density methods. Pebble counts have been shown to underestimate the fine-grained component of the bed (Wohl et. al., 1996) and usually involve sampling material from a variety of bedform features without necessarily focusing on depositional features (Wolman, 1954). Since we are only sampling depositional features, our sample results will include a larger percentage of fine-grained material. Coarse material such as gravel, cobble and boulder would likely be randomly scattered in the bed or occur as bank material. Collected bed samples were dried and sieved to obtain the percent material within each size class, by volume.

Selected sediment samples were then analyzed to determine mineralogical composition. Dried samples were analyzed using a hand lens to roughly describe the texture of the sample and to provide the mineralogical composition as a percentage of the total sample. The native material found in the basin is decomposed granite (DG), which consists primarily of quartz, feldspar, and ferromagnesium particles. Since these DG constituents are easily recognizable, imported material found in the samples should be clearly evident.

To assess the relationship between sediment delivery from road features and channel substrate conditions, stream sediment delivery points were selected based on where road drainage intersects the stream network (Figure 2.8; see Section 7 for road drainage maps and additional information regarding the method used to calculate sediment loads). Sediment loads by sub-watershed, as estimated from the road analysis section of this report, were used to estimate the amount of sediment delivered to the channel on an annual basis. Sediment loads delivered from fully treated sub-watersheds (e.g. – sediment basins) were subtracted from the total load to estimate a delivery rate to the stream channel. Treatment found in the watershed included sediment vaults, sediment basins, retaining walls, rock slope protection, and rock-lined roadside ditches. Stream intersection sites and sediment sample sites that positionally corresponded with each other were compared to understand the bed conditions in relation to sediment delivery (Figure 2.8).

Legend

- Highways and Roads
- Lakes
- Streams
- Watershed Boundary
- Sediment Basins
- Stream Intersects
- Sediment Sample Sites

Relative Sediment Yields

- Extreme
- Very High
- High
- Moderate

Scale is 1:24,000 or 1 inch = 2000 feet

0 1,000 2,000 4,000 Feet

Stream Intersection Id	Estimated Sediment Load (Tons/Yr)	Sub-Watersheds			Sediment Load Following Treatment (Tons/Yr)
		No Treatement	Partial Treatment	Full Treatment	
A	1.32		2		1.32
B	9.59		1,3		9.59
C	1.89	5			1.89
D	31.98		4,7	6	22.06
E	127.68	23	13,14,22	12,15,17,21	80.62
F	71.12	16,18		8,9,10,11	16.07
G	15.62	19,20			15.62
H	21.28	24			21.28
I	18.97	25,26,27			18.97
J	7.42	28,29,30			7.42
K	48.85	31,32,34,35,36,38	33,37	39	48.58
L	0	40,41			0

Edgewood Creek Integrated Watershed Assessment Team	**Edgewood Creek Watershed Total Load at Sub-Watershed Stream Intersections**	Figure 2.8

2.4.3 Results and Discussion

The historic USGS data and our 2002 sediment sample results are summarized in Figure 2.9. At all sampling sites the percent of material less than 2 millimeters has not changed considerably since the mid-1980s with the exception of sites E7 and E9. At these two sites, the percentage of fine sediment less than 2 millimeters has increased. Site E7 is located downstream of the Mainstem and North Fork confluence. This site captures road drainage impacts from the poorly maintained access road as well as untreated road drainage from the middle portion of Kingsbury Grade. In 1983, 1984, and 1987, the USGS reported percent fine material to be 43, 34, and 38 percent of the sample, respectively, whereas in 2002, percent fines accounted for 91 percent of the sample. Though the changes can be partially attributed to differences in the sampling method, the magnitude of the change points to increased sediment delivery and the poor condition of the dirt road. Site E9 is located just downstream of the Boulder Lodge Parking Lot. In 1983 and 1984, fine material less than 2 millimeters was estimated to be 55 and 41 percent of the sample respectively. In 2002, the portion less than 2 millimeters was estimated to be 70 percent of the sample. The difference between these two sample results may be due to differences in the sampling method and not necessarily an increase in fine sediment delivery.

Figure 2.8 shows the sediment delivery potential of each road drainage subwatershed, the location of each stream intersection point, estimated sediment load, treatment status of each road drainage subwatershed that affects each stream intersection point, and the final estimated sediment load based on treatment status. The locations receiving the highest sediment delivery potential without considering treatment condition are points E, F, K, and D. When considering treatment conditions, the locations receiving the most sediment are points E and K. Treatment of road runoff with sediment basins significantly reduced sediment delivery at point F. Sediment delivery at point E was also reduced significantly though further improvements could be made at this site. The results of this analysis should be considered carefully when determining future locations and design aspects of new sediment basins in the watershed. Though a majority of the sediment basins appeared to be an effective approach to reducing sediment loads to Edgewood, we observed several sediment basins that were installed with very little benefit in terms of reducing sediment delivery to the stream channel due primarily to their placement in locations that lacked significant flow of sediment production. These include the sediment basin and rock-lined swale at the base of subwatershed 17 (see Figure 2.8) that has very little upstream drainage area and an undersized sediment basin at the intersection of Kingsbury and South Benjamin.

Bed conditions at selected sediment sampling sites were then compared to estimated delivery amounts, the results of which are shown in Figure 2.9. A total of 5 sediment and stream intersection sites were compared. The results suggest a positive correlation exists between percent fine sediment less than 2 millimeters and estimated sediment delivery from untreated roads. Though this suggests that treatment of road runoff will reduce sediment delivery to stream channels and improve bed conditions, the magnitude of the improvement may not significantly change the quality of the habitat for aquatic organisms given the natural production of sand-sized sediment in the watershed. The benefit may relate more directly to sediment delivery to Lake Tahoe, an issue of great importance in the Tahoe Basin.

Mineralogical analyses of selected sediment samples are presented in Table 2.2. The results suggest that a significant amount of imported material is being delivered to the stream channel, presumably related to application of abrasives to road surfaces during the winter. Samples collected adjacent to road surfaces (E5 and E8) or from sediment basins (E1, E6) contain a high proportion of non-DG material including scoria, volcanics, and metamorphics. Additionally, a sample collected just downstream of a sediment basin that collects road runoff from upper Kingsbury contained non-DG material (E2) with a higher percentage than what was found in the sediment basin. The finer-grained lithic fragments are potentially bypassing the sediment basin as suspended load and either being deposited out on depositional surfaces or are continuing as suspended load to the lake. The implications of these results will require further analysis to understand the relationship between imported road abrasives and impacts to Lake Tahoe. Such impacts may be occurring throughout the Lake Tahoe Basin. Any future analysis of the impacts of road abrasives on water clarity in Lake Tahoe should be part of a comprehensive, basin-wide study.

Table 2.2: Mineralogical composition of selected sediment samples from Edgewood Creek Watershed.

Sample ID	Texture	Composition	
		Decomposed Granite (DG)	**Imported Material**
E1	Medium-fine sand	50% quartz, 10% feldspar, 20% ferromags	20% lithics (scoria and other volcanics)
E2	Medium-fine sand	30% quartz, 10% feldspar, 10% ferromags	50% lithics (scoria and volcanics)
E5	Coarse-medium sand	50% quartz, 10% feldspar, 10% ferromags	30% lithics (scoria and metamorphics)
E6	Coarse-medium sand	70% decomposed granite	20% lithics (volcanics and metamorphics), 10% organics
E7	Medium sand	100% decomposed granite	None detected
E8	Coarse-medium sand	90% decomposed granite	10% lithics (schist? and volcanics
E9	Medium-fine sand (rust colored)	100% decomposed granite	None detected

ID	Location	Year	Percent < 2mm	< 0.062 mm	0.062 - 2 mm	2 - 4 mm	> 4 mm	Stream Intersection ID
E1	Kingsbury / Buchanan Sediment Basin	2002	71	1	70	20	9	NA
E2	USGS Cross-section Group 65/70/75	1987	65	No Information				NA
		2002	85	25	60	12	3	
E3	USGS Cross-section Group 5/10	2002	71	1	70	19	10	A
E4	USGS Cross-section Group 50/55/60	1983	95	58	37	3	2	D
		1984	83	47	36	7	10	
		1987	93	No Information				
		2002	80	5	75	16	4	
E5	USGS Cross-section Group 80/85/90	1983	58	9	49	13	30	F
		1987	95	No Information				
		2002	92	2	90	7	1	
E6	USGS Cross-section Group 95/100/105	1987	99	No Information				E
		2002	95	20	75	4	1	
E7	USGS Cross-section Group 110/115/120	1983	43	1	42	1	56	I
		1984	34	18	16	2	64	
		1987	38	No Information				
		2002	91	2	89	4	0	
E8	Summit Village / Kingsbury Sediment Basin	2002	96	1	95	3	1	NA
E9	USGS Cross-section Group 40/45	1983	55	7	48	19	26	NA
		1984	41	11	30	12	47	
		2002	70	1	69	22	8	
E10	USGS Cross-section Group 30/35	1987	70	No Information				NA
		2002	70	3	67	15	15	

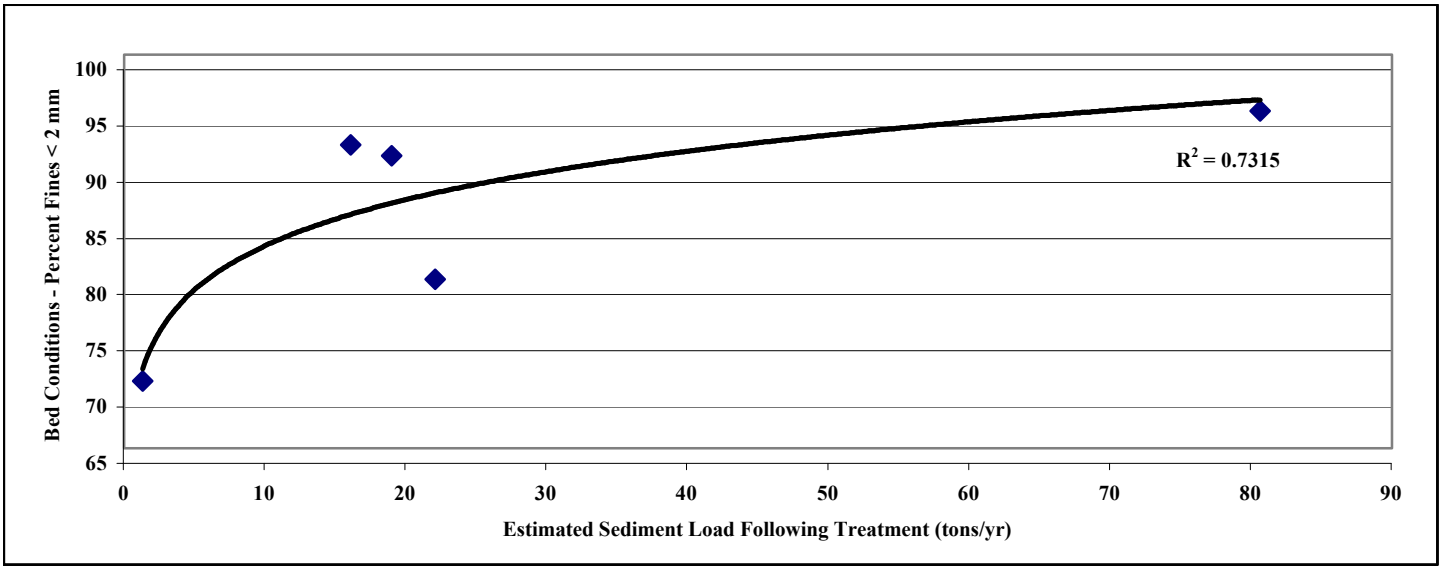


Figure 2.9: 3ed material pebble count and grain-size analysis for selected USGS monitoring sites and sediment basins in the Edgewood Creek Watershed. Pebble count and grain-size data from the 1980's was taken from a USGS study published in 1990 (Hill et. al.) where bulk samples (1987) and pebble counts (1983 and 1984) were conducted. The 2002 data were collected by project team members in the vicinity of the USGS cross-section groups using a grab sample method on bar features in the channel. Samples were then seived to determine percent material within each size class by volume. Also listed is the stream intersection ID from Figure 2.2 that is corresponds the best with the sample location. The scatter diagram at the bottom is the result of plotting the sediment load delivered to the channel at each stream intersection point against the percent fine sediment measured at sampling locations. The correlation suggests a positive relationship exists between estimated sediment delivery from stream channels and the percent of fine sediment occurring in the bed samples.

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3.0 WATER QUALITY

The master scope of services for the Edgewood Creek Watershed Assessment calls for observations of water quality conditions during field work. Physical measurements and samples of water quality were to be taken if significant degraded conditions were encountered that could not be assessed through observational methods. Much of our observations focused on water quality impacts as they relate to sediment inputs from upland and bank erosion sources and other direct inputs from urban land uses. Water quality impacts associated with water temperature and dissolved oxygen are discussed in the Fisheries and Aquatic Habitat chapter (Chapter 4).

The instream walk-through survey was conducted between August and October, 2002. During this period, direct, qualitative observations of water quality impairment were determined to be sufficient to assess potential impacts. Consequently, additional direct measurement or monitoring during the study period was not considered to be necessary given the short duration of the assessment. However, future monitoring is recommended in locations where water quality impacts to aquatic habitat were observed and additional long-term monitoring data was determined to be valuable.

Our direct observations indicate evidence of potential water quality problems affecting aquatic habitat quality in specific areas. These observations are restricted to aquatic habitat in surveyed streams only and are listed below:

1) The streams of Edgewood Creek Watershed are to an extent naturally dominated by sand sediment due to the nature of the weathered granitic geology underlying the watershed (*see Geologic Map of the Watershed*). However, accelerated erosion and excessive sediment supply to streams is a highly visible impact of current and past land use and is a well-documented impact associated with urbanization and historic logging practices (Booth and Henshaw, 2001; Gregory et al., 1992; Park, 1997). Many human altered reaches of Edgewood Creek lack appropriate pool/riffle ratios and narrow channel morphology and riparian vegetation cover which contributes to degraded aquatic habitat conditions when an excessive sediment supply is present. Reaches with good channel morphology, a low width to depth ratio, appropriate pool/riffle morphology and good floodplain function with dense riparian vegetation appear to have greater resilience to high sediment inflows than degraded reaches. With good flood plain function, overbank flow is filtered. With a narrow channel, recessional flood flows can scour the low flow channel and leave coarse substrate. Properly functioning channel and floodplain conditions were found in the reference reach surveyed on PCC land where resident fish populations were observed despite abundant fine sediment sources and erosion from upstream. The project team fisheries biologists observed spawning by resident brook trout in fine gravel substrate in the PCC reach. In contrast, many other reaches with poor morphology and a lack of vegetation cover tend to exhibit shallow and overly wide channels with poor habitat and cover.

Degraded stream reaches should be restored to a more favorable morphology to flush fine sediments, develop pools and sort coarser substrate from the fine material. This effort would improve water quality conditions by increasing flood plain sediment deposition. This effort is consistent with the recommendations resulting from the aquatic habitat and fisheries assessment.

2) The Friday Station Pond Dam and the coarse terminal moraine lag deposit on PCC property above Highway 50 trap nearly all of the coarse sediments (coarse sand and larger) from upstream reaches. As mentioned above, the quality of channel morphology and riparian vegetation cover directly affects the resilience of the stream to high sediment input. It appears that the "functional reach" on PCC land retains high biological productivity despite high sediment loading. Downstream, modification to the natural channel morphology and lack of riparian cover has compromised aquatic habitat conditions.

   It appears that restoring natural geomorphic function and riparian cover to degraded reaches can overcome significant non-point source sediment input and thus reconstructing channels and flood plain could have significant short term benefits. The benefits associated with implementing numerous erosion control projects in the watershed may take longer.

3) The lack of riparian vegetation cover and overly wide and shallow low flow channels could lead to higher water temperatures under certain conditions, particularly during hot days in the mid and late summer months. While the background levels of stream temperature in Edgewood Creek are well below lethal levels for salmonids, it appears that elevated water temperatures could occur in the lower watershed where fully exposed stream reaches and ponds occur. The effect of this on aquatic habitat is unknown and further study and data collection should be considered. We recommend installation of continuous temperature monitoring equipment on Edgewood Creek at Highway 50 and at the mouth to determine the extent to which open ponds and lack of riparian vegetation impact water temperatures. This is discussed in more detail in the Fisheries and Aquatic Habitat chapter (Chapter 4). The USGS has collected spot samples from 1983 to 1987 at Highway 50 and 1984 to 2001 at the mouth. Unfortunately, sampling primarily occurred in the winter and spring months to correspond with peak runoff events. Additionally, sampling at Highway 50 and the mouth were not synoptic, limiting their application.

4) Extensive iron deposits were found in emergent groundwater, especially near Heavenly Valley Boulder Parking Lot where the stream exited the parking lot fill. The iron deposits were characterized by an orange-red, gelatinous substance that was most likely ferric oxide or ferric hydroxide precipitate that results from oxidation of reduced iron by bacteria. Water quality samples were not collected at the site since visual observations clearly identified the iron deposit due to the presence of the precipitate. What is currently not known is the potential source of the iron. The local geologic material may contain deposits of iron that reaches the surface when it comes into contact with groundwater and surface springs. Conversely, the highest concentrations were observed in areas where

water flowed through significant quantities of fill material. It is possible that the iron is leaching out of the fill material. Future sampling of iron should be conducted over a full year in order to understand water quality impacts under different flow regimes and whether or not the observed concentrations are determined to be impairing to the aquatic ecosystem

5) Several of the sediment basins in the watershed appear to be undersized and trapping only coarse sand. Sedimentological analysis described in the geomorphology section of this report reveals that undersize basins trap coarse sands but pass finer sediments and road abrasives (termed "lithics") to streams.

   An effort should be made to determine what size basins are needed to allow for settlement of finer sediment constituents (silt and clay sizes). If the required basin size is larger than is feasible to construct, other measures should be considered such as source control, vegetated filter strips and a series of basins. Constructed wetlands at the edge of stream flood plains may serve to filter runoff prior to discharge to the stream. Maintenance of these facilities should be a major consideration as their sediment trap efficiency could decline rapidly given the volumes of sediment in transport. Provisions for stripping and replanting vegetation after removal of sediment should be considered as a means to reduce overall sediment supply near the stream channel. A cost-benefit assessment should be made with regard to money spent on stream restoration versus sediment control projects.

6) Lower Kingsbury (Stateline/Kingsbury/Highway 50 Commercial area and the U.S. Post Office in this area) may contribute significant pollution to Edgewood Creek through direct, untreated runoff from streets, parking lots and roofs. Besides sediment contributions, these sources could include heavy metals (Cu), oils, grease, detergents and other potentially toxic compounds that could affect aquatic habitat quality. The lower Kingsbury area lacks the oil and grease traps, sediment traps, and sediment basins that are prevalent in the upper watershed resulting in untreated runoff discharging directly into a tributary to Edgewood Creek. The entire area eventually discharges into Friday Station Pond which may filter some of the pollutants.

   Source control measures and properly sized treatment facilities should be installed to reduce the pollution input to lower Edgewood Creek.

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4.0 FISHERIES AND AQUATIC HABITAT REPORT

This report summarizes the results of field assessments of fish and aquatic habitat conducted on Edgewood Creek in October of 2002. A fisheries biologist and a geomorphologist conducted a qualitative stream survey of the mainstem channel, and much of the tributary channels. Quantitative reach assessments of two sections of the mainstem channel were also conducted. Results of these surveys are summarized in the channel section of this memo; this section reviews survey findings with respect to aquatic habitat.

Also included in this memo are reviews of previously collected information not summarized in the first technical memorandum. The USFS habitat typing database is currently being analyzed as part of another Tahoe Basin project (TRPA fishery thresholds update). The results of this analysis, currently being prepared by a consultant to TRPA, and will be examined for any data pertinent to Edgewood Creek. Historical aerial photographs (1939) were reviewed to gain insight into the condition of the stream and riparian areas at that time. The results of this analysis are summarized in following sections.

4.1 Historic Channel and Habitat

As noted in the channel section of this report, much of Edgewood Creek is relatively steep and confined. Prior to disturbance by European man, the channel in these reaches was mostly step-pool in form. Riparian vegetation was likely dense, dominated by alders and willows. Because the riparian vegetation was well developed, organic debris in the channel was probably an important morphological component, as it is today in relatively undisturbed reaches of the channel.

However, in a few locations, underlying geological structure has formed large meadows. The stream flowing though these meadows was lower in gradient, highly meandering, and probably had a low width-to-depth ratio. The largest of these meadows was located from the mouth upstream to the Highway 50 crossing, and from the Eagle Rock Creek confluence upstream to the end of PCC property.

The historical geomorphology of the mouth of the stream cannot be ascertained from aerial photos. The earliest aerials, from 1939, were taken well after the lower meadow had already been modified for agriculture; irrigation ditches are visible. The photos do suggest, however, that a lagoon may have been present behind a barrier beach. If the stream had a lagoon and barrier beach similar to other relatively undisturbed Tahoe streams (e. g. Taylor Creek), it is likely that passage was not available for all species under all conditions. For example, during droughts when low streamflow and low lake stands occurred, the creek was probably very wide and shallow across the barrier beach, restricting access for at least larger fish. During high lake stands in wetter years, the barrier beach may have been backwatered and fish could access the creek from the lake during most seasons.

Fish migrating into the stream from Lake Tahoe could probably go no farther upstream than the boulder cascades above Friday Station pond. Brook trout were found upstream of the cascades in fish surveys done by NDOW in 1972, probably the result of planting many decades ago by local residents (see, for example, Scott 1951), but rainbow trout were not. NDOW planted rainbows in 1973, and this section of the stream may have resident rainbows today.

4.2 Results of Qualitative Stream Survey

The results of the initial walk-through assessment are given in detail in the channel section of this report. This section summarized the results with respect to aquatic habitat.

Throughout steep, confined areas of the watershed, the primary disturbance to the stream channel has been construction of roads, both for logging and for residential and urban development. Logging impacts started as early as the 19th century, especially in the lower part of the watershed (Scott 1957). Many of the older logging roads and skid trails are still evident, as well as newer roads from logging that occurred in the 1950's and 1960's. Most of the significant disturbance caused by logging roads was noted in the series of photographs taken by Frantz in 1971, especially failing crossings. Although it was apparent during our survey that the stream had been modified in areas for logging access (for example, around the confluence with the second southern tributary), the channel has since been stabilized by the growth of heavy riparian cover. While we were able to locate many of the 1971 Frantz photographs, none of these locations are currently actively eroding. Although a few areas of eroding banks or incised channel were noted during the survey, in general the stream is stable.

Ponds and diversions are still active upstream of Highway 50. The Friday Station pond, upstream of Highway 50, dams the entire channel. Fish passage is not possible through this pond, although historically fish were probably blocked by the cascades just upstream. Another off-channel pond is found a few hundred feet downstream of the Crestview Road crossing; the source of water for the pond was not identified. It appears that the stream was modified during construction of this pond and a nearby berm, but most of the channel in this area is now stable.

The stream has been highly modified through Edgewood Golf Course. Two fish passage barriers exist on the course: a culvert at the mouth under the 18th fairway; and a diversion structure at the upstream end of the golf course. The culvert at the mouth is likely passable during high lake stands when it is backwatered, but is not passable during most flows at low lake stands. The diversion at the upstream end of the golf course is probably not passable during any flow. Other modifications include the construction of two large ponds through which the stream flows. As a result, a significant portion of the historic stream habitat has been converted to pond habitat. Remaining stream is significantly steeper than the historic channel. One lower section of the channel, recently restored, is bordered by native riparian grasses, though few woody shrubs are present. Restored reaches further upstream have little riparian buffer.

Upstream reaches of the mainstem have also been highly altered. Fill for the Boulder parking lot at Heavenly Valley Ski Area covered the channel and riparian area for several hundred feet. Construction of a ski run upstream of the parking lot resulted in disturbance to the stream channel documented by Frantz in 1971. While much of this area has subsequently stabilized, gullies and headcuts are still apparent. Riparian vegetation is disturbed on an annual basis, likely retarding stabilization of the gullies.

One location on the North Fork has also been highly altered, with resulting impacts to aquatic habitat. A USFS road crossing the drainage upstream of the Kingsbury Grade road crossing may be the remnants of a dam. The channel was subsequently routed around the pond area, and is incised and eroding.

Above the boulder cascades upstream of the Friday Station pond, the stream flows through a large meadow. This reach of the channel is relatively undisturbed; although there is evidence of logging operations throughout the surrounding uplands, no significant impacts to the meadow are obvious. Conversations with Park Cattle personnel suggest that the meadow has not been grazed. Beavers were active in the meadow in the past, but no recent sign was found. Small overflow channels bisect the surrounding meadow, which is very wet with standing water in depressions even during low flow. This meadow is a good example of relatively undisturbed low gradient meadow and stream for small east side Tahoe streams.

Fish were observed throughout most of the mainstem and in the lower portions of larger tributaries. During reach surveys, large numbers of brook trout were spawning in the meadow reach at the upstream end of PCC property.

Macroinvertebrates were not examined in detail for this assessment. Cursory observations suggested that the macroinvertebrate community was representative of local physical habitat conditions. For example, communities in lower gradient sand dominated reaches likely had higher proportions of black flies than higher gradient riffles where substrate was dominated by cobbles.

Although macroinvertebrate assessments at the level of the watershed would probably not provide additional detail on habitat or water quality conditions, more focused macroinvertebrate investigations based on the results of other portions of this watershed assessment might assist in analysis of potential water quality impacts. For example, collection of macroinvertebrate samples at points where water quality or habitat impacts are suspected, such as inflows of road runoff, or where the channel has been highly modified, could be compared to areas where habitat and water quality are relatively unimpacted. Such an assessment would require fairly intensive sampling and assessment, but may provide useful data with which to analyze relatively localized suspected water quality impacts, and could be added to recommendations for future assessment needs.

In summary, the major findings of the channel survey with respect to aquatic habitat are the following:

1) Although roads from logging and residential development have highly altered the channel in the past, the channel has subsequently been stabilized by recruitment of dense riparian vegetation. Eroding banks and headcuts are found in a few localized portions of the stream, but are not extensive or found throughout the watershed.
2) Fish passage from Lake Tahoe is restricted to the area downstream of the boulder cascades above Friday Station pond. The stream on the Edgewood Golf Course therefore represents most of the habitat available to fish migrating from Lake Tahoe.
3) Significant changes to stream and riparian habitat have occurred in lower gradient meadow areas on the Edgewood Golf Course. Both the channel form and riparian vegetation have been highly modified.
4) Modifications to the channel at the upstream end for Heavenly Valley Ski Area operations have also resulted in significant changes to the stream, likely resulting in the loss of wet meadow and riparian habitat.
5) Trout have reproduced successfully following introductions. They are now found throughout most of the watershed where flow is perennial, including areas that may have been fishless historically. Resident brook trout appear to be numerous in some areas of the stream.

4.3 Reach Assessments

Two reaches were selected for further collection of habitat data. The reach on the Edgewood Golf Course was selected because of its potential importance as habitat for fish migrating from Lake Tahoe. The meadow reach upstream of Friday Station pond was also selected to provide baseline data on relatively undisturbed channel characteristics.

4.3.1 Results

The results of these surveys are given in the channel section of this document. In general, the undisturbed channel in the upstream area is narrower and deeper than the channel on the golf course, though the surrounding meadows were probably similar prior to disturbance of the lower meadow. Substrate is much larger on the golf course reaches due to imported cobble and gravel used during channel construction.

Riparian areas are also significantly different in the two areas. The lower reach on the golf course has riparian buffers, composed mainly of sedges. The upper reach on the golf course has little riparian buffer. The two reaches in the undisturbed meadow, however, have large expanses of riparian vegetation on either side of the channel, composed of both grasses and woody shrubs. The following photographs show the extent of riparian vegetation in each of the reaches surveyed.

Figure 4.1 Riparian vegetation on the reaches surveyed. The top two photographs are the reaches on the golf course. The photograph in the bottom center is of the upper reach in the undisturbed meadow.

4.3.2 Discussion

Width-to-depth ratio is an important indicator of the quality of fish habitat (Spence et al. 1996). Generally, lower width-to-depth ratios results in better habitat. The upper golf course reach had a significantly higher width-to-depth ratio than the undisturbed meadow. The lower restored reach in the golf course had a width-to-depth ratio nearly equivalent to the undisturbed area.

These differences are partly explained by slope. The upper reach in the golf course is significantly steeper than the other reaches surveyed, and steeper channels tend to have higher width-depth ratios. This high slope is the result of the golf course configuration; because the stream goes through the ponds, which are essentially flat, the grade of the remaining stream channel must be steeper.

Another significant factor in width-depth ratio is the influence of riparian vegetation. Well-vegetated banks tend to narrow the channel, increasing depth and decreasing the width-to-depth ratio (Hunter 1991). The lower golf course reach was constructed such that riparian vegetation could strengthen the banks and encroach on the channel, reducing width. Parts of this reach resemble the undisturbed channel in the upper meadow. Streambanks on the upper golf course reach, though stable, have not encroached on the channel and are unlikely to do so in the future due to the high slope of this section. Thus, for much of the golf course channel above the lower portion, the width-to-depth ratio is likely to remain high.

Riparian vegetation provides other important components of fish habitat. In meadow streams, riparian vegetation is an important form of cover, allowing fish to escape predators (Hunter 1991). Riparian vegetation also provides shade, lowering water temperature; supports insects that provide food for fish; and provides habitat for birds, amphibians, and other animals.

NDOW conducted electrofishing surveys on the golf course on October 3, 2002. While these surveys were not designed to produce actual estimates of fish population size, the number of trout captured in various reaches suggests that fish habitat in the modified golf course channel does not support large numbers of fish. Speckled dace, a native minnow capable of utilizing nearly any habitat, was found throughout the areas surveyed. However, only one trout was captured in a survey area near the golf course clubhouse. In contrast, 34 trout were captured in a survey area between the upper diversion and Highway 50. The channel in this area resembles the channel in the undisturbed meadow upstream of the boulder cascades, with low width-to-depth ratio, high depths, and vigorous riparian vegetation. Relatively high numbers of trout in this section suggests that fish habitat could be improved throughout the golf course.

Water quality factors may also influence fish distribution throughout the golf course section of Edgewood Creek. The USGS has collected water quality data at the Highway 50 crossing, just upstream of the golf course reach, and at the mouth downstream of the golf course reach, including water temperature, pH and dissolved oxygen. These observations have been spot samples at these locations, about 10-20 per year, and therefore do not represent continuous monitoring, nor were sampling locations extended throughout the golf course. However, the results suggest that temperature, and perhaps dissolved oxygen, may be limiting the distribution of cold water fish in the lower portions of the golf course reach.

For example, on May 11, 2001, the temperature at the mouth was 18.5° C at 1:00 PM. Under Nevada water quality standards for Lake Tahoe tributaries, maximum water temperature should not exceed 10° C between October 1 and May 31, primarily to protect cold water beneficial uses such as fisheries (Nevada Administration Code, Chapter 445A, Water Pollution Control, Standards for Water Quality, section 445A.191, sub-section 445A.1915). The data suggest that these warm temperatures may be the result of conditions within the golf course reach. While a temperature measurement was not taken above the golf course on May 11, they were taken on May 9 (10.0° C at 3:20 pm) and on May 14 (9.5° C at 1:40 pm), both of which are significantly lower than measured downstream of the golf course and both of which meet the Nevada Division of Environmental Protection temperature standard. On September 10, 2001, temperatures were taken both at the Highway 50 station and at the mouth. Water temperature at Highway 50 was 10° C at 5:15 pm, while it was 18.0° C at 3:50 pm at the mouth.

These data must be evaluated with caution, as only a few measurements are available. Several factors can influence spot measurements of water temperature, including time of day, sampling location, and antecedent weather conditions. Nonetheless, the available data suggest that water temperature and pH both increase through the golf course reach, and dissolved oxygen concentration decreases. Between 1996 and 2001, water temperature did not exceed 13.5° C in any of the USGS measurements at Highway 50, while temperatures measured at the mouth during the same period regularly exceeded 15° C during the summer, and ranged up to 18.5 ° C.

Similarly, dissolved oxygen measurements tended to be lower at the mouth station, and pH measurements tended to be higher, though these parameters rarely exceeded water quality standards.

Additional data will be required to evaluate the potential impact of these water quality factors on aquatic biota. It is recommended that a monitoring program be instituted to continuously measure water temperature both upstream and downstream of the golf course. This program could also include measurement of pH and dissolved oxygen at short intervals throughout a few days during warm summer months to assess daily variability and differences between the stations in these parameters.

Although the available data are limited, this discussion suggests that cold water fish populations in the lower portion of the golf course reach may be limited by temperature, especially given that physical habitat is adequate based on our surveys. Low population numbers in the upper portion of the golf course reach, above the ponds, may be the result of physical habitat factors, such as a lack of cover or high width-to-depth ratio. However, these conclusions are based on limited data on the fish populations. To more accurately assess the relative impacts of physical habitat and water quality factors, fish population estimates should be conducted on several reaches throughout the golf course, at least twice in a given year, and compared to control sections above the golf course.

4.3.3 Fish Migration Barrier

As noted earlier in this section, a natural barrier blocks fish access from Lake Tahoe a few hundred feet upstream of the Friday Station pond. The Friday Station pond outlet is currently a fish migration barrier, but modification of the outlet for passage would provide access to only a short portion of the channel upstream. The Highway 50 culvert is also a partial barrier, but modification for passage here would also only provide access to the short portion of channel upstream to the Friday Station pond. Because substantial modification of these barriers for passage would be complicated and expensive, they should both be considered relatively low priority.

Modification of the passage barrier posed by diversion structure at the upstream end of the golf course similarly would provide access to only a short portion of stream, from the diversion through to the Friday Station pond (with the partial barrier of the Highway 50 crossing in the middle). However, the habitat upstream of the diversion is relatively high quality, and the priority for modifying this barrier should be moderate.

A bypass channel around the irrigation pumphouse in the middle of the golf course was constructed to provide fish passage in this area. The use of flat weirs in the construction of this channel probably does not allow fish passage during low flows. Moreover, the lack of riparian vegetation or water depth does not provide sufficient cover for migrating fish. This bypass channel is thus at least a partial barrier, and some modification should be considered.

Highest priority for fish passage modification should be given to the culvert at the mouth of the stream. Providing adequate passage will require removing the stream from the culvert and reconstructing the channel across the fairway. A population of Tahoe yellow cress at the mouth will require careful design of the mouth. The stream must be constructed to maintain the geomorphic processes responsible for providing substrate for yellow cress establishment.

4.3.4 Fish and Aquatic Habitat Improvements

Because the greatest alteration of aquatic habitat has occurred in the lower part of the watershed, the best opportunities for habitat improvement occur here as well. Moreover, most of the stream that could be accessible to fish migrating from Lake Tahoe is in the lower part of the watershed.

Following are recommendations for improving fish and aquatic habitat on Edgewood Golf Course. The primary objectives of habitat improvement here should be: 1) Increase riparian vegetation along the creek; 2) Restore more natural channel morphology, with a higher width-to-depth ratio. Several alternatives are available, ranging from full geomorphic and riparian restoration to enhancement of existing riparian communities.

A full geomorphic restoration would consist of separating the ponds from the stream channel, and restoration of stream channel throughout the golf course at a grade more similar to the historic channel. It is probably feasible to keep the ponds in their current location (thus maintaining habitat benefits associated with the ponds), and build the channel around the edges. The width of native riparian buffer along the channel should be increased, at least to the extent of the lower restored channel near the clubhouse. A full geomorphic restoration would provide the maximum habitat benefits, including; increased cover and depth, reduced with-to-depth ratio, increased shade, lower water temperature; habitat for riparian-dependent animals, and increased food for trout and other aquatic organisms.

A less extensive habitat improvement program might include expansion of riparian areas along the existing channel. This would probably require modifying the channel margins to provide more floodplain. This alternative would be unlikely to significantly improve the morphology of the channel, but would provide increased cover and other benefits associated with riparian vegetation. It should also be noted that the riparian fringes around the ponds are not well developed. Allowing more riparian vegetation to grow around the edges of the ponds would provide similar aquatic habitat benefits.

Apart from Edgewood Golf Course, aquatic, riparian and fish habitat improvement opportunities are found in a few other areas. The lower portions of the southern tributary near the upstream end of PCC property may have been channelized in the past, resulting in incision and lowering of the water table in the surrounding floodplain. A restoration project in this area could improve the channel condition and surrounding riparian vegetation. On the north fork, restoration of the former pond site would improve channel condition and expand the extent of riparian and wetland vegetation. Finally, allowing the expansion of riparian vegetation along the channel upstream of the Boulder parking lot would increase channel stability and begin to restore wet meadow and riparian habitat.

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Spence, B. C., G. A. Lomnicky, R. M. Highes, and R. P. Novitzki. 1996. *An ecosystem approach to salmonid conservation*. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR. (Available from the National Marine Fisheries Service, Portland, Oregon.)

5.0 RIPARIAN/UPLAND VEGETATION & HABITAT REPORT

5.1 Introduction

Vegetation and site condition surveys were conducted in September 2002 throughout the Edgewood Creek watershed (Edgewood Creek and its tributaries). The survey area consisted of private as well as public property, including land owned by the PCC, the United States Forest Service, the State of Nevada, and Douglas County. The project area includes Edgewood Golf Course, continues across Highway 50 to SR 207 (Kingsbury Grade), including tributaries on both sides of SR 207, and portions of Heavenly Valley Ski Area. As per the Phase I report, the purpose of the broad, assessment level surveys was to:

1. Evaluate potential habitat of Threatened, Endangered and Sensitive Plants
2. Evaluate Noxious Weed habitat, noxious weed presence
3. Spot field verify location and extent of old growth forest
4. Evaluate riparian vegetation including:
    - extent of habitat
    - composition of dominant species
    - evaluation of community health
    - evaluation of reproductive condition and potential
    - evaluation and quantification of resources suitable for restoration
5. Evaluate conifer encroachment of riparian areas

Although not in the initial scope, upland vegetation was evaluated for general structure and health. Quantification of materials was not conducted for this survey. This can be done in conjunction with particular restoration projects, and with aerial photos that more clearly delineate riparian vegetation.

The surveys were not intended to produce a complete flora, and were conducted at a sub-optimum time for maximum species identification. The surveys did not extend to the origins of the tributaries in the steeper, forested reaches of the watershed.

5.2 Environmental Setting

The majority of the project area is composed of riparian and meadow habitats with mixed conifer forest overstory species including Jeffrey pine, lodgepole pine, and white fir in the upland habitats. The project area is mountainous and very steep in places, with a semi-arid climate. Annual precipitation falls predominantly in the form of winter snow. Summers typically are dry and warm, with average daytime temperatures in the 70-80 degree (F) range. Elevation of the project area ranges from approximately 6230 to 7800 feet.

Much of the lower watershed has been developed and altered, including Edgewood Golf Course, State Route 207 and associated commercial and residential development, and Heavenly Valley Ski Area. In addition, past logging activities, and old logging roads have contributed to the

disturbance of the watershed. In spite of this, most of the riparian areas above PCC are quite intact in terms of native vegetation. Introduced species and the few sightings of noxious weeds are concentrated around disturbance or erosion control projects, but have not colonized the vast majority of the survey area.

5.3 METHODOLOGY

5.3.1 Pre-field Research

During Phase I of this assessment project, pre-field literature searches were conducted to obtain information for regarding potential occurrence of Threatened, Endangered, and Sensitive species in the watershed (Table 5.1).

Table 5.1 Edgewood Watershed Potential Threatened, Endangered, and Sensitive Plant Species

Common Name	Scientific Name	Elevation (ft)	Habitat	Status Forest Service/ F&WS/Nevada Natural Heritage Program	CNPS and R-E-D Code
Tahoe Draba	*Draba asterophora* var. *asterophora*	10,000-11,000	Steep, rocky slopes, subalpine	Sensitive/No listing/Watch list	1B 3-1-2
Cuplake Draba	*Draba asterophora* var. *macrocarpa*	5,500-9,000	Rocky slopes and outcrops	Sensitive/No listing/No listing	1B 3-1-3
Torry's buckwheat	*Eriogonum umbellatum var torryanum*	6,,085-8,600	Meadows and seeps, and upper montane coniterous forest on volcanic, rocky substrate	No listing/No listing/no listing	L1B _
Long-petaled Lewisia	*Lewisia pygmaea* ssp. *longipetala*	6,000-11000	Shaded canyons and slopes	Sensitive/No listing/No listing	1B 3-1-3
Sierra Sedge	*Carex paucifructus*	6,500-8300	Subalpine meadows Considered and rejected for the CNPS Inventory of rare and endangered plants: a synonym of *C. mariposana*, a common taxon	Sensitive/No listing/No listing	
Tahoe Yellow Cress	*Rorippa subumbellata*	6,000	Sandy shores of Lake Tahoe, wet depressions	Sensitive/ Species of Concern Critically Endangered in Nevada/Threatened	1B 3-3-2
Hidden-petaled Campion	*Silene invisa*	7,000-10,000	Red Fir and Lodgepole forests	No listing/No listing/No listing	4 1-2-3
Washoe tall rockcress	Arabis rectissima var. simulans	6,035-7,350	Dry granitic or andesitic soils, thinly littered open Jeffrey pine stands	No lsiting/no listing/Sensitve.	NA
Galena Creek Rockcress	*Arabis rigidissima* var. *demota*	7,400-9,600	Mixed Conifer and subalpine forest	No listing/ Species of Concern/Watch list	1B 1-1-3

Key to Table 5.1

Forest Service Classification: Lake Tahoe Basin Management Unit Sensitive Plant Species List, Verified March 2000 Fish and Wildlife Service Classification System System Revised 1996, Listing Verified March 2000: Endangered Proposed Endangered Threatened Proposed Threatened Candidate Species Species of Concern Nevada Natural Heritage Program Sensitive list Watch list Threatened	CNPS Classification: 1B- Plants rare, threatened, or endangered in California or elsewhere. All plants constituting List 1B are eligible for state listing. It is mandatory that they be considered under CEQA. 2- Plants rare, threatened, or endangered in California but more common elsewhere. All plants constituting List 2 and endangered for state listing. It is mandatory that they be considered under CEQA. 4- Plants of limited distribution. Few plants constituting List 4 are eligible for state listing. It is mandatory that they be considered under CEQA. CNPS R-E-D Code R-Rarity: 1. Rare, but found in sufficient numbers and distribution that potential for extinction is low at this time. 2. Occurrence confined to several populations or to one extended population. 3. Occurrence limited to one or a few restricted populations, or present in small numbers. E-Endangerment: 1. Not Endangered 2. Endangered in a portion of its range 3. Endangered throughout its range D-Distribution: 1. More or less widespread outside of California 2. Rare outside California 3. Endemic to California

*This table was compiled from several existing sources and includes State of California species according to the California Department of Fish and Game Natural Diversity Data Base and the State of Nevada Department of Conservation & Natural Resources – Natural Heritage Program

5.3.2 Field Surveys

During mid to late September 2002, two botanists performed field surveys of 5 tributaries and the main channel. The watershed, with the exception of the upper end of the tributaries where access was limited, was surveyed intensively by vehicle and on foot. GPS waypoints were obtained for sites having particular interest or characteristics. Plant species were identified, documented, and compiled into a species list during the survey (Table 5.2). A complete floristic inventory was not compiled due to the time of year the survey took place.

5.4 Results

5.4.1 Evaluation of Threatened, Endangered, and Sensitive Plant Habitats

Tahoe Draba. According to the literature, habitat for this species does not occur within the survey area, as it is found at higher elevations in the sub alpine plant community.

Cuplake Draba. Very little habitat occurs within the survey area and the plant was not encountered during the surveys.

Torry's Buckwheat. Habitat for this species does exist in the project area, although no plants were located. If a restoration project takes place in the future, the affected areas should be thoroughly surveyed.

Long-petaled Lewisia. Habitat for this species does exist in the project area, although no plants were located. If a restoration project takes place in the future, the affected areas should be thoroughly surveyed.

Sierra Sedge. This is a synonym for a common sedge, and should be deleted from the list of potential TES.

Tahoe Yellow Cress. This plant has been located at the outlet of Edgewood Creek. An inter-agency working group is monitoring its status.

Hidden-petaled Campion. Very little habitat exists for this plant, as it is found in red fir stands and generally elevations greater than 7,000 ft.

Washoe Tall Rockress. Although habitat may occur within the survey area, this species is not known to occur on the west side of the Carson Range or Sierra Nevada.

Galena Creek Rockcress. Although habitat may occur within the survey area, this species is not known to occur on the west side of the Carson Range or Sierra Nevada

5.4.2 Noxious Weed Habitat and Presence

Noxious weeds were located in several places, all associated with disturbance. Several spotted knapweed (*Centaurea maculosa*) plants were found along Andria Drive, by the water tanks located just south and east of Brautovich Park. Bull thistle (*Cirsium vulgare*) was located along Kingsbury Grade where the north fork crosses the highway. It was also located in the vicinity of Cypress Lane, where disturbance remains from an old erosion control project, along with Canada thistle (*Cirsium arvense*) and Spotted knapweed. Canada thistle was also located at Edgewood Golf Course. All of these sightings should be reported to the University of Nevada, Reno Extension Service. It is possible that other noxious weeds occur elsewhere on disturbed sites in the watershed. However, the riparian corridors, with the exception of the north fork along Kingsbury Grade, are free of noxious weeds. Vegetation is generally very dense in these areas, limiting the likelihood of establishment.

The Golf Course ponds should be surveyed for Eurasian milfoil and other potential noxious or problematic aquatic vegetation in the spring of 2003.

Restoration plans implemented in the future should include a noxious weed management plan. All imported material, including topsoil, fill, seed, and mulch must be weed free.

5.4.3 Old Growth Forest

Scattered individual trees, mostly Jeffrey pines (*Pinus jeffreyi*), occur throughout the survey area. These trees are remnant survivors from old logging activities. Particular locations of Jeffrey pines were along the stretch of the main channel east of Cypress Way, and around the buildings on the PCC property.

A stand of remnant sugar pines (*Pinus lambertiana*) occurs in a somewhat linear configuration between approximately 6800' and 7400' along the second tributary of Edgewood Creek, counting from west to east (Sue Fox, personal communication).

A distinct stand of old growth of cottonwoods (*Populus sp*.) occurs along the easternmost fork of tributary 4 (Sue Fox, personal communication).

5.4.4 Upland and Riparian Vegetation/Community Structure

A species list for the entire project area is in included in Table 5.2 below.

Table 5.2. Project Area Species List

Botanical Name	Common Name	Family Name
Abies concolor	White Fir	Pinaceae
Abies magnifica	Red fir	Pinaceae
Achillea millefolium	Yarrow	Asteraceae
Achnatherum occidentalis ssp. *californicum*	Needlegrass	Poaceae
Achnatherum lettermanii	Letterman's needlegrass	Poaceae
Agoseris grandiflora	Large flowered mountain dandelion	Asteraceae
Agropyron cristatum	Crested wheatgrass	Poaceae
Agrostis exerata	Spike bentgrass	Poaceae
Agrostis scabra	Ticklegrass	Poaceae
Agrostis stolonifera	Creeping bentgrass	Poaceae
Alnus incana ssp. *tenuifolia*	Mountain alder	Betulaceae
Amelanchier utahensis	Utah serviceberry	Rosaceae
Antennaria rosea.	Pearly everlasting	Asteraceae
Aquilegia Formosa	Crimson columbine	Ranunculaceae
Arabis holboellii	Holboel's rockcress	Brassicaceae
Arabis platysperma	Rockcress	Brassicaceae
Arctostaphylos nevadensis	Pine mat manzanita	Ericaceae
Arctostaphylos patula	Green manzanita	Ericaceae
Artemisia douglasiana	Mugwort	Asteraceae
Artemisia ludoviciana	Silver wormwood	Asteraceae
Artemisia tridentata ssp. vaseyana	Mountain sagebrush	Asteraceae
Aster integrifolius.	Aster	Asteraceae
Aster occidenatalis	Western aster	Asteraceae
Aster sp.	Aster	Asteraceae
Bidens sp.	Beggar's tick	Asteracee
Bromus carinatus	California brome	Poaceae

Botanical Name	Common Name	Family Name
Bromus inermus	Smooth brome	Poaceae
Bromus tectorum	Cheatgrass	Poaceae
Carex athrostachya	Slender beak sedge	Cyperaceae
Carex lanuginose	Wooly sedge	Cyperaceae
Carex microptera	Small wing sedge	Cyperaceae
Carex multicostata	Many-ribbed sedge	Cyperaceae
Carex nebrascensis	Nebraska sedge	Cyperaceae
Carex praegracilis	Clustered field sedge	Cyperaceae
Carex rossii	Ross sedge	Cyperaceae
Carex subfusca	Rusty sedge	Cyperaceae
Castilleja applegateii	Applegate's paintbrush	Scrophulariaceae
Castilleja miniata	Paintbrush	Scrophulariaceae
Ceanothus cordulatus	White thorn	Rhamnacaeae
Ceanothus prostratus	Squaw carpet	Rhamnacaeae
Ceanothus velutinus	Tobacco brush	Rhamnacaeae
*Centaurea maculosa**	Spotted knapweed	Asteraceae
Cerastium fontanum vulgare	Mouse-ear chickweed	Caryophyllaceae
Chenopodium sp.	Lamb's quarters	Chenopodiaceae
Chrysolepis sempervirens	Bush chinquapin	Fagaceae
Chrysothamnus nauseosus	Rubber rabbitbrush	Asteraceae
Cicuta maculata	Water hemlock	Apiaceae
*Cirsium arvense**	Canada thistle	Asteraceae
Cirsium andersonii	Anderson's thistle	Asteraceae
*Cirsium vulgare**	Bull thistle	Asteraceae
Collomia grandiflora	Large-flower collomia	Asteraceae
Conyza Canadensis	Horseweed	Asteraceae
Cornus sericea	American dogwood	Cornaceae
Dactylis glomerata	Orchard Grass	Poaceae
Delphinium glaucum	Mtn. larkspur	Ranunculaceae
Deschampsia cespitosa	Hairgrass	Poaceae
Eleocharis macrostachya	Spikerush	Cyperaceae
Elymus elymoides	Squirreltail grass	Poaceae
Elymus glaucus	Blue wildrye	Poaceae
Elytrigia intermedia	Pubescent wheatgrass	Poaceae
Epilobium angustifolium ssp. circumvagum	Fireweed	Onagraceae
Epilobium brachycarpum	Willowherb	Onagraceae
Epilobium ciliatum	Willowherb	Onagraceae
Epilobium glaberrimum	Willowherb	Onagraceae
Equisetum arvense	Common horsetail	Equisetaceae
Equisetum hyemale	Common horsetail	Equisetaceae

Botanical Name	Common Name	Family Name
Ericameria bloomeri	Bloomer goldenweed	Asteraceae
Erigeron breweri	Brewer's aster	Asteraceae
Eriogonum marifolium	Buckwheat	Polygonaceae
Eriogonum nudum var. nudum	Naked buckwheat	Polygonaceae
Eriogonum wrightii	Wright's buckwheat	Polygonaceae
Erodium cicutarium	Stork's bill	Geraniaceae
Festuca ovina	Sheep fescue	Poaceae
Festuca rubra	Red Fescue	Poaceae
Festuca trachyphylla	Hard fescue	Poaceae
Fragaria virginiana	Wild strawberry	Rosaceae
Gayophytum diffusum	Diffuse gayophytum	Onagraceae
Geum macrophyllum	Large leaf avens	Asteraceae
Glyceria elata	Tall mannagrass	Poaceae
Heracleum lanatum	Cow parsnip	Apiaceae
Hieracium albiflorum	White flower hawkweed	Asteraceae
Holcus lanatus	Velvetgrass	Poaceae
Hordeum jubatum	Foxtail barley	Poaceae
Hypochaeris sp.	Cat's ear	Asteraceae
Ipomopsis aggregata	Scarlet gilia	Polemoniaceae
Juncus balticus	Baltic rush	Juncaceae
Juncus ensifolius	Iris-leaf rush	Juncaceae
Juncus nevadensis	Nevada rush	Juncaceae
Lactuca serriola	Prickly lettuce	Asteraceae
Lathryus lanszwertii var. lanszwertii	Nevada sweet pea	Fabaceae
Lepidium densiflorum	Dense-flower peppergrass	Brassicaceae
Leymus triticoides	Creeping wildrye	Poaceae
Lilium parvum	Alpine lily	Liliaceae
Lupinus andersonii	Silverleaf lupine	Fabaceae
Lupinus argenteus	Anderson's lupine	Fabaceae
Lupinus grayii	Gray's lupine	Fabaceae
Lupinus polyphyllus	Marsh lupine	Fabaceae
Machaeranthera canescens	Hoary aster	Asteraceae
Melilotus officinalis	Yellow sweet clover	Fabaceae
Mentha arvensis	Mint	Lamiaceae
Mimulus guttatus	Yellow monkeyflower	Scrophulariaceae
Mimulus lewisii	Lewis' monkeyflower	Scrophulariaceae
Mimulus moschatus	Musk monkeyflower	Scrophulariaceae
Mimulus primuloides	Primrose monkeyflower	Scrophulariaceae
Monardella odoratissima	Coyote mint	Lamiaceae
Muhlenbergia richardsonis	Mat muhly	Poaceae

Botanical Name	Common Name	Family Name
Holodiscus discolor	Ocean spray	Rosaceae
Osmorhiza chilensis	Mountain sweet cicely	Apiaceae
Penstemon gracilentus	Graceful penstemon	Scrophulariaceae
Penstemon speciosus	Royal beardtongue	Scrophulariacae
Phacelia hastate	Silver leaf phacelia	Hydrophyllaceae
Phalaris arundinacea	Reed canary grass	Poaceae
Phleum pratense	Timothy	MDW, SEZ
Pinus contorta ssp. murryana	Lodgepole pine	Pinaceae
Pinus jeffreyi	Jeffrey pine	Pinaceae
Plantago lanceolata	English plantain	Plantaginaceae
Poa pratensis	Kentucky bluegrass	Poaceae
Polygonum arenastrum	Knotweed	Polygonaceae
Polygonum douglasii	Douglas knotweed	Polygonaceae
Populus trichocarpa	Black cottonwood	Salicaceae
Populus tremuloides	Quaking aspen	Salicaceae
Potentilla glandulosa	Sticky cinquefoil	Rosaceae
Potentilla gracilis	Cinquefoil	Rosaceae
Potentilla gracilis	Slender cinquefoil	Rosaceae
Pteridium aquilinum	Braken fern	Dennstaedtiaceae
Pterospora andromedea	Pine drops	Ericaceae
Purshia tridentata	Bitterbrush	Roscaceae
Pycnanthemum californicum	Pycnanthemum	Lamiaceae
Pyrola asarifolia	Wintergreen	Ericaceae
Pyrola picta	Wintergreen	Ericaceae
Ribes cereum	White squaw currant	Grossulariaceae
Ribes lacustre	Swamp currant	Grossulariaceae
Ribes nevadense	Sierra currant	Grossulariaceae
Rorippa curvisiliqua	Curve pod yellowcress	Brassicaceae
Rosa woodsii	Woods rose	Rosaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Rumex crispus	Curly-leaf dock	Polygonaceae
Salix exigua	Coyote willow	Salicaceae
Salix geyeriana	Geyer's willow	Salicaceae
Salix lemmonii	Lemmon willow	Salicaceae
Salix lucida ssp. *lasiandra*	Shining willow	Salicaceae
Salix scouleriana	Scouler's willow	Salicaceae
Salsola tragus	Russian thistle	Chenopodiaceae
Sarcodes sanguinea	Snow plant	Ericaceae
Scirpus acutus	Tule	Cyperaceae
Scirpus microcarpus	Small fruit bullrush	Cyperaceae
Sidalcea glaucesens	Glaucus sidalcea	Malvaceae

Botanical Name	Common Name	Family Name
Sidalcea oregana ssp. *spicata*	Meadow sidalcea	Malvaceae
Silene sp.	Campion	Caryophyllaceae
Smilacina stellata	Starry solomon's seal	Liliaceae
Symphoricarpos mollis	Creeping snowberry	Caprifoliaceae
Taraxacum officionalis	Dandelion	Asteraceae
Thalictrum fendleri	Meadow rue	Ranunculaceae
Tragapogon dubius	Goat's beard	Asteraceae
Trifolium longipes	Long-leaf clover	Fabaceae
Trifolium repens	White clover	Fabaceae
Typha latifolia	Cattail	Typhaceae
Urtica dioica	Stinging nettle	Urticaceae
Veratrum californicum	Corn lily	Liliaceae
Verbascum thapsis	Mullein	Scrophulariaceae
Veronica americana	American brooklime	Scrophulariaceae
Wyethia mollis	Mule's ears	Asteraceae

* Noxious Weeds as determined by the State of Nevada Department of Agriculture

Vegetation community structure in the project area is primarily forested with a mixed conifer overstory, and montane riparian and meadow vegetation along Edgewood Creek and its tributaries, and dispersed patches of montane chaparral. The forested habitats in the project area are dominated by an over-story of Jeffrey pine forest with white fir *(Abies concolor)* and lodegpole pine (*Pinus contorta* ssp. *murryana*). Lodgepole pines occur primarily along the riparian corridors, generally in seasonally wet soils such as meadow margins. Other over-story species include red fir (*Abies magnifica*) at higher elevations and occasional sugar pines *(Pinus lambertania).*

5.4.4.1 Upland Vegetation

The upland areas include other plant communities, such as mountain sagebrush and montane chaparral habitats. The sagebrush habitat type is dominated by mountain sagebrush (*Artemisia tridentata* ssp *vaseyana)* and bitterbrush (*Purshia tridentata*), and includes components of the montane chaparral habitat type. This includes mountain whitethorn *(Ceanothus cordulatus)*, and huckleberry oak *(Quercus vaccinifolia)*. Understory species found within the project area include greenleaf manzanita (*Arctostaphylos patula*), pine-mat manzanita *(Arctostaphylos nevadense)*, white squaw currant *(Ribes cereum)*, squaw carpet (*Ceanothus prostratus*), huckleberry oak *(Quercus vaccinifolia)*, and tobacco brush *(Ceanothus velutinus)*. Cone production by Jeffrey pines, as well as seed production by bitterbrush was excellent this year.

Upland canopy cover varies throughput the project area. Some of the steeper slopes, such as the section of creek east of Cypress Way, are covered with dense slash as well as pine needle mulch, and support little understory. These open canopies are generally stable, in spite of the steepness. Other areas support a fairly dense canopy, where few conifer seedlings were noted. Old logging

activities are visible throughout the project area, including flumes and roads, which have resulted in development of channels and gullies. Channels have developed along some old logging roads, such as at the end of Aspen Way off of North Benjamin, and continue to convey runoff.

5.4.4.2 Condition and Extent of Riparian Vegetation

Riparian habitat is associated with flowing and standing water. With the exception of Edgewood Golf Course, the pond and sections of creek above Highway 50 (PCC), sections of creek that become subterranean, and Boulder run at Heavenly Valley Ski Area, riparian vegetation is generally productive and healthy. There is enormous opportunity for natural recruitment by many species should a restoration project take place at some future date. Potential plant materials for restoration include seed, woody material (willow branches) and wetland sod. Some species are also available from commercial sources. No attempt was made to quantify acreage of material for this report, since aerial photos did not provide adequate detail. This can be done on a project specific level.

The composition of riparian vegetation varies with the steepness of the individual tributary. Steep, upper areas of watershed are dominated by conifers in the over-story, and have been historically, as evidenced by old stumps (Sue Fox, personal communication). Throughout the watershed, quaking aspen (*Populus tremuloides*) and Mtn. alder (*Alnus incana ssp. tenuifolia*), with species of willow (Lemmon's willow, *Salix lemmonii*; shining willow *(Salix lucida var lasiandra*) dominate the over-story vegetation. Other common woody species include American (creek) dogwood (*Cornus sericea*), Sierra currant (*Ribes nevadense*), swamp currant (*Ribes lacustre*), and Utah serviceberry (*Amelanchier utahensis*). Dominance of these species varied from site to site, but the basic structure remained the same.

The riparian habitat associated with the first and second tributaries appears to be healthy, stable, and relatively continuous along the length of the channels. The plants are large and provide a continuous canopy over the tributaries.

In the steep, mid to upper elevations (e.g., above 6800 feet in elevation), the vegetation is composed of alders, and alders and dogwood, respectively. The second tributary has two forks above approximately 6800 feet in elevation. An alder with a trunk at least two feet in diameter is present along the easternmost fork. Portions of this drainage that burned in the Gondola Fire (July 2002) were surveyed for a distance of several hundred feet. In some areas, the alders had stump sprouted, but not all showed evidence of doing so. Scant herbaceous understory was present in the riparian community along the steeper reaches of these drainages, but where the topography was occasionally level, some grasses and forbs grew. On the fourth tributary, alder is the dominant riparian plant with only occasional patches of willows on less steep slopes.

East of Highway 50, the riparian habitat lines the main channel in a fairly continuous pattern except for the following locations: the boulder cascades located upstream of Friday Station Pond; intermittent portions along the fourth tributary; and the Boulder Ski Run, Heavenly Valley Ski Resort. The lack of riparian vegetation along the boulder cascades is considered a natural condition due to the jumble of large granite boulders and lack of alluvial deposits. The fourth tributary is paralleled by an existing USFS road, which eventually narrows into a single-track

trail. Some portions of the tributary are devoid of riparian vegetation, perhaps as a consequence of the road's proximity. Prior to the westernmost fork of this tributary, someone has pruned the riparian plants from the trail. The extent of the disturbance is relatively minor compared to the overall length of the vegetated tributary.

At low elevations the vegetation consists mainly of willows, alders, and occasional, small aspen groves. Where channels flatten out and a floodplain occurs, herbaceous vegetation dominates. Dominant species include small fruit bullrush (*Scirpus microcarpus*), tall manna grass (*Glyceria elata*) and many-ribbed sedge (*Carex multicostata*). Other common species include *Leymus triticoides* (creeping wildrye), species of fireweed (*Epilobium sp*.), western aster (*Aster occidentalis*) and meadow rue (*Thalictrum fendleri*). A large wetland system in the vicinity of the eastern PCC property boundary is dominated by Nebraska sedge (*Carex nebrascensis*) and beaked sedge (*Carex utriculata*). This wetland sod could be harvested and used on restoration projects.

The construction of the Boulder Ski Run for Heavenly Valley Ski Resort in 1971 disturbed the stream channel and the associated riparian vegetation. The woody vegetation component appears to have been entirely removed during the lift's construction and the ski run's development (1971 Frantz photographs). The riparian vegetation currently found along the channels consists of willows and alders. Height of woody vegetation is seasonally controlled by mechanical means to be annually maintained in this stunted state. Branches that sprout from the plants were sparse and less than three feet in height. The clipped branches are piled and removed from the area. In several locations, dense patches of riparian vegetation adjacent to the ski run are principally composed of alders. These plants are at least ten feet in height. Because the alders grow on the edges of the ski run, it is assumed that controlling their growth by pruning is not necessary for ski area operation. The density and height of these plants suggests that a similar riparian component originally grew along this portion of Edgewood Creek. The riparian habitat alteration extends from the parking lot upstream for approximately one-third mile. Few riparian plants are present above the maintenance road at the top of the lift.

Vegetation around the perimeter of the Boulder parking lot, as well as on the ski run includes erosion control species seeded by the ski area and Forest Service, such as timothy (*Phleum pratense*), and smooth brome (*Bromus inermis*). Height of woody vegetation is seasonally controlled by mechanical means. Numerous locations of erosion and sedimentation were noted along the run up to the North Bowl chair (the extent of the survey), as well as iron-laden pockets of water. Erosion of the face of a fill slope at the North Bowl chair has resulted in sedimentation in portions of the channel.

Wetland vegetation on Edgewood Golf Course is primarily confined to the perimeters of the ponds and channels, and is dominated by herbaceous species such as small fruit bulrush, tule, and red fescue (*Festuca rubra*). Although saplings of willows and alders occur in a few locations, golf course maintenance practices preclude the establishment of older plants that could provide wildlife habitat. Large stands of cattail (*Typha latifolia*) occur around the perimeter of Pond #10, in contrast to the other ponds. A thick stand of Mtn. alder, willows, and currants occur near the highway culvert crossing.

5.4.4.3 Extent of Aspen Stands and Cottonwoods

Aspen are found in varying extents along the main channel upstream of Highway 50 to the Heavenly Valley Ski Area parking lot, and they grow along the low and moderate slopes of the first and second tributaries to approximately 6600 feet in elevation. No aspens were noted on the fourth tributary, and the third tributary was not surveyed. The aspens are found as stringers, small stands, and extensive groves. No aspen stands were noted on relatively drier upland sites independent of perennial water.

The Edgewood Creek watershed contains a mapped aspen-dominated stand > 2.47 acres (1 ha) as modeled in the Lake Tahoe Watershed Assessment (LTWA). The stand is located downstream of the Heavenly Valley parking lot and is upstream of the fourth tributary. A second stand of aspen is present between the first and second tributaries along the main channel. The stand is not continuous but is composed of numerous distinct groves, some of which extend up the tributaries. The aspen in this region vary in age and structure. In the vicinity of tributary one (PCC property), the trees range from mature, occasional standing dead, at least two freshly fallen, as well as intermediate-aged and young trees. In the vicinity of tributary two, a stand of young aspen encompasses approximately 0.5 acres and occurs as an understory layer beneath a scattered over-story of lodgepole pine.

A unique stand of mature and decadent cottonwood is located in the vicinity of the easternmost fork of the fourth tributary (T13N R18E northeast ¼ northeast ¼ section 25). This patch is less than approximately three acres in size and is situated west of the mapped flow and below the mapped road (on the USGS South Lake Tahoe quadrangle). The trees in this stand are large, one was approximately 36" dbh. There is some regeneration as several small cottonwood trees approximately 8-10" dbh were present. Many of the largest trees are dead topped. No aspens were present in the cottonwood stand.

Several large downed cottonwoods were present, but none appeared recently fallen. The understory consists mainly of grasses. The stand is downstream and adjacent to a contiguous patch of willows growing in a bowl shaped basin less than 5 acres in size. The willows are more than 10 feet in height and skunk cabbage was present in a few openings. Two standing dead trees ($\geq$ 12" dbh) , a lodgepole and a Jeffrey pine, were present in the midst of the willows. If this patch retains standing water during summer, it could provide potentially suitable nesting habitat for willow flycatchers. It is not designated as either emphasis or suitable habitat by the USFS. At approximately 7,160 feet in elevation, it is within the elevational range of documented breeding sites in the Sierra Nevada 4,000 to 8,000 feet (USDA 2001). Large Jeffrey pine tree stumps (> 5' dbh) are present on the periphery of this basin.

In some locations, aspen stands might be becoming more numerous, as the example of the young stand in the vicinity of tributary two suggests. Based on ocular estimates of canopy closure and diameter at breast height, the aspen stands in the Edgewood drainage appear to be young and intermediate aged stands. Canopy cover is lower in mature aspen stands (25 to 60%) than in young and intermediate aged stands (60 to 100%) (Verner 1988). Root suckering was observed in all the aspen stands, which indicates that there is regeneration. Few standing dead aspens were

noted and no aspens with large diameter trunks (> 24" dbh) were observed. No historic graffiti was noted on any of the trees.

No evidence of historic cutting of aspen was found. However, the stands in the vicinity of tributary one are mixed with various size conifers, mainly lodgepole. If conifers are prominent within aspen stands, then it is likely that aspen is not the dominant tree species at climax (USDA 2000). Whether this is the case in this location would require further investigation. Whether aspen were ever more extensive between the first and second tributary could not be determined. Portions of this area are heavily shaded by dense conifer cover.

The spatial extent of the existing aspen groves has probably been affected by the establishment of the road adjacent to the north side of the main channel. However, the loss of this potential habitat is minor.

5.4.5 Conifer Encroachment of Riparian Areas

Within the lower watershed, white fir and lodgepole pine occur adjacent to the creek in several places, but do not appear to be out-competing riparian vegetation at the present time. This could occur if the system becomes drier, and is considered a natural process. However, as stated above, fire suppression has led to encroachment of conifers in some steeper areas of tributaries to Edgewood Creek, suppressing riparian vegetation. Along selected steep reaches of tributary #2 in the upper watershed, sugar pines occur adjacent to the channel, and old stumps indicate that this is a historical condition.

Aspen stands represent a significant ecological resource, that has the potential to expand where conifers are indeed encroaching. Aspen are intolerant of shade, and shade tolerant conifer species may eventually replace an aspen community. They are designated an Ecologically Significant Area (ESA) in the LTWA for two reasons: they have an exceptionally diverse array of associated species, and they are uncommon in the Lake Tahoe basin. Using the 1991 CalVeg vegetation layer (USDA 1991) and the criteria of aspen stands > 1 ha, Manley and Schlesinger (2001), estimated that less than 0.5% of the basin's land area consists of aspen. Manley and Schlesinger (2001) further suggest that aspen and cottonwood in the basin may function as keystone species because they rated relatively high in diversity (richness and composition) despite occurring infrequently on their sample reaches. A keystone species is one "whose impact on its community and ecosystem is large, and disproportionately large relative to its abundance" (Power et al. 1996).

Aspens and cottonwoods are associated with soils that are seasonally flooded and are commonly associated with riparian environments. Aspen stands typically have an open canopied structure and a well-developed understory including a high diversity of shrubs, grasses, and particularly herbs. Aspen communities are considered highly productive environments because of their high insect populations and the high food value associated with their catkins, buds, and leaves (Verner 1988). In the Lake Tahoe basin, aspens and cottonwoods are associated with high richness of birds, mammals, and insects (Manley and Schlesinger 2001).

If conifer invasion leads to the eventual loss of the aspen community then there would be a concomitant decrease in the associated biological diversity in the Edgewood watershed. Conifer invasion in the near-stream zone, as a consequence of fire suppression, would be considered an adverse impact. If however, conifer invasion occurs as a consequence of natural succession, then a decline in biodiversity would be a natural process. Further research (e.g., soil types) would be required to understand the nature of these potential scenarios.

5.4.5.1 Factors Affecting Aspen/Conifer Dynamics in Riparian Areas

As with the rest of the Tahoe basin, factors affecting aspen stand succession and regeneration are large scale, occur throughout the basin and are not unique to the Edgewood Creek watershed. Aspen stands are typically ephemeral, and are replaced by coniferous trees (or infrequently grasslands and shrublands) if succession progresses without disturbance (Manley and Schlesinger 2001). However, Barry (1971) considered most aspen stands in the Sierra Nevada to be stable communities adapted to ecotonal areas between forest and meadows. It is likely that aspen is not the dominant tree species at climax when conifers are prominent within aspen stands.

Fire is the most common form of disturbance that retains the presence of "seral" aspen stands (Jones and DeByle 1985). Whether fire suppression in the basin has affected the extent and character of aspen stands is unknown. Fire has been suppressed in the basin since the 1920s. Normally there would have been between three to five fires in the mixed conifer and pine zones (Manley and Schlesinger 2001). Historically, the Washoe tribe used fire in the basin, particularly in or near meadows. Fire would have eliminated encroaching conifer saplings and perpetuated aspen communities by improving soil conditions (Cryer and Murray 1992). However, the extent and frequency of fires set by the Washoe tribe is not known.

In the vicinity of tributary one, the lodgepole in the meadow and in the aspen stand, might have been previously controlled in this way. It is likely that lodgepole pine has become more prevalent throughout the basin, particularly in association with riparian and meadow environments because of the lack of fire (Manley and Schlesinger 2001). Lodgepole pine has thin bark and is readily killed by fire (Whitney 979). Lodgepole has been cut from the meadow, which is another method to control its intrusion into either community. Grazing can alter aspen's vegetative character, but no evidence of impacts from livestock grazing was noted. Livestock have not grazed in this area for several years.

The following description of the response of aspen to disturbance is from the LTWA (USDA 2000): "As an aspen stand matures, a nutrient rich mollic soil layer develops. Aspens thrive in this rich humus layer, but over time the stands will degenerate without disturbance. As a stand deteriorates, amendments to and nutrients in the organic layer are reduced, and in turn the demise of the stand is perpetuated. Low to moderate intensity burning tends to maintain productive aspen stands on ideal soil types (Schier and Campbell 1978; Howard and Tirmenstein 1996). A deteriorating aspen stand that is burned may be more likely to revert back to a more productive stand because burning increases soil pH and adds organic carbon and nutrients to the soil (Cryer and Murray 1992). Potter (1994) recommends that treatments involving the mechanical pushing of aspen followed by broadcast burning may rejuvenate aspen stands showing stagnation.

5.5 Conclusions

The majority of riparian vegetation, with the exception of heavily developed areas, is dense, thriving, and intact with reproduction occurring in numerous woody and herbaceous species. There is enormous potential for natural recruitment of native plants if disturbance occurs, as with restoration projects. Introduced cultivars, such as erosion control species, are mostly confined to erosion control projects and do not appear to be invasive or problematic at the current time. Noxious weeds were also only found in disturbed, isolated areas to date. Some old growth conifers, including Jeffrey and sugar pines, as well as cottonwoods, occur in the watershed. Conifers occur adjacent to various sections of channel in the upper watershed where they have occurred historically. In the lower watershed, conifers also occur adjacent to channels but are not out-competing riparian vegetation at the current time. However, in selected areas, conifers, especially lodgepole pines, may be out-competing riparian vegetation due to fire suppression. These areas should be clearly identified, mapped, and considered for selective hand thinning of white fir and lodgepole pine. The previously mentioned species occurring in 'match stick' stands could be removed using hand crews, since controlled burns are probably not an option due to the urbanized nature of parts of the watershed as well as other factors such as air and water quality. However, a stand improvement plan must consider and evaluate disturbance that might occur during the selective thinning process, as well as disposal of resulting timber and slash. Stand improvement must not result in increased potential for erosion

Tahoe yellow cress, an Endangered species, occurs at the outlet of Edgewood Creek. No other sensitive species were located, and habitat is limited.

Noxious weeds, although only located in two places during the survey, are a concern, especially on construction projects. Nevada State seed laws do not allow any Noxious Weeds, as defined by the Nevada Department of Agriculture, in any seed. However, noxious weeds may be entering a project site through mulches, composts, imported fill material, and from vehicles. It is recommended that future erosion control and restoration projects be monitored for noxious weeds. This will require adequate funding by the overseeing agencies. Although the Nevada State laws do not allow for Noxious Weeds, the state law does NOT require that seed mixes be 100% 'weed' free since the state allows for up to 1.5% weed seed, as well as 2% of 'other crop'. This allows for invasive, nondesirable species such as cheatgrass (*Bromus tectorum*) sweet blossom clover (*Melilotus alba,, M occidentalis*) and alfalfa (*Medicago sativa*). It is therefore also recommended that future specifications exceed Nevada requirements for seed.

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6.0 TERRESTRIAL WILDLIFE REPORT

6.1 Introduction

The purpose of Tech Memo II is to present the results of field reconnaissance surveys in the project area, provide an assessment of limiting factors within the Edgewood Creek watershed for threatened, endangered, at-risk or special interest species, and compile and link data to the GIS database. Questions posed in Tech Memo I are also addressed here. In addition, information on wildlife conditions, which was previously unavailable for Tech Memo I, is presented. (The purpose of Tech Memo I was to provide on overview of terrestrial wildlife conditions for the Edgewood Creek watershed using existing reports and resources.)

Field reconnaissance surveys were conducted in the following portions of the Edgewood Creek watershed: mouth of creek at Lake Tahoe to Highway 50; Friday Station Pond upstream to the tributary at the east end of the Park property; the first tributary (tributaries are numbered from west to east) upstream to approximately 8640 feet in elevation; the second tributary to approximately 7480 feet in elevation; the fourth tributary, which has two mapped forks, to elevations of approximately 7280 and 7240, respectively; the main channel of Edgewood Creek from the first tributary to the fourth tributary; and Edgewood Creek along the Heavenly Ski Run to an elevation of approximately 7840 feet in elevation. The third sequential tributary, which crosses beneath Kingsbury Grade, was not surveyed.

Surveys were performed in portions of the watershed that are likely to provide high wildlife values. For example, the junctions of the first and second tributaries with Edgewood Creek, in contrast to the portions of the creek adjacent to Kingsbury Grade, which was not surveyed. The surveys were performed in a cursory fashion to cover as much area as possible (since wildlife conditions vary by habitat type and elevation) while still developing a reasonable overview of existing conditions. No surveys for threatened, endangered, or at-risk or special interest species were conducted. Existing state and federal records were used to assess current and historic TES species occurrences.

In addition to the sources cited in Tech Memo I, information for Tech Memo II was derived from the following sources: NDOW 20-year deer survey data; occurrence records for sensitive species compiled by the Nevada Natural Heritage Data Base (NHDBB); and the Burned Area Emergency Rehabilitation Assessment Report (USDA 2002).

A potentially useful source of information on wildlife occurrences in the Edgewood Creek watershed is the raw data collected for the report titled *Riparian Biological Diversity in the Lake Tahoe Basin* (Manley and Schlesinger 2001). Four sample reaches were located along the main Edgewood Creek channel. Data was collected on birds, mammals, amphibians, and invertebrates. The 2001 report does not present the data by watershed. Attempts to review the data prior to submission of Tech Memo II were unsuccessful.

6.2 Updated wildlife occurrences

Amphibians

Two species of amphibians occur in the golf course portion of the Edgewood Creek watershed. Both adult and juvenile (i.e., recent metamorphs) western toads (*Bufo boreas*) were observed around the margins of all the golf course ponds on September 10. Two long-toed salamander (*Ambystoma macodactylum*) larvae were detected at Edgewood Golf Course in 1998 (cited in USDA 2000). Attempts to discover from which pond the larvae were collected via personal communication were unsuccessful.

Vole (*Microtus spp.*) burrows observed near the golf course ponds provide potential cover and winter hibernation sites for amphibians. Burrows were not seen more than several feet distant from a pond's periphery. Areas with tall, naturalized grass and riparian shrubs also contained networks of vole burrows and trails. Burrows were not present in the fairways.

No amphibians were noted in other portions of the survey area. The field surveys were not conducted at a time of year conducive to detecting amphibian adults, eggs, or larvae (e.g., spring, summer). The following sites surveyed within the watershed contain potentially suitable amphibian habitat, which would be worth surveying at the appropriate time of year: the meadow upstream of Friday Station Pond; the marsh area situated where the first tributary enters the main channel; the cottonwood stand; and the main channel between the second and fourth tributaries.

Goshawk

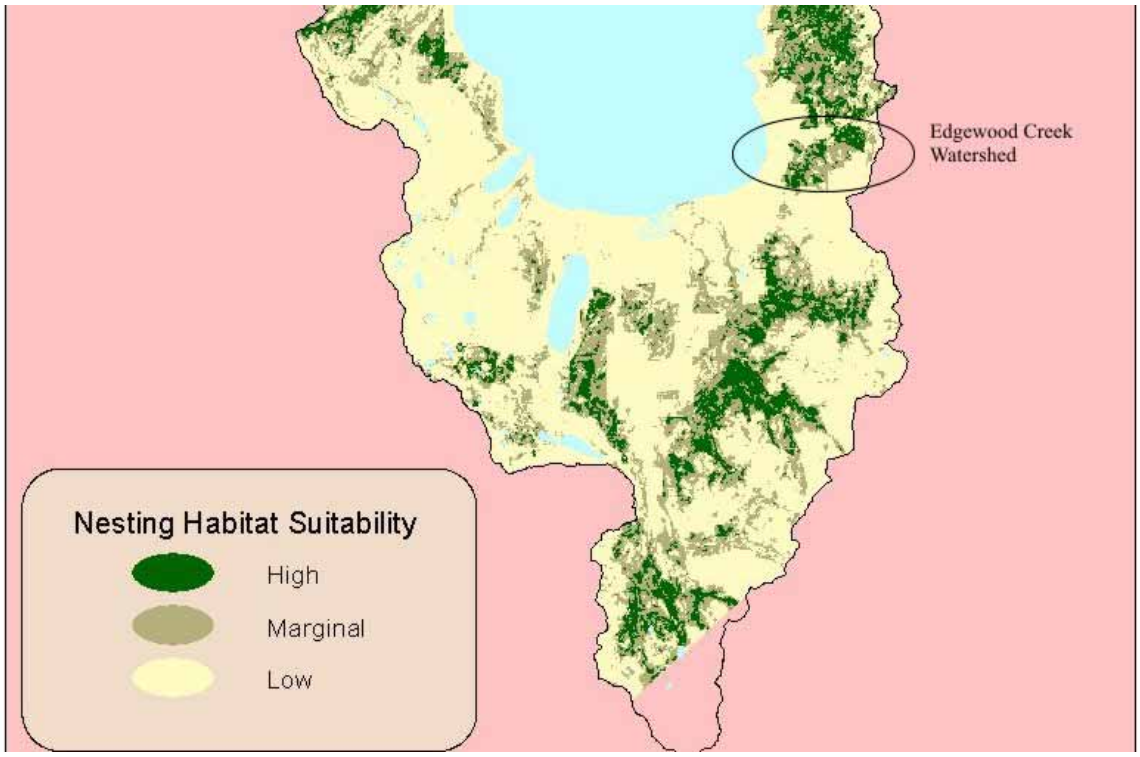
The database search conducted by the USFS and Nevada Natural Heritage Program (NNHP) did not show any records for nesting northern goshawks (*Accipiter gentilis)* in the Edgewood Creek watershed. However, a record of a goshawk nest, labeled GO25uh992, was hand-written on the South Lake Tahoe USGS quad map for my files. The purpose of the USGS map was to record all special status species occurrences documented in the Lake Tahoe Basin for my files. The records were copied onto the quad from the paper records at the South Lake Tahoe USFS office in the late 1980s and early 1990s.

Lori Allesio, USFS Lake Tahoe Basin Management Unit (LTBMU), special uses, was contacted for further information regarding this record because she was a wildlife biologist in the South Lake Tahoe office in the late 1980s and early 1990s. She recalled a historic, inactive nest territory in the Edgewood Creek drainage, presumably the one depicted on my map. Year(s) of occupancy for this territory are currently unavailable. The historic nest territory is located in Township 13 north, Range 18 east, southeast ¼ northwest ¼ section 25. It does not appear that any activities (e.g., logging) have occurred in the vicinity of this site, which would render the habitat unsuitable. It is possible that increased urban development on Edgewood Drive, Vista Drive, and adjacent streets, and increased recreational use has created disturbances that make the site less suitable. Because it is unknown where the actual nest was, this is only speculation.

A model depicting suitable nesting habitat for goshawks, ranked from high to low, was developed by Shane Ramsos (TRPA, wildlife biologist) for the Lake Tahoe basin. For the Edgewood Creek drainage, the model shows suitable high quality nesting habitat is located in

portions of the mid to upper elevations of tributaries one, two, and three (see Figure 6.1). The model is an additive model that created a basin-wide surface of relative nest site suitability. The most current Northern Goshawk nest site GIS layer (location data from 1978 to 2000, n = 50) was used as the bases for this model to identify suitable goshawk nesting habitat through the Lake Tahoe Basin. It was assumed that environmental variables associated with known nest sites were indicative of habitat variables that might be selected for throughout the Tahoe region. All nest sites were buffered to 100 and 200 meters. Buffers were then intersected with several other GIS layers, representing vegetation (using the 1997 tmueveg USFS Remote Sensing Lab for vegetation type, size, canopy cover), slope, aspect, elevation, distance of nest to streams, and land use, in order to summarize parameters associated with the location of known nest sites.

FIGURE 6.1 GOSHAWK NESTING SUITABILITY IN THE EDGEWOOD CREEK WATERSHED (TRPA MODEL).



White-wash and several plucking sites (e.g., Stellar's jay, Douglas squirrel) were observed in the proximity of the second tributary at approximately 7,000 feet in elevation. Although such signs can be attributed to an Accipiter, they cannot definitively be attributed to goshawks. Nonetheless, the signs are additional evidence that goshawks are likely using the Edgewood Creek watershed.

Protocol surveys (USDA 2000) for goshawks were conducted by a private contractor in Van Sickle State Park in 2003. Two goshawks were detected along the Eagle Rock Creek Tributary to Edgewood Creek on June 27, 2002. This area was burned in the July Gondola Fire, which created unfavorable habitat conditions for goshawks. No goshawks were detected in the

subsequent survey conducted in 2002. Dawn acoustical surveys for goshawks will probably begin in February 2003.

California Spotted Owl

The California spotted owl (*Strix occidentalis occidentalis*) is a LTBMU sensitive species and a federally proposed threatened species. The remnant old-growth trees in tributary two provide potential nesting habitat for spotted owls, however, no signs (e.g., pellets, feathers) were detected. Protocol surveys (USDA 1993) for California spotted owls were conducted in the Van Sickle State Park in 2002. No auditory or visual detections of California spotted owls or other owl species were documented in the survey area. As required by the protocol, a second year of surveys for spotted owls will be conducted in 2003.

Marten

Winter furbearer surveys conducted by NDOW in 2002/2003 confirmed the presence of American marten in the watershed. Martens were detected at two different remote camera stations located within the Van Sickle portion of Lake Tahoe Nevada State Park.

Blue Grouse

Blue grouse (*Dendragapus obscurus*) are an LTBMU Management Indicator Species. Blue grouse scat was observed in the vicinity of the easternmost fork of the fourth tributary (T13N R18E northeast ¼ northeast ¼ section 25). Suitable habitat for this species is located in the upper elevation, forested portions of the watershed.

White headed woodpecker

White-headed woodpeckers (*Picoides albolarvatus*) do not have any special status designation in the LTBMU. However, they are a Region 4 (Toiyabe National Forest) USFS sensitive species. White-headed woodpeckers were observed in the vicinity of the second and third tributaries.

Pileated woodpecker

Pileated woodpeckers (*Dryocopus pileatus*) are an LTBMU Management Indicator Species. This species excavates large, conspicuous rectangular shaped holes in standing dead trees. Such sign was not noted in the survey areas.

Golden eagle

The golden eagle (*Aquila chrysaetos*) is a TRPA Special Interest Species. A golden eagle feather was found beneath a large Sugar Pine (> 36 " dbh) in the upper elevation of the second tributary.

Mule deer

Mule deer (*Odocoileus hemionus*) are a TRPA Special Interest Species. The Edgewood watershed is located within the summer range for the Carson River deer herd. Mule deer sign (e.g, scat, tracks, browsed shrubs) was detected throughout the watershed upstream of the boulder cascade. Sign was most common in the vicinity of the tributaries and was less frequently noted near the main channel. Stump sprouting vegetation, including both montane chaparral (e.g., golden chinquapin) and riparian vegetation (e.g., alder) in the burned areas (Gondola fire) surveyed near the first and second tributaries were heavily browsed by mule deer. Foraging by

deer in the burned area might temporarily increase as a result of the shrub growth, but the burned area is not expected to contribute to an increase in herd numbers through increased availability of forage.

No fawning habitat is mapped in the watershed. A migration corridor is located in the watershed's higher elevations near the periphery of Heavenly Valley Ski Resort. The regional migrations of the Carson River deer herd entail movements from summer range to lower elevation winter range located in the Carson Valley.

The Carson River herd is an interstate herd that is managed by both the Nevada Division of Wildlife and the California Department of Fish and Game. Agency information on deer use of specific watersheds, such as the Edgewood Creek watershed, is not collected as habitat use by deer is monitored at a larger scale than specific watersheds. The population of the Carson River deer herd is dynamic, and varies from year to year. However, in general, deer numbers are declining; when herd numbers peak, they do so at lower and lower numbers (Mandeville NDOW personal com). Numerous factors contribute to declining deer numbers, including long-term changes in vegetation structure due to historic logging and fire suppression, as well as disease. However, the primary factors are development in deer winter range (e.g., along the Carson front) and summer range (e.g., the Tahoe Basin, including the Edgewood Creek watershed) with the concomitant loss of habitat, disruption of migration routes, and mortality due to collision with vehicles.

Black Bear

Although no population figures are available, the number of black bears in the Edgewood Creek watershed is higher than average (Lackey, NDOW, personal com). The watershed is excellent bear habitat and provides essential habitat components such as food, water, escape cover, travel corridor, and den sites. Bears that occupy the watershed are large, healthy males. Several NDOW radio-collared bears occur in the vicinity of the watershed.

At night, bears forage on garbage in the adjacent neighborhoods and then retreat to the drainage during the day. Nuisance bears have been a problem in the Kingsbury Grade area, according to Ann Bryant, executive director, Bear League, and five bears were destroyed in that area last year. In addition, bears have been hit by cars. The number of nuisance calls the NDOW responded to has decreased since two of the larger homeowner associations, Tahoe Village and Lake Village, required homeowners to use bear-proof containers for refuse (Lackey, NDOW, personal com). The NDOW has conducted trap-and-release of problem bears in the watershed, as well as aversion conditioning. The number of bear nuisance calls would be expected to further decrease if additional homeowners in the vicinity of the Edgewood watershed also used bear-proof garbage containers.

Mountain Beaver

The mountain beaver (*Aplodontia rufa*) is a Nevada state species of concern. Potentially suitable habitat is present along the Edgewood Creek riparian corridor. Preferred foraging habitat (e.g., grasses, sedges, forbes) is scarce in the upper elevation reaches of the tributaries. Woody vegetation in the riparian corridors consists of alder and dogwood with little herbaceous

understory. In places where step pools are present, grasses, sedges, and forbes grow, but only within the vicinity of the pool. Away from the immediate riparian corridor, conditions abruptly shift to montane shrubs or conifers. Potential burrows were noted in two locations, at approximately 6800 feet in elevation along the second tributary, and in the vicinity of the main channel, south of the fourth tributary. However, no other sign, such as scat, tracks, or browsed vegetation were noted, and it is possible the burrows were dug by another species. A more thorough inventory of these locations would better evaluate whether this species is present.

Sierra Nevada Snowshoe Hare

The Sierra Nevada snowshoe hare (*Lepus americanus tahoensis*) is designated a federal species of concern, a California species of special concern, and a USFS sensitive species. The Sierra Nevada snowshoe hare is a subspecies of the snowshoe hare that is restricted to the Sierra Nevada mountain range (Zeiner et al. 1990). Lagomorph scat was noted in the vicinity of the junction of the fourth tributary with the main Edgewood Creek channel. No other signs, such as clipped browse or urine marks (reddish or yellowish deposits that form a crust on the dirt) were detected. The size of lagomorph scat cannot be relied upon for species identification, but in conjunction with geographic location and habitat type, a reasonable assessment of species identification can often be made without direct observation of the animal. The Edgewood Creek watershed provides potential habitat for both snowshoe hares and Nuttal's cottontail (*Sylivagus nuttallii*).

Beaver

Beavers (*Castor canadensis*) are a species of interest because of their potential impacts to watersheds through their dam building activities and because aspens are a preferred food source. Old beaver sign was noted in the meadow above the Friday Station Pond, but no recent sign was found in this location. Beaver were last noted in this area, informally called beaver meadow, by an Edgewood Golf Course employee more than ten years ago (Seibel, personal communication). A single beaver occupied Friday Station Pond for approximately one year prior to summer 2002. Water from the pond is used to irrigate the golf course. The beaver plugged the pond's outflow with its dam debris. As a consequence, the golf course operator's raised the pond's level so that water flowed over the top of the debris dam. The beaver was trapped and removed in fall 2002 per consultation with NDOW. No additional sign of beaver activity was noted in other portions of the watershed.

6.3 Wildlife Species Occurrence in Aspen Stands

A variety of mammal species are known to use aspen for cover, nesting, thermal insulation, and foraging. Young stands of aspen, especially during fall and winter when protein content of aspen is high relative to other shrub species, provides forage for mule deer. However, no mule deer use was detected in the vicinity of the aspen stands. Black bears forage on berry producing plants and forbs in the understory of aspen stands. It might be assumed that the watershed provides sufficient food for black bears since the bear scat observed in the watershed consisted of grasses, forbs, and berries, not garbage. Aspen groves also provide bears with suitable denning sites. Lagomorphs (rabbits, hares) eat quaking aspen buds, twigs, and bark year round. Small rodents including squirrels, pocket gophers, mice, and voles feed on aspen during at least part of the year. Most of the aspen stands investigated were composed of young and intermediate age trees.

These trees do not typically have the abundant nest cavities associated with mature and decadent stands of aspens. Because the Edgewood Creek watershed was surveyed in fall, birds were harder to detect, but the typical complement of birds that occupy aspen stands in the Lake Tahoe basin would be expected to occur in the Edgewood watershed (see Manly and Schlesinger 2001).

6.4 Amphibian Habitat

Prior to the arrival of Europeans in the Lake Tahoe Basin, it is possible that fish did not occupy more than approximately one mile of the main channel of Edgewood Creek. The boulder cascades, which are situated upstream of Friday Station Pond, currently block fish passage and the water is subterranean in some portions. Assuming the boulders are a natural occurrence and that the Washoe Indians did not transplant fish, then it is likely that the main channel was historically without fish. "Milk can plantings" of non-native fish could have begun as early as the beginning of the twentieth century with formal agency transplants occurring thereafter.

The historic conditions of Edgewood Creek could have provided suitable habitat for mountain yellow-legged frog. Preferred habitat for mountain yellow-legged frog is well-illuminated, sloping banks of meadow streams, riverbanks, isolated pools, and lake borders with vegetation that is continuous to the water's edge (Martin 1992). Suitable breeding habitat is considered to be low gradient (up to 4%), perennial streams, and lakes. These stream types generally have the potential for deep pools and undercut banks, which provide habitat for this frog.

Non-native trout have adversely affected known populations of mountain yellow-legged frogs through predation (see citations in USDA 2000). The introduction of non-native trout in the main channel of Edgewood Creek might have caused the local extirpation of any mountain yellow-legged frogs. This is speculative since no records of occurrence for this species were found.

Long-toed salamander larvae could potentially occur in the shallow portions of Friday Station Pond and in suitable habitat upstream of the boulder cascades. Suitable habitat consists of temporary ponds, wet meadows, and flowing water. Long-toed salamander larvae are cryptic, wary, and can be difficult to see and/or net. Without focused surveys, it is not possible to determine the extent of their occurrence within the Edgewood Creek watershed. However, it is likely this species occurs in more than their current recorded location (i.e., Edgewood Golf course ponds).

Bullfrogs (*Rana catesbiana*) are documented in the southern portion of the Lake Tahoe basin, including the Tahoe Keys marina and near the mouth of the Upper Truckee River. The Edgewood golf course ponds and Friday Station Pond provide potential habitat for this non-native species. However, bullfrogs have not been documented in these ponds, and none were observed during the field survey. Bullfrogs are considered undesirable because they prey on native amphibians. Predaceous birds, including herons, mergansers, cormorants, and kingfishers, forage at these ponds, and presumably would also prey on any bullfrogs and their larvae.

Suitable breeding habitat for native amphibians is not typically present in the upper elevations of the tributaries. The tributaries tend to be steep, with only occasional step pools. Old logging

roads cross the second tributary in at least two locations. Water pools above some of these crossings and could provide potential amphibian breeding habitat. The watershed habitat with the highest potential to support amphibians is typically located in the vicinity of the main channel where the tributaries enter. In particular, the marshy area upstream of the first tributary (PCC property) provides potentially suitable habitat for most of the amphibian species known to occur in the watershed. Livestock (e.g., cows, horses) grazing can adversely affect amphibians through direct loss of eggs, larvae, and adults due to trampling (personal observation). However, the marsh does not appear to have been grazed for several years and such impacts are unlikely to have recently affected any amphibians.

If optimal conditions are defined as those that maximize opportunities for occurrences of native species, then current conditions in the Edgewood Creek watershed might be considered less than optimal for some species of amphibians (e.g., mountain yellow-legged frog). The habitat from the mouth of Edgewood Creek upstream to the Highway 50 crossing provides suitable habitat for two species of amphibians, however it cannot be unequivocally stated whether these conditions are optimal. Prior to historic and recent disturbances (e.g., agriculture, grazing, and the golf course), it is possible that the area provided habitat for the same two species (i.e., long-toed salamander, western toad) if the stream formed a lagoon because of a barrier beach. Relict channels in the meadow could also have provided suitable habitat for both species.

The TRPA Environmental Improvement Plan stream assessment for Edgewood Creek (2001) notes the presence of pacific tree frog larvae and adults in the upper reach of Edgewood Creek located within Heavenly Valley Ski Resort. This species also is likely to occur in the downstream reaches of the watershed and possibly in the golf course ponds.

6.5 Old-Growth Wildlife Habitat

The condition of the watershed's forest shows considerable variation from previously harvested areas to patches of uncut timber. Timber harvesting and fragmentation began in the 1860s. Extensive clear cutting of the forests (approximately 60%) ended at the turn of the twentieth century. Uniform harvesting of timber did not occur, more than 60% of the low elevation pine forests were harvested, whereas only a fraction of higher elevation fir forests were cut, and very little of the subalpine forest was entered (USDA 2001). Fire suppression management since the 1920s resulted in a trend of increasing density of forest stands. This condition is apparent in lower elevations of the watershed. However, even in areas where harvest has occurred, numerous large trees are interspersed throughout, including large standing snags (> 36" dbh).

Old-growth late successional forests are forests with a high degree of structural complexity, a high density of large trees, snags, and logs. Only five percent of forested land in the basin is considered to be old growth status. It is estimated that the distribution and extent of precontact old-growth forest in the Tahoe basin was 55%. No old growth stands were mapped in the watershed using the criteria developed for the LTWA (2001). However, there are locations in the watershed were old growth is present. Perhaps the criteria for canopy cover were insufficient to detect the stands in the LTWA model.

Very large sugar pines (> 5' dbh) were felled in the vicinity of the two forks of the second tributary (determined through the presence of stumps). Many of the cut trees were not entirely harvested as numerous large down logs are present at the sites were the trees were felled. There are still standing large diameter old-growth sugar pines, white fir, and Jeffrey pine. But these trees occur as a relatively narrow strip along the drainages. Tall thickets of white fir grow where trees were previously harvested. The current forest surrounding the upper reaches of the main channel in the vicinity of Boulder Ski Run, Heavenly Valley (west side of the run) consists of old growth white pine and Jeffrey pine. Outside the area of immediate effects from development of the ski run, no stumps or other evidence of previous timber harvest were noted. Although the habitat might not have changed much in this location, other changes, such as the ski area and associated urbanization have probably altered the suability of this habitat for sensitive wildlife species that prefer late seral stage forest.

The wildlife expected to occur within the old-growth forest in the watershed includes species typically associated with late seral forest in the Lake Tahoe basin, such as northern goshawk, pine marten, and spotted owl. All but the latter species are documented in the Edgewood watershed.

6.6 Riparian Habitat Value to Wildlife

Alder and willow are typically considered a highly productive environment capable of supporting a high vertebrate diversity because of their association with water and because deciduous trees are associated with food resources (i.e., edible plant material and associated with phytophagus insects) (Grenfell 1988). Riparian environments support a greater richness of bird species than upland environments (Manley and Schlesinger 2001). Riparian vegetation provides potential cover, nesting and foraging habitat for the variety of birds known to use this habitat type for one or more portions of their life history in the Lake Tahoe basin (e.g., neotropical migrants such as the yellow warbler). The riparian community also provides habitat for typical mammal fauna including black bear, mule deer, raccoon, weasel, lagomorphs, and bats. Because the stream channels are considered stable, it is unlikely the habitat function will change over time. Manley and Schlesinger (2001) suggest that alder-willow can potentially degrade the suitability of a stream reach for some aqua-dependent bird species (e.g., dippers), may pose a physical barrier to foraging by such birds, and may potentially reduce stream productivity by

occluding sunlight. They caution that conservation efforts should not assume that more alder willow will necessarily enhance the diversity of stream associated bird species. However, often times those benefits are outweighed by stream stability benefit.

6.7 Current and Probable Historic Wildlife Conditions of the Edgewood Golf Course

The historic conditions of the Edgewood Golf Course were very different from current conditions. Historic habitat probably consisted of large wet and dry meadows, perhaps a backwater lagoon in some years, relict channels, and riparian vegetation associated with the stream. In addition, the surrounding habitat was different based on the historical accounts of Washoe Indians who collected service berries, roots, and grass seeds at Edgewood Creek (USDA 2000). The precontact environment provided habitat for a variety of wildlife classes. The

conversion of the original habitat into a golf course has resulted in a loss of riparian habitat. The current conditions of this portion of the watershed no longer provide potentially suitable habitat for nesting willow flycatchers or for other species of birds dependent upon riparian structure for some or all of their life history requirements. It is likely that prior to the development of the golf course, potential habitat for willow flycatchers was present. However, cattle grazing, which occurred prior to development of the golf course, is also known to adversely affect nesting willow flycatchers. Mammals that might have occurred in the lower reach of the watershed include those extirpated from the state (e.g., grizzly bear) and species that were rare in the basin, such as the otter (Orr 1949).

A model used to predict aquatic/riparian bird species richness in the Lake Tahoe Watershed Assessment (USDA 2000), designates the four ponds at Lake Tahoe Golf Course (Edgewood) as potential hotspots of aquatic/riparian bird species richness. Lentic analysis units with high potential aquatic/riparian bird species richness were generally found at lower elevations with an abundance of nearby meadows and minimal nearby forest. These potential hotspots of aquatic/riparian bird diversity were chiefly large areas in basins with gentle sloping areas. However, the model predictions might be less accurate than suggested by the 90% confidence intervals because human disturbance was not included as an explanatory variable. Furthermore, many areas predicted to have high bird species richness were in highly disturbed sites such as golf courses. The classification of golf courses as meadows in the vegetation map layer obviously affects the results. Bird species richness is positively correlated with meadows, but it is likely that golf courses support a lower diversity of species because of the homogenous vegetation structure, use of herbicides, and human presence (Manley and Schlesinger 2001). Fewer species and numbers of birds were observed on the Edgewood golf course compared to those observed in the meadow associated with the Upper Truckee River, approximately four miles southwest of the Edgewood watershed (personal observation).

However, golf courses might provide quality habitat for some birds, because the ponds on golf courses were among the most species-rich sites surveyed by (Manly and Schlesinger 2001). The TRPA has designated Edgewood Golf Course as one of 18 sites as "mapped waterfowl habitat." Data on avian species richness and diversity, which TRPA has been collecting since 1999, ranks the habitat for Edgewood Creek as 12th out of the 18 sites (i.e., ranked in the lower quartile) (Romsos, personal communication). It is unknown if the surveys were conducted when the golf course was open to users, or if the surveys were performed prior to or after the golf course was opened or closed for the season. The ponds provide a type of habitat that was probably not present year-round prior to conversion of the stream reach into a golf course. As such, they can be considered enhancements. In particular, the cattail marsh systems in the ponds provide excellent habitat for a variety of blackbird species. It is unknown if the original habitat supported a cattail marsh system.

6.8 Human Disturbances

Aside from the development of the Boulder Ski run in the upper headwaters, housing and roads adjacent to the main channel and the third tributary, few recent disturbances have occurred to this habitat. (The disturbance necessary for safe ski operation might preclude the establishment of

riparian vegetation on the upper reach of the main channel. However, it represents a net loss of riparian habitat.) A wood pole powerline bisects portions of the fourth tributary, but generally, the human disturbances are the same as those described for the aspen community. Many of the human disturbances are unlikely to result in further encroachment. An informal trail used by bicyclists, hikers, and dog walkers is present on the north side of the main channel. A smaller, single-track trail is also located on the south side of the main channel and crosses both the first and second tributaries.

Although the riparian habitat is intact and stable, some older disturbances are detectable. For example, downstream of the Boulder Ski run parking lot, several large lodgepole stumps are present under the canopy of the denser portions of the riparian habitat. Because the surrounding riparian habitat (e.g., alders and willows) has large trunks, and no damage to the vegetation from falling trees is evident, this would suggest that the cutting took place at least several years ago.

Old logging roads traverse the first and second tributaries at various elevations, and old skid trails parallel them. However, the skid trails do not appear to directly impact riparian habitat since they are located outside, but parallel to the drainages, and are re-vegetated. At the steep, upper elevations, the old logging roads follow natural contours and seem to end before they cross the tributaries.

Recreation can adversely affect aspen communities (e.g., trampling understory) and the wildlife that occur within them. The standard recommendation to restrict recreation to well-established hiking trails to minimize disturbance to wildlife (USDA 2000) is probably already naturally occurring. The existing trail systems are informal, and are not engineered or maintained by the USFS (Lane, USFS, personal communication). No evidence of trail building, or less formal trail networks through the aspen stands was noted. Motorized access is currently restricted and most use appears to be non-motorized (e.g., hiking, mountain biking, dog walking). Below the Heavenly Valley boulder parking lot, it is unknown to what extent the watershed is used for winter recreation, including over-the-snow vehicles.

Conservation measures to conserve aspen groves include curtailing grazing to maintain the natural diversity of herbaceous cover and natural succession pathways (Greenway 1990). Aspen communities are susceptible to adverse impacts from grazing. Heavy grazing by domestic livestock, such as sheep and cattle, and intense overbrowsing by wildlife of young aspen sprouts can retard aspen growth and reproduction (Sawyer and Keeler-Wolf 1995). No evidence of these potential impacts was observed in the watershed. The grazing schedule for PCC is unknown, but no cow scat was observed in any of the watershed surveyed on the Park property. Most browsing by deer was detected (e.g., sign such as tracks, clipped browse, and scat) in the mid to upper elevations of the watershed, not in the main channel where most of the aspen is present.

6.9 Current Management Direction in the Watershed

As described in Tech Memo I, management direction in the USFS portion of the project area is provided by the Sierra Nevada Forest Plan Amendment (2000). Where the project area is

mapped as general forest, the management direction is to (1) reduce hazardous fuels to effectively modify wildland fire behavior to reduce uncharacteristically severe wildland fire effects; and (2) to increase the numbers of large trees and the distribution and connectivity of old forests across landscapes.

How the general forest management directions are implemented could affect habitat suitability for a variety of wildlife. Given the existing forest conditions (e.g., patches of dense white fir), increasing the numbers of large trees might not be possible without management activities such as fire or selective thinning. It is unknown whether such actions are planned in the future.

Portions of the watershed are likely mapped urban wildland intermix zone. The urban wildland intermix zone is an area where human habitation is mixed with areas of flammable vegetation. It is comprised of two zones: an inner ¼ mile wide buffer, called the defense zone, and an outer 1 ¼ mile wide buffer, called the threat zone. Urban wildland intermix zones have highest priority for fuels treatment. Fuels in the inner defense zone are more intensively treated to prevent loss of life and property. The management directions for this land allocation are designed to attain the management objective, which is to enhance fire suppression capabilities by modifying fire behavior inside the zone and providing a safe and effective area for possible future fire suppression activities. Most of the heaviest fuels occur in this zone and the longest fire season is in this zone (USDA 2000). During a 23-year period (1973-1996), most fires in the Tahoe Basin were not caused by lightening. They were ignited by people in the urban/wildland interface.

Standard USFS setbacks, 50 feet on either side from seasonal streams and 100 feet on either side from perennial streams, typically apply to any timber removal projects in riparian areas. No timber projects are currently under consideration in the Edgewood Creek watershed (Parsons, USFS, personal communication). An assessment of conditions in the east shore region will be conducted by the USFS in 2003. The TRPA regulations governing activities within Stream Environment Zones (SEZs) would apply to proposed projects on any portion of the watershed.

The management directions provided by SNFPA will eventually provide conditions more favorable to special status wildlife species that are dependent on late seral stage forest, since they reduce the risk of a catastrophic, stand-replacing fire, and they are oriented toward developing late seral stage forest conditions.

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7.0 LAND USE / UPLAND WATERSHED REPORT

To quantitatively assess the upland erosion hazard within Edgewood Creek Watershed, field data were collected from all public roadways. Collected field data include the size, slope, and description of all roadside shoulders, roadside channels, and roadway cut-slopes, the location and size of all erosion control structures, and the drainage direction of roads. With the collected field data, a database of roadway erosion severity and its potential linkage to Edgewood Creek and its tributaries was compiled and integrated into GIS. A comparative analysis was made within the project site, estimating relative sediment yield within sub-watersheds. Recommendations for EIP projects within the upland watershed have been made during the analysis.

Engineers and hydrologists also field surveyed water quality features and compared them to design documents to predict potential effectiveness. Interviews were scheduled with NDOT maintenance personnel and significant information was gathered from them. Interview of KGID maintenance personnel has not been possible and should be scheduled prior to the design of EIP's within their jurisdiction.

Roadways are contributors of various types of sediment and pollutants from several primary sources. The potential for water quality improvement is directly related to each source of pollutant. Vehicles generate hydrocarbons and heavy metals, which deposit in the roadways. The key sources of sediment within road right-of-ways are from roadway cut and fill slopes that are unstable and producing sediment from erosion and disturbance; roadway de-icing sand and salt applied to the roadway during the winter time to provide for traffic safety; and unprotected road shoulders which are subject to erosion or sediment deposition.

The sediment type material generated from roadways includes large grained material (sand size fraction), finer grained material (silts), organic matter (litter), de-icing salts and contaminates from vehicular traffic (oil, grease, heavy metals, etc.). Understanding the source of the material that is present and available for transport from the roadway areas is important for understanding the opportunities and constraints associated with the necessary improvements or best management practices needed to reduced the presence of these materials in the storm runoff.

In the Tahoe Basin, there are many years of experience treating roadway runoff. That experience has focused on implementation of improvements or best management practices that fall into two major categories: 1) source control measures (reducing erosion at the source) and 2) treatment control measures.

Source control measures focus on stabilization of cut and fill slopes and roadway shoulder areas. This measure attempts to prevent sediment from reaching the drainage system to avoid treatment that is costly and maintenance intensive. Typical source control measures include:

- Slope Re-shaping and Revegetation – If the steepness of a cut slope can be reduced to a slope that is generally flatter than 3:1 and the toe of the slope can be stabilized with toe protection, the slope can be revegetated with a reasonable probability of success with appropriate revegetation techniques.

- Toe Protection – Slope stability can be decreased significantly if the toe of the cut slope is constantly disturbed by shoulder maintenance or snow removal operations. The disturbance of the toe accelerates erosion of the cut slope above the disturbed toe. Toe protection measures typically include paving of the shoulder area and construction of a concrete or AC curb at the toe of the slope. In extreme cases, a retaining wall may be necessary to allow filling of the back slope, which decreases the slope of the cut area and increases slope stability. Curbs can be a problem also for snow removal equipment since the plow blade can damage or destroy these improvements, requiring maintenance or replacement. It has been found that roll curb is less susceptible to plow damage.

- Mechanical Treatment of the Slope – In the case of overly steepened slopes that can't be laid back due to right-of-way constraints, the use of mechanical treatments can be applied to stabilize the surface of the cut slope. Typical mechanical treatments include covering the slope with rock (rip-rap), benching, geo-cellular armoring, covering the slope with a wire mesh, use of slope paving or construction of retaining walls. In the Tahoe Basin, scenic threshold constraints limit or prevent the use of some of these options. Benching tends to create linear features that are visible for long distances (depending on their location and potential viewshed). Wire mesh and slope paving often have undesirable aesthetic impacts.

- Fill Slope Erosion Control – Fill slope erosion control is typically addressed by eliminating uncontrolled runoff from the roadway surface onto the fill slope. Followed by revegetation or mechanical treatment of the fill slope surface.

- Erosion Control for Roadway Shoulders - Typically, this area of the roadway has the lowest erosion potential due to shallower grades and highly compacted nature of the surface. However, it often appears to be a problem because de-icing material and eroded material from the cut slopes accumulate in the shoulder giving the impression that this material originated in the shoulder. The shoulder areas provide the greatest opportunities for treatment control measures. Collection and disposal of deposited material may be necessary.

Treatment control measures focus on collection of sediment and pollutants in a way that allow maintenance equipment to remove the collected materials or use bioengineered methods to collect sediment and immobilize or uptake nutrients. Typical treatment control measures applied to Tahoe Basin roadways include:

- Street Sweeping - This measure is a best management practice (BMP) that relates to a maintenance activity. However, certain improvements in the roadway area are necessary to make this BMP possible. This BMP is one of the most effective ways to collect accumulated de-icing materials and materials generated from cut slopes that accumulate in the road shoulder areas. This measure requires that the shoulder areas be paved at a shallow cross slope that will allow the sweeper truck to access this part of the roadway. This BMP also requires that a large capacity sweeper truck be available to the maintenance crews (equipment and labor cost).

- Sediment vaults - Sediment vaults are in widespread use in the Tahoe Basin. These structures are usually built with vertical CMP or concrete structures typically 5 to 10 feet below the culvert inlet. This allows a storage area for the large grained materials contained in the runoff. It has been found from monitoring, that the large grained materials captured in these facilities contain measurable amounts of hydrocarbons that are attached to sand sized particles. These structures must be maintained with a Vactor truck. The maintenance time frame for each vault is dependent on design, sediment contributing area and nature of treatment. There is evidence from existing facilities that if the sediment is not removed prior to a large storm event, the sediment is resuspended. The removed materials have to be transported out of the Tahoe Basin for disposal.

- Oil/Water Separators - These types of facilities are used where there are a significant number of vehicles present in a small area, such as parking lots. These are multi-chamber storage structures constructed at the end of the storm drainage network that capture oil and grease. A sediment vault may also have oil absorbent pillows to capture oils and greases floating on the surface of the storm water exiting the structure. These structures must be maintained annually with a Vactor truck. The removed materials also have to be transported out of the Tahoe Basin for disposal.

- Infiltration Facilities - This technology has been used for many years in the Tahoe Basin. These facilities collect runoff from paved areas in facilities with sufficient storage to collect an inch of runoff from the paved surface. The runoff is infiltrated into the underlying soil. It is anticipated that the facility has the ability to capture large and fine grained sediment to prevent soil clogging; capture of hydrocarbons to prevent groundwater contamination; and filter the runoff through the soil. Small quantities of hydrocarbons are anticipated to be consumed by organisms in the soil or be volatilized. Below surface infiltration galleries consisting of tanks and large pipes are also possible. Complete and detailed analysis of the sub-surface soil conditions is essential to the proper function of any type of infiltration basin.

- Sediment Basins – Sediment or water quality basins are present in the Lake Tahoe area in significant numbers. They can be combined with infiltration facilities to pre-treat the storm water prior to recharge. These facilities can be of the dry type that utilizes gravitational actions only or may be combined with treatment wetlands to use bio-chemical interaction to reduce soluble pollutants also. Design of sediment basins has matured from using only "rules-of-thumb" for sizing to using advanced design equations that predict desired water quality and removal efficiencies. The use of flocculating agents as a passive feed to significantly reduce fine sediment and phosphorus is also being advanced. Providing a hard maintainable surface at the very beginning of a sediment basin is essential in guaranteeing performance.

BMPs can be highly effective for a certain duration after installation, but the effectiveness may decrease significantly over time if there is a lack of maintenance. All BMPs must be maintained on a regularly scheduled basis to guarantee effectiveness. This maintenance can be a significant cost and is sometimes neglected due to budgetary, planning or resource constraints.

7.1 Road and Subdivision Survey Methods

Significant volume of the sediment is being conveyed within and from roadway areas as a result of roadway de-icing operations, it is therefore important to note the differences within the project area. Roadways that experience the heaviest traffic loads, receive the greatest level of roadway de-icing material application. The material applied to the roadways for de-icing include two major constituents; sand/cinders for providing abrasive to reduce skid potential and salt (sodium chloride) to melt ice build-up on the roadway surface. Within the Edgewood Creek watershed, US50 and SR207 (Kingsbury Grade) receive the greatest volume of applied roadway de-icing material. The subdivision streets receive less de-icing application which is readily observable in the field. Usually major intersections and bus stops within the developments receive additional abrasive and salt for safety reasons. However, in this case we did not observe any significant signs of additional road abrasive deposition in the vicinity of major intersections or bus stops. This may mean that the road abrasives are either being transported downhill to a different location or the sediment collection features in the vicinity are large enough to accommodate the additional de-icing material.

SR207 – December 2002 – Roadway De-Icing Material Build-Up in Road Shoulder

Typical Subdivision Street – December 2002 – Little De-Icing Material and More Extensive Slope Treatments

In order to evaluate the nature of the problem within the study area, subdivision roads and SR 207 were field surveyed by engineers and hydrologists several times. Maintenance data was collected from the Nevada Department of Transportation (NDOT) for SR207 and US50. We were not able to obtain such data for the subdivision streets. Field surveys were conducted in the fall of 2002. Locations of problem areas were mapped and preliminary EIP's were developed to remediate the areas of concern. Once the preliminary EIP's were developed, the sites were revisited with NTRT Staff in the spring of 2003. The visit with NTRT Staff lead to a decrease in the number of EIP's proposed for the subdivision streets and street adjacent areas because they were able to provide historical and political project information. Figure 7.1 provides an overview of areas where EIP's are necessary to reduce erosion and improve water quality.

Legend

- Stream EIP Areas
- Road EIP Areas
- Edgewood Creek Watershed
- Stream Reach Breaks
- Existing Sediment Basins

Recomended BMPs

- Sediment Basin
- Sediment Can
- Road Shoulders
- Cut Slopes
- Earth Channels

EIP Areas

- A, Edgewood Golf Course
- B, Park Cattle Company
- C, USFS, NDSL, Private or Other
- D, USFS, Douglas County, Heavenly Valley
- E, Private Property, USFS
- F, Heavenly Valley, USFS
- G, NDOT Lower Kingsbury
- H, NDOT Middle Kingsbury
- I, NDOT Upper Kingsbury
- J, Lower Kingsbury
- K, North Benjamin and Upper Kingsbury

0 0.25 0.5 1 Miles

SB 1 SB 2 SB 3 SB 4 SB 5 SB 6 SB 7 SB 8 SB 9 SB 10 SB 11 SB 12 SB 13 SB 14 SB 15

R1 R2 R3 R4 R5 R6 R7 R8 R9 R10

A B C D E F G H I J K

North Benjamin

South Benjamin

Route 207

Route 50

Palisades Rd

Edgewood Creek Integrated Watershed Assessment Team

Proposed Edgewood Creek Watershed EIPs

Figure 7.1

N W E S

C:\GIS\3090-edgewood\edgewood EIPs

Modified : 6/10/03

7.2 Roadway Maintenance Practices

Since a significant portion of the sediment that is present in SR207 is from roadway de-icing operations, it is important to characterize the potential annual volumes of material placed on, and removed from the roadway by maintenance practices (please also see Section 2.4). It is also important to evaluate the changes anticipated in these practices in the future by NDOT. We interviewed NDOT maintenance staff and reviewed maintenance records for NDOT roadways in the Tahoe Basin. We were unable to interview KGID personnel prior to publication of this document.

Over the past 10 years, NDOT has been embarking on an aggressive master planning, CIP, and maintenance improvement program for roadways in the Tahoe Basin. The first segment of roadway to be addressed was SR 28. This process began with a demonstration project for the segment of SR28 from Incline Village to Memorial Point. This project was intended to serve as a trial project for implementation of source control and treatment control measures that would be possible given the constraints of steep roadway cut and fill slopes, narrow right-of-way and close proximity to the Lake and several SEZs'. Close collaboration was conducted with TRPA to determine how to best balance potentially conflicting environmental threshold standards associated with water quality, scenic standards, land capabilities, and other factors. As a part of this project, maintenance practices were also critically evaluated and goals were established for reduction in de-icing abrasive applications. Additional maintenance practices were evaluated related to sweeping and sediment vault cleaning and monitoring of structural and maintenance BMP effectiveness over the last 6 years. Since that project was completed NDOT has completed several additional improvement projects on additional reaches of SR28 and US50. Master planning for improvements for SR207 is planned in the future.

The previous project experience yielded several key conclusions associated with control of sediment and de-icing material in the road right-of-way:

- Volume of Material Collected - The volume of material collected has been significantly lower than anticipated volumes based on USLE estimates. This may be due to a number of factors. Additional shoulder sweeping is being conducted which may be intercepting sediment before it reaches the sediment vaults; the source control measures may be more effective than anticipated; and the USLE estimates may also be overly conservative.

- Hydrocarbon Contamination of Sediments - There are larger concentrations of hydrocarbons attached to the sediment removed from the sediment vaults than anticipated. This may mean that removal of this pollutant on captured large grained material could be more effective than originally anticipated.

- Changes in De-Icing Agents - NDOT has tried several approaches to the use of de-icing agents to seek the best approach that uses the least amount of these agents. The use of sand/NaCl and sand/MgCl mixes has been compared. The use of straight salt, salt brine and combinations of these agents has also been tried. It has been concluded that the use

of less abrasives and a combination of straight salt combined with salt brine, only when conditions warrant is most effective. This, combined with application only to the center portion of the roadway, has increased the effectiveness of the agents, and has resulted in less application. In the case of SR28, the quantities of sand/salt mixture have been reduced to approximately one third of the application rates used a decade ago and the quantities of salt have been reduced by similar amounts. However, due to the steepness of SR207 and the volume of early morning traffic, this program has not been completely applied to this road.

- Design Improvements - Experience on these projects has also yielded key information regarding maintainability of the water quality improvements constructed in the roadway areas. This experience will lead to better future projects that are more maintainable and more effective in reducing pollutant and sediment loads from the roadway areas.

The Washoe County segment of 11 miles of SR28 maintenance records, presented in Table 7.2 below, represents an indication of the potential change in both applied de-icing materials and ability to recover sediment. This recovery is from the roadway shoulders as a result of the combination of improvement technologies and changes in maintenance practices.

Table 7.2: Sediment recovery and applications for SR 28

NDOT Maintenance Records For SR28 (Washoe County Sta 0.00 to 10.99)						
	Sand Recovered From	**Material Recovered**	**Material Added to**	**Sand & Salt Mixture**	**Straight Salt**	**Salt Brine**
Fiscal Year	**Sweeping (Cubic Yards)**	**From Cut Cleaning (Cubic Yards)**	**Slopes (Cubic Yards)**	**Applied (5 to 1) (Cubic Yards)**	**Applied (Cubic Yards)**	**Applied (Gallons)**
1990 - 1991	72	5871	376	845	0	0
1991 - 1992	61	1310	0	646	0	0
1992 - 1993	142	2892	0	1747	0	0
1993 - 1994	151	10	0	1455	0	0
1994 - 1995	39	28	25	1268	0	0
1995 - 1996	35	40	0	1484	0	0
1996 - 1997	170	778	0	1359	0	0
1997 - 1998	160	322	24	1102	11	0
1998 - 1999	416	1242	160	761	125	0
1999 - 2000	234	83	32	300	36	2770
2000 - 2001	645	320	100	322	13	3850
2001 - 2002	259	133	2	158	132	17700

NDOT will be developing a master plan for SR207 improvements in the future. NDOT District 2 staff also plans to make changes to the de-icing practices on SR207 that will reduce application rates. They are cautious about these changes due to traffic safety concerns and the steepness of

this roadway segment in the Edgewood Creek watershed. So, changes have to be based on effective means of minimizing icing conditions in a way that does not reduce safety standards. However, the experience from the other roadway segments has been very positive. NDOT maintenance supervisors plan on implementing these changes on SR207 in future years. The records for past years de-icing and material recovery for SR207 show the following:

Table 7.3: Sediment recovery and application for SR 207

NDOT Maintenance Records For SR 207(Douglas County Sta 0.00 to 3.20)						
	Sand Recovered From	**Material Recovered**	**Material Added to**	**Sand & Salt Mixture**	**Straight Salt**	**Salt Brine**
Fiscal Year	**Sweeping (Cubic Yards)**	**From Cut Cleaning (Cubic Yards)**	**Slopes (Cubic Yards)**	**Applied (5 to 1) (Cubic Yards)**	**Applied (Cubic Yards)**	**Applied (Gallons)**
1990 - 1991	28	160	2	481	1	0
1991 - 1992	37	2713	1728	294	0	0
1992 - 1993	109	695	240	677	1.5	0
1993 - 1994	59	50	0	338	1.5	0
1994 - 1995	74	136	0	792	0	0
1995 - 1996	14	2319	845	748	3	0
1996 - 1997	0	122	3	452	0	0
1997 - 1998	16	50	194	654	0	0
1998 - 1999	68	0	14	426	0	0
1999 - 2000	113	0	62	537	1	0
2000 - 2001	115	0	60	334	17	1866
2001 – 2002	138	0	14	222	0	456

It is anticipated that changes to maintenance practices on SR207 that follow the changes implemented on SR28 will reduce the application rates of sand and salt to quantities that are less than potential recovery quantities from sweeping and catch basin/sediment vault cleaning.

SR207 is in need of source and treatment control measures in addition to the changes in de-icing practices. Funding for master planning and implementation of these master planned improvements is needed to establish SR207 as a priority segment of roadway. Recommendations of this paragraph have been added to the list of EIP's.

7.3 Existing Water Quality Infrastructure

As a part of the field survey drainage engineers and hydrologists collected information on the existing water quality infrastructure. The field information was then evaluated by an engineer familiar with storm water quality treatment processes to determine the effectiveness of the installed infrastructure. The installed infrastructure was evaluated qualitatively and not quantitatively.

Most of the sediment traps and cans installed as a part of the improvement to KGID roads and NDOT roads appear to be of appropriate size and are in good working conditions, except for the sediment vaults installed in Hwy 50 W on the bridge over the creek. Either these vaults are not located correctly, or they are not maintained often enough, or they are undersized for the amount of road abrasives applied. Snow removal in this area may be delivering cast-off directly to the creek. Some form of infrastructure may need to be added to the bridge to prevent cast-off from being delivered to the creek without treatment.

As mentioned in the water quality section, no water quality infrastructure is apparent in the parking lot of the U.S. Post Office on lower Kingsbury Grade. Untreated parking lot run-off may be routed to the creek from this location.

Identifiable sediment basins are located on Figure 7.1. Some sediment basins that are shown on plans provided to us could not be located in the field. It is assumed that these basins were not built.

In general most of the sediment basins in this area appear to be functional for the removal of coarse sediment and road abrasives (Please see section 2.4.3 also). If removal of fine sediment is necessary, then modifications to the sediment basins will also be necessary. Modification to sediment basins for the removal of fine sediments is not recommended for basins located high in the watershed. The Friday Station Pond located in the lower watershed may be a potentially suitable site for fine sediment removal if necessary.

Engineers and hydrologists conducted a plan review and an on-site assessment of the sediment basins. All of the sediment basins are lacking a debris pad. Debris pad should be considered for the larger basins, but may not be necessary if the maintaining agency does not request them. The lack of vegetation within the sediment basins will prevent the development of a bio-chemical approach to treatment and may even cause erosion and generation of excess sediment. However, the granular soils present in the area may not be suitable for vegetation. If possible the banks of the basins should be vegetated to prevent future erosion. As mentioned above, most of the sediment basins appear to be stable, functional and adequate, but some of the basins may need some retrofits to improve treatment capability. These are as follows:

- SB6: This appears to be a very large basin and may be used for infiltration since no outlet is present. The inlet CMP is partially blocked and needs to be cleaned. Infiltration basins should have debris pads to facilitate sediment and debris removal. The bottom of the basin should be scarified to aid infiltration and vehicle barriers should be placed to prevent potential vehicular access.
- SB8: A second inlet pipe appears to be installed close to the outlet structure. This may cause short-circuiting and transport of sediment during high flows. Directing flow from this pipe away from the outlet structure may improve performance.
- SB14: Severe head cutting and gullying upstream of this sediment basin is compromising its effectiveness (see picture on page 15). Rock gabion may be causing a velocity increase and exacerbating the problem in the north stream to the basin. south stream needs stabilization and vegetation.

Additional changes to the sediment basins are not necessary. It appears that this area has sufficient water quality infrastructure, and minor retrofits as mentioned above will be sufficient to maintain water quality.

Field investigations revealed several areas of concern in the upper Kingsbury and North Benjamin Drive locations. Existing sediment cans in the area are full and appear to be overwhelmed with sediment loads. There is evidence of sediment passing through the system and being deposited down gradient of the sediment cans. Additional sediment storage should be added near existing sediment cans on South Benjamin Drive as shown on Figure 7.1 (Recommended BMPs - sediment cans).

Large accumulations of sediment in the SEZ off of North Benjamin Drive just north of Aspen Way should be attenuated by the placement of a sediment basin at the base of the steep grade above the SEZ (Figure 7.1 – Recommended BMPs - sediment basin). Large amounts of roadway deicing material move down the steep grade into the sediment can near the corner, passing through and eventually being deposited in the SEZ. Flows also appear to move overland, bypassing the sediment can completely.

Sediment accumulation in the SEZ below North Benjamin Drive north of Aspen Way. May 2003

Slope protection should be added to cut slopes on Barton Court near Barton Drive and at Bonnie Drive near Tramway Drive (Figure 7.1 – EIP Area "K" – North Benjamin and Upper Kingsbury).

In the lower Kingsbury area adjacent to the Post Office, the parking lot is not equipped with BMPs and it appears that during the winter the SEZ is used for snow storage. East of this location, two drop-inlets appear to be directly connected to the creek without any water quality features (Figure 7.1 – EIP area "J" – Lower Kingsbury).

Willows deformed from snow storage in the SEZ behind the Post Office parcel. April 2003