Final Report

Upper Truckee River Reclamation Project

Environmental Assessment, Feasibility Report and Conceptual Plans

City of South Lake Tahoe, County of El Dorado, California

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Fish and Wildlife Coordination Act of 1934

Upper Truckee River Reclamation Project

South Lake Tahoe, CA

City of Lake Tahoe

El Dorado County

Environmental Assessment, Feasibility Report and Conceptual Plans

January 2003

FINAL REPORT

SUMMARY

INTRODUCTION

A consultant team selected by the Tahoe Resource Conservation District has prepared this Final Report for the Upper Truckee River Reclamation Project. This Final Report includes environmental assessment, alternatives analysis and feasibility report, preliminary design report, and conceptual plans.

STUDY AREA

The Upper Truckee River Watershed is located in the City of South Lake Tahoe and the Counties of El Dorado and Alpine. The Upper Truckee River study area is located between the Elks Club Bridge at Highway 50 in El Dorado County and Lake Tahoe Boulevard Highway 50 Bridge in the City of South Lake Tahoe. The project study area comprises about 791 acres in three sections: (1) the privately owned meadow totaling 367 acres; (2) 189 acres on the former Sunset Stables Property (now owned by California Tahoe Conservancy) and (3) 235 acres on property owned by the City of South Lake Tahoe under airport jurisdiction. The reach of Upper Truckee River in the study section is approximately five miles in length.

The project area contains three specific reaches; the upper reach, airport reach, and lower reach. The California Tahoe Conservancy and the United States Forest Service own the upper reach and the City of South Lake Tahoe owns the airport reach. The Ledbetter family owns the lower reach.

PURPOSE

The purpose of this study is to provide a comprehensive overall environmental assessment of the study area, develop restoration alternatives for the river ecosystem, select the preferred alternative and provide a preliminary design along with conceptual plans for the preferred alternative.

Upon completion of the study, funding will be secured for the preparation of environmental impact statement/report, project design, construction plans and specifications, continuing river monitoring, and the acquisition of permits from local, regional and federal agencies.

PROBLEMS AND OPPORTUNITIES

The project study area of the Upper Truckee River has various features such as the Lake Tahoe Airport, irrigation channels, high terraces, and other manmade structures, which have changed the river morphology to an unnatural state. This study will analyze the current alignment and provide a project plan to reconstruct several segments of the channel, stabilize eroding banks, and establish a greater diversity of wildlife, fisheries, and vegetation.

The key planning and engineering constraints for the project include cattle grazing operations on private land in the meadow, the Lake Tahoe Airport, the South Tahoe Public Utility District's force and gravity sewer mainlines, two road crossings, and seasonal use of the river by recreational rafting.

RESTORATION MEASURES/ ALTERNATE PLANS

The alternatives being proposed represent varying degrees of restoration. The proposed alternatives include:

- The "No Action" Alternative
- The Moderate Enhancement Plan
- The Full Enhancement Plan

In Reaches 1 and 2, a fourth alternative (re-establishment of historic channel) is also presented; however this alternative is currently assumed infeasible.

Restoration measures include, but are not limited to, the implementation of no action, partial or complete filling of gully channel(s), banks enhancement, overflow enhancement, place in-channel structures, modification of existing diversion dams, replacement of bridge structures, divert airport runoff, remove fill to restore stream environment zone, place buried rock rip-rap, lowering of floodplain, construction of new channels, and modify river crossing.

The Upper Truckee River study area has six distinct reaches. Enhancement alternatives include no action, moderate level, and maximum enhancement measures. This document defines each reach by its beginning and endpoints, a description of its channel and habitat characteristics, and its key constraints. Each reach is evaluated for its opportunities for ecological and water quality improvements, which can be described as "enhancement" projects. The degree of restoration of ecological function possible in each is dependent upon their individual constraints.

SELECTED PLAN

The selected plan for the project area has been evaluated based on the cumulative impacts, stream restoration and water quality benefits.

Reach	Selected Plan
1	Moderate enhancement plan.
2	Full enhancement plan
3	Moderate enhancement plan
4	Full enhancement plan (The moderate and full enhancement are the same)
5	Full enhancement plan
6	Moderate enhancement plan

An additional engineering, topographic survey and the engineer's report will confirm the feasibility of the proposed selected plan.

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I. PROJECT PURPOSE AND NEED

I.A INTRODUCTION

The Upper Truckee River watershed is located in the State of California, Counties of El Dorado and Alpine. The Upper Truckee River watershed is a sub-watershed of Lake Tahoe.

The Upper Truckee River watershed is almost entirely within El Dorado County. About 3 square miles of the southern tip is located in Alpine County. This watershed is the largest in the Lake Tahoe Basin and covering 56.5 square miles, which is 18 percent of the total land area tributary to Lake Tahoe. Lake Tahoe is 314 square miles. The Upper Truckee River has a drainage perimeter of 59.3 miles (Cartier and others, 1995). The Upper Truckee River main channel length is 21.4 miles. The land surface elevations range from lake level, 6223 feet (low water) to 10,063 feet above sea level at Red Lake Peak.

The percent slope, which describes the steepness of the topography within the watershed, ranges from approximately zero near Lake Tahoe and along the valley bottom, to as much as 50 in the upper altitudes of the watershed (Cartier and others, 1993). Dominant aspect, which is the compass direction of a slope face, is generally east, west, northeast, and northwest facing slopes.

The main tributary drainages to the Upper Truckee River include Grass Lake Creek, Angora Creek, Echo Creek, and Big Meadow Creek. Major wetlands include Grass Lake, Osgood Swamp, Truckee Marsh, Benwood Meadow, and Big Meadow. Major lakes in the area include Upper and Lower Echo Lakes and the smaller lakes include Dardanelles, Round, Showers, Elbert, Tamarack, Ralston and Angora Lakes.

I.B CURRENT CONDITIONS

The Upper Truckee River flows into Lake Tahoe. Lake Tahoe, a national treasure, is known for its beauty and clarity is 22 miles in length, 12 miles in width, 1,645 feet in depth, and at 6,223 foot elevation (low water) is a sub alpine treasure. Unfortunately, as famous as it is, Lake Tahoe is in jeopardy of losing its world famous clarity. Since measurements began in the 1960's, the lake has been losing an average of one foot of clarity per year. The California State Water Resources Board (303d list 5.19.94) has listed Lake Tahoe as an Impaired Water Body. In October 1998, Lake Tahoe was listed as a Category I Impaired Priority Watershed under the CA Watershed Assessment. The impairment is due to loss of water quality documented by research by the Tahoe Research Group, University of California at Davis, and others, showing impacts on clarity due to accelerated algae growth and fine suspended particles. The results of these impacts are established in long-term studies, which have shown a tripling of phytoplankton production since 1968 resulting in a reduction of over 40 feet in Secchi Disc readings.

Historically, the lake has been limited in the amount of available nitrogen and phosphorus, both necessary nutrients for algae growth. Recent studies by the University of California at Davis indicate that nitrogen is no longer a limiting nutrient; leaving the reduction of bio-available phosphorus as the best option for limiting algae as growth. Since phosphorus is strongly associated with particulates, erosion and sediment control is thought to be one of the most effective methods in preserving lake clarity. The re-establishment of active floodplains, restoration of wetlands, and restoration of riparian habitat will enhance biological removal of entrained nutrients.

The Upper Truckee River watershed has been modified from its natural conditions through human activities such as logging, livestock grazing, roads, golf courses, airport, residential, commercial, and industrial developments.

The upper portion of the Upper Truckee River watershed consists of steeply sloping mountains and is primarily National Forest lands. The lower portion of the watershed is relatively flat and highly urbanized. The lower watershed consists of a mixture of private and public lands. The lower portion includes the communities of Meyers and South Lake Tahoe.

The land use of the Lake Tahoe Basin by humans first began with the Washoe Indian Tribe. Major changes in land use occurred with the discovery of the Comstock Lode in Virginia City, Nevada. Trees in the Lake Tahoe Basin, including those in the Upper Truckee River watershed, were harvested to provide shoring timbers for the Comstock mines. When the Comstock era began to decline during the late 1800’s, the Lake Tahoe Basin began to emerge as a seasonal vacation area.

After the 1950’s, rapid urbanization occurred. To illustrate this, in the 1950’s there were approximately 900 full-time residents in the Basin; by the 1970’s and early 1980’s, that number had risen to approximately 19,000. Today, we have over 30,000 homes on the south shore alone. These homes are serviced by a vast system of roads, which serve as a delivery system for eroded soil to enter the river and lake. Runoff from these urbanized areas transports about one-third of the total sediment and attached nutrients to the lake. Although new construction is limited and strictly regulated, these environmental regulations did not take effect until the mid-1980’s.

Currently the Tahoe Regional Planning Agency (TRPA) regulations require all residential and commercial developments in the Tahoe Basin to be retrofitted with Best Management Practices or BMPs. These practices include paved driveways and parking areas, infiltration trenches, drainage basins and dry wells, vegetative cover and stabilized slopes. These practices are designed to infiltrate the water on site and thus eliminate water runoff from the property from a 20-year one-hour storm event, approximately one inch of water falling in one hour.

I.C SCOPING AND PUBLIC INVOLVEMENT

The Tahoe Resource Conservation District executed the Bureau of Reclamation grant on January 16, 2002 and the Bureau of Reclamation executed the grant on February 4, 2002.

In an effort to coordinate the scoping and public involvement, three committees were formed. The three committees are the Directing Committee, Agency Technical Advisory Committee and Scientific Technical Advisory Committee.

The Directing Committee includes at least one member from the California Tahoe Conservancy, City of South Lake Tahoe, California State Parks, Natural Resources Conservation Service and Tahoe Resource Conservation District. The Directing Committee oversees the grant process, public involvement, and reviews the progress of the environmental assessment consultants. The Directing Committee meets on as needed basis.

The Agency Technical Advisory Committee, TAC, includes one member from local, regional, and federal agencies. Members of the TAC, include but not limited to, Bureau of Reclamation, California Regional Water Quality Control Board, California Tahoe Conservancy, City of South Lake Tahoe, County of El Dorado, Lake Tahoe Airport, Natural Resources Conservation Service, California State Parks, U. S. Forest Service, South Tahoe Public Utility District, U. C. Extension, and Tahoe Regional Planning Agency. The TAC was formed to review and comment on the consultants' data and reports. The Swanson Hydrology and Geomorphology Upper Truckee River Alternative Description Report was circulated to the committee. The draft report will be sent to the members for review and comments. No formal TAC meetings are scheduled.

On June 17, 2002, a community workshop was held at the City of South Lake Tahoe Council Chambers. The purpose of the community workshop was to introduce the community to the proposed project study, have an interactive meeting with the community, present to the community the goals and objectives of the project, collect and share information, and receive comments. The next meeting with the community will be scheduled sometime in November or December 2002.

The Upper Truckee River Watershed Advisory Group, WAG, was formed in June 2002. The WAG membership is comprised of members of the community interested in the planning and design process. The purpose of the WAG is to allow citizens to review and comment on the environmental assessment, feasibility report, and conceptual plans. The group meets with staff members of the NRCS and TRCD. The WAG met on August 14, 2002.

I.D PARTICIPANTS AND COORDINATION

I.D.1 City of South Lake Tahoe (CSLT)

The city of South Lake Tahoe, incorporated in 1965, operates the Lake Tahoe Airport.

The Upper Truckee River flows through the Airport parcel. for approximately 1.75 miles. The airport was constructed in 1958 and expanded in 1960's. With the development of the taxiway and runway, the Upper Truckee River was altered from its meandering historical channel. The city has proposed erosion control and stream restoration projects within the watershed.

I.D.2 County of El Dorado

The County of El Dorado has several erosion control and stream environment zone restoration projects proposed in the Upper Truckee River watershed. The project list includes the Angora Creek SEZ Restoration Project, Apalachee Erosion Control Project, Christmas Valley Erosion Control Project, South and North Upper Truckee Erosion Control Projects, and the Grass Lake Road Erosion Control Project.

I.D.3 State Regional Water Quality Control Board, Lahontan Regional

"The State Board's mission is to preserve, enhance and restore the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations."

I.D.4 Tahoe Regional Planning Agency (TRPA)

The TRPA is a California/Nevada planning agency that was established in 1969 by Congress. The TRPA leads the cooperative effort to preserve, restore, and enhance the unique natural and human environment in the Lake Tahoe Basin.

In 1998, the TRPA developed an environmental document and program known as the Environmental Improvement Program (EIP), a strategy to achieve the environmental threshold capacity standards required by law and adopted by TRPA. The thresholds capacities are water-quality, soil conservation, air quality, vegetation, fisheries, wildlife, scenic resources, recreation, and noise. TRCD works closely with TRPA's Erosion Control Team (ECT) to educate and implement BMPs on the California side of the Tahoe Basin.

I.D.5 California State Parks

The California Department of Parks and Recreation has a representative on the Directing Committee. Currently, the Department of State Parks is implementing an enhancement project on Angora Creek, a tributary to the Upper Truckee River. Its goal is to move the creek off the sewer line, construct a new channel, while stabilizing slopes, restoring the water table, improving water quality and habitat, and restoring the geomorphic function of the creek.

I.D.6 USDA/Natural Resource Conservation Services (NRCS)

The NRCS works with local property owners on Best Management Practices (BMPs) for residential homes, and confined animal waste issues. USDA/NRCS is supplying an in-kind match for office equipment and staff assistance.

I.D.7 California Tahoe Conservancy (CTC)

The CTC is an independent State agency within the Resources Agency of California. It was established in its present form by State law in 1984. Its jurisdiction extends only to the California side of the Lake Tahoe Basin. The Conservancy is not a regulatory agency. It was established to develop and implement programs through acquisitions and site improvements to improve water quality in Lake Tahoe, preserve the scenic beauty and recreational opportunities of the region, provide public access, preserve wildlife habitat areas, and manage and restore lands to protect the natural environment.

The CTC owns large parcels of land in the Upper Truckee River watershed, between the bridge on Highway 50 (located in the city of South Lake Tahoe) and the lake. The CTC has two projects in progress in the lower section of the river. Lower West Side Project removed fill from an area in the Keys Subdivision and is restoring it to a functioning stream environment zone. This project was under constructed in 2001 and was complete in 2002. The second project, Upper Truckee River Restoration Project, is in the planning stage. The river between the highway and the lake has been altered from its historical channel.

The CTC is a property owner in the Upper Truckee River Reclamation Project. The 189-acre parcel, formerly known as the Sunset Stables Property, is located adjacent to and south of the Lake Tahoe Airport.

I.D.8 South Tahoe Public Utility Department (STPUD)

STPUD is the drinking water provider and operates the wastewater treatment facilities in the City of South Lake Tahoe and parts of El Dorado County.

I.D.9 United States Forest Service (USFS)

The USFS completed the Lake Tahoe Basin Watershed Assessment (LTBWA) in January 2000. The LTBWA identifies and quantifies the impacts of past, current, and future human activities. USFS manages about 75% of the Lake Tahoe Basin lands.

I.D.10 Upper Truckee River Watershed Focus Group (UTRWFG)

The ultimate goal of the Upper Truckee River Watershed Focus Group is to protect, improve, and maintain the natural resources of the Upper Truckee River Watershed. Actions taken are consistent with the land and water capabilities, and are supported by affected citizens, therefore reducing conflict. The UTRFWG is comprised of members of local, state and federal agencies and members of the community.

I.E STUDY AUTHORITY

The Upper Truckee River Reclamation Project, Phase I Planning and Design is being conducted under the authority of the Fish and Wildlife Coordination Act of 1934, P. L. 85-624, U. S. C., 661 et seq.

II. PROPOSED ACTION AND ALTERNATIVES

II.A INTRODUCTION

The Upper Truckee River has been subject to modification due to land use and resource extraction dating back to the 1860s and more recently by urban development to service a tourist economy. These modifications have impaired the natural hydrologic function of the marsh, reduced wetland areas, and modified channel morphology in a manner that has reduced aquatic habitat quality and created abundant pollutant sources. A main focus of ecological improvement is the Upper Truckee River channel, which has eroded into the valley floor 2-4 feet in response to historical changes. The channel within the project reach is generally of low habitat quality in terms of morphology (channel width, depth and plan form), substrate (predominately sand), bank stability, and vegetative cover. Overcoming the historic incision, increasing overbank flow, and raising groundwater elevations within marsh and floodplain areas are key strategies for ecological improvement.

The effects of reclamation and urban development have reduced the floodplain area and modified natural hydrologic function. Some areas have been filled to accommodate uses such as the South Lake Tahoe Airport, while other areas have been ditched and bermed to control irrigation on developed pastures. These changes, in combination with the reduced overbank flow and incision of the Upper Truckee River channel, have diminished the original and potential ecological values of the floodplain areas and the amount of filtration, a benefit to water quality.

The overall goal of the Upper Truckee River Restoration Project is to implement projects that improve water quality discharge to Lake Tahoe while bettering ecosystem function for aquatic and terrestrial wildlife. It is well accepted in stream sciences that physical geomorphic process and stream hydrology interact with ecosystem processes in fundamental ways. Since the highest value ecosystems are comprised of the native species of flora and fauna that originally inhabited the watershed, a key strategy is to restore original geomorphic and hydrologic conditions as they can best be estimated empirically. The recommended design must account for watershed and land use changes that may have altered original conditions. For example, increased sediment supply and increased runoff can influence channel geometry and pattern.

A program to improve ecological function through enhancement of geomorphic and hydrologic conditions must establish at the outset what is feasible to achieve within the context of existing land use factors, which may limit potential restoration opportunities. In this regard, the project must be classified to provide designers with the appropriate guidance for engineering a feasible project with realistic goals. Table II.A.1 shows the types of project context and the prevailing land use conditions that must be considered as possible constraints to restoration. The opportunities for ecological and water quality improvements within the project reach qualify as “enhancement” projects, with the

Table II.A.1 Context for Stream Ecosystem Improvement

Context	Anticipated Overall Results of Program	Site Constraints	Limiting Factors
Full Restoration	Allows for unimpeded geomorphic processes to take over project once constructed.	No constraints within project boundaries for flooding, erosion, and sedimentation.	Changed watershed factors. Changed climatic factors.
Enhancement	Allows for establishment of some geomorphic processes but in a manner that can be managed. Enhancement offers a wide range of ecosystem opportunities depending upon the degree of constraint.	Constraints on flooding, erosion, sediment transport processes due to land use, structures or infrastructure. Also, special status species may colonize the human-modified system and be sustained by artificial conditions.	Flooding. Erosion. Sediment transport. Spatial constraints Infrastructure (bridges and pipelines). Habitat modifications affecting sensitive, special-status species. May require active management such as irrigation, erosion control, etc.
Source Control/ Landscaping	Virtually no geomorphic processes restored. Source control achieved through hardening landscape or modifying hydrology.	Limited opportunities for vegetation; site conditions must be enhanced through irrigation. Project may improve water quality for habitat areas downstream.	Perception that need to control pollution sources is more important than ecosystem improvement; vegetation established through artificial means may require more maintenance and have less chance of success.

degree of ecological function restoration of each being dependent upon their individual site constraints.

Six distinct reaches were identified within the project limits for the purpose of addressing planning, design and impact analysis issues. The six reaches, as described in Table II.A.2, are shown in Figures II.B.1, 3, 5, 7, and 9.

The key planning and engineering constraints for the project are as follows:

1. Cattle grazing operations on private land in the meadow areas of Reaches 1 and 2 between the South Lake Tahoe Airport and lower Highway 50 crossing will not allow for restoration of the Upper Truckee River to its historic channel;
2. The physical presence of the South Lake Tahoe Airport in the middle project reach constrains the valley width for floodplain and channel restoration and sets limits on allowable flooding impacts;
3. The presence of two municipal sewer pipelines along the present course of the Upper Truckee River Channel may constrain use of areas on the valley floor for floodplain and channel restoration, though alterations to their alignments may be feasible. Table II.A.3 provides details on elevation, existing ground cover and recommended treatments for each sewer line crossing;
4. Two road crossings over the Upper Truckee River constrain channel restoration opportunities, although modifications can be made to improve their hydrologic function; and
5. Seasonal use of the river for recreational rafting requires consideration of safe passage in channel design.

All of the alternatives developed herein assume no significant changes in land use, primarily that the South Lake Tahoe Airport would remain on its existing footprint and that cattle grazing and private ownership and control of the lower meadow would continue. Sewer line alignments are an important constraint and any modification must be addressed. Removal of the South Lake Tahoe Airport to restore the Upper Truckee River and associated wetlands in the former meadow that existed prior to 1958 was not developed or analyzed because it is assumed that the Airport will remain indefinitely. A second alternative involving restoration of the Upper Truckee River to its original alignment in Reaches 1 and 2 (Alternative 4) was developed and analyzed but is not deemed feasible or a candidate for selection as a preferred alternative due to existing private landowner desired use as a grazing meadow.

Table II.A.2 Reach Characteristics and Constraints

Reach	Endpoints	Character	Key Constraints
1	Lower Highway 50 to split channel junction	Braided channel system with main incised channel along east edge of valley and main gully channel to the west.	Grazing operation on meadow. Sewer line alignments. Residences along eastern bank of river.
2	Split channel junction to Old River Junction	Single, straight and incised channel flowing along east edge of valley; overly wide and eroding in several sections.	Alignment along valley edge adjacent to steep upland to east. Sewer line alignments. Bridge crossing constrains channel meander belt.
3	Old River Junction to Windsock	Straight, riprap-lined, incised channel bounded by upland to the east and high terrace (former meadow) and Airport to the west.	River and floodplain confined by upland to east and Airport to west, limiting floodplain and meander belt area.
4	Windsock to Diversion Dam	Straight, riprap-lined, incised channel bounded by upland to east and Airport immediately to west.	River channel confined by upland and Airport limiting channel and floodplain width to existing alignment.
5	Diversion Dam to Sunset Stables	Deeply incised channel with open meadow to the east; short reach of riprap impinges on Airport.	Minor constraints formed by sewer line alignments.
6	Sunset Stables to Elk's Club	Moderately incised channel bounded by higher terraces and forest areas.	Sewer line alignment and forest affect potential meander belt areas.

Table II.A-3 Depth Over Sewer/Water Lines in Upper Truckee River Project Area

Reach	ID	Sewer Line Elevation (ft)	Existing Ground Cover (ft)*	Recommended Treatment
1	S-1	6231.0	3.0	None
1	S-2	6233.5	0.5	None, Filling Channel
2	S-3	6235.0	2.0	None, Filling Channel
2	S-4	6234.0	2.0	None
2	S-5	6234.0	4.0	None
2	S-6	6235.0	3.0	None
2	S-7	6235.0	3.5	None
2	S-8	6235.0	3.0	None
2	S-9	6237.0	3.0	None
2	S-10	6237.0	1.5	None, Filling Channel
5	S-11	6248.0	4.0	Armored Riffle
5	S-12	6245.0	2.0	None
5	S-13	NA	NA	Armored Riffle
5	S-14	NA	NA	None
6	S-15	6256.5	2.5	Armored Bank

* Sewer/Water Line depth from Clair A. Hill & Associates, 1966

II.B PROPOSED ACTIONS/ALTERNATIVES

Given the land use constraints described above, at least three alternatives were developed for each of the six project reaches reflecting varying levels of enhancement or restoration:

1. Alternative 1 involves No Action and allows existing conditions continue into the future;
2. Alternative 2 proposes a modest level of ecosystem enhancement with limited impacts and disturbance; and
3. Alternative 3 (and Alternative 4 in Reaches 1 and 2) involves a high level of enhancement or complete reconstruction of the channel to original conditions.

The following describes existing reach conditions and the proposed set of alternatives. These alternatives are summarized in Tables II.B.1 and II.B.2, which provide approximate cost estimates and construction quantities for each.

Table II.B.1: Summary of Proposed Alternatives by Reach

Matt Weld, Civil Engineering
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NOTE: ESTIMATES REFLECT COSTS ASSOCIATED WITH IMPORT OR EXPORT OF MATERIAL, AS REQUIRED TO BALANCE GRADING QUANTITIES ASSOCIATED WITH INDIVIDUAL PROPOSED MEASURES. TABLE 4 SUMMARIZES THESE QUANTITIES. SIGNIFICANT COST REDUCUTIONS MAY BE POSSIBLE THROUGH SELECTION OF MEASURES WHICH TEND TO BALANCE PROJECT GRADING VOLUMES.

REACH	ALTERNATIVE	MEASURES	DESCRIPTION	QUANTITY	UNITS	UNIT COST	SUBTOTALS
1	1: No Action	-	-	-	-	-	-
1	2: Moderate Enhancement Plan	1.2.1	**Meadow Floodplain, Meadow Wetlands:** Partially fill (50%) the gully channel and the tributary channel to the west to the elevation of the meadow in order to eliminate flow capture from the existing main channel, while retaining isolated wetlands within unfilled portions of the gully and tributary channels.				
			Partially fill gully channels	8,096	CY	$6	$44,525
			Place native sod, revegetate	10,989	SY	$6	$65,934
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$16,569	$16,569
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$127,028
1		1.2.2	**Meadow Floodplain Area:** Enhance channel banks by lowering them to bankfull flow elevations and revegetating them with meadow sod and willow plantings.				
			Lower Existing channel banks	9,704	CY	$24	$232,896
			Place native sod, revegetate	18,782	SY	$6	$112,692
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$51,838	$51,838
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$397,426
1		1.2.3	**Meadow Floodplain Area:** Provide fenced buffers from livestock (part of NRCS grazing Management Plan)				
			Install fence	TBD	LF	$6	TBD
						Subtotal	$0
1		1.2.4	**Meadow Floodplain Area:** Construct overflow areas at select locations along the existing channel by lowering the bank heights to the bankfull stage (370 cfs) and Revegetating with meadow sod (Fig. 9).				
			Construct overflow areas	3,333	CY	$24	$79,992
			Place native sod, revegetate	5,000	SY	$6	$30,000
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$16,499	$16,499
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$126,491

Table II.B.1: Summary of Proposed Alternatives by Reach

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REACH	ALTERNATIVE	MEASURES	DESCRIPTION	QUANTITY	UNITS	UNIT COST	SUBTOTALS
1		1.2.5	**Stream Banks:** Construct bank protection along 2980 LF of existing channel using bioengineering methods (willow brush matting and layering have worked well).				
			Construct bank protection	2,980	LF	$133	$396,340
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$59,451	$59,451
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$455,791
						Moderate Enhancement Total	**$1,106,736**
						w/ 30% contingency	**$1,438,757**
1	3. * Full Enhancement Plan	1.3.1	**Meadow Floodplain Area:** As a replacement to Measure 1.2.1, fill the entirety of both gully channels and restore to meadow, a total of 19,200 cubic yards of fill.				
			Completely fill gully channels	16,191	CY	$6	$89,051
			Place native sod, revegetate	12,088	SY	$6	$72,528
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$24,237	$24,237
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$185,815
			* Measures 1.2.2-1.2.5			**Subtotal**	$979,708
			* The Full Enhancement Plan includes and/or replaces measures from the Moderate Enhancement Plan				
						Full Enhancement Total	**$1,165,523**
						w/ 30% contingency	**$1,515,180**

Table II.B.1: Summary of Proposed Alternatives by Reach

Matt Weld, Civil Engineering
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115 Limekiln Street Santa Cruz, California USA 95060

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REACH	ALTERNATIVE	MEASURES	DESCRIPTION	QUANTITY	UNITS	UNIT COST	SUBTOTALS
2	1: No Action	**-**	-	**-**		-	-
2	2: Moderate Enhancement Plan	2.2.1	**Meadow Floodplain Area:** Re-route old river channel to discharge into a swale that would extend along the western edge of the valley flat. Completely fill the lower 450 feet of the old river channel to create isolated wetlands and an overflow area.				
			Re-rout old river channel	5,000	CY	$6	$27,500
			Place native sod, revegetate	1,500	SY	$6	$9,000
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$5,475	$5,475
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$41,975
2		2.2.2	**Stream Channel, Meadow Floodplain:** Modify the diversion dam at the downstream end of Reach 2 by adding boulders to improve fish passage and stabilize banks; remove old wing walls and fill extending westward from west bank wing wall.				
			Install boulders for fish passage	1	LS	$50,000	$50,000
			Stabilize banks, remove wing walls, place fill	1	LS	$30,000	$30,000
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$12,000	$12,000
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$92,000
2		2.2.3	**Meadow Floodplain Area:** Create seven bankfull overflow points covering 1160 feet of the west bank to improve overbank flow above 370 cfs (Fig. 9).				
			Excavate overflow area	5,649	CY	$24	$135,576
			Place native sod, revegetate	8,470	SY	$6	$50,820
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$27,959	$27,959
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$27,959
2		2.2.4	**Stream Channel:** Replace private bridge crossing with a larger span structure to reduce erosion and hydraulic disruption. Design bridge to accommodate flow irrigation diversion and to maintain channel grade control. Incorporate a higher bridge approach with proper through drainage to accommodate overbank flows.				
			Install new bridge	1	LS	$125,000	$125,000
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$18,750	$18,750
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$143,750

Table II.B.1: Summary of Proposed Alternatives by Reach

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NOTE: ESTIMATES REFLECT COSTS ASSOCIATED WITH IMPORT OR EXPORT OF MATERIAL, AS REQUIRED TO BALANCE GRADING QUANTITIES ASSOCIATED WITH INDIVIDUAL PROPOSED MEASURES. TABLE 4 SUMMARIZES THESE QUANTITIES. SIGNIFICANT COST REDUCUTIONS MAY BE POSSIBLE THROUGH SELECTION OF MEASURES WHICH TEND TO BALANCE PROJECT GRADING VOLUMES.

REACH	ALTERNATIVE	MEASURES	DESCRIPTION	QUANTITY	UNITS	UNIT COST	SUBTOTALS
2		2.2.5	**Meadow Floodplain Area:** Partially fill and or otherwise stabilize eroding tributary gully to prevent flow capture and improve dispersion of overbank flow within the meadow flood plain.				
			Partially fill/stabilize irrigation channels	668	CY	$6	$3,671
			Place native sod, revegetate	1,144	SY	$6	$6,864
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$1,580	$1,580
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$12,116
						Moderate Enhancement Total	**$317,800**
						w/ 30% contingency	**$413,140**
2	3. * Full Enhancement Plan	2.3.1	**Stream Channel:** Install 2025 LF of instream enhancements such as logs, boulders and vegetation plantings into the e channel in order to improve aquatic habitat (Fig. 10).				
			Stabilize irrigation channels	20	EA	$5,000	$101,250
			Revegetate	4,500	SY	$4	$17,010
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$17,739	$17,739
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$135,999
2		2.3.2	**Stream Channel:** Install bioengineered bank protection on 210 LF of bluff erosion sites.				
			Install bank protection	210	LF	$150	$31,500
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$4,725	$4,725
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$36,225
2		2.3.3	**Meadow Floodplain Area:** As a replacement to Measure 2.2.5, completely fill and or otherwise stabilize eroding tributary gully to prevent flow capture and improve dispersion of overbank flow within the meadow flood plain.				
			Stabilize irrigation channels	1,335	CY	$6	$7,343
			Place native sod, revegetate	3,333	SY	$6	$19,998
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$4,101	$4,101
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$31,442
			* Measures 2.2.1-2.2.4			**Subtotal**	$305,684
			* The Full Enhancement Plan includes and/or replaces measures from the Moderate Enhancement Plan				
						Full Enhancement Total	**$509,350**
						w/ 30% contingency	**$662,155**

Table II.B.1: Summary of Proposed Alternatives by Reach

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REACH	ALTERNATIVE	MEASURES	DESCRIPTION	QUANTITY	UNITS	UNIT COST	SUBTOTALS
3	1: No Action	-	-	-	-	-	-
3	2: Moderate Enhancement Plan	3.2.1	**Meadow Floodplain Area:** Remove 56,225 cy of fill from 17 acres of the terrace between the river channel and the Airport fenceline in order to lower the terrace approximately 2 feet to the bankfull floodplain elevation and revegetate.				
			Remove fill from terrace	56,225	CY	$24	$1,349,400
			Place native sod, revegetate	82,280	SY	$6	$493,680
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$276,462	$276,462
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$2,119,542
3		3.2.2	**Stream Channel:** Replace the existing ford crossing with a bridge to span the channel and minimize the disruption of flow and habitat. Design the new bridge to maintain grade control and to provide flow capacity for overbank flooding.				
			Install new bridge	1	LS	$125,000	$125,000
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$18,750	$18,750
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$143,750
3		3.2.3	**Stream Channel:** Install channel habitat improvements along the entire 3,767 feet of channel, consisting of logs, boulders and vegetation plantings (Fig. 10).				
			Install log and boulder structures	38	EA	$5,000	$188,350
			Revegetate	16,742	SY	$4	$63,286
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$37,745	$37,745
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$289,381
						Moderate Enhancement Total	**$2,552,673**
						w/ 30% contingency	**$3,318,475**
3	3. * Full Enhancement Plan	3.3.1	**Stream Channel, Meadow Floodplain Area:** Construct 3,500 LF of new mildly sinuous channel within the excavated terrace and fill/abandon existing channel.The bridge replacement design would allow for a full span crossing over the bankfull and for overbank flow (Fig. 11).				
			Excavate new channel	34,222	CY	$4	$136,888
			Construct new channel	3,500	LF	$179	$626,500
			Fill existing channel	28,496	CY	$6	$170,976
			Place native sod, revegetate	22,167	SY	$6	$133,002
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$160,105	$160,105
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$1,227,471

Table II.B.1: Summary of Proposed Alternatives by Reach

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REACH	ALTERNATIVE	MEASURES	DESCRIPTION	QUANTITY	UNITS	UNIT COST	SUBTOTALS
3		3.3.2	**Meadow Floodplain Area:** Install a 3,050-foot buried riprap windrow along the Airport fenceline to protect the Airport and sewer lines from future lateral erosion.				
			Excavate trench	7,230	CY	$16	$115,168
			Place rock	7,230	CY	$38	$277,184
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$58,853	$58,853
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$451,205
			* Measures 3.2.1-3.2.2			**Subtotal**	$2,263,292
			* The Full Enhancement Plan includes and/or replaces measures from the Moderate Enhancement Plan				
						Full Enhancement Total	**$3,941,968**
						w/ 30% contingency	**$5,124,558**
4	1: No Action	**-**	**-**	**-**	**-**	**-**	**-**
4	2: Moderate Enhancement Plan	4.2.1	**Stream Channel:** Modify the old diversion dam to increase its stability and to improve its hydraulic function for aquatic habitat quality. This would include placement of boulders, logs and native vegetation plantings.	-			
			Place boulders and logs	1	LS	$50,000	$50,000
			Revegetate with willows	1	LS	$10,000	$10,000
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$9,000	$9,000
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$69,000
4		4.2.2	**Stream Channel:** Install logs and boulders throughout the reach for instream enhancement (Fig. 10).				
			Install log and boulder structures	14	EA	$5,000	$67,500
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$10,125	$10,125
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$77,625
						Moderate Enhancement Total	**$146,625**
						w/ 30% contingency	**$190,613**
4	3. * Full Enhancement Plan		* The full enhancement plan is the same as the moderate enhancement plan.				$146,625
			* The Full Enhancement Plan includes and/or replaces measures from the Moderate Enhancement Plan				
						Full Enhancement Total	**$146,625**
						w/ 30% contingency	**$190,613**

Table II.B.1: Summary of Proposed Alternatives by Reach

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REACH	ALTERNATIVE	MEASURES	DESCRIPTION	QUANTITY	UNITS	UNIT COST	SUBTOTALS
5	1: No Action	-	-	-		-	-
5	2: Moderate Enhancement Plan	5.2.1	**Floodplain Area:** Create a meander belt within the existing channel alignment by excavating 77,344 cy of the meadow surrounding the existing channel. Meadow sod and willow cuttings would be used to revegetate the flood plain within the meander belt. The meander belt area would be set to the elevation/stage of overbank flow at 370 cfs (Fig. 12).				
			Create meander belt	77,344	CY	$24	$1,856,256
			Place native sod, revegetate	31,924	SY	$6	$191,547
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$307,170	$307,170
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$2,354,973
5		5.2.2	**Stream Channel:** Install Logs and boulders as instream habitat enhancements (Fig 10).				
			Install log and boulder structures	72	EA	$5,000	$359,150
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$53,873	$53,873
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$413,023
						Moderate Enhancement Total	**$2,767,996**
						w/ 30% contingency	**$3,598,394**
5	3. * Full Enhancement Plan	5.3.1	**Stream Channel, Meadow Area:** Construct 6,900 LF of new channel through the meadow using geomorphic design criteria of 370 cfs capacity and proper width, depth and plan form. The old channel would be filled to meadow elevations and revegetated. Instream enhancement measures would be added as part of the new channel construction (Fig. 11).				
			Excavate new channel	67,467	CY	$4	$269,867
			Construct new channel	6,900	LF	$179	$1,235,100
			Fill old channel	51,775	CY	$6	$310,650
			Place native sod, revegetate	74,201	SY	$6	$445,206
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$339,123	$339,123
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$2,599,946
			* Measure 5.31 replaces measures 5.2.1-5.2.2			**Subtotal**	$0
			* The Full Enhancement Plan includes and/or replaces measures from the Moderate Enhancement Plan				
						Full Enhancement Total	**$2,599,946**
						w/ 30% contingency	**$3,379,930**

Table II.B.1: Summary of Proposed Alternatives by Reach

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REACH	ALTERNATIVE	MEASURES	DESCRIPTION	QUANTITY	UNITS	UNIT COST	SUBTOTALS
6	1: No Action	-	-	-		-	-
6	2: Moderate Enhancement Plan	6.2.1	**Floodplain Area, Stream Channel** Lower 2,300 LF of bank to stabilize eroding banks, restore flood plain area and improve stream habitat.				
			Lower bank	14,441	CY	$24	$346,584
			Place native sod, revegetate	10,222	SY	$6	$61,333
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$61,188	$61,188
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$469,105
6		6.2.2	**Stream Channel:** Install logs and boulders along the entire 4860 LF of Reach 6 channel and revegetate in order to improve instream habitat (Fig. 10).				
			Install log and boulder structures	49	EA	$5,000	$243,000
			Revegetate	21,600	SY	$4	$81,648
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$48,697	$48,697
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$373,345
						Moderate Enhancement Total	**$842,450**
						w/ 30% contingency	**$1,095,185**
6	3. * Full Enhancement Plan	6.3.1	**Stream Channel, Meadow Area** Construct 3,950 LF of new channel through forested and meadow reaches in areas where the sewer line will not be affected at the lower end of the project reach (Fig. 11).				
			Excavate new channel	38,622	CY	$4	$154,488
			Construct new channel	3,950	LF	$179	$707,050
			Fill existing channel	27,334	CY	$6	$164,004
			Place native sod, revegetate	50,967	SY	$6	$305,802
			Mobilization, Phasing, Erosion Control, Etc.	1	LS	$199,702	$199,702
			Protect existing sewer pipeline (if encountered)	1	LS	TBD	TBD
						Subtotal	$1,531,046
			* Measures 6.3.1 replaces measures 6.2.1-6.2.2			**Subtotal**	$0
			* The Full Enhancement Plan includes and/or replaces measures from the Moderate Enhancement Plan				
						Full Enhancement Total	**$1,531,046**
						w/ 30% contingency	**$1,990,359**

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Table II.B.2: Summary of Material Quantities for Proposed Alternatives

ME = MODERATE ENHANCEMENT PLAN
FE = FULL ENHANCEMENT PLAN

			Grading Quantities (cubic yards)		Net for ME Plan	Net for FE Plan
REACH	ALTERNATIVE	MEASURE	CUT	(FILL)	CUT or (FILL)	CUT or (FILL)
1	ME	1.2.1		(8,096)		
		1.2.2	9,704			
		1.2.3				
		1.2.4	3,333			
		1.2.5				
	net		*13,037*	*(8,096)*	**4,941**	**na**
	FE	1.3.1		(16,191)		
		1.2.2-1.2.5	13,037			
	net		*4,941*	*(16,191)*	**na**	**(11,250)**
2	ME	2.2.1		(5,000)		
		2.2.2				
		2.2.3	5,649			
		2.2.4				
		2.2.5		(668)		
	net		*5,649*	*(5,668)*	**(19)**	**na**
	FE	2.3.1				
		2.3.2				
		2.3.3		(1,335)		
		2.2.1-2.2.5		(19)		
	net			*(1,354)*	**na**	**(1,354)**
3	ME	3.2.1	56,225			
		3.2.2				
		3.2.3				
	net		*56,225*	*0*	**56,225**	**na**
	FE	3.3.1	34,222	(28,496)		
		3.3.2	7,230			
		3.2.1-3.2.3	56,225			
	net		*97,677*	*(28,496)*	**na**	**69,181**
4	ME	4.2.1				
		4.2.2				
	net		*0*	*0*	**0**	**na**
	FE	4.3.1				
	net		*0*	*0*	**na**	**0**
5	ME	5.2.1	77,344			
		5.2.2				
	net		*77,344*	*0*	**77,344**	**na**
	FE	5.3.1	67,467	(51,775)		
	net		*67,467*	*(51,775)*	**na**	**15,692**
6	ME	6.2.1	14,441			
		6.2.2				
	net		*14,441*	*0*	**14,441**	**na**
	FE	6.3.1	38,622	(27,334)		
	net		*38,622*	*(27,334)*	**na**	**11,288**

II.B.1 Reach 1

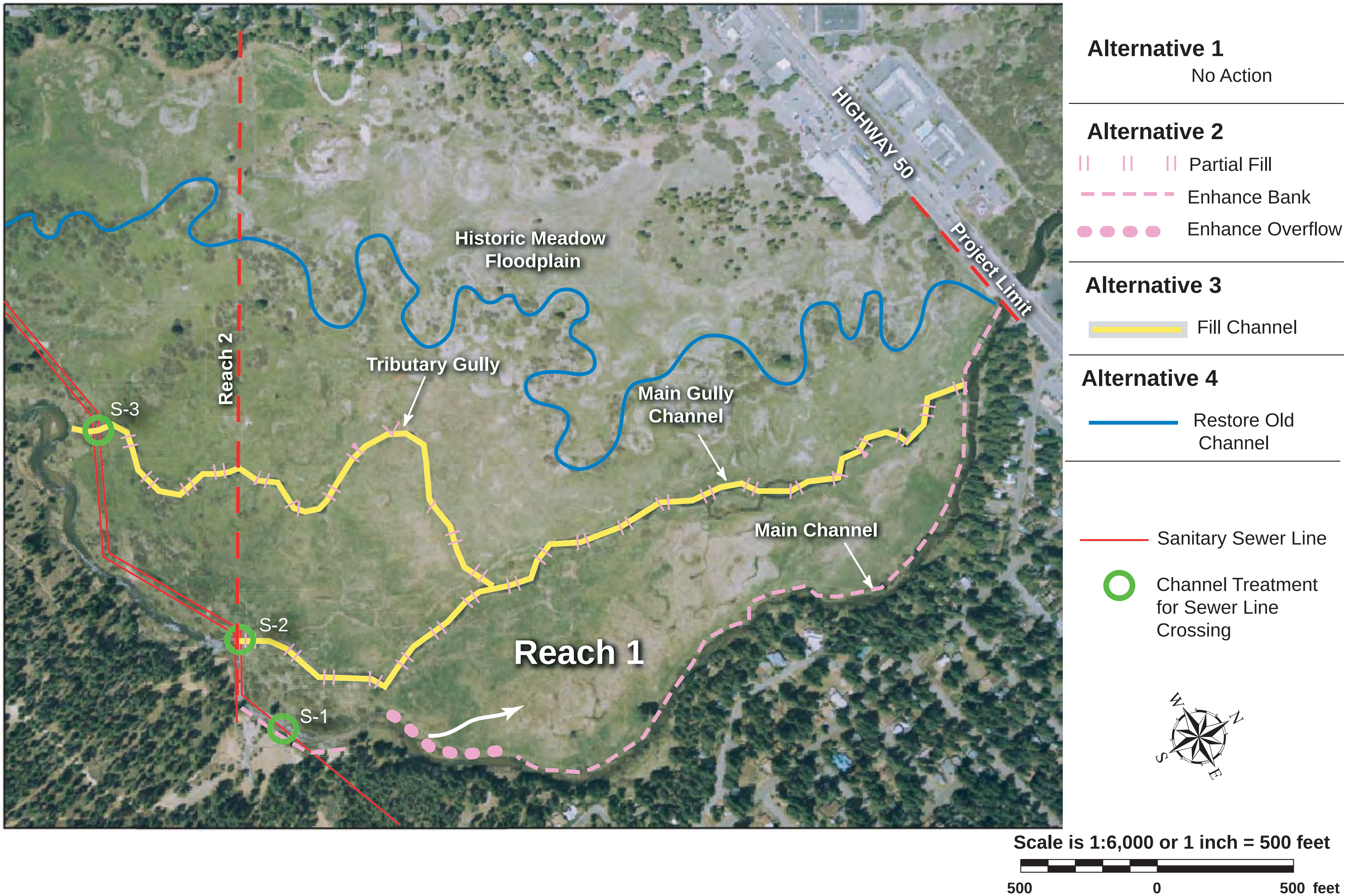
Reach 1 includes 4,226 linear feet of stream channel and approximately 112 acres of meadow floodplain that is predominately in private ownership and used for cattle grazing. The Upper Truckee River flows around the eastern perimeter of the meadow within an incised channel that was created during the Comstock Era to reclaim the meadow for grazing. The original meandering channel that is visible along the western half of the Reach 1 meadow shows a relatively narrow, pool / riffle morphology and a more sinuous plan form. The existing channel flows along the base of the upland area east of the meadow near the backyards of residential properties. The morphology of the existing channel consists of a flat sandy bed with low aquatic habitat value. The existing channel has a capacity of about 800 cfs.

A 3,290-foot long gully channel recently formed in the meadow lies west of the existing Upper Truckee River channel. The gully channel is 4-8 feet deep, 20 to 40 feet wide, and shows abundant evidence of recent erosion. The presence of head cuts and extensive vertical eroding banks indicates a low level of stability. Flow in the river splits at the head of Reach 1 and recent monitoring indicates that about half of the flow goes into the gully channel. However, it appears that the gully channel could carry the majority of large floods due to the head alignment of the gully channel at the flow split junction and the sharp right hand turn taken by the existing channel. Historical aerial photographs indicate that the gully channel was originally an irrigation ditch that has subsequently captured a significant portion of the flood flow. Continuous water quality monitoring conducted by the City of South Lake Tahoe (Russ Wigert, pers. comm. 2002) has found an increase in turbidity of 10 to 20 NTU discharging from the gully. Other observers claim that in past years the majority of summer low flow has been carried by the gully channel (Jerry Owens, pers. comm. 2002). Besides erosion and entrainment of fine sediments, the gully channel has decreased groundwater elevations, reduced overbank flow and diminished soil moisture in the meadow. Observations made during the 1994-95 water year found that the meadow in Reach 1 became inundated and flooded to a depth of 1-3 feet at flows around 300 cfs; in 2002 flows above 300 cfs were contained in the existing main channel and gully channels, while the adjacent meadow remained dry.

Reach 1 is in private ownership with the exception of easements along sewer lines.

The proposed alternatives for restoration of Reach 1 (Figure II.B.1) are as follows:

1. **The No Action Plan** would leave existing conditions as is. Under this scenario, the existing channel would remain, but the gully channel would likely expand. This would lead to further releases of sediment from bank erosion of the gully channel and additional drying of the meadow as the gully channel continued to incise and capture flows.



Swanson Hydrology & Geomorphology
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tel: 831.427.0288 fax: 831.427.0472

Figure II.B-1: Proposed alternatives and measures for Reach 1 of the Upper Truckee River Restoration Project in South Lake Tahoe, California. Wavy arrow demonstrates the desired direction of overflow.

2. **The Moderate Enhancement Plan** would involve the following measures:

   1.2.1 Partially fill (50%) the gully channel and the tributary gully channel to the west to the elevation of the meadow in order to eliminate flow capture from the existing main channel, while retaining isolated wetlands within unfilled portions of the gully and tributary gully channels;
   1.2.2 Enhance channel banks by lowering them to bankfull flow elevations and revegetating with meadow sod and willow plantings;
   1.2.3 Provide fenced buffers from livestock (part of NRCS Grazing Management Plan);
   1.2.4 Construct overflow areas at select locations along the existing channel by lowering the bank heights to the bankfull stage (370 cfs) and revegetating with meadow sod (Figure II.B.2); and
   1.2.5 Construct bank protection along 2,980 LF of existing channel using bioengineering methods (willow brush matting and layering could work well).

It is anticipated that the restored hydrology will improve marsh vegetation without plantings. Vegetation for bank protection and overflow areas will be meadow sod and willows obtained onsite. The source of fill needed to treat the gully channels may be obtained from fill removal projects described below in Reaches 2, 3 and 5.

3. The **Full Enhancement Plan** for Reach 1 includes all of the measures of the Moderate Enhancement Plan with:

   1.3.1 As a replacement to Measure 1.2.1, fill the entirety of both gully channels and restore to meadow, requiring a total of 19,200 cubic yards of fill.

Alternative 4 would involve restoring the Upper Truckee River to its historical alignment west of the present channel. This project would also involve filling the gully channels and the present existing Upper Truckee River channel situated along the eastern edge of the valley. No construction details or quantities were developed for Alternative 4, as it is not deemed feasible; however it is compared in Chapter 3 to other alternatives in terms of potential environmental benefits and potential impacts.

II.B.2 Reach 2

Reach 2 is bounded at its downstream end by the flow split to the gully channel and at its upstream end by the confluence of the existing channel with the Old River channel near the northeast corner of the South Lake Tahoe Airport. Reach 2 includes 3,788 feet of existing Upper Truckee River channel and approximately 68 acres of meadow. Reach 2 flows along the eastern edge of the valley flat and is bounded by hillslope and upland to the east. The channel was moved to its present location during the Comstock Era (1860s)

Upper Truckee River Restoration Project
Alternatives Analysis

Modify Bank for Enhanced Overflow

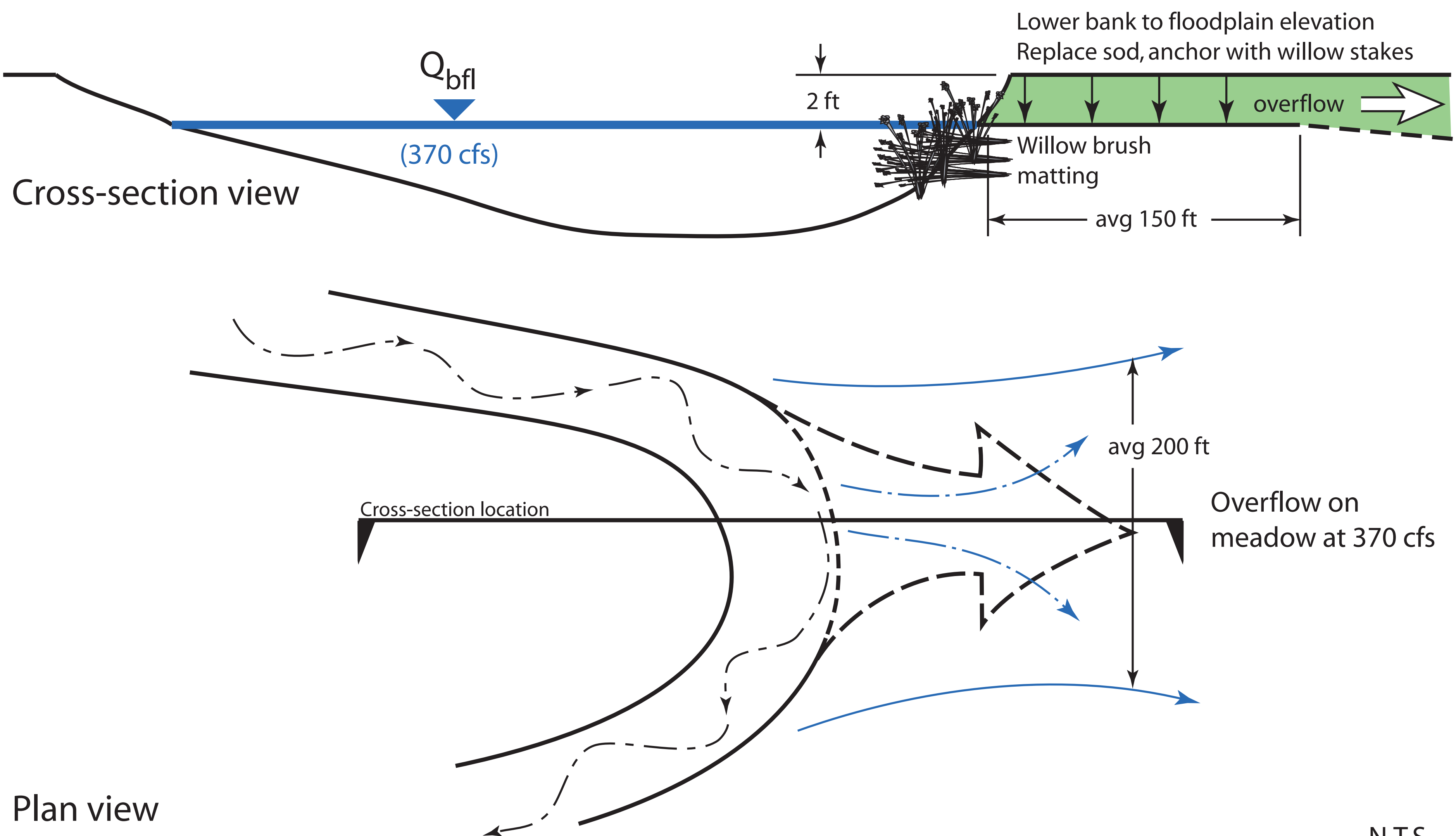

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Figure II.B.2: Proposed measure to improve overbank flow. Bank height is lowered to bankfull stage and revegetated with meadow sod and willow stakes at select locations to enhance overflow onto meadow.

in order to reclaim the meadow for grazing. The channel is incised and has a capacity of 800 cfs or greater.

Reach 2 has one damaged, old diversion dam at its downstream end, which is still an effective grade control on the existing Upper Truckee River channel bed. Wing walls and fill associated with the structure extend westward onto the floodplain and meadow. The channel in Reach 2 has several bank erosion locations involving loss of meadow floodplain and erosion of upland bluffs. The two sewer alignments run alongside and near the western channel bank. In one location, following the February 1986 flood, a major bank repair using riprap was installed by the South Tahoe Public Utility District (STPUD) to protect the sewer line against advancing bank failures. The channel morphology consists of a predominately sandy bed that is generally shallow and wide with isolated pools formed as the result of scour around trees and woody debris. Several areas exhibit good point bar development, with lateral erosion of the opposite bank being associated with these features.

The Old River channel drains the area that includes the Airport, Highway 50, and part of the industrial area west of Highway 50 into the existing Upper Truckee River channel at the northeast corner of the Airport.

The land ownership is mostly private within Reach 2, with the exception of the easement along the sewer lines and the City of South Lake Tahoe Airport.

The Alternatives for Reach 2 are as follows (Figure II.B.3):

1) The **No-Action** alternative would allow existing conditions to persist.

2) The **Moderate Enhancement Plan** would include the following measures:

   - 2.2.1 Re-route the Old River channel to discharge into a swale that would extend along the western edge of the valley flat. Partially fill the lower 450 feet of the Old River channel to create isolated wetlands and an overflow area.
   - 2.2.2 Modify the diversion dam at the downstream end of Reach 2 by adding boulders to improve fish passage and stabilize banks; remove old wing walls and fill extending westward from west bank wing wall;
   - 2.2.3 Create seven bankfull overflow points covering 1,160 feet of the west bank to improve overbank flow above 370 cfs (Figure II.B.2);
   - 2.2.4 Replace private bridge crossing with a larger span structure to reduce erosion and hydraulic disruption. Design bridge to accommodate flow irrigation diversion and to maintain channel grade control. Incorporate a higher bridge approach with proper through drainage to accommodate overbank flows; and

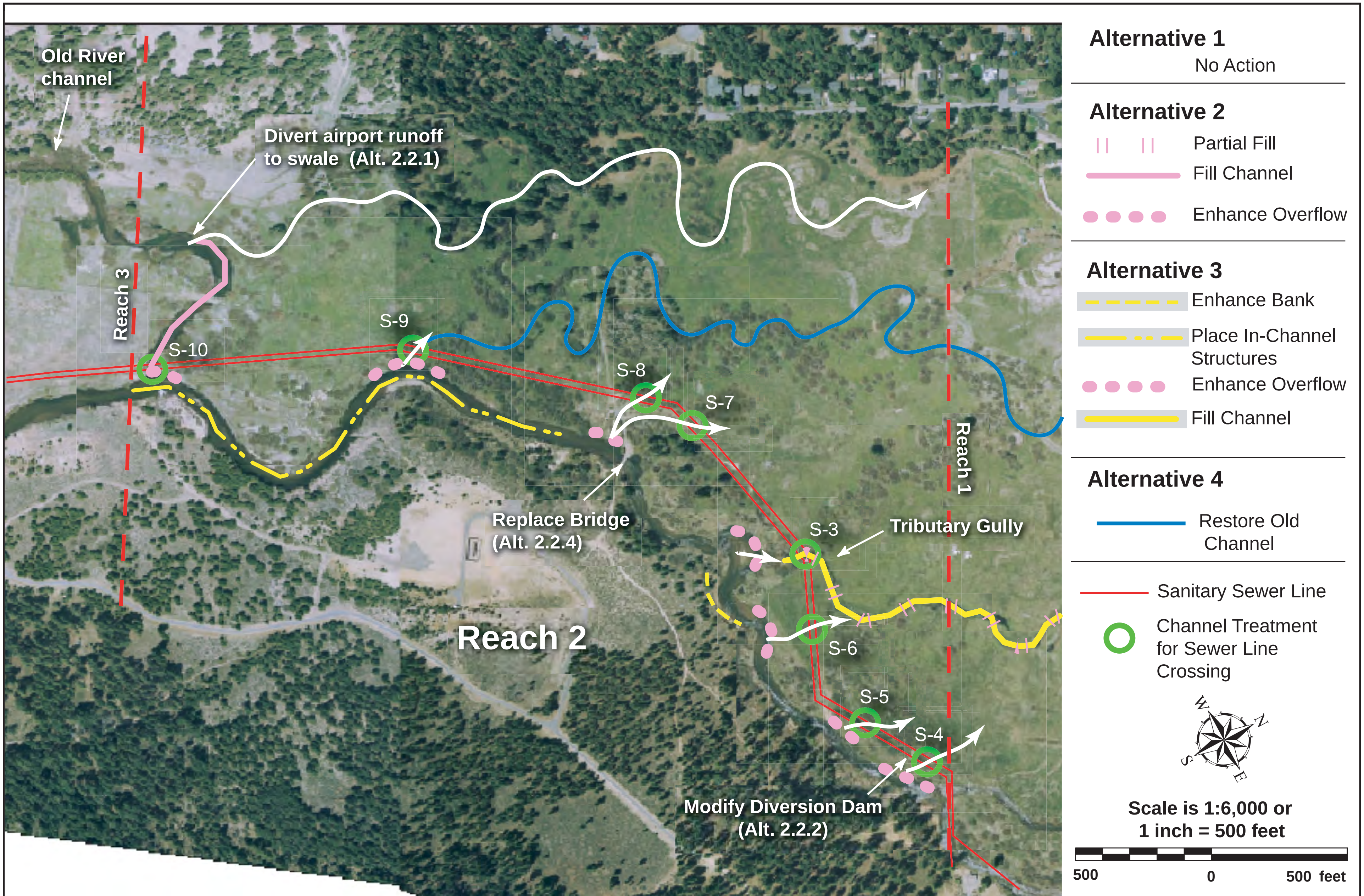

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Figure II.B.3: Proposed alternatives and measures for Reach 2 of the Upper Truckee River Restoration Project in South Lake Tahoe, California. Wavy arrow demonstrates the desired direction of overflow.

2.2.5 Fill and/or otherwise stabilize eroding irrigation channels to prevent flow capture and improve dispersion of overbank flow within the meadow floodplain.

3) The **Full Enhancement Plan** would include all of the actions of the Moderate Enhancement Plan and the following additional measures:

2.3.1 Install instream enhancements such as logs, boulders and vegetation plantings into the existing channel in order to improve aquatic habitat (Figure II.B.4);
2.3.2 Install bioengineered bank protection on 210 LF of bluff erosion sites.

Alternative 4, restoration of the original Upper Truckee River channel in Reach 2 is a continuation of Alternative 4 in Reach 1.

II.B.3 Reach 3

Reach 3 consists of 1,350 LF of channel and approximately 17 acres of modified floodplain / meadow in the Upper Truckee River between the Old River Junction and the Windsock structure. The channel is straightened, deep and lined completely in riprap with little vegetation. The eastern bank abuts the upland hills and in some areas the channel abuts tributary valley alluvial fans. A 250 – 300 foot wide terrace that is comprised of fill from the Airport development binds the west bank. The Airport bounds the overflow area west of the terrace and the sewer lines are within the runway crash zones. This reach of the river has remained very stable since the Airport Runway extension project that was completed in 1963. A ford crossing provides Airport personnel access from the Airport runways to utilities and emergency access to landing approach areas.

The existing channel has a uniform trapezoidal shape with low aquatic and riparian habitat value. The channel bed is predominately sandy. The floodplain areas are 4-6 feet above the low flow water surface elevation in the channel and support only sparse xeric vegetation (a few pines). Vegetation cover improves upstream of the road crossing, yet it still only supports dry species. One exception is an old 3-4 foot deep excavation cut that was dug into the terrace when the Airport was constructed. This cut intercepts groundwater, supports wetland vegetation (cattails, willows, sedges), and provides aquatic habitat for frogs. Reach 3 is within City of South Lake Tahoe ownership.

The alternatives for Reach 3 are as follows (Figure II.B.5):

1. The **No Action Plan** would leave existing conditions as they are.

Upper Truckee River Restoration Project
Alternatives Analysis

In-Channel Enhancements

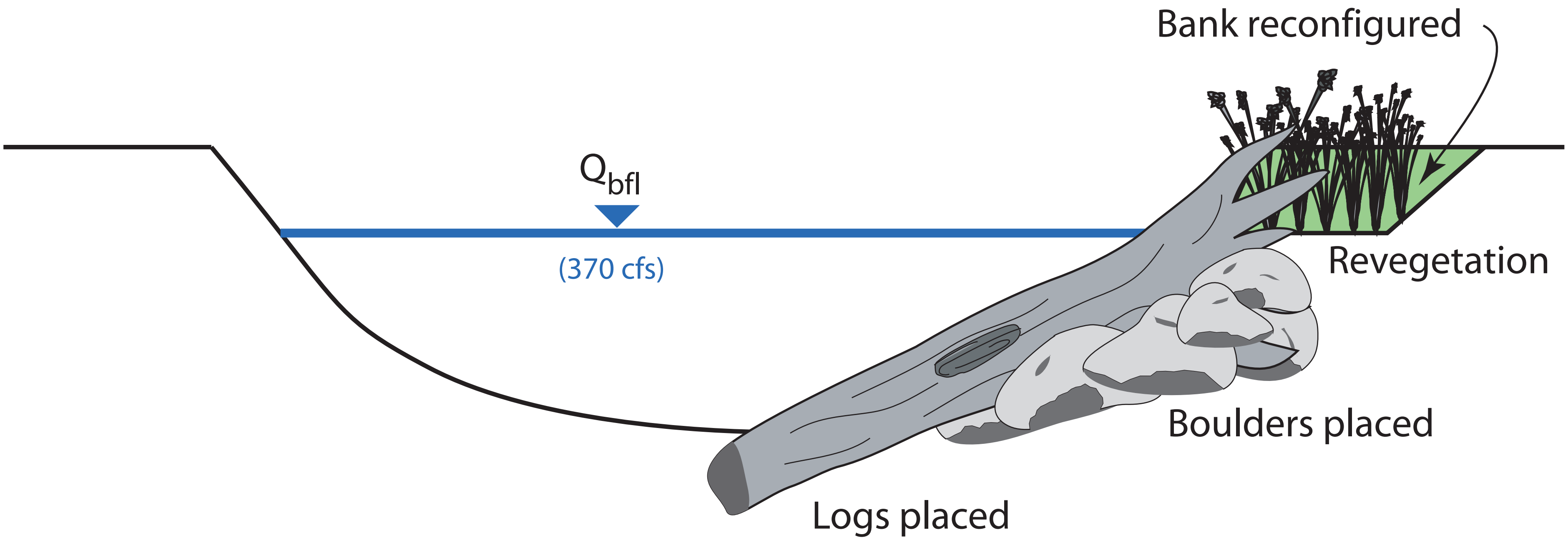

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Figure II.B.4: Proposed measure to improve aquatic habitat through the placement of logs, boulders, and vegetation.

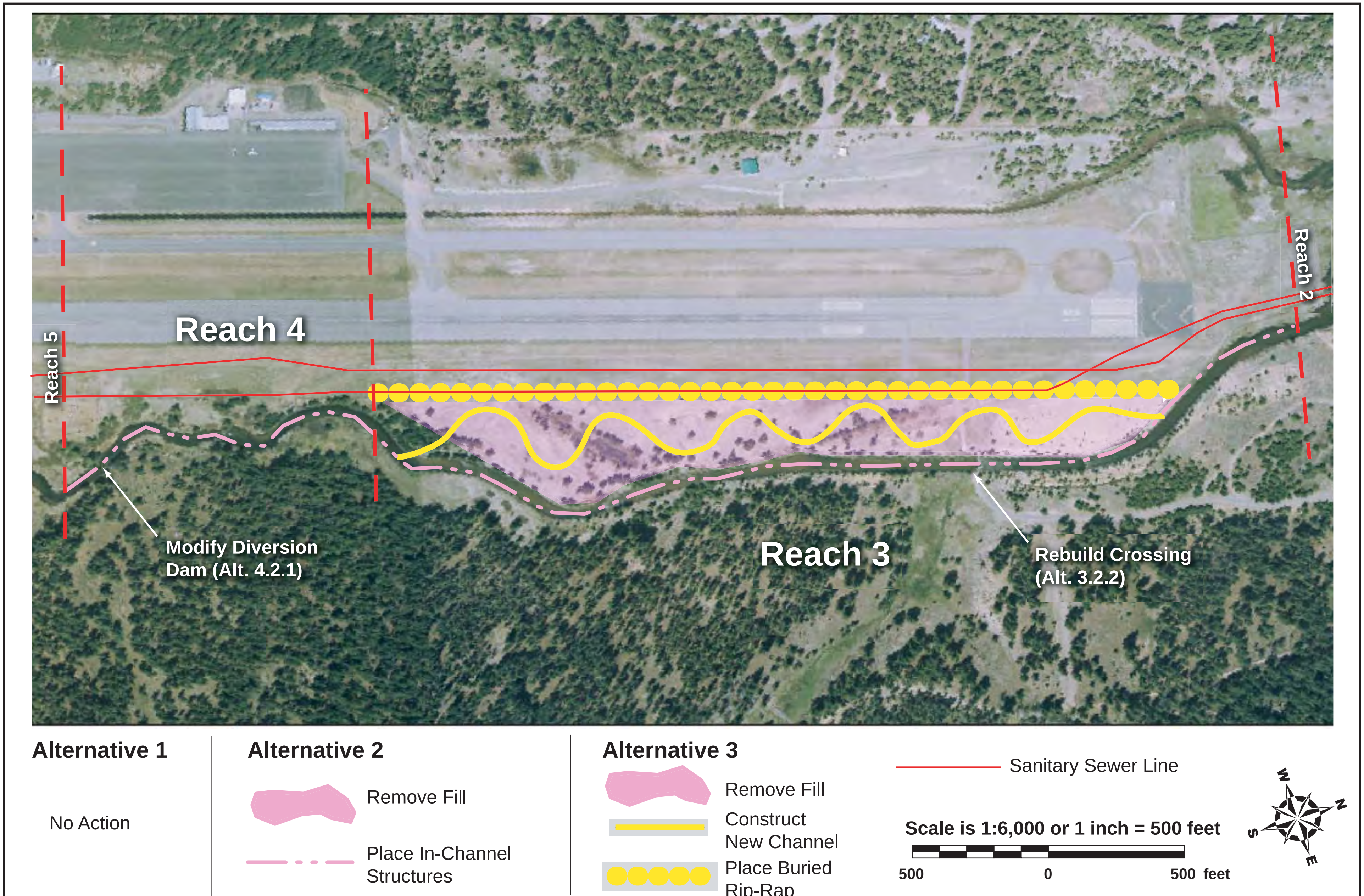

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Figure II.B.5: Proposed alternatives and measures for Reaches 3 and 4 of the Upper Truckee River Restoration Project in South Lake Tahoe, California.

2. The **Moderate Enhancement Plan** includes the following proposed actions:

    3.2.1 Remove 56,225 cy of fill from 17 acres of the terrace between the river channel and the Airport fence line in order to lower the terrace approximately 2 feet to the bankfull floodplain elevation and revegetate;
    3.2.2 Replace the existing ford crossing with a bridge to span the channel and minimize the disruption of flow and habitat. Design the new bridge to maintain grade control and to provide flow capacity for overbank flooding; and
    3.2.3 Install channel habitat improvements consisting of logs, boulders and vegetation plantings along the entire reach (Figure II.B.4).

3. The **Full Enhancement Plan** consists of the following measures in addition to those of the Moderate Enhancement Plan:

    3.3.1 Construct 3,500 LF of new mildly sinuous channel within the excavated terrace and fill/abandon existing channel (Figure II.B.6). Install a 3,050-foot buried riprap windrow along the Airport fence line to protect the Airport and sewer lines from future lateral erosion. The bridge replacement design would allow for a full span crossing over the bankfull channel and for overbank flow during floods.

II.B.4 Reach 4

Reach 4 consists of a 1,350-foot long reach of channel bounded closely by the hillslope and uplands to the east and the Airport fence line to the west. The lower 385 feet of the reach is lined with riprap. The floodplain area is severely limited. An old failing concrete diversion dam is the upstream boundary of Reach 4 and forms a grade control. Reach 4 is within the City of South Lake Tahoe ownership.

The alternatives for Reach 4 are as follows (Figure II.B.5):

1. The **No-Action Plan** would leave conditions as they are.

2. The **Moderate and Full Enhancement Plans** are the same and include the following measures:

    4.2.1 Modify the old Diversion Dam to increase its stability and to improve its hydraulic function for aquatic habitat quality. This would include placement of boulders, logs and native vegetation plantings.
    4.2.2 Install logs and boulders throughout the reach for instream enhancement (Figure II.B.4).

Upper Truckee River Restoration Project
Alternatives Analysis

New Channel Construction

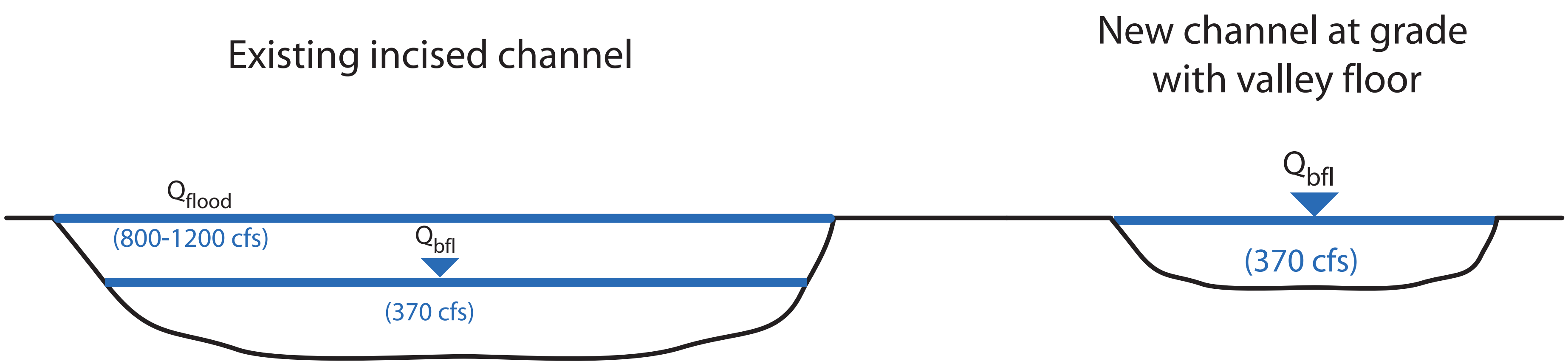

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Figure II.B.6: Proposed measure to build new channel with proper width, depth, and plan form. Existing channel would be filled and revegetated.

II.B.5 Reach 5

Reach 5 consists of 7,183 LF of channel and approximately 98 acres of floodplain meadow within a relatively unconstrained area. The river flows through a forested area and then along the Airport fence line for about 300 feet where riprap has been installed on the banks. Downstream of the fence line the river turns eastward and flows within an incised channel across the broad meadow. The channel becomes deeply incised near the downstream end before impinging on the hillslope that bounds the east side of the valley. The downstream area of Reach 5 includes a braided channel section and ends at the Diversion Dam of Reach 4. The channel exhibits some reaches with quality habitat, where recent bank erosion has incorporated large trees to create variability and shelter. Much of the channel in Reach 5 has low quality habitat with limited bank vegetation and sandy substrate. Channel grade control structures exist where the sewer line crosses the channel, and at the downstream end of Reach 5 at the Diversion Dam.
Two sewer lines cross from the Airport through the meadow to the east side of the valley. At the upstream end of Reach 5, the sewer lines are set at the base of the hillslope.

Reach 5 is within the City of South Lake Tahoe, U.S. Forest Service and CTC land ownership.

The alternatives for Reach 5 are as follows (Figure II.B.7):

1. The **No Action Plan** would leave existing conditions as they are.

2. The **Moderate Enhancement Plan** involves the following actions:

   5.2.1 Create a meander belt within the existing channel alignment by excavating 77,344 cy of the meadow surrounding the existing channel. Meadow sod and willow cuttings would be used to revegetate the floodplain within the meander belt. The meander belt area would be set to the elevation/stage of overbank flow at 370 cfs (Figure II.B.8);
   5.2.2 Install logs and boulders as instream habitat enhancements (Figure II.B.4).

3. The **Full Enhancement Plan** would include the following actions:

   5.3.1 Construct 6,900 LF of new channel through the meadow using geomorphic design criteria of 370 cfs capacity and proper width, depth and plan form (Figure II.B.6). The old channel would be filled to meadow elevations and revegetated. Instream enhancement measures would be added as part of the new channel construction.

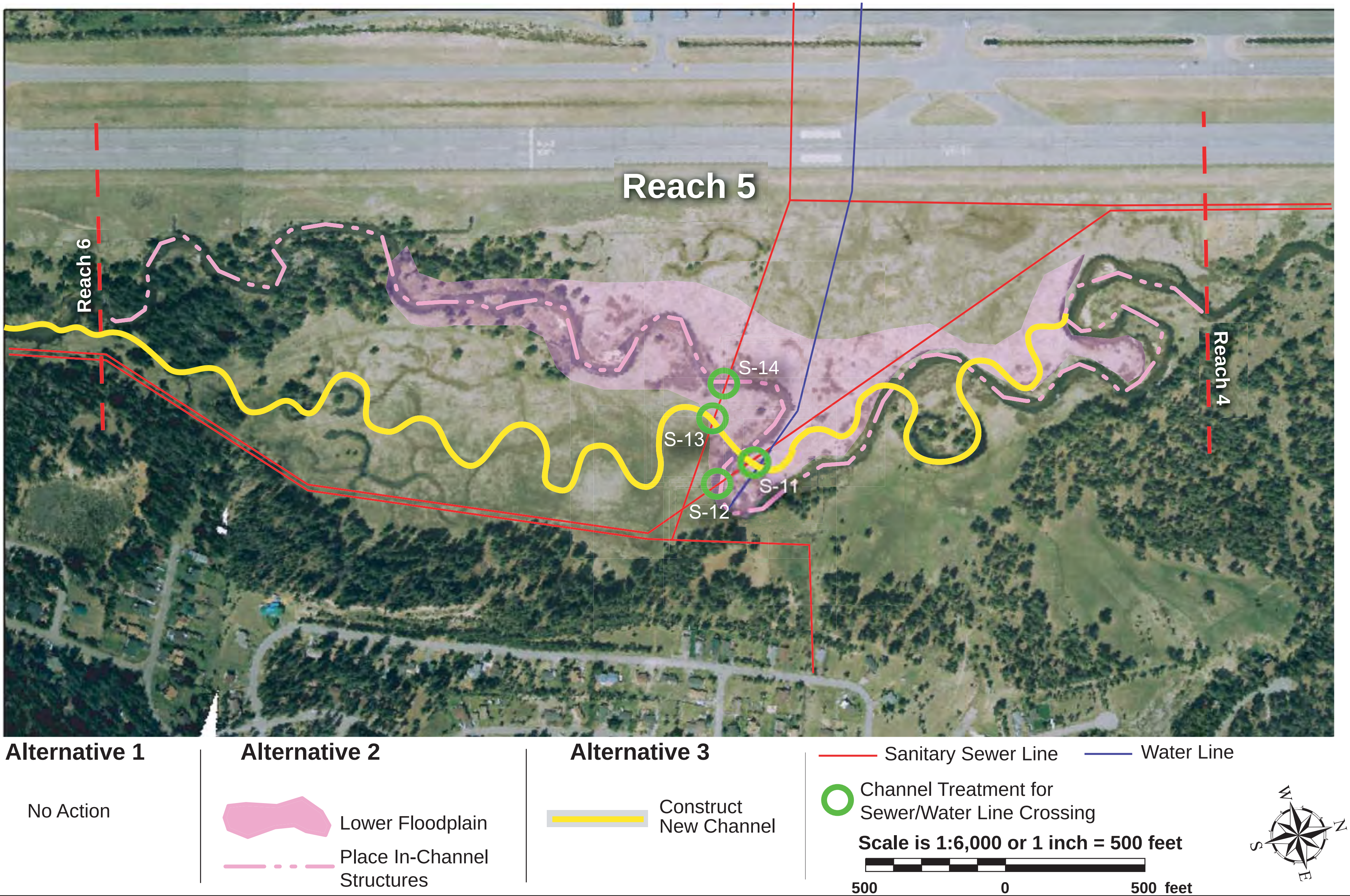

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Figure II.B.7: Proposed alternatives and measures for Reach 5 of the Upper Truckee River Restoration Project in South Lake Tahoe, California.

Restore Meander Belt

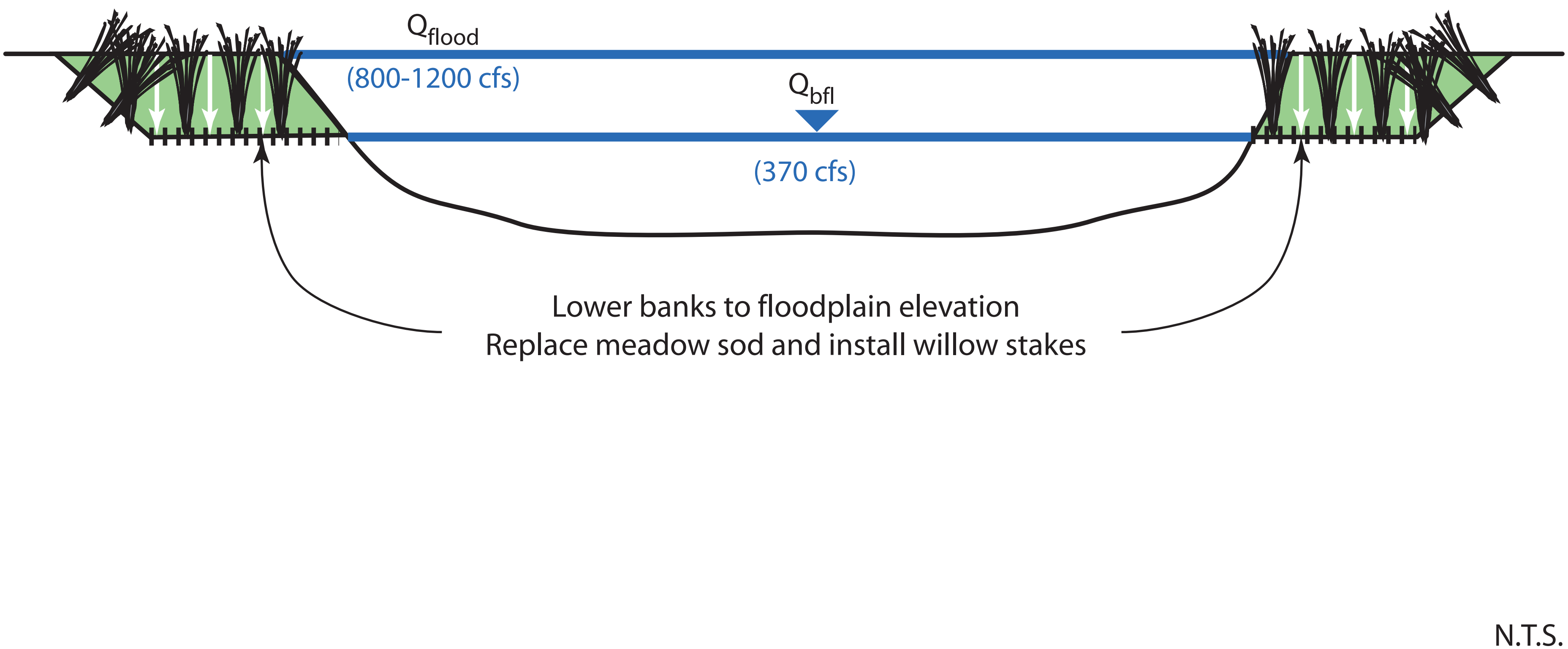

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Figure II.B.8: Proposed measure to create/restore meander belt by excavating surrounding meadow. Floodplain would be revegetated with meadow sod and willow trees.

II.B.6 Reach 6

Reach 6 includes 4,860 LF of channel and approximately 38 acres of floodplain between the Highway 50 crossing at Elk's Club and the downstream end of Sunset Ranch. The upstream end of Reach 6 flows through lodge pole forest within an overly wide and incised channel. The bed is predominately sand substrate and aquatic habitat is limited by the lack of pools and bank cover. Better habitat is found in areas where logs have recently fallen into the stream and pool development and cover have been enhanced. Point bars occur within the incised channel and places outside of the forested reach exhibit significant outer bank erosion.

A concrete ford crossing acts as grade control in the middle of Reach 6. The two sewer alignments occur near the channel in the downstream end of Reach 6 and then cross under the river channel near the upstream end; the pipeline is encased in concrete where it crosses the riverbed. The sewer lines constrain floodplain width at the lower end of Reach 6.

Reach 6 is owned by the California Tahoe Conservancy (CTC) as part of the Sunset Ranch acquisition.

The alternatives for Reach 6 are as follows (Figure II.B.9):

1. The **No Action Plan** would leave the river as is.

2. The **Moderate Enhancement Plan** involves the following measures:

    6.2.1 Lower 2,300 LF of bank to stabilize eroding banks, restore floodplain area and improve stream habitat.
    6.2.2 Install logs and boulders along the entire reach and revegetate in order to improve instream habitat (Figure II.B.4).

3. 3) The **Full Enhancement Plan** would include the following measures:

    6.3.1 Construct 3,950 LF of new channel through forested and meadow reaches in areas where the sewer lines will not be affected at the lower end of the project reach. If sewer lines were moved to the east along the edge of the valley, then an additional 500 LF of channel could be constructed within the meadow (Figure II.B.6).

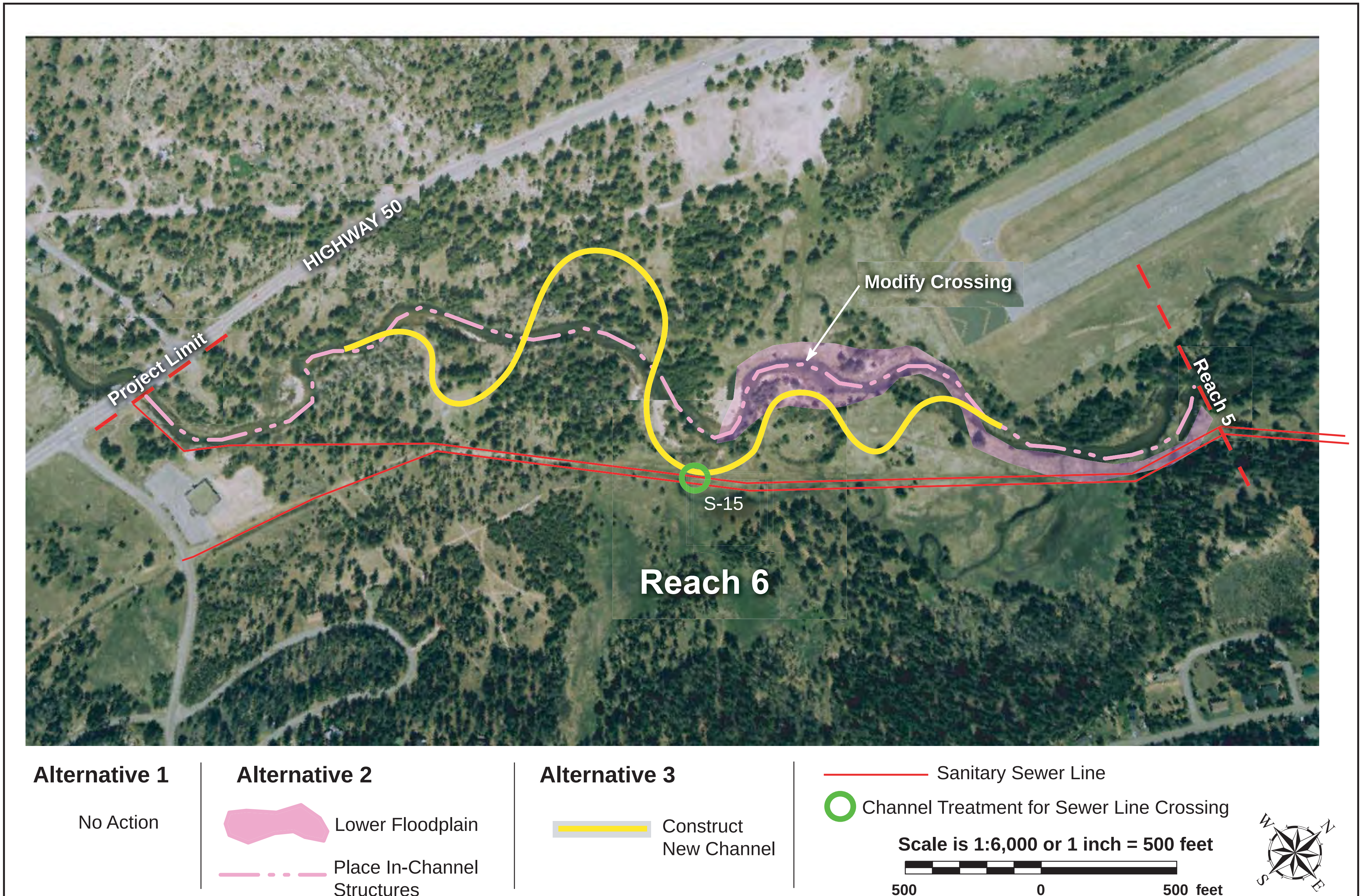

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Figure II.B.9: Proposed alternatives and measures for Reach 6 of the Upper Truckee River Restoration Project in South Lake Tahoe, California.

II.C CUMULATIVE IMPACTS ANALYSIS

The consultant team conducted initial biological, socio-economic, visual and cultural resources studies to determine the impacts of the project alternatives. These included impact and benefit assessments for each discipline in the project reach and the overall effects in the watershed cumulatively.

The following presents a synthesis of cumulative impact sections:

1. Alternative 1 (No Action)

The no action plan could result in further negative hydrologic and geomorphic impacts such as channel downcutting and floodplain degradation. This would reduce soil moisture on the meadow and further decrease flood plain connectivity to the channel and minimize ecological values. No Action might be more detrimental to the project site than any of the proposed alternatives, which would counteract these problems. Taking no action would continue the current erosion patterns.

Water quality conditions would remain as they are with the eroded banks along the incised channel continuing to provide abundant fine sediments and turbidity downstream.

The fisheries could continue to have degraded spawning and rearing habitat along with an increase in fish mortality due to current flow patterns and reduced the lack of riparian habitat.

Historical data together with field observations have indicated that the meadows were once much wetter than their current status. If the no action plan is taken the current condition and trends in the wetland areas are expected to continue. This will lead a reduction in the hydrologic benefits from the wetland.

The vegetation throughout the site indicates that plant community diversity and rejuvenation is on the declining trend. Thus, taking the no action alternative would be detrimental to the current plant communities. It is assumed that the current land use would not change. This may lead to a long-term shift in the plant communities' structure species and disturbance regimes.

Because the no action plan leaves the improvements of the grazing resources up to the landowner this will most likely mean that no modifications to the existing channels and floodplain will occur. However, there would be an increase in fencing and livestock water facilities. In addition, the configuration of the pastures would be at the discretion of the landowner.

The wildlife resources would not be disturbed or displaced under the no action alternative. However, opportunities for improved habitat within the floodplain would not occur. If the meadow and riparian areas continue on their current trend, the area might then shift to fauna adapted to drier meadows with less shrub cover.

If the no action alternative is taken the recreational resources and usage would remain unchanged. Therefore Alternative 1 would not have any effect on recreation.

Air quality within the project area would continue to be affected by local pollutant emissions if the no action alternative is chosen. However, there would not be any construction related emissions.

The visual resources would also be unaffected under the no action plan. The existing conditions would not change.

The cultural resources of the area would be unaffected by Alternative 1. It is assumed that there would be no significant change in the current land use.

If the no action alternative is implemented in Reach 1, the socio economic impact could be negative. This would be a result of the continual reduction of the productive private pastureland. However, this alternative would not have any socio-economic negatives in the other five reaches.

In sum, no action plans would perpetuate the current ecologically degraded conditions and could potentially become worse. The Upper Truckee River would exist in a state well below its ecological potential. In addition, no action would retain poor water quality conditions with existing chronic bank erosion and fine sediment discharge which is far greater than could exist under restored (project proposals) conditions.

2. Alternative 2 (Moderate Enhancement)

The proposed actions associated with Alternative 2, the moderate enhancement plan, have a variety of benefits to the fishery. In general, it would reduce local sediment sources, arrest downcutting and provide additional cover as streamside vegetation grows. The temporary related impacts will include the need for fish rescue and relocation, short-term sediment impacts from the construction of the bridge crossings and the placement of in channel structures.

Alternative 2 does propose some grading and filling impacts to the current geomorphology. There will be temporary fill and soil from the edge of live channel to the perimeter of the grading, hauling of soil off site or to disposal sites within the project area. However, none of the proposed actions will worsen channel morphology conditions. Increasing cover and creating hydrologic improvements can achieve significant improvement in aquatic habitat.

Wetland acreage would be increased by the implementation of Alternative 2. There would be short-term effects but the re-vegetation would utilize hydrophytic species and hydric soils would remain in place or be used for fill. The hydrology would also be enhanced. The main impact is associated with the type of wetland that would be altered and created in some areas.

The impacts to the vegetation, if Alternative 2 is implemented, will occur during construction. The existing vegetation will be removed or stressed due to the construction activities. Most of the vegetation loss will occur during ground disturbing activities and from vehicle traffic. However, Alternative 2 also offers the opportunity for new growth to be established through plantings, seeding and natural regeneration. None of the species on the site are protected by local, state or federal policies so the impact to them is considered less that significant. Alternative 2 offers the ecological enhancement of the floodplain that would improve the diversity, plant vigor and the percent cover of the vegetation at the project site.

Alternative 2 would achieve greater control of potential livestock impacts to water quality by excluding livestock from the Upper Truckee River and adjacent streambanks. The landowner, in consultation with the NRCS, will select the most appropriate means of excluding livestock from streambanks, revegetated sites and other sensitive locations subject to disturbance by livestock trampling. To provide the necessary livestock watering facilities, two additional troughs and approximately 1200 linear feet of pipeline will be installed.

The most probable adverse impact to the grazing resources from implementation of Alternative 2 would be the increase in overland flooding. It may require a seasonal delay of the introduction of livestock. However, the potential for improved productivity within the pastures may be a greater gain. However, considerations should include the timing and duration of flooding to accommodate the seasonal introduction of livestock.

The wildlife resources will experience short-term impacts under Alternative 2. The temporary loss of habitat will be a result of construction activities, vegetation removal and the ground disturbance for the grading. A temporary decrease in the populations of small mammals could affect the prey base for predators. No permanent loss of habitat will occur due to the implementation of Alternative 2, however, through the construction species some fauna will be disturbed or displaced.

During construction, Alternative 2 could result in restricted access to the river. This restriction will affect, in particular, fishing, rafting/boating activities and trail activities in Reaches 3, 5 and 6. Because these activities will resume immediately following construction these impacts are considered less-than significant.

Alternative 2 would not have any long-term effects on air quality. However, combustion and dust emissions would result because of the construction. Therefore the overall effect on air quality, due to construction of the Alternative 2 would be significant due to the exceedence of emissions standards.

The construction activities required for Alternative 2 would distract from the visual resources of the site. However, because the long-term impact is going to result in a qualitative improvement in the visual quality of the site as site conditions are enhanced and reclamation is completed.

Prior to an assessment of cumulative impacts on a heritage resource, it must be formally recorded and its significance must be evaluated. Both tasks are outside the current project scope. It is likely, however, that the implementation of Alternative 2 would result in impacts to a variety of heritage resources. These impacts may result from the disturbance or destruction of prehistoric or historic archaeological sites during project ground disturbance activities, and/or general changes in land use that may affect the integrity of the setting of heritage properties by introducing incompatible visual or audible elements into the setting of a potentially significant resource.

There will be no negative socio-economic impacts if alternative 2 is implemented. The grazing operation will not be impacted if in reach 2 the plan for permanently diverting airport runoff onto the grazing property is implemented. In addition, the employment and wages generated by construction will have a temporary positive benefit.

3. Alternative 3 (Full Enhancement)

The impacts to the fisheries resource if the Full Enhancement plan is implemented essentially mimic those discussed for Alternative 2 (Moderate Enhancement Plan). The fish habitat conditions would have an expanded benefit from those discussed in Alternative 2, with no additional short-term construction related impacts. If Alternative 3 is implemented Reaches 3, 5 and 6 would have a complete reconstruction of a new channel and a filling of the old, degraded channel. This complete reconstruction would greatly improve fish habitat. There would be temporary construction related impacts as a result of implementing this alternative. Following construction of the new channel, the old channel would need to be filled, resulting in the need to capture and transport all fish from the old channel to the new channel. There would also be a temporary pulse of fine sediment from the new channel when water is diverted into it. Mitigations for their impact have been developed and would be effective at minimizing the impact.

None of the proposed actions would worsen channel morphology conditions. The greatest benefit of improving ecosystem function would be derived from the Full Enhancement Plan. The restored channel will have a more sinuous meandering pattern, a channel with a low width to depth ratio and the hydraulics of a high quality pool riffle stream.

The proposed Alternative 3 would place fill in some areas of wetlands and remove fill from areas that were historically wetlands. However, implementing Alternative 3 would increase wetland acreage. The re-vegetation would utilize the hydrophytic species and the hydric soils would remain in place or be used for fill and the hydrology would be enhanced. As with Alternative 2 this alternatives greatest impact will be only in the change in the type of wetland present on the site.

Alternative 3 has the same potential impacts to the vegetation as Alternative 2 has. However, because of the increase in new channel construction the opportunity to revegetate in the small window of time during the optimum fall months may be at risk. The impact associated with sediment runoff in the following spring could have a significant impact. This impact is not foreseen at this time but would require further consideration once a schedule has been laid out for the chosen alternatives. This alternative also influences a greater surface area than Alternative 2. However, it is not considered to be a significant impact as long as the mitigation measures for revegetation are implemented.

Alternative 3 creates greater flexibility for the livestock operator to reconfigure his existing grazing pastures. It would also create additional opportunities for out of bank flows in Reach 1 and 2; which will possibly result in greater forage production in areas so influenced.

Although there would be a greater proportion of the project area influenced by construction compared to Alternative 2 the potential impacts to the wildlife resources are similar to those described for Alternative 2. The greater spatial extent of the construction area is not expected to be a significant impact due to the minimal amount of habitat affected compared to the surrounding available habitat. In addition, because the species that will be directly affected have no special status, the removal of this habitat is not considered a significant impact.

The overall quality of the recreational resources will be impacted during construction and for a short duration after construction due to construction activities, construction noise and the short –term removal of vegetation along portions of the river. However, with the re-establishment of vegetation and the increased quality of fish habitat due to in-stream structures the post-project quality of recreation will be increased.

The air quality would have a short-term negative impact with emissions, from construction activities, exceeding the air quality standards that would not be able to be mitigated to less-than significant.

As with Alternative 2, this alternative will require construction activities and equipment that would detract from the visual resources. However, Alternative 3 is expected to improve the visual quality of the site as site conditions are returned to more natural state by restoring and enhancing a damaged natural resource.

Prior to an assessment of cumulative impacts on a heritage resource, it must be formally recorded and its significance must be evaluated. Both tasks are outside the current project scope. It is likely, however, that the implementation of Alternative 3 would result in impacts to a variety of heritage resources. These impacts may result from the disturbance or destruction of prehistoric or historic archaeological sites during project ground disturbance activities, and/or general changes in land use that may affect the integrity of the setting of heritage properties by introducing incompatible visual or audible elements into the setting of a potentially significant resource.

In addition, positive socio-economic benefits can be expected with the implementation of the Full Enhancement Plan because of the employment and wages generated by construction. There are no negative socio-economic impacts expected from the implementation of this alternative.

In summary, the preliminary synthesized cumulative impact assessment found unavoidable significant impacts to short term air quality due to emissions with construction activities (earth grading and hauling). Cultural resource impacts are not conclusive as specific areas of construction must be analyzed before construction and monitored during construction. There is potential for short-term impacts to recreation, visual quality, wildlife and water quality during the construction phase, however the long term benefits outweigh these over the long term. The no action plan is the least attractive from the standpoint of ecosystem restoration and water quality improvement.

II.D COMPARISON AND FEASIBILITY ANALYSIS OF ALTERNATIVES

A comparison and feasibility of each alternative was conducted in order to identify the best-preferred alternative for each reach. Tables II.D.1and II.D.2 show summaries of the estimated of each alternative. Tables II.D.3 and II.D.4, respectively, show the grading quanitities (cut and fill) associated with each alternative and with the recommended plans.

Table II.D.1 Cost Analysis

Reach	Alternative	Cost
1	No Action	$ 0
1	Moderate Enhancement Plan: 1.2.1-5	$1,438,575
1	Full Enhancement Plan: 1.3.1	$1,515,180
2	No Action	$ 0
2	Moderate Enhancement Plan: 2.2.1-5	$414,140
2	Full Enhancement Plan: 2.3.1-3	$662,155
3	No Action	$ 0
3	Moderate Enhancement Plan: 3.2.1-3	$3,318,475
3	Full Enhance Plan: 3.3.1-2	$5,124,558
4	No Action	$ 0
4	Moderate Enhancement Plan: 4.2.1-2	$190,613
4	Full Enhancement Plan: 4.3 (Same as Moderate	$190,613
5	No Action	$ 0
5	Moderate Enhancement Plan: 5.2.1-2	$3,598,394
5	Full Enhancement Plan: 5.3.1	$3,379,930
6	No Action	$ 0

6	Moderate Enhancement Plan: 6.2.1-2	$1,095,185
6	Full Enhancement Plan 6.3.1	$1,990,359

Table II.D.2 Cost Analysis By Alternative

Reach	Alternative	Cost
1-6	No Action	$ 0
1-6	Moderate Enhancement Plan	$10,055,382
1-6	Full Enhancement Plan	$12,862,795

Table II.D.3 Summary of Material Qualities Analysis

Reach	Alternative	Cut or (Fill) (Cubic Yards)
1	ME	4,941
1	FE	(11,250)
2	ME	(19)
2	FE	(1,354)
3	ME	56,225
3	FE	69,181
4	ME	0
4	FE	0
5	ME	77,344
5	FE	15,692
6	ME	14,441
6	FE	11,288

Table II.D.4 Summary of Material Qualities Analysis Selected Plan

Reach	Alternative	Cut or (Fill) (Cubic Yards)
1	ME	4,941
2	FE	(1,354)
3	ME	56,225
4	FE	0
5	FE	15,692
6	ME	14,441
	Total Quantity	89,945

II.E PREFERRED/CHOSEN ALTERNATIVE DESIGN REPORT AND CONCEPTUAL PLANS

The impact analysis discussed above showed that the no-action plan was the least attractive over the long period. In some cases, site constraints prevent implementation of a full enhancement plan, thereby necessitating the moderate enhancement plan. For the reasons discussed below, the following alternatives were chosen as the preferred alternative on a reach-by-reach basis.

In Reach 1, Alternative 2 would solve the gully incision problem through partial filling.

The remnant areas would become isolated wetlands. The overflow areas would be enhanced, as would some eroded banks.

In Reach 2, the full enhancement plan is feasible with all features.

In Reach 3, the moderate enhancement plan is preferred as floodplain width is too narrow to relocate a naturally meandering river channel. Protecting the airport under Alternative 3 would require an additional $1.8 million.

Reach 4 is highly constricted due to the encroachment of the airport, however channel enhancements and modifications to the old diversion dam would be good ecological improvements.

Reach 5 has the least constraints in the project reach and therefore the room to construct a naturally meandering channel as envisioned under alternative 3 without threatening property and infrastructure.

Reach 6 has significant forest stands within the historic meander belt. Without a specific assessment of the impacts of its removal for stream restoration a full enhancement project (Alternative 3) cannot be recommended. However, Alternative 2 appears feasible and would have significant benefits.

Table II.D.5 summarizes the costs of the preferred alternatives for each reach.

Table II.D.5 Cost Analysis Selected Plan

Reach	Alternative	Cost
1	Moderate Enhancement Plan: 1.2.1-5	$1,438,575
2	Full Enhancement Plan: 2.3.1-3	$662,155
3	Moderate Enhancement Plan: 3.2.1-3	$3,318,475
4	Full Enhancement Plan: 4.3 (Same as Moderate)	$190,613
5	Full Enhancement Plan: 5.3.1	$3,379,930
6	Moderate Enhancement Plan: 6.2.1-2	$1,095,185
1-6	Total proposed cost	$10,084,873

Note: The cost includes environmental documents, design, construction, inspection, administration, and miscellaneous items.

Aside from the potential impacts to cultural resources that must be addressed in the detailed design and construction phases, construction impacts due to air quality emissions and impacts to water quality are potentially significant and unavoidable. The amount of emissions released will be proportional with the volume of grading and hauling that would likely occur under each option.

The following provides a review of the preferred plan for each reach per the project description.

II.E.1 Reach 1

Reach 1 is in private ownership with the exception of easements along sewer lines.

The **Preferred Moderate Enhancement Plan** would involve the following measures:

1.2.1 Partially fill (50%) the gully channel and the tributary gully channel to the west to the elevation of the meadow in order to eliminate flow capture from the existing main channel, while retaining isolated wetlands within unfilled portions of the gully and tributary gully channels;
1.2.2 Enhance channel banks by lowering them to bankfull flow elevations and revegetating with meadow sod and willow plantings;
1.2.3 Provide fenced buffers from livestock (part of NRCS Grazing Management Plan);
1.2.4 Construct overflow areas at select locations along the existing channel by lowering the bank heights to the bankfull stage (370 cfs) and revegetating with meadow sod; and
1.2.5 Construct bank protection along 2,980 LF of existing channel using bioengineering methods (willow brush matting and layering could work well).

II.E.2 Reach 2

The land ownership is mostly private within Reach 2, with the exception of the easement along the sewer lines and the City of South Lake Tahoe Airport.

The **Preferred Full Enhancement Plan** would include all of the actions of the Moderate Enhancement Plan and the following additional measures:

2.3.1 Install instream enhancements such as logs, boulders and vegetation plantings into the existing channel in order to improve aquatic habitat;
2.3.2 Install bioengineered bank protection on 210 LF of bluff erosion sites.

II.E.3 Reach 3

Reach 3 is within City of South Lake Tahoe ownership.

The **Preferred Moderate Enhancement Plan** includes the following proposed actions:

3.2.1 Remove 56,225 cy of fill from 17 acres of the terrace between the river channel and the Airport fence line in order to lower the terrace approximately 2 feet to the bankfull floodplain elevation and revegetate;

3.2.2 Replace the existing ford crossing with a bridge to span the channel and minimize the disruption of flow and habitat. Design the new bridge to maintain grade control and to provide flow capacity for overbank flooding; and

3.2.3 Install channel habitat improvements consisting of logs, boulders and vegetation plantings along the entire reach.

II.E.4 Reach 4

Reach 4 is within the City of South Lake Tahoe ownership.

The **Preferred Moderate and Full Enhancement Plans** are the same and include the following measures:

4.2.1 Modify the old Diversion Dam to increase its stability and to improve its hydraulic function for aquatic habitat quality. This would include placement of boulders, logs and native vegetation plantings;

4.2.2 Install logs and boulders throughout the reach for instream enhancement.

II.E.5 Reach 5

Reach 5 is within the City of South Lake Tahoe, CTC, and U.S. Forest Service land ownership.

The **Preferred Full Enhancement Plan** involves the following actions:

5.3.1 Construct 6,900 LF of new channel through the meadow using geomorphic design criteria of 370 cfs capacity and proper width, depth and plan form (Figure II.B.6). The old channel would be filled to meadow elevations and revegetated. Instream enhancement measures would be added as part of the new channel construction.

II.E.6 Reach 6

Reach 6 is within the California Tahoe Conservancy ownership.

The **Preferred Moderate Enhancement Plan** involves the following measures:

6.2.1 Lower 2,300 LF of bank to stabilize eroding banks, restore floodplain area and improve stream habitat.

6.2.2 Install logs and boulders along the entire reach and revegetate in order to improve instream habitat.

III. ENVIRONMENTAL ASSESSMENT/CONSEQUENCES

III.A AQUATIC AND FISHERIES RESOURCES

III.A.1 Issues

The quality of aquatic and fisheries resources in the Upper Truckee River is a function of both the physical habitat conditions such as pool depths, substrate size, and escape cover, and biological conditions such as macro invertebrate density, the degree of stream shading by terrestrial vegetation, and the size and density of in stream woody material. The quality of habitat is also dependent upon the life stage of interest.

Though the specific habitat requirements will vary between trout species, there are several important components that make up high quality trout habitat. Adult spawners require clean, coarse gravel located at the tail of a pool or head of riffle to build a nest, or redd, which has adequate water circulation to keep the eggs oxygenated and free of metabolic wastes. A primary limiting factor in egg survival and eventual emergence from the gravels is the amount of fine sediment that occurs in the redd and the mobility of the sediment being used to build the redd. If a redd contains too much fine sediment, the survival rate is often low since the eggs may be poorly oxygenated and the metabolic wastes, once the young hatch, cannot be carried away, essentially smothering the young fish. If the substrate used to build the nest is not armored by smaller cobble and the fish are required to build the nest with smaller substrate, low magnitude storm events can wash away the established nests prior to emergence of the fry.

Following emergence of the young from the gravels, juvenile fish, or fry, will spend their time foraging for food in low velocity areas such as the margins of riffles or pools. Once strong enough to actively swim they will begin to use riffle habitat where food is available and turbulent water provides a place to hide from predators and aggressive fish within the same species. Once they reach an adequate size to compete with other fish of their own species, they will move into pools and other deep-water habitat to feed. It is at this time that adequate escape cover, or a spot to hide, becomes extremely important. Escape cover can include, but is not limited to, undercut banks, root wads, large woody material, overhanging vegetation, and underneath large cobbles and boulders. It is the combination of deep pools and adjacent and abundant escape cover that provides the highest quality habitat for rearing of juvenile and adult trout.

Lack of high quality spawning habitat, barriers to migration, lack of places to hide, reductions in macro invertebrate production, and increased water temperatures can all have a detrimental impact on preferred species of fish, such as the trout species. Poor quality habitat conditions for trout species can be the result of local or watershed-wide conditions. Local impacts can include rapid channel incision resulting in excessive erosion of fine sediment from stream banks, poor hydraulic conditions that limit localized accumulations of spawning substrate and does not allow deeper pools to form, and loss of riparian vegetation that results in higher water temperatures, less overhanging vegetative cover, and fewer undercut banks.

III.A.2 Analysis Methods and Assumptions

III.A.2.1 Impact Analysis Methods

The following criteria were considered when assessing the potential impact to aquatic habitat and fisheries resources of the proposed action:

1. Grain-size distribution:
   Negative impact: The proposed action increases fine sediment production, filling pools, degrading the quality of spawning gravels, and embedding riffles.
   Positive impact: The proposed action reduces fine sediment production, resulting in improved spawning habitat and macroinvertebrate production.

2. Pool depth:
   Negative impact: The proposed action reduces pool depth and complexity.
   Positive impact: The proposed action increases pool depth and complexity.

3. Escape cover:
   Negative impact: The proposed action reduces available escape cover resulting in less habitat complexity.
   Positive impact: The proposed action improves escape cover through increases in stable, undercut banks, recruitment of woody material, and growth of overhanging streamside vegetation.

An assessment of the potential positive or negative impacts that each proposed action or alternative may have on the quality and quantity of available aquatic and fisheries habitat is based on previous experience monitoring similar actions. Assessing the degree to which an impact can be considered positive or negative is based on a combination of professional experience and a thorough review of the scientific literature defining the tolerance limits and life cycle of the various species of fish identified through the project reach.

III.A.2.2 Assumptions

The primary assumption guiding the impact assessment is that fisheries management through this portion of the Upper Truckee River is being driven by the desire to increase populations of the sport fishery. Improvements in the condition of the fishery are based on how each action impacts the quality and quantity of habitat for the cold-water fish assemblage, namely the various species of trout.

An additional assumption being made is that the current condition of the fishery and the stream channel is degraded and sub optimal for trout production. This assumption is based on field observation, limited habitat data, and qualitative comparisons to both degraded, high quality, and restored stream channels throughout the Tahoe Basin. Due to the lack of historical information prior to the Comstock Era disturbances, inferences must be made regarding the historic, "unimpaired" condition of the Upper Truckee River through the study reach.

III.A.2.3 Cumulative Actions Considered

Though considerable improvement could be made to habitat conditions that affect fisheries resources through the study reach, there are also impacts and conditions outside of the study reach that will ultimately have an influence on the future success or failure of the proposed actions. These include the following:

- *Upstream sediment inputs:* Restoration or enhancement of the mainstream channel does not reduce, but instead mitigates, the potential impact caused by upstream conditions such as excessive erosion of fine sediment. For example, introduction of woody material in the channel can improve spawning habitat quality by increasing hydraulic complexity and allowing for sediment sorting, but, if the system is completely overwhelmed by fine sediment, such as decomposed granite, only small benefits can be achieved.
- *Downstream barriers to migration:* Several of the fish species present, or potentially present, through the project reach use the downstream reaches of the Upper Truckee River as a migratory corridor to reach spawning or rearing habitat. If conditions downstream do not permit migration of these fish species, any future improvements in habitat quality through the project reach may not result in significant gains in fish numbers.

III.A.3 Affected Environment

III.A.3.1 Area of Influence

The primary area of influence of this project, in terms of direct action, includes a five-mile stretch of the Upper Truckee River between the lower Highway 50 crossing and the middle Highway 50 crossing near the Elk's Club. Through this reach a range of alternatives have been proposed that include enhancement and/or complete restoration of the channel to improve hydrologic and geomorphic functioning of the channel. Those improvements will greatly benefit the fish populations through that reach, the scale of which will depend greatly on the selected alternative.

The enhancement and restoration measures proposed will also have the potential to have a beneficial influence on fish populations throughout the entire Upper Truckee River or at least the portion that is downstream of any significant barrier in the upper watershed. The benefits to other parts of the River outside of the direct area of influence will be the result of improved spawning through the project reach and the removal or modification of existing barriers to migration. If the barriers through the project reach were significant enough to limit access to certain species are life stages, those areas will now become available. Improved spawning conditions through the project reach could provide excessive juvenile production to areas of the river where poor spawning conditions still exist.

III.A.3.2 Existing Fisheries Resources/Aquatic Habitat Conditions

III.A.3.2.1 Hydrologic regime

The lower reaches of the Upper Truckee River support a wide variety of both native and introduced fish species (Table III.A.1). The majority of fish species present in the Upper Truckee River can be roughly divided into two function groups. The trout and whitefish are cold-water species that rely on swift flowing water to carry a "conveyor belt" of drifting or terrestrial derived insects to feeding stations in riffles, runs, and the heads of pools. The remaining fish, with the exception of the Piute sculpin and the brown bullhead, can be classified as minnows. They primarily use slow moving or edge water to forage.

In terms of management of the fisheries and aquatic habitat resources in the Upper Truckee River, the primary functional group of interest, due their size and importance as a sport fishery, are the cold-water species. The only native species of trout in the Tahoe Basin, the Lahontan cutthroat trout, is of particular concern, following over fishing and competition with introduced trout species. Attempts have been made to reintroduce cutthroat into the upper watershed with little success.

Habitat data collected on the Upper Truckee River and analyzed by Interfluve (1996) for the reach below Highway 50, suggests that the habitat composition, in terms of the ratio between pool, riffle, and run habitat, is sub optimal to support a trout dominated cold-water fishery. They noted lack of riffle habitat and roughness elements that reduce hydraulic variability.

Our observations throughout the study reach of the Upper Truckee River point to the overall lack of habitat variability, excessive amounts of fine sediment, and a lack of roughness elements. All of these factors are tied to degraded physical characteristics of the channel form (*see Geomorphic section*) that produces poor physical habitat. A widened, deepened channel that lacks roughness elements, such as woody debris, does not allow for the hydraulic variability that is necessary to scour pools and sort sands from gravel. Instead, homogeneous velocity conditions move sand waves through the system, ultimately filling pools and burying riffles that previously would have provided spawning habitat for fish and substrate for macro invertebrates to colonize. By introducing a roughness elements, such as large woody material, into the system, and restoring appropriate channel width, depth, and sinuosity patterns, the physical conditions that support good trout habitat will also be restored.

The existing channel through the study reaches provides several pockets where adequate habitat is available to support trout populations. These locations occur where an obstruction, such as a rootwad, is impeding the natural erosion pattern and sinuosity of the channel. A sharp bend in the channel produces hydraulic variability, undercut banks,

Table III.A.1 Fish species known to be present in the Upper Truckee River

Common Name	Scientific Name	Native / Introduced	Functional Assemblage
Lahonton cutthroat trout	*Oncorhynchus clarki henshawi*	Native	cold water
Tahoe sucker	*Catostomus tahoensis*	Native	minnow
mountain whitefish	*Prosopium williamsoni*	Native	cold water
speckled dace	*Rhinichthys osculus*	Native	minnow
Lahontan redside	*Richardsonius egregius*	Native	minnow
Piute scuplin	*Cottus beldingi*	Native	other
brown bullhead	*Ameiurus nebulosus*	Introduced	other
rainbow trout	*Oncorhynchus mykiss*	Introduced	cold water
brown trout	*Salmo trutta*	Introduced	cold water
brook trout	*Salvelinus fontinalis*	Introduced	cold water
Kokanee salmon	*Oncorhynchus nerka*	Introduced	cold water

and an accumulation of woody material. It is in these locations that deeper scour pools have formed, the pool tail-outs have sorted fine sediment from the gravels, and escape cover is present amongst the woody material.

The most degraded habitat found through the study reach is the straightened sections, such as the reach that flows along the edge of the airport, and the sections that abut the valley slope. Due to lack of hydraulic variability, very little scour in pools, hardened rip rap banks, and eroding hillsides, spawning or rearing habitat is either unavailable or is highly degraded.

III.A.4 Environmental Consequences

III.A.4.1 Anticipated Impacts

III.A.4.1.1 Proposed Alternative 1

Reach 1

The no action alternative for Reach 1 would result in further channel down cutting and additional loss of both spawning and rearing habitat as available habitat becomes overwhelmed with fine sediment. Additionally, increased numbers of fish may get stranded in the tributary gully, which appears to have low dissolved oxygen levels and high water temperatures due to the lack of riparian vegetation and very little summer inflow. Losses of stream flow to the tributary gully during peak flow events will likely result in less stream power in the main channel, to flush fine sediment from pools, resulting in pool filling.

Reach 2

The no action alternative for Reach 2 would result in similar conditions to a no action alternative for Reach 1. A portion of the tributary gully flows through Reach 2, resulting in the same degraded conditions. In addition, a diversion dam, located at the downstream end of Reach 2, currently limits fish passage under most flow conditions. No action would result in the continued lack of free movement of adult and juvenile fish with a potentially significant, yet unknown, detriment to these populations.

Reach 3

Reach 3 is one of the more degraded sections of Upper Truckee River study area due to the straightening and confinement of the channel. No action through this section will result in a continued degraded state and poor habitat quality for fish.

Reach 4

Similar conditions exist in Reach 4 as in Reach 3. A failing diversion dam and banks lined with riprap provide poor aquatic habitat conditions and a lack of escape cover. No action on Reach 4 would maintain this portion of channel in a degraded state.

Reach 5

Though some habitat exists through Reach 5, riprap lined banks and extensive channel down cutting have degraded the habitat considerably. The no action alternative through Reach 5 would, at best, maintain the current degraded condition. At worst, further down cutting and erosion of hill slopes consisting of fine-grained material would further degrade the reach.

Reach 6

Road crossing, recreational uses, and sewer line easements have impacted reach 6 considerably. These have modified the channel considerably and are resulting in significant sediment input. The no action alternative would result in a continued degraded condition with the potential for increased sediment production and future impacts to sewer line crossings.

III.A.4.1.2 Proposed Alternative 2

Reach 1

Carrying out proposed Alternative 2 through Reach 1 would primarily reduce local sediment sources, arrest downcutting and provide additional escape cover as streamside vegetation grows. Stable, less erosive banks would also allow for some undercutting that would likely provide additional escape cover for fish. What this alternative would not provide is the hydraulic variability that would allow for increased pool scour and beneficial sediment sorting, though partial filling of the gully channel may provide additional hydraulic force to flush out excessive fine sediment loads from the pools. Additionally, partial filling of the tributary gully may reduce potential stranding of trout and provide refuge habitat for the various minnow species.

During implementation of Alternative 2, fish occurring in the gully channel that would be partially filled would require rescue and relocation with additionally disruption to the distribution of fish located in the primary channel. Localized, short-term sediment impacts may occur at construction access crossings and locations where modifications will be made to the sewer lines.

Reach 2

The proposed actions for Alternative 2 through Reach 2 would have a variety of benefits to the fishery. Modification of the diversion dam to allow free movement of fish would be highly beneficial. Free movement, both up and downstream, allows fish to reach spawning habitat as well as adjust to changing habitat conditions as flows recede in the summer and fall months. Rerouting of the old channel would reduce sediment and pollutant loads originating from the airport, which will benefit both fish and macro invertebrates.

The remaining actions will have a beneficial impact similar to those for Reach 1 with limited benefit to overall channel morphology and function, in terms of pool development and hydraulic variability.

Temporary, construction related impacts will include the need for fish rescue and relocation from the tributary gully, and short-term sediment impacts from construction of bridge crossings and placement of in-channel structures.

Reach 3

The proposed Alternative 2 actions through Reach 3 will have significant benefits through this highly degraded reach. Restoring floodplain function, installing structural elements, and planting riparian vegetation will improve habitat conditions through increases in pool scour, sediment sorting, and more escape cover. These actions should improve overall habitat quality and increase macroinvertebrate productivity.

Reach 4

The proposed Alternative 2 actions through Reach 4 are very similar to the proposed actions in Reach 3, in terms of improvements to aquatic habitat. Due to limited room available to improve floodplain function, the hydraulic conditions, and therefore scour dynamics, may not change significantly. The constricted nature of this reach due to the location of the hill slope, airport, and riprap bank protection, results in limited enhancement potential. This is likely to result in limited improvement to aquatic habitat conditions.

Reach 5

The enhancement and restoration potential of Reach 5 improves considerably over Reach 6 due to the widening of the valley. Improvements to Reach 5 are constrained by a number of water line and sewer crossings through the Reach and the incised, constricted channel at the lower end as it transitions into Reach 4. Alternative 2 improvements to Reach 5 include floodplain development and placement of in-channel structures. These proposed treatments will ultimately create hydraulic conditions that increase the quality and quantity of both spawning and rearing habitat throughout the reach.

Short-term impacts of the proposed treatments include loss of riparian cover due to excavation of terraces and increases in sediment production due to construction.

Additionally, there may be a need for temporary fish capture and relocation during construction activities.

Reach 6

The area available to improve conditions through Reach 6 increases considerably upstream of the airport runway footprint. Proposed improvements under Alternative 2 are similar to the proposed improvements made through Reach 5 with less floodplain expansion. The result would be similar benefits and impacts to those expected to occur in Reach 5. Construction related impacts through Reach 6 would be less than those in Reach 5 due to lack of sewer and water line crossings and less extensive floodplain expansion.

III.A.4.1.3 Proposed Alternative 3

Reach 1

The impacts and benefits due to treatments proposed under Alternative 3 through Reach 1 would essentially mimic those discussed for Alternative 2. The only difference lies in the extent to which the gully channels will be filled. In Alternative 3, complete filling of the gully channels will occur that will result in no significant change to trout populations over Alternative 3. Minnow species may be able to use the isolated wetlands if the hydrology is appropriate resulting in a slight loss of potential habitat by selecting Alternative 3 over Alternative 2.

Reach 2

In terms of fish habitat conditions, Alternative 3 would expand the benefits discussed in Alternative 3 with no additional short-term construction related impacts. By adding structural elements to the channel, sediment sorting and pool scour would improve, improving both spawning and rearing habitat quality. In addition, repairs to a heavily eroded bank in the lower portion of the reach will reduce chronic sources of fine sediment to both Reach 2 and Reach 1, ultimately improving substrate conditions through both reaches.

Reaches 3, 5 and 6

Analysis of Alternative 3 has been combined through these reaches since the treatment proposed for these reaches all include complete reconstruction of a new channel and filling of the old, degraded channel. Complete reconstruction has many positive benefits for fish populations. The goal of complete channel reconstruction is to restore hydrologic and geomorphic function, which would ultimately provide the appropriate physical conditions necessary to support a more natural and historic assemblage of aquatic organisms and meadow and riparian plant species.

Temporary construction related impacts would also result from complete channel restoration. Following construction of the new channel, the old channel would need to be filled, resulting in the need to capture and transport all fish from the old channel to the new channel. Additionally, there may be a temporary pulse of fine sediment from the new channel when water is eventually diverted into it. Mitigations for this impact have been developed and successfully implemented during the construction phase of Trout Creek. There may also be short-term loss of riparian vegetation cover under this Alternative.

Reach 4

Alternative 2 and 3 were the same for Reach 4.

III.A.4.2 Unavoidable Adverse Impacts

The primary unavoidable adverse impacts were discussed in the Alternatives assessment portion of this chapter. They include short-term construction related impacts such as sediment production from crossing treatments, barrier removal, and bridge repair. Excavation of floodplain terraces can also cause additional short-term sediment impacts if appropriate BMP's are not discussed and implemented. Short-term impacts to fish populations will also occur during certain phases of construction that require fish capture and transfer in the event of a dewatering. Temporary loss of riparian vegetation cover will also impact fish populations by potential increases in temperature and loss of potential escape cover.

The only remaining unavoidable adverse impact that was not discussed in the alternatives assessment is the potential for significant changes in fish species assemblages. This potential impact is discussed in this section because there is a potential for an impact, though the extent and implications of the impact are fairly unknown. More detailed data and research would be necessary to fully understand this potential impact.

III.A.4.2.1 Changes in fish species assemblages

Over the last century, the types of species and their relative numbers have been greatly influenced and altered by human impacts. Species have been introduced and the habitat conditions that support native fish have been altered, in some cases favoring the introduced species. By restoring these 6 reaches of the Upper Truckee River to more natural hydrologic and geomorphic function, the intent is to create habitat conditions that will support a more native assemblage of fish and improve conditions for trout species. Unfortunately, what is good for some native species may also benefit some introduced species as well. Therefore, improvements in habitat can result in an increase in non-native fish in favor of native fish. The final outcome, at this time, is unknown because the existing fish species and their numbers ultimately affects the results with a trajectory that is also unknown.

III.A.4.3 Proposed Mitigation

Short-term sediment impacts due to construction can be mitigated if practices developed as part of the Trout Creek Restoration are used. The BMP's and sediment control techniques developed and used in that project were highly successful.

Loss of escape cover and reductions in riparian canopy has already been mitigated through the proposed enhancement treatments including introduction of in-channel cover elements and willow staking. Either way, short-term losses in escape cover and riparian canopy will be an unavoidable impact.

Mitigating undesirable fish species assemblages will require monitoring and possible modifications to the enhancement options as data becomes available. Any potential solution will require a monitoring program that is identified up front and a program of adaptive management that will deal with any potential impacts.

III.B GEOMORPHOLOGY

III.B.1 Issues

Geomorphology is concerned with the study of landforms and the geologic processes that form them. *Fluvial geomorphology* is concerned with landforms formed by flowing water and incorporates the processes of sediment transport, hydrology and hydraulics in stream channels. These phenomena comprise *geomorphic processes* that create and sustain stream channel form (channel width and depth and pattern as viewed from above) or *channel morphology*. Native plant communities in riparian zones are adapted to geomorphic processes and have considerable influence on channel bank stability and hydraulics. Fisheries and wildlife populations are dependent upon habitat formed by geomorphic processes and the resultant vegetation cover.

Restoring geomorphic processes is the foundation of restoration of the Upper Truckee River ecosystem in the project reach (Figure III.B.1; III.B.2). The basic strategy is to restore channel form and processes that are in “equilibrium” with current climatic and watershed conditions, including the effects of current and past land use. The term “equilibrium” in stream channels does not mean that the channel remains statically in place, rather that channel morphology is subject to movement across the valley floor due to lateral erosion (i.e. meandering) but in a manner that retains an average channel width, depth and pattern. Diversity in channel form occurs as a result of stochastic processes associated with interaction with riparian vegetation and non-uniform timing of erosion and sediment deposition processes.

Past and present human land use activities have a considerable influence on fluvial systems in terms of direct impacts (i.e. channel straightening and deepening for reclamation) and indirect impacts (higher storm water volumes and peak flows due to urbanization translate into more hydraulic work and sediment transport in the channel which can expand channel width and depth). These factors are accounted for in the geomorphic design process used to develop and design the proposed restoration actions.

The Upper Truckee River in the project reach is in a degraded condition due to historical deepening and straightening. The key processes of sediment transport and deposition occur 3-4 feet down within the entrenched channel, rather than at grade with the valley floor as was originally the case pre-1860 disturbance. The soil moisture available from shallow groundwater to the meadow areas has decreased considerably due to the lower channel and low water surface elevation in the entrenched channel; this has dried the meadow considerably (WBS, 2002) and reduced the quality and diversity of wetland plants as well as grazing forage in the lower meadow. The deeper channel also means more hydraulic force is concentrated in the channel leading to undercutting of bank vegetation below the root zone and chronic detachment and dispersal of fine sediments. Gully development in the lower meadow of Reach 1 and 2 along flow paths that short circuit the main Upper Truckee River channel has compounded these problems. In

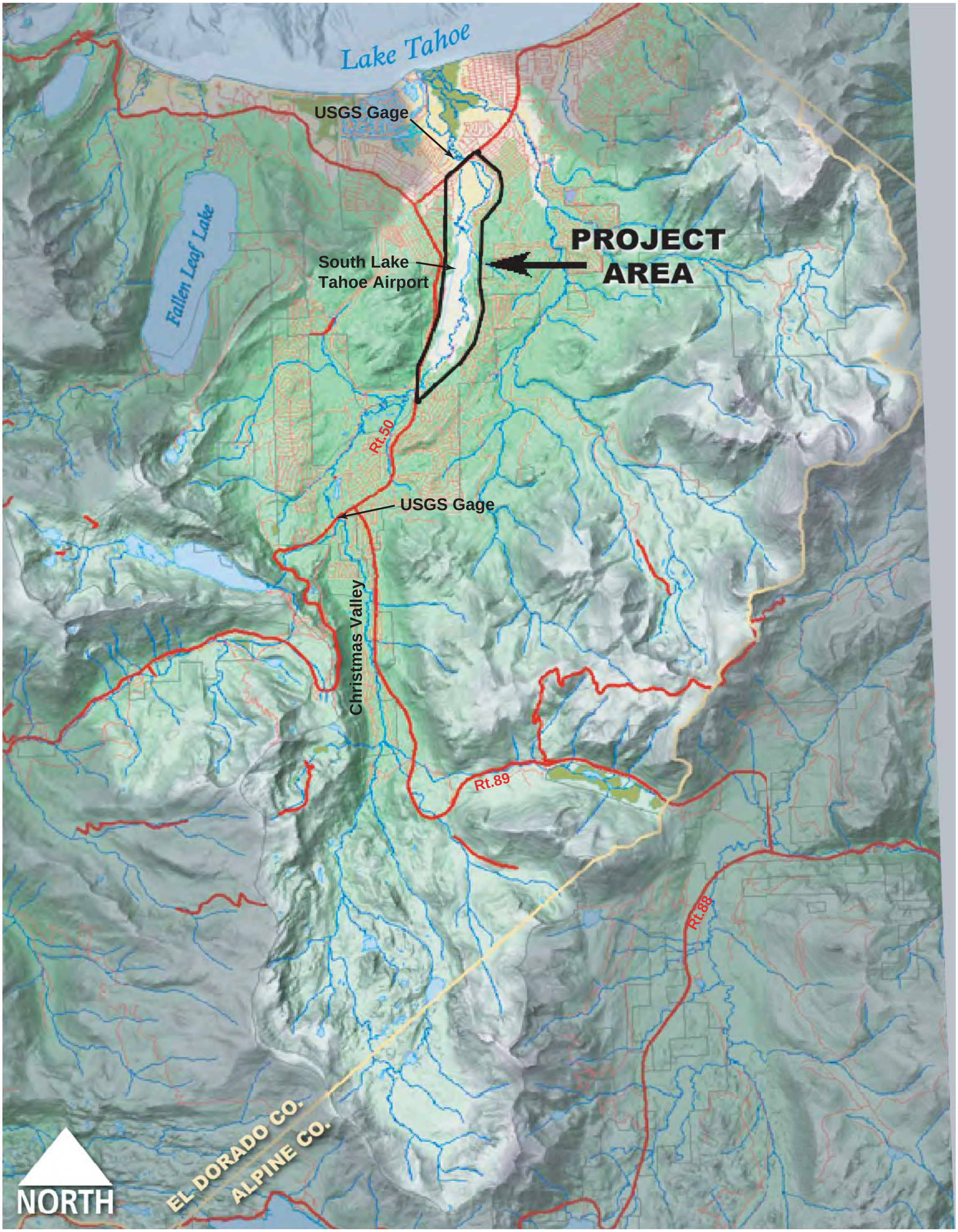

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Figure III.B.1: Map shows Upper Truckee River project reach. The Upper Truckee River flows adjacent to Route 50 and the South Lake Tahoe Airport making its way north to Lake Tahoe.

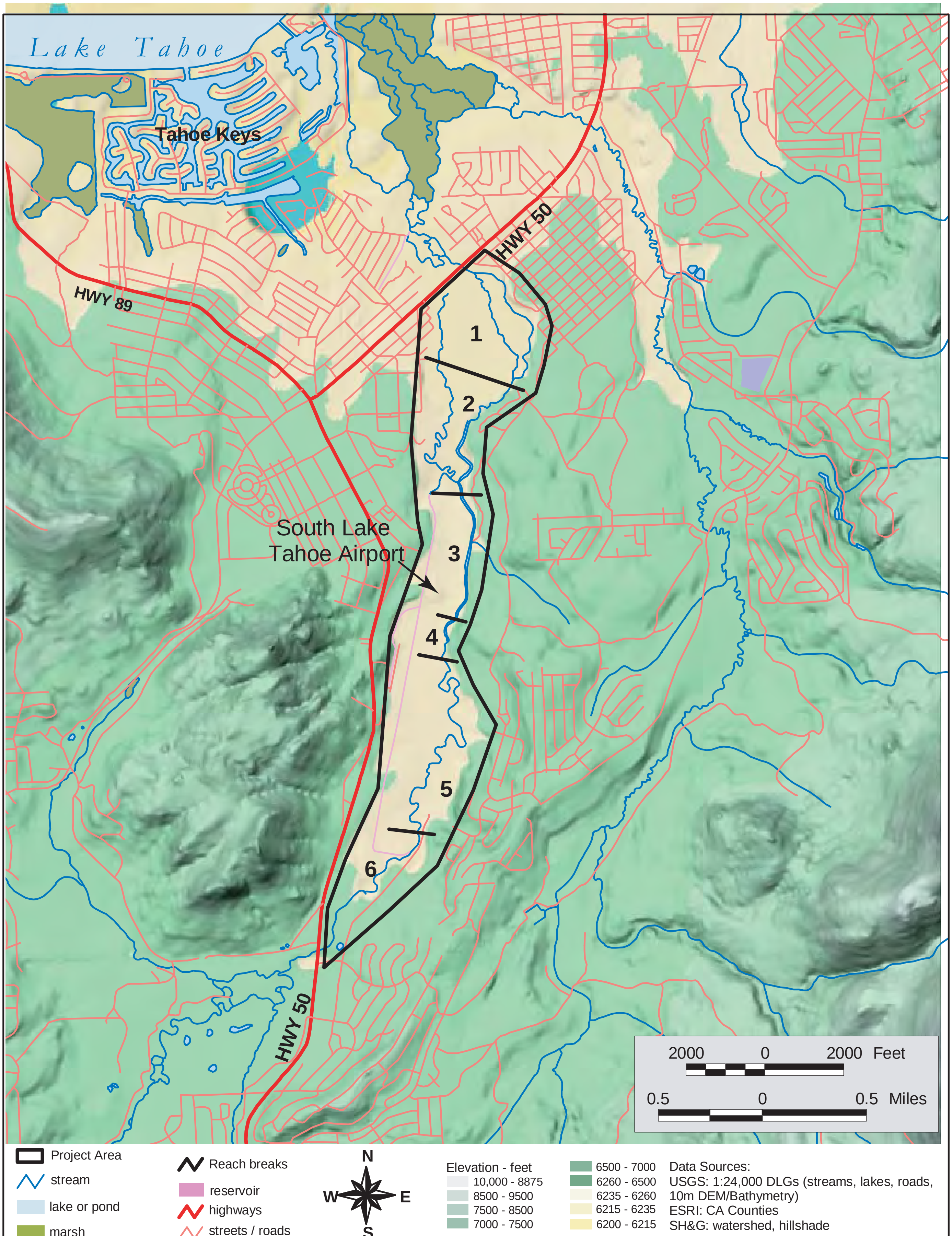

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Figure III.B.2: Project area and surroundings for the Upper Truckee River Restoration Project in South Lake Tahoe, California. The project is broken into six reaches, numbered downstream to upstream from the lower Highway 50 crossing, through the airport to the middle Highway 50 crossing. Scale is 1:40,000 or 1 inch = 3,333 feet.

addition, the lack of meandering due to historical straightening and the hydraulic impacts of deepening has created a flat, sandy stream bed with little value for fisheries habitat (pools, coarse gravel riffles), spawning and primary aquatic production (i.e. food for fish); a notable exception are locations where woody debris has fallen into the channel and stream hydraulics have been diversified by bank erosion and channel widening.

The measures proposed for enhancement or restoration of the Upper Truckee River are designed to enhance if not restore natural geomorphic processes. They incorporate geomorphic design criteria derived from field evidence of channel forming processes (i.e. depositional surfaces and bars within the entrenched channel). A key design factor in channel restoration is selection of the design channel width and depth, its pattern as viewed from above, and the discharge capacity before flow overtops the banks of the channel onto the floodplain (i.e. bankfull discharge). In order to develop a “design bankfull flow”, several factors must be accounted for.

The recent geologic history of the Upper Truckee River includes a wetter period between the end of the last ice age (18,000 years before present) and the time when the current interglacial period climate was established (5-6,000 ybp). The decrease in flow has resulted in a smaller “under fit” stream cut within a valley floor formed by larger flows in the past climatic condition. As a result of this, and higher levels in Lake Tahoe during the 18,000-6,000 ybp period, the UTR in the project area flows within higher “terraces” of older glacial/fluvial deposits from the Middle Highway 50 crossing to the downstream end of Reach 6 near the south end of the Airport and within a flat surface of old “lake sediments” from the south end of the airport to the Lower Highway 50 crossing. Examination of old segments now abandoned in Reach 1 reveals an original channel 40-50 feet in width, highly meandering and at grade with the valley floor in the old lake bed sediments. Similar meanders are found in Reach 6.

Newly deposited bars (Figure III.B.3) within the entrenched channel occur throughout the project reach. These indicate the present channel forming processes of the UTR. These bars were mapped by the Corps of Engineers contractors (Corps 1999) and were identified as bankfull indicators in previous studies of the UTR Cove East project (Swanson and Hanes, 1995, 1997). These bars clearly fit the definition of recently-formed, geomorphic “flood plain” elucidated by Leopold (1995), Rosgen (1995), Knighton (1998) and Williams (1986) while the valley floor under present conditions with the entrenched channel are “terraces” or old abandoned flood plain”. Although the Corps study clearly missed the relevance of the bars, and wrongly focused upon the entrenched channel morphology to the elevation of abandoned terraces, use of the Corps HEC-RAS hydraulic model running at 370 cfs corroborates earlier studies by Swanson and Hanes (1995, 1997) that the bars are bankfull features as defined by Leopold (1995) and Williams (1986) and bankfull discharge that should be used as design is about 370 cfs (Figure III.B.4) HEC-RAS profile). Further evidence was collected as a part of this study during the spring snowmelt of 2002 where flows in the 370 cfs range just began to overtop the bars and abundant fine mineral soil sediments were observed freshly deposited on the bars, thus verifying their recent creation and continued growth. It is also

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Figure III.B.3: Photograph (May 16, 2002) of newly deposited point bar within the incised Upper Truckee River in Reach 5. Feet of Toby Hanes at approximately bankfull stage of 370 cfs. Note fresh fine sediment deposition below Hanes' feet and towards channel. River discharge is 264 cfs as measured at USGS Gage# 10336610 below Highway 50.

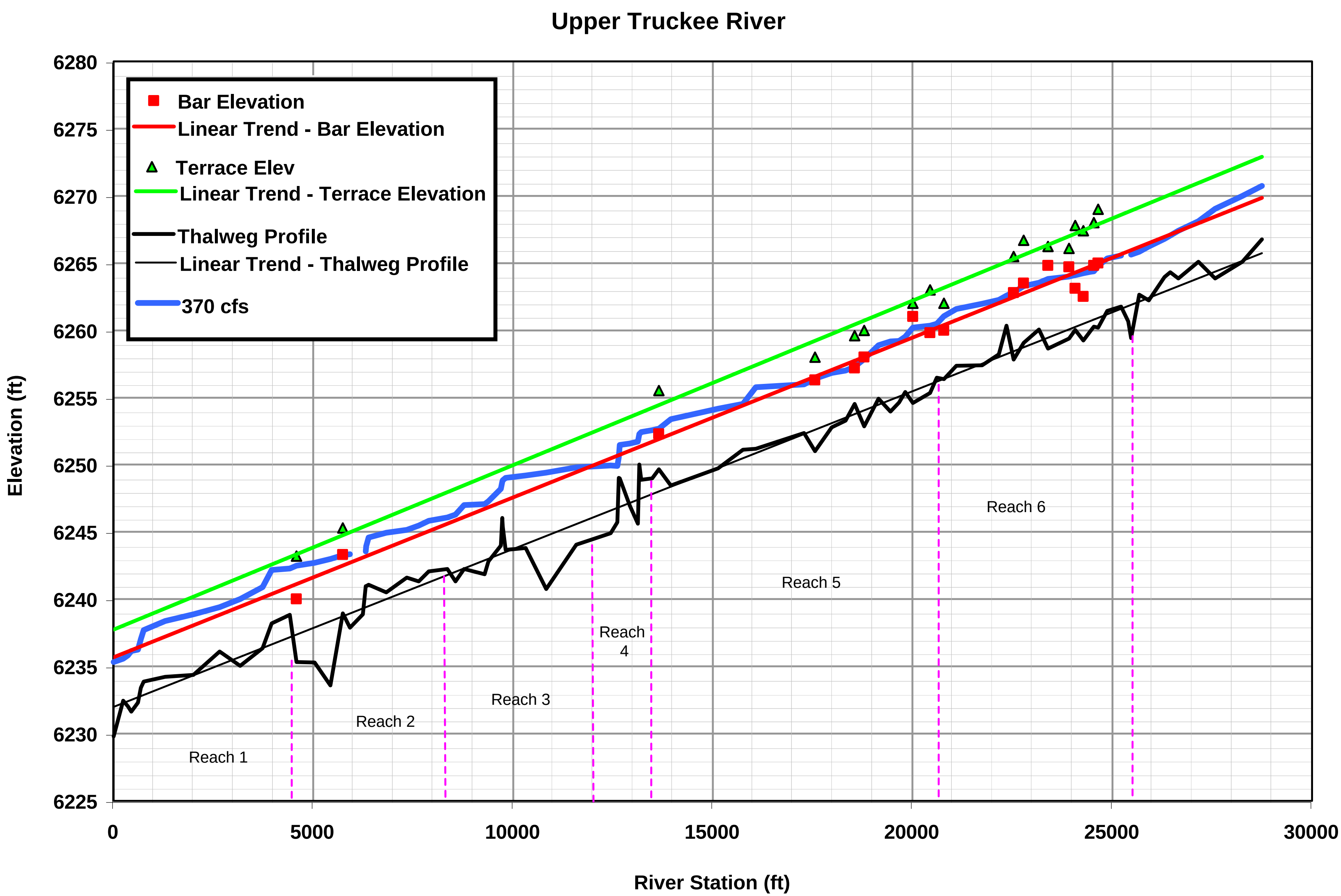

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Figure III.B.4: Longitudinal plot of valley flat (terrace), in channel bars, and thalweg elevations with hydraulic water surface profile showing a distinct relationship between bankfull flows (370 cfs) and recently deposited bars. Plot based on HEC RAS model adopted from Army Corps of Engineers (1999).

noteworthy that the dominant vegetation species colonizing the bars (salix spp, carex spp juncus spp.) is also found on old terraces in decadent and/or declining populations (WBS, 2002). Previous estimates of bankfull discharge by the Corps of Engineers (1999) and Larsen (personal communication, 2002) were made dependent upon stream flow statistics (2-year flood) as if all streams form at the same frequency flow. Use of stream flow statistics is useful only in a “first cut” estimate of bankfull flow at a stream gage; the definition of bankfull flow must have evidence of channel forming processes such as point bar formation and accretion – i.e. sediment deposition of new flood plain – and clear evidence of the flow at bar/new floodplain overtopping and sediment deposition (Swanson and Hanes, 1997; Spring snowmelt monitoring for this study by Swanson, 2002).

Examination of abandoned channel segments reveals channel widths and pattern supportive of formation to 370 cfs capacity (Swanson and Hanes 1995, 1997). These historical segments were the main channel pre-1860 (Figure map and aerial) and reflect pre-Comstock conditions. Evidence indicates that new flood plain is being formed to dimensions equal 1.5-year snowmelt event (370 cfs) and these conditions have not changed substantially since Comstock Era due to the fact that most of the upper watershed where snowmelt peaks are generated, is still un-urbanized.

The proposed enhancement measures described in the UTR alternatives were designed using local knowledge of successful and problematic stream restoration projects in the Lake Tahoe Basin. The recently completed Trout Creek Restoration Project located in the next basin to the east is a similar (but smaller) restoration in a meadow setting of lake deposits. Since it’s watering in fall of 2001, the meadow has become a lush wetland with a marked increase in wetland plant diversity and abundance. Initial examination of fisheries conditions show that spawning and rearing of trout has increased significantly. Recent monitoring data indicate natural sediment transport processes are working effectively to create excellent aquatic habitat. These immediate benefits could be realized in the UTR as the same geomorphic design approach has been used.

III.B.2 Analysis Methods and Assumptions

III.B.2.1 Impact Analysis Methods

The scope of geomorphic impacts considered in this analysis includes the following areas:

1. Erosion and Sediment Production:
   Negative impacts*:* The proposed action generates more sediment through erosion and transport into or along stream channels.
   Beneficial Impact*:* The proposed action will reduce erosion and sediment generation and benefit water quality and aquatic habitat.

2. Hydrologic Changes
   Negative Impact: Increased flooding or reduced plant productivity due to lack of soil moisture
   Beneficial Impact: Improved soils moisture conditions for plants; improved fish habitat in pools.

3. Construction Impacts
   Negative Impact: Potential to cause short-term hydrologic changes and impact to aquatic resources and fisheries; release of fine sediments (or turbidity) to surface water during construction.
   Beneficial Impact: Immediate correction of water quality problem with construction of measure.

4. Channel Morphology and stability
   Negative Impact: Loss of channel bank and bed stability due to actions.
   Beneficial Impact: Improvements in bank and bed stability and ecosystem function as a result of actions.

The potential impacts and benefits of the proposed alternatives were identified through experience on other similar projects and through the application of accepted principles and practices of civil engineering, erosion control, construction methods and geomorphology.

III.B.2.2 Assumptions

A primary assumption is that the present condition of the UTR is degraded from an ecosystem and water quality point of view. This assumption is based upon an evaluation of the present condition, recent historical changes, and project original conditions pre-Comstock Era disturbance. The present degraded condition is considered the "baseline" existing condition. More information regarding existing conditions is provided below.

III.B.2.3 Cumulative Actions Considered

The following analysis assumes that existing watershed conditions will prevail into the future. Much of the Upper Truckee River upstream and downstream of the project site is in a degraded condition due to land use impacts of past 150 years. There are many river/wetland restoration projects in the development stages in the watershed that aim to improve ecosystem function and water quality. Some of these are:

- Cove East Wetlands restoration project (Parcel 4) constructed in 2001.
- Upper Truckee River Restoration Project near Cove East from Lake Tahoe to Lower Highway 50
- Lake Tahoe Golf Course projects along Upper Truckee River
- CDPR Upper Truckee Restoration Project
- Upper Truckee River at Sunset Ranch (Reaches 5 and 6 in Project area)

In addition, the City of South Lake Tahoe, El Dorado County, Caltrans, Tahoe Resource Conservation District, the U.S.D.A. Forest Service Lake Tahoe Basin Management Unit and the California Tahoe Conservancy are all active in developing and implementing erosion control, water quality and wetlands restoration projects in the Upper Truckee River Watershed. Most of this effort is aimed at improving discharge to Lake Tahoe and reversing the decline in lake optical clarity and achieving ecosystem restoration.

Environmental restoration projects require construction activities and often-temporary incursion of heavy equipment into sensitive areas and soil disturbance. Any construction activity with sensitive zones, in this case "Stream Environment Zones" or SEZs is highly regulated by the Tahoe Regional Planning Agency (TRPA) and the State Water Resources Control Board – Lahonton Region. For this document, it is important to consider the timing of construction of other restoration projects in order to assess whether activities in other river reaches will have a significant impact.

III.B.3 Affected Environment

III.B.3.1 Area of Influence

Restoration activities in the project area can influence water quality conditions downstream and ecosystem conditions upstream and downstream. Reduced sediment delivery to the river can improve discharge to Lake Tahoe and aquatic and terrestrial wetland habitat restoration can increase wildlife populations and diversity in other areas of the river upstream and downstream.

Construction activities have the potential to reduce water quality downstream of the project site and thus affect wildlife and Lake Tahoe clarity. Construction disturbance can have short-term impacts to wildlife populations and this could affect areas upstream and downstream.

III.B.3.2 Existing Conditions

III.B.3.2.1 Drainage Basin Description and Geology

The Upper Truckee River drains over 50 mi^2 from the crest of the Sierra Nevada into Lake Tahoe at the south shore (Figure III.B.5). The drainage area has an elongated shape reaching elevations above 9,000 feet above Mean Sea Level (MSL) in the southern headwaters to 6227 feet at Lake Tahoe. The drainage basin can be divided into four distinct areas:

1. The headwaters of approximately 20 mi^2 occur within volcanic terrain covered in patches of bedrock peaks and hill slopes, forest, meadow and lakes. Annual peak snowmelt flows are generated from within this area.

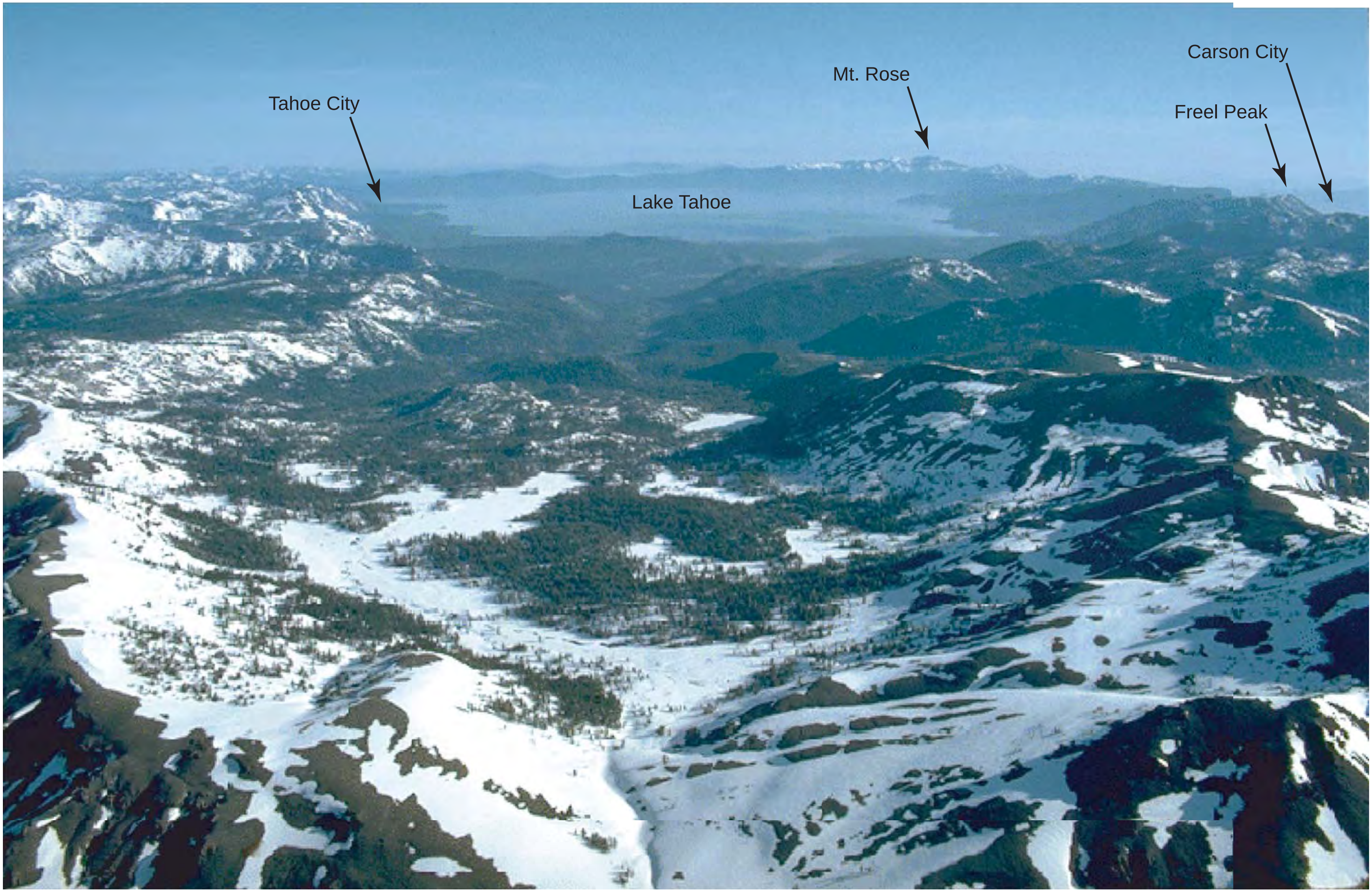

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Figure III.B.5: Aerial photograph of Upper Truckee River drainage basin from near Carson Pass north towards Lake Tahoe.

2. The Christmas Valley area is a classic "U"-shaped glacially carved valley with steep granitic bedrock hill slopes surrounding a moderately steep northward dipping valley floor. The steep and short drainages and tributaries (e.g. Grass Lake Creek) along the sides of Christmas Valley periodically generate debris flows/avalanches that spill onto the valley floor. The Upper Truckee River flows within forested areas on the valley floor and within a channel incised into poorly sorted glacial and fluvial deposits ranging in size from boulders to sandy loam soils.
3. The river reach between Meyers / Highway 50 crossing and the South Lake Tahoe Airport flows in a wider alluvial valley and a series of meadows and fluvial/ glacial morrainal deposits. Within this reach, the river actively erodes stream banks and experiences discontinuity in sediment transport during large flood events; large gravel bars occur below Highway 50 at a location where stream transport capacity declines. The river flows within a channelized reach within the Lake Tahoe Golf Course, which was built upon a large meadow. The river flows within a set of older glacial fluvial terraces between the Elk's Club and the south end of Lake Tahoe Airport before discharging on a reach of old lake deposits.
4. From the south end of the Lake Tahoe Airport to Lake Tahoe, the Upper Truckee River flows within a flat valley floor of old lake deposits that are large, expansive meadows. The river flows within an "under fit" channel characteristic of Late Holocene (last 5,000 years) and dense meadow soils.

The geology of the Upper Truckee River and recent glacial history of the last 2 million years has considerable influence on today's' conditions in the project reach. The uplift of the Sierra Nevada over the past 5 million years occurred along north/south trending faults such as the one the trends along Christmas Valley and along the west shore of Lake Tahoe. The ongoing tectonic uplift was periodically accompanied by volcanic eruptions that laid down thick layers of ash, flows and volcaniclastic rocks that are now visible in the upper watershed. The volcanic terrain includes large areas of fine erodible soils that have experienced years of grazing disturbance.

The three major periods of glaciations over the past may have stripped much of the middle watershed to hard bedrock throughout Christmas valley and along the west side of the lower watershed and deposited the large lateral moraines that now form the prominent ridge that bounds the project area to the east. The glacial periods were also periods of high stands of Lake Tahoe, up to 900 feet above present levels (i.e. elevation 7,100 MSL +/-). These high lake stands coincided with high rates of runoff and sediment loads from glaciers and resulted in the large deltaic deposits upon which South Lake Tahoe sits; these deltaic deposits of well sorted sands have become lithified (hardened into rock) and now form hard ledges under the river streambed and along banks. Late small glaciations deposited moraines within the valley floor that have been re-worked by fluvial transport. Recent high lake stands have resulted in the deposition of lake deposits that now form the valley floor of meadows between the South Lake Tahoe Airport and Lake Tahoe.

III.B.3.2.2 Climate and Hydrology

The climate of the Upper Truckee River is characterized by cold wet winter and cool dry summer seasons. Winter season brings considerable snow pack (average annual 10+ feet cumulative in the upper watershed along the Sierra Crest and up to 3 feet in lower elevations). Winter storms often result in snowfall above 5,000 feet MSL and the upper watershed usually generates an annual snowmelt peak between mid May and mid June. "Normal" patterns of predominately snowfall are punctuated by periods of intense warm rains associated with subtropical moisture in "El Nino" conditions. The last El Nino mid winter rainstorm occurred atop a large snow pack and resulted in the highest peak floods of record (January 1, 1997). The El Nino events occur about once every ten years on average (1955, 1964, 1974, 1986, 1995, 1997, 1998).

Stream flow in the Upper Truckee River has been measured at two USGS stream gage stations since 1970s: one is located at Meyers, above ¼ mile downstream of the upper U.S. Hwy 50 crossing; the second is located just downstream of the lower Highway 50 crossing at a Pedestrian/ Bicycle bridge. The stream flow regime consists of five distinct types depending upon the hydrology of the runoff source. Base flow, which occurs between precipitation events, is generated from the emergence of subsurface flow in the watershed and from surface water spilled from lakes in the watershed. Snowmelt runoff occurs seasonally in the spring and early summer months when the bulk of the runoff from the watershed occurs (Figure III.B.6)**.** Rain on snow events occur during winter months during periods of warm precipitation and El Nino periods, or late in the winter season and early spring. Thunderstorm events occur occasionally in the late summer months. Winter rainfall events occur late fall and/or early winter during the onset of early storms.

The stream flow record for the Upper Truckee River shows distinct differences in peak flow between snowmelt runoff and rain on snow precipitation events (See Figure III.B.6) It also shows peak runoff events for annual snowmelt and rainfall peaks. The largest peak floods are generated by rainfall events while the greatest volumes of runoff are carried by snowmelt events.

III.B.3.2.3 Fluvial Geomorphology

The fluvial geomorphology of the Upper Truckee River in the project reach is dominated by the fact that it is an under fit stream bounded by dense cohesive meadow soils that provide a high level of horizontal stability. Channel forming processes are dominated by snowmelt floods as indicated by widespread occurrence of newly deposited bars within an overall incised channel.

Land use history has had an important influence on the present channel condition. Initially the river was affected by reclamation for grazing, which often included channel relocation, straightening and deepening. This has reduced the occurrence of over bank flows and the seasonal elevation of shallow groundwater in the surrounding meadows. Recent erosion of gully channels within the meadow has further lowered the groundwater and drastically reduced wetland plant abundance and vitality (WBS, 2002). Placement of

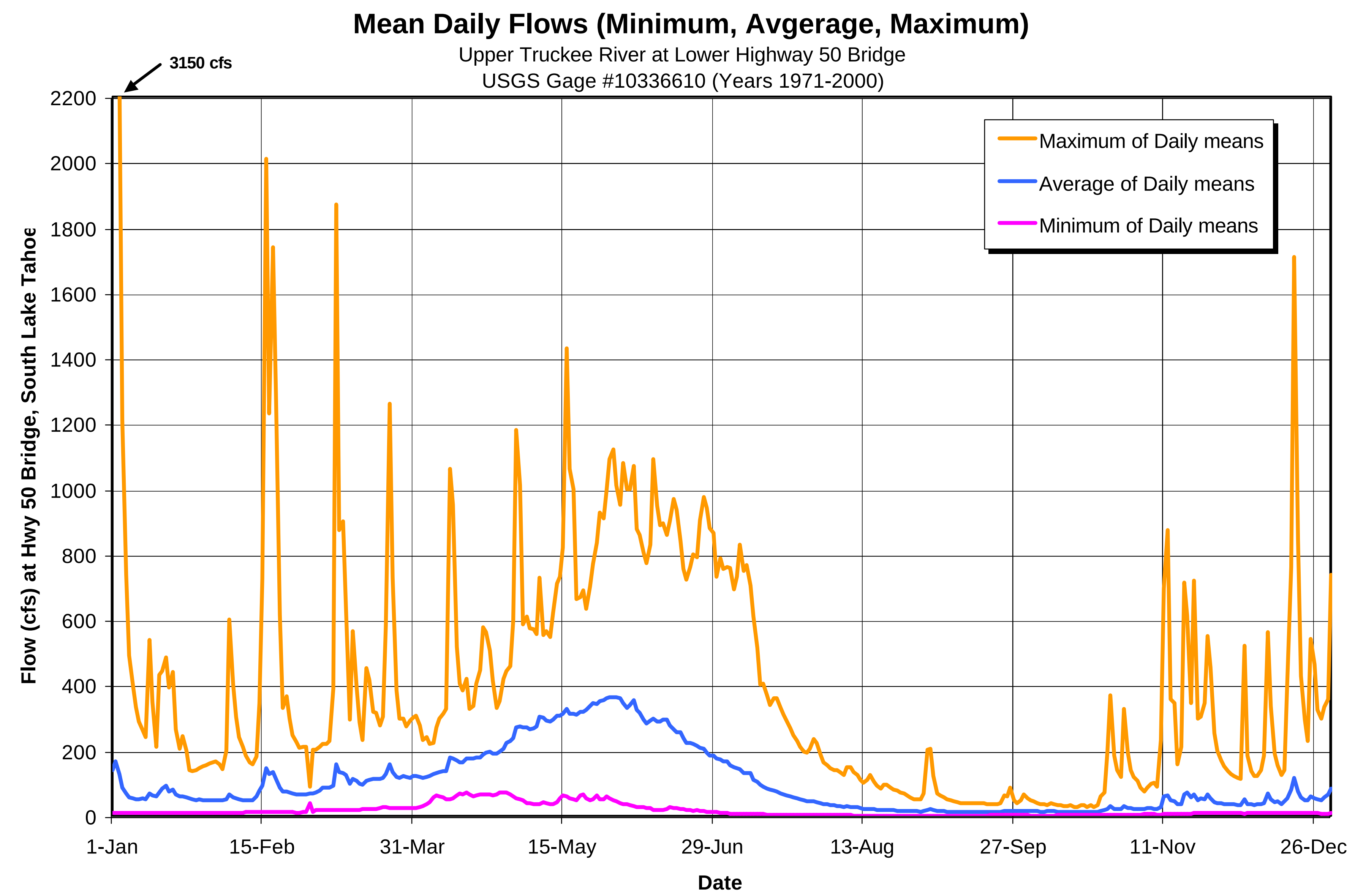

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Figure III.B.6: The annual hydrograph from average daily flows shows an increase in watershed runoff during spring and early summer months when snowmelt runoff occurs. Higher peaks are caused by rain and/or rain on snow events.

fill in the flood plain/meadow areas and placement of other hydraulic structures such as bridges, culverts and pipelines has affected natural sediment transport and channel hydrologic processes. Grazing over the project site has been heavier in the past than presently; recent implementation of a grazing management plan has employed rotation techniques that are designed to improve vegetation conditions.

The historic incision of the Upper Truckee River channel in the project area has caused several significant ecosystem and water quality problems. First, the elimination of natural meandering and over bank flow through channel deepening and straightening has reduced aquatic habitat by removing pools and coarse gravel riffles in favor of large sand bars; this has left virtually no spawning habitat nor coarse substrate for primary aquatic biota. Second, loss of over bank flow and lowered groundwater was simultaneous with large scale grazing operations in the meadows that in turn reduced wetland plant abundance diversity and vitality. This reduction in natural plant ecosystem quality has likely reduced biotic productivity for wildlife significantly. Recent restoration of Trout Creek in a similar meadow setting in the next basin to the east has led to a dramatic increase in rearing and spawning salmonids and a dramatic increase in insect and rodent populations in the meadow, which in turn provides greater food sources for species higher in the food web. The restored reach of Trout Creek had many of the characteristics of the present conditions in Upper Truckee River.

A critical issue in the design of a restoration project is the selection of a design flow upon which to plan channel width, depth, pattern and over bank flow frequency. Most stream channels in nature exhibit sedimentological features that indicate channel forming process or building of new flood plain. These features are usually bars within the overall flood channel, especially if the channel has experienced historic incision or if remnants of past wetter climates have been left as higher benches or terraces. Flood plain surfaces represent an elevation at which flow initially overtops a flat bench naturally over bank and by definition receive frequent deposits of fine sediments. There has been a great deal of confusion over the terms “bankfull channel” and the significance of the flow associated with it. However, there are converging lines of evidence on the Upper Truckee River within the project reach and downstream that this bankfull flow begins to top recently formed floodplain at about 370 cfs.

The recent geologic history of the Upper Truckee River resulted in a stream channel that was at grade with the valley floor (or valley) flat from the south end of the airport (Reach 5) to lower Highway 50. Remnant segments of channel in Reaches 1 and 2 show width and pattern features that strongly correlated to those found within the incised channel today (See Swanson and Hanes; 1995 and 1997).

III.B.3.2.4 Water Quality

A key concern within the Lake Tahoe Basin and of considerable effort and expenditure by numerous agencies and organizations is the quality of runoff discharged into Lake Tahoe. This has been prompted by the well-documented and rapid decline in the optical clarity since measurements began in the mid-1960s. It is generally agreed that excessive nutrients and fine sediments especially in urban runoff from streams surrounding the Lake are a primary cause of clarity decline.

The main water quality issues associated with the efforts to restore the Upper Truckee River involve fine sediment and bio-available nutrients including forms of soluble forms of nitrogen and phosphorous. Other issues include release of urban runoff pollutants (metals, oils grease hydrocarbons, etc.) The main concerns include potential changes in the supply and discharge of sediment and nutrients with the project as compared with current conditions and the potential for their release during construction and post-construction conditions.

Examination of past water quality data taken at the USGS stream gage below the project site indicates passage of high levels of nitrogen during the winter months (Hanes, 1995) during non-precipitation periods; this suggests exfiltration of sanitary sewer lines that occur in and along the channel. Other nutrient sources in the watershed include urban landscapes and golf courses, grazing and wildlife feces and organic debris (vegetation, algae, etc.).

Inspection of the Upper Truckee River watershed reveals numerous fine sediment sources generated by land use activity such as road construction and urban development. These sources are often situated within or adjacent to urban drainage systems that efficiently collect and transport pollutants to receiving waters. One very obvious source of fine sediment is generated by applied road de-icing abrasives during winter snow storms; these sands and in some cases cinders are applied when road surfaces are frozen but then become easily entrained in street runoff and gutter systems before being discharged to receiving waters and in some cases Lake Tahoe. Some volcanic derived road abrasive materials might weather to “dispersive clays” and become colloidal in fresh water and never settle out of water column.

A significant source of fine sediments is generated by chronic bank erosion along the Upper Truckee River. A survey of bank erosion sediment sources conducted in 1995 found that the bulk volume of bank erosion was approximately 10% of the sediment runoff that had occurred in the spring of 1995 (a greater than 10-year peak snowmelt flood). However, the fine sediment constituents detached annually are likely significant to optical clarity to the lake. Much of the bank erosion occurs as a result of channel incision where the rooting depth of bank vegetation to above the lower half of exposed banks. Without incision (bank depth 2-3 feet above low water).

III.B.4 Environmental Consequences

III.B.4.1 Anticipated Impacts

III.B.4.1.1 Proposed Alternatives 1, 2 and 3 (4 in Reaches 1 and 2)

Erosion and Sediment Production

With a no action plan, the present erosion and sediment supply regime would continue and perhaps worsen. The development of the large gully in the Reach 1 meadow since 1995 has resulted in measurable increases in turbidity; this will degrade the quality of water discharged to Lake Tahoe and for aquatic habitat in the project reach and downstream. All other reaches are incised channels with exposed soils below the root zone that are subject to erosion, undermining and failure; these sources occur throughout the project reach and are significant sources of fine sediment. Where the river impinges on the valley edges and steep eroded bluffs, considerable sand and fine sediments are eroded and entrained in the river flow.

Implementation of Alternatives 2, 3 or 4 will result in reduced erosion and sediment delivery downstream. This will result from the filling of the large recently formed gully in Reach 1 meadow and through stabilization revegetation of eroding banks. The improvement in water quality resulting from sediment reduction should help improve aquatic habitat and the quality of water flowing into downstream reaches and into Lake Tahoe.

Of the proposed measures, Alternative 4 in Reaches 1 and 2 and Alternative 3 in Reach 5, the full restoration of river channel to original configuration, would achieve the greatest erosional stability because the channel would be at grade with the meadow and meadow vegetation would be rooted well below the potential depth of channel erosion and scour. This would not only remove significant sources of sediment, but increase over bank flows under Alternatives 2 or 3 in Reaches 1, 2, and 3 and Alternative 3 in Reach 5 will filter runoff as over bank flow to a greater degree than current conditions. Using the design discharge of 370 cfs, over bank flow should increase from less than 2 days per year on average to over three weeks per year.

In summary, the feasible alternatives with the best project benefits in reducing erosion and sediment production are: Alternatives 2 or 3 in Reach 1; Alternative 2 or 3 in Reach 3; Alternative 3 in Reach 5, and Alternatives 2 or 3 in Reach 6.

Hydrologic Changes

The no-action plan would maintain the current degraded hydrologic conditions throughout the project area meaning that the river and associated wetlands will exist well below their potential ecological quality. Conditions could worsen as the large gully in Reaches 1 and 2 meadows continues to deepen and expand; this would further reduce the seasonal groundwater table elevation and result in drier meadow conditions. Some areas of previously wet meadow area are now exhibiting upland hydrologic and plant community characteristics. Dry characteristics dominate other meadow areas in Reaches

3, 4, 5 and 6 due to incised channel conditions and low seasonal groundwater.

Alternative 2 in Reaches 1, 2, and 3 would vastly improve hydrologic conditions by raising seasonal groundwater table to the land surface by 2-4 feet, causing over bank flow at 370 cfs in several areas (versus 800 – 1200 cfs presently) and by filling (or partially filling) the large gully in the Reach 1 meadow. Alternatives 4 in Reach 1 and 2, Alternative 3 in Reaches 3, 5 and 6 would improve hydrologic conditions to a greater extent because the relief between the channel and the adjacent meadow would be minimized; this would likely convert the presently degraded meadow to a full time wet meadow, as shown by the recently completed Trout Creek restoration project.

In summary for the feasible alternatives, Alternative 2 or 3 in Reaches 1 and 2, Alternatives 3 in Reaches 3, 5 and 6.

Construction Impacts

No construction impacts would occur under Alternative 1 the no-action alternatives in all reaches.

Under Alternatives 2 grading will occur in and adjacent to the low flow channel and live stream in Reaches 1, 2, 3, 5 and 6. For construction of overflow areas, the anticipated construction activities include: temporary removal of meadow sod and willows, excavation of fill and soil from the edge of the live channel to the perimeter of the grading, hauling of soil off site or to disposal sites within the project area (i.e. completely or partially fill large gully in Reach 1 meadow). Large woody debris and boulders will also be placed along the channel banks for in stream habitat enhancement.

Alternatives 2 and 3 involve filling either completely or partially (Alternative 2) the large gully in the meadow of Reach 1. This and all other alternatives involving excavation will require establishment of haul routes for dump trucks to bring fill to the gully sites in Reaches 1 and 2, a staging area to unload fill and transfer to loaders, scrapers or other equipment for placing fill, use of a bulldozer or other equipment to gain necessary finished grade and compaction and then access for revegetation phases.

Greater construction impacts should be expected under Alternatives 3 (and 4) in Reaches 1, 2, 3, 5 and 6 as these projects will require in stream work, flow diversion and flushing of new channels.

Construction impacts could affect water quality in a negative manner affecting aquatic habitat and the quality of discharge to Lake Tahoe and Lake clarity.

Channel Morphology

None of the proposed actions will worsen channel morphology conditions. Under the no-action alternative, there are some locations where continued erosion is causing poor channel morphology that is similar to much of the river in the project reach. The only benefit to lateral erosion is the incorporation of logs and woody debris that accounts for the only good aquatic habitat in the project reach. Otherwise, without enhancement or restoration projects, the Upper Truckee River in the project reach will remain in a degraded state.

The greatest benefit to improving ecosystem function would be derived from full channel restoration: Alternative 4 in Reaches 1 and 2, Alternative 3 in Reach 3, Alternative 3 in Reach 5 and Alternative 3 in Reach 6. The restored channel will have a more sinuous meandering pattern, a channel with a low width to depth ratio and the hydraulics of a high quality pool and riffle stream. It is likely that a restored channel would sustain gravel substrate in riffles that would dramatically improve cover and primary aquatic production essential for rearing fish. In addition, sustained gravel riffles would increase spawning habitat for fall run and spring run fish. A more naturalistic meander pattern in conjunction with enhanced conditions for willow and meadow sod growth (juncus spp. and carex spp.) will create and encourage deep pools, undercut banks and vegetated bank cover. The meadow sod and dense soils create highly resistant banks under the restored conditions as demonstrated by the recently completed Trout Creek Project. Full channel restoration is feasible in Reaches 3, 5 and 6.

In Reach 1 and 2, the desires of the private landowner are to retain the present location of the channel, thus Alternative 4 is not deemed feasible. In Reach 5 there do not appear to be any impediments to full channel restoration and it would be a preferred alternative. In Reach 3 the valley width is constricted by the airport and as a result, creation of a new channel will require installation of a buried rip rap windrow to protect the airport, an expensive project component; for this reason and the fact that moving the stream channel closer to the airport may present airport safety issues. Alternative 3 in Reach 3 is considered less favorable than Alternative 2. In Reach 6, restoration of the original channel would require extensive clearing of lodge pole forest to create room for a meandering channel and it is unclear whether the aquatic ecosystem benefits outweigh this impact; implementation of Alternative 2 would create aquatic habitat benefits without the forestry impacts (note: a proposed future study of Reach 6 in the Sunset Ranch and California Tahoe Conservancy [CTC] property will get underway Fall of 2002 and the future of Reach 6 will likely be considered in further detail).

The second greatest benefit is derived from channel enhancement projects where woody debris, logs and vegetation plantings would be installed into the channel to enhance in stream habitat. This would be Alternatives 2 or 3 in Reach 1 and 2; Alternative 2 in Reaches 3, 4, 5, and 6. Also, the five existing diversion dam structures in the project reach would be modified to improve fish passage, hydraulics and aesthetics on a case-by-case basis. In stream enhancement will not restore natural channel processes and all of the full environmental benefits of restoration, however, significant improvement in aquatic habitat can be achieved by increasing cover, creating hydrologic conditions that favor wetland plants on stream banks and by constricting flow to create pools and coarse gravel substrate. Stream channel enhancement is the best alternative where significant land use constraints eliminate channel restoration as an option such as Reaches 1, 2, 3, 4 and 6.

III.B.4.2 Unavoidable Adverse Impacts

From the perspective of hydrology, erosion sediment production and ecosystem restoration, the proposed alternatives will to some degree improve conditions and have considerable benefits. Allowing conditions to continue to degrade under the no-action alternative will result in worsening impacts in the future, especially in Reaches 1 and 2 where the large gullies in the meadow areas continue to expand and this could be deemed an unavoidable adverse impact to water quality. Further degradation would also impact aquatic habitat in the future.

All Alternatives involving construction can potentially affect water quality but over a short-term basis. With proven water quality protection and construction methods used on a nearby project Trout Creek, it is anticipated that these impacts can be reduced to a level less than significant.

III.B.4.3 Proposed Mitigation

III.B.4.3.1 Sewer / Water Line Protection

In many locations along the Upper Truckee River in the project reach, municipal sewer pipelines are located near the channel or cross the channel. In the past, the STPUD has installed emergency erosion control in the form of riprap weirs or bank revetment in Reaches 1, 2 and 3 in order to protect the lines. The location of the sewer pipelines is shown in Figures II.B.1, 3, 5, 7, and 9; where the pipeline location occurs near an area of proposed action, a circle and code number has been placed. This code number related to Table II.A.3, which shows the post-project alternative depth of cover over the pipeline and a statement of recommended actions to protect it with the proposed project.

The sewer line underlies the channel in a crossing at several locations under existing conditions. In Reach 5 with implementation of Alternative 3, the existing crossings will be buried. Where the channel crosses over a sewer line, it will be to less depth than existing conditions, and the construction plans will utilize an armored riffle design that was used successfully at Trout Creek (and approved by STPUD). Where it is deemed that the stream channel or overflow area will come close to a sewer line, measures will be taken to protect them.

III.B.4.3.2 Construction Activity Impacts

All construction activities involving earth grading in or near a live stream or within an SEZ requires special techniques to avoid water quality impacts (it is assumed that impacts to air quality and wildlife are discussed in the appropriate sections). These techniques include use of sediment containment structures such as silt fences, temporary sediment basins, carefully constructed access roads and preparation for precipitation events during the construction season (July through mid-October). It is anticipated that the construction techniques developed and proven during the Trout Creek Restoration Project can be successfully applied on the Upper Truckee River and that application of those specific techniques will be required and developed in detail during project design and permitting phase. A key aspect is the immediate protection and armoring provided by meadow sod, which instantly protects soils and roots within a matter of two weeks. Meadow sod can withstand high velocity flow and virtually protects soils 100 percent. Lowering the banks in overflow areas also reduces erosion by allowing roots to extend below the depth of scour and reducing hydraulic depth and force. With these water quality protection measures incorporated into project design, no additional mitigation measures would be required.

For Alternatives 3 involving new channel construction in Reaches 3, 5 and 6 (and Alternative 4 in Reaches 1 and 2), restoration of the original channel would require excavation, revegetation and monitoring for two years, then diverting flow into the new channel, flushing the new channel, then filling the old channel. This has been successfully done on Trout Creek and the techniques and procedures would be nearly identical. With these techniques no further mitigation is deemed necessary.

III.C WETLANDS

III.C.1 Issues

Wetlands are areas that are periodically or permanently inundated by surface or ground water and support vegetation adapted for life in saturated soil.
A significant natural resource, wetlands serve important functions relating to fish and wildlife habitat, protection and maintenance of water quality, regulation of storm and floodwaters, and ground water recharge. (Environmental Laboratory 1987) Wetlands are protected under federal law and by federal agency policy.

Section 404 of the Clean Water Act requires authorization from the Secretary of the Army, acting through the Corps of Engineers (COE), for the discharge of dredged or fill material into all waters of the United States, including adjacent wetlands. Discharges of fill material include: placement of fill necessary for construction of any structure or impoundment; site-development fills; causeways or road fills; dams and dikes; artificial islands; property protection or reclamation devices such as riprap, groins, and revetments; levees; fill for intake and outfall pipes and subaqueous utility lines; fill associated with the creation of ponds; and any other work involving the discharge of fill or dredged material. A COE permit is required whether the work is permanent or temporary. Examples of temporary discharges include dewatering of dredged material prior to final disposal, temporary fills for access roadways, cofferdams, storage and work areas. (Environmental Laboratory 1987)

Federal agencies are also obligated by policy to protect wetlands. Executive Order 11990 (42 FR 26961; May 27, 1977) directed federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands.

The Upper Truckee River Reclamation Project will receive federal funding and technical assistance and a portion of the project area is federally owned land (US Forest Service). Measures proposed under Alternatives 2 & 3, in Reaches 1-6, including placing fill, installing structures and stabilizing the stream banks will require a Section 404 Clean Water Act permit from the COE. Nationwide Permit 27, Stream and Wetland Restoration Activities, will likely cover implementation of either Alternative 2 or 3 (Carter, pers. com.).

Before issuing a permit for the discharge of dredged or fill material, the COE requires a delineation of waters of the United States, including wetlands in accordance with their 1987 Wetland Delineation Manual (Environmental Laboratory 1987). Three parameters are used to determine whether or not an area is wetland under COE jurisdiction. First, there must be a prevalence of hydrophytic vegetation, that is, plants that are adapted for life in saturated, anaerobic soils. Second, hydric soils – those that possess characteristics of development under reducing, anaerobic conditions - are present. Finally, the area must have hydrology by being inundated or saturated to the surface during the growing season. (Environmental Laboratory 1987)

COE regulatory staff can perform the delineation upon request, however there is typically a wait of one year or more between the time of request and the completion of delineation. Many project proponents hire consultants to prepare a preliminary delineation, which is subject to review and acceptance by the COE. (Carter, pers. com.)

The Natural Resources Conservation Service (NRCS) also delineates wetlands on agricultural land and non-agricultural land if requested by a landowner that is a USDA program participant. In order to be eligible for certain USDA program benefits, participants must comply with the wetland conservation provisions of the Food Security Act of 1985, as amended. The wetland conservation provisions were intended to remove certain financial incentives to convert wetlands to make possible the production of agricultural commodities. NRCS in California does not delineate "other waters of the U.S., other than wetlands." (USDA 2000) Unvegetated river, tributary and gully channels in the project area may be considered by the COE to be waters of the U.S.

A portion of the project area is agricultural land (used and managed for the production of food and fiber, i.e. beef). The producer is a participant in USDA programs subject to the wetland conservation provisions. NRCS could complete delineation on this portion of the project site if the producer requests it in writing. A consultant or the COE could complete delineation on the remainder of the project area and for waters of the U.S.

III.C.2 Analysis Methods and Assumptions

III.C.2.1 Impact Analysis Methods

The first step in determining impacts of the various alternatives on wetlands in the project area was to approximate the location and extent of historical and existing wetlands. Historical information was obtained by reviewing previous investigations done in this area, including those appearing in the COE's Ecosystem Restoration Report and Environmental Assessment (2000). In addition, field examination of the site soils provided clues as to the conditions under which the soil developed. Methods used to estimate the location and extent of existing wetlands are detailed later in this chapter.

The Upper Truckee River Alternatives Description (Chapter II) was used to assess the impacts of the alternatives on the site's existing wetlands.

III.C.2.2 Assumptions

Evidence that the project area is not as wet as it was historically was obtained from reviewing previous investigations as mentioned above, as well as through field observations of vegetation, soils, and hydrology detailed below. It was therefore assumed that Alternative 1, No Action, would result in continued degradation of hydrology and hydrophytic vegetation and a continued loss of wetland acreage.

Alternatives 2 and 3 emphasize restoration of "original…hydrologic conditions…." It was assumed that material used to fill channels will be removed elsewhere in the project area and that re-vegetation will be accomplished with native meadow sod and willow plantings (Chapter II). It is thus assumed that the three parameters for jurisdictional wetlands would continue to be present in the area of influence after implementation of either Alternative 2 or 3. No net loss of wetlands would result and the total wetland acreage would be increased.

III.C.2.3 Cumulative Actions Considered

Additional restoration projects have been implemented or are being planned in the Upper Truckee River watershed. The goal of all of these projects is to improve the water quality of Lake Tahoe while enhancing wildlife habitat (Chapter II). This goal is compatible with the protection and restoration of wetland functional values. It is expected that the cumulative actions of these restoration projects in the watershed will have beneficial effects on wetlands.

III.C.3 Affected Environment

III.C.3.1 Area of Influence

The area directly influenced by the project alternatives is the low-lying meadow along the Upper Truckee River between the lower Highway 50 crossing in the City of South Lake Tahoe and the middle Highway 50 crossing near the Elk's Club. Downstream wetlands and waters of the U.S., including the Truckee Marsh and Lake Tahoe, could be indirectly influenced.

III.C.3.2 Existing Conditions

III.C.3.2.1 Wetland Acreage within the Project Area

Preliminary data on the extent and types of wetlands in the project area was obtained from National Wetlands Inventory (NWI) maps of the US Fish & Wildlife Service (FWS). These maps classify most wetlands in the project area as "temporarily" flooded, based on the Cowardin system (Cowardin, et al. 1979). This is the shortest duration water regime classification, making the associated plant communities difficult to map accurately from aerial photography (Environmental Laboratory 1987). Field visits to the project area indicated the potential for substantially more acres of jurisdictional wetlands than were mapped by the NWI.

Another source of preliminary data was maps from the Land Capability Classification of the Lake Tahoe Basin, California-Nevada (Bailey 1974). These maps delineate homogeneous units of lands grouped according to the frequency and magnitude of hazards encountered there along with the type and intensity of suitable land use. Most of the project area is classified as 1b, Stream channels, Marshes, Flood plains and Meadows. These areas are further described as "naturally wet and poorly drained" (Bailey 1974). However, this classification system does not consider the three parameters for jurisdictional wetlands.

To estimate the extent of jurisdictional wetlands in the project area, an NRCS biologist and soil scientist used the Routine Wetland Determination method detailed in the 1987 COE Manual (Environmental Laboratory 1987) to identify potential wetlands. Data on each of the three parameters were collected at 13 observation points that represented several plant communities and topographic positions within the project area.

Hydrophytic vegetation was prevalent at all but 1 of the 13 observation points. At some points obligate wetland plants (those that occur in wetlands > 99% of the time) appeared to be stressed and dying with dry, brown leaves. Other points appeared to be in transition to upland vegetation. Hydrophytes were marginally dominant at these points. Ten of the 12 observation points that had a prevalence of hydrophytic vegetation also met the FAC-neutral test for hydrology (Environmental Laboratory 1987).

Hydric soils were present at all but 2 of the 13 observation points, including 1 that also did not have a prevalence of hydrophytic vegetation. The primary soil map unit in the project area, Loamy Alluvial Land, is not on the local hydric soils list for the Tahoe Basin Soil Survey Area (Rogers 1974), however observations in the field indicate that this omission was an error. Exclusion from the list was based on a reported water table for the map unit at 12-24 inches. The water table must be within 12 inches for this mapping unit in order to be included on the list. However, the hydric list should be based on conditions under which the soil formed not the present hydrology if it has been altered. The Upper Truckee River channel was moved to the edge of the meadow prior to 1940 as revealed in the earliest available aerial photography of the area and possibly as early as the late 1800's (US Army Corps of Engineers 2000). This constitutes an alteration of the natural hydrology (an artificial lowering of the water table), therefore; the Loamy Alluvial Land map unit should have been included on the local hydric soil list (Sheldon 2002). Observation of redoximorphic features (field indicators of hydric soil) confirmed that the water table has been within 12 inches of the surface (USDA 1998).

The parameter for hydrology is met within the project area if the depth to saturated soil is less than or equal to 18" from the surface (a "major portion of the root zone") for 6.5 consecutive days during the growing season (5% of the growing season) (Carter pers. com., Environmental Laboratory 1987, USDA 1999). Definitive recorded data on the hydrology of the area is lacking. Surface water was observed at only one of the observation points. Depth to free water in augured holes at the observation points ranged from 16 inches to more than 60 inches (the length of the auger). Several assumptions had to be made to determine the presence or absence of wetland hydrology.

Recorded surface water data for the Upper Truckee River indicate that the 50% chance (1 year out of 2) flood event is contained within the channel (Swanson, pers. com.). Therefore, flooding is not presently the source of hydrology for the project area. Hydrology must then come from ground water and/or localized precipitation runoff. If it is assumed that the ground water in the meadow is at the same elevation as the water in the channel, it is within 12 inches of the surface in most areas throughout the meadow

(Swanson, pers. com).

In addition, monitoring well data from upstream of the project area were examined. These data seem to indicate water tables within 12 inches of the surface in April and/or May. This would mean the field observations in mid-June missed the peak hydrology of the year. It was therefore assumed that earlier field observations would have met the hydrology parameter. However, the hydrology must be present during the growing season, which is May 25th – October 2nd (USDA 1999).

A wetland delineation prepared by Gibson & Skordal (1995) for the portion of the meadow downstream of the project area was examined as well. These consultants concluded that the entire meadow area downstream met the hydrology parameter for wetlands.

Additional data from the local soil survey, including the map unit description and placement of the map unit in a hydrologic group, vegetative group, and land capability class, indicate that Loamy Alluvial Land is poorly drained, has a high water table and limitations due to wetness. This local soil survey data, together with the vegetation passing the FAC-neutral test, meant that 2 secondary indicators of hydrology were present, and therefore the hydrology parameter met at 8 of the observation points where surface water was not observed.

All these assumptions taken together with vegetation and soils data led to the conclusion that the hydrology parameter is met in most of the meadow portion of the project area. Recorded data could be obtained through the installation and monitoring of piezometers and/or observation wells in the project area. Monitoring must continue for several years to determine 50% chance of occurrence (USDA 1997).

After a determination of wetland or non-wetland was made for each of the 13 observation points based on a preponderance of the evidence from the data collected above (9 wetland, 4 non-wetland), most of the project area was traversed on foot to locate areas similar to the 9 representative observation points determined to be wetland. These areas were delineated as potential wetlands on base maps with an aerial photo background. Inaccessible portions of the project area were delineated based on aerial photo signatures similar to those observed on the ground. Since NRCS in California does not delineate waters of the U.S. other than wetlands, channels that may be considered “waters” by the COE were included in the potential wetland designation. The maps are not published in this Environmental Assessment due to the limitations on NRCS authority mentioned in the “Issues” section. The data and maps could be used by staff or consultants in the future to prepare preliminary wetland delineation if a COE permit is needed.

Several areas along the western edge of the lower meadow (Reaches 1 and 2) and along Reach 3 of the Upper Truckee River could not pass the FAC-neutral test; therefore the hydrology parameter was not met. Observation point 3 is representative of these areas. However, there was no corresponding photo signature on the base maps, which made it impossible to accurately delineate these areas separately from adjacent areas that did pass the FAC-neutral test. These areas were included as potential wetlands. They may be indicative of the degradation of hydrology (lowering of the water table) that has occurred due to downcutting in the river and gully channels.

The base maps used to delineate potential wetlands did not have a project boundary defined, making it difficult to know where to stop measuring acres of wetlands. Therefore, lines on the base maps were hand-transferred to the project area map of the six reaches identified in the alternatives description (Chapter II). An acreage-calculating grid was used to estimate the extent of wetlands and waters of the U.S. in the project area. The total extent is roughly estimated to be 425 acres.

III.C.3.2.2 Description of Wetland types

Several types of wetlands occur in the project area. The NWI maps, which use Cowardin's Classification of Wetlands and Deepwater Habitats of the United States (1979), show both Riverine and Palustrine Wetland Systems.

Riverine Systems are contained within channels. Both Upper Perennial and Intermittent Subsystems are identified. Upper Perennial Subsystems have a high gradient and rapid water velocity. There is some flow throughout the year; in the project area, the water regime is classified as permanently flooded. These wetlands are further grouped into the Unconsolidated Bottom Class. This means at least 25% of the cover is smaller than stones (cobble-gravel, sand) and vegetative cover is less than 30%. (Cowardin, et al. 1979) The main channel of the Upper Truckee River falls into this classification.

Intermittent Subsystems contain flowing water for only part of the year. Surface water may remain in isolated pools after flow ceases. Project area wetlands in this subsystem are in the Streambed Class. The water regime for these wetlands is semi-permanently flooded. (Cowardin, et al. 1979) The tributary and gully channels in the project area are in this group, as is the drainage ditch through the airport and the Old River channel.

Trees, shrubs, and/or emergents may dominate Palustrine System wetlands. These types of wetlands are commonly referred to as marshes, bogs, or meadows. Ponds are also included in the Palustrine System. Classes identified in the project area are Emergent (Subclass Persistent), Scrub-Shrub, and Forested. Water regimes are classed as temporarily or seasonally flooded, meaning surface water is present for brief to extended periods early in the growing season in most years. (Cowardin, et al. 1979)

Persistent emergent wetlands in the project area are characterized by grass-like plants such as sedges (*Carex spp*.) and rushes (*Juncus balticus*) and true grasses such as meadow barley (*Hordeum branchyantherum*) and bluegrass (*Poa spp.*) Forbs such as arnica (*Arnica chamissonis*), cinquefoil (*Potentilla gracilis*) and long-stalk clover (*Trifolium longipes*) are also very common.

Scrub-Shrub Class wetlands are dominated by woody vegetation less than 20 feet tall

(Cowardin, et al. 1979). In the project area, willows (*Salix spp.*) dominate these wetlands. The Forested Class is characterized by woody vegetation taller than 20 feet (Cowardin, et al. 1979). Project area wetlands in this class have an open canopy of lodgepole pine (*Pinus contorta*), sometimes with an under story of willows, and a herbaceous layer of emergent wetland plants.

III.C.3.2.3 Wetland Functional Values Description

Wetland functional values can be broadly grouped into hydrology, water quality, and habitat associations (Nivitski, et al. 1997).

Hydrology functions provided by wetlands relate to the quantity of water that enters, is stored in, and leaves a wetland. These functions have been greatly impaired in the project area. Runoff from developed parts of the watershed has probably increased the amount of water entering the project area from historical levels. Relocation and downcutting of the river channel and tributaries has resulted in lowering of the water table in the meadow. Thus, less water is stored in the project area, and it leaves the site more quickly than it did historically.

Wetlands maintain and improve water quality by trapping sediment and pollutants such as heavy metals (Carter 1997). Wetland vegetation along stream banks and shorelines helps prevent erosion that leads to increased sediment in adjacent water bodies (Nivitski, et al. 1997). The degradation of hydrology functions has led to a decrease in wetland vegetation available to perform these functions on the project site. Wetland vegetation in the meadow is gradually being replaced by drier species. Stream bank vegetation is lacking in many places, resulting in increased erosion and sedimentation downstream.

Habitat functions of wetlands include providing refugia for a diversity of native plants as well as places for feeding, breeding, resting, and sheltering of fish and wildlife. These functions are intact at the project site, but are diminishing as wetland vegetation declines.

III.C.4 **Environmental Consequences**

III.C.4.1 **Anticipated Impacts**

Impacts from the proposed project alternatives considered in Environmental Assessments may be positive or negative. Impacts may be further classified into short-term (construction period) and long-term (after project completion). Potentially significant adverse impacts may be mitigated to reduce the impact to a level of insignificance. The impacts for the proposed alternatives (Chapter II) are discussed below.

III.C.4.1.1 Proposed Alternative 1

Historical data together with field observations of the project area indicate that the meadow was once much wetter than it is today. Indeed, the hydrology in some places has degraded to the point that it no longer meets the parameter for jurisdictional wetlands. Downcutting and stream bank erosion continue to occur in the Upper Truckee River and associated tributary and gully channels.

Field observations within two weeks of the beginning of the growing season revealed stressed, dead-appearing obligate wetland plants in some low-lying areas of the meadow. Higher topographic positions in the meadow have been invaded by species that usually occur in uplands, such as dandelion (*Taraxacum officinale*) and yarrow (*Achillea millefolium*). Willows (*Salix spp.)* in the project area appear to be all of the same age class and are not currently regenerating.

If Alternative 1 (no action) is adopted, current conditions are expected to continue. As no construction activities would occur, there would be no short-term impacts. However, further downcutting will continue to drain wetlands in the project area. Lateral erosion of gullies and river channels will reduce Palustrine wetland acreage and the sediment resulting from this erosion will tend to fill in downstream wetlands and waters of the U.S. Wetland vegetation will continue to be replaced by upland species. Over the long-term, most of the project area could cease to function as wetland at all. Associated values related to floodwater retention, ground water recharge, stream flow maintenance, fish and wildlife habitat, and water quality improvement would be lost.

III.C.4.1.2 Proposed Alternative 2

Alternative 2 (Moderate Enhancement Plan) would place fill in some areas of wetlands and excavate others, remove fill from areas that were historically wetland, replace existing river crossings, and install bank protection and stream habitat improvements. Areas disturbed by cut-and-fill activities would be re-vegetated with native meadow sod and willow cuttings. (Chapter II) The disturbance during construction could result in potentially significant short-term impacts; however, wetland acreage would be increased by implementation of Alternative 2. Re-vegetation would utilize hydrophytic species, hydric soils would remain in place or be used for fill, and hydrology would be enhanced, so the three parameters for jurisdictional wetlands would continue to be met in areas of existing wetlands. Wetland hydrology and hydrophytic vegetation would be restored to portions of the project area that currently do not meet the hydrology parameter for jurisdictional wetlands.

The main long-term impact from implementation of Alternative 2 is that the type of wetlands present would be altered in some areas. In Reach 1, fill placed in the gully channels would change approximately 3 acres from Riverine System to Palustrine Emergent and Scrub-Shrub System wetlands. In Reach 2, fill placed in the Old River and tributary gully channels would change approximately 1.2 acres of Riverine System to Palustrine Emergent and Scrub-Shrub System wetlands.

The existing Riverine wetlands have a low level of functional values characterized by a lack of vegetative cover, streambed material smaller than stones, bank instability, and high channel width-to-depth ratios. Further, the existing gully channels are draining and eroding adjacent Palustrine wetlands. Implementation of Alternative 2 would increase the functional values of these wetlands. The enhancement of hydrology from the cut-and-fill work would result in increased plant growth. Banks would be stabilized with vegetation. The enhanced wetlands would slow water discharge from the project area and water quality would be expected to improve. Habitat functions would likewise be improved. Therefore, a change in wetland types in Reaches 1 and 2 is not considered a significant adverse impact.

Portions of Reaches 3-6 currently do not meet all three parameters for jurisdictional wetlands, due to the placement of fill associated with construction of the airport and sewer lines and downcutting in the Upper Truckee River. Removal of fill and lowering of the floodplain under Alternative 2 would restore wetland hydrology and vegetation to these areas. Alternative 2 would also enhance the hydrology and growth of hydrophytic vegetation on the remainder of Reaches 3-6 and improve wetland functional values.

Replacement of the existing bridge in Reach 2 and ford crossing in Reach 3 with other bridge structures may result in placing fill in wetlands and/or waters of the U.S., depending on the final design of these structures. The fill removed by demolition of the existing structures would offset the amount of any fill placed. Design would maintain grade control and accommodate over bank flows, therefore, hydrologic function of any wetlands/waters of the U.S. should be improved by these measures and the impacts would not be considered significant.

Placement of boulders and logs in the stream channel in Reaches 2, 3, 4, 5, and 6 can be considered fill in waters of the U.S., however the purpose of installing these measures is to improve bank stability and aquatic habitat. Re-vegetation of the in-channel enhancements will further improve these wetland functional values. No significant adverse impact to wetlands will result from these measures.

Local drainage patterns will be altered by implementation of Alternative 2. Improvement of hydrologic functions is expected to retain water in project site wetlands longer. Runoff from storm events will be temporarily stored and released downstream more slowly. Flooding hazards will be reduced outside the project area. This is considered a positive impact.

Overall, the long-term impacts of Alternative 2 on wetlands in the project area would be positive. Downstream wetlands and waters of the U.S. would also benefit from reduced erosion and enhanced water quality improvement functions of the project area wetlands.

III.C.4.1.3 Proposed Alternative 3

Alternative 3 (Full Enhancement Plan) would place fill in some areas of wetlands, remove fill from areas that were historically wetlands, excavate new channels, replace existing river crossings, and install bank protection and stream habitat improvements. Areas disturbed by cut-and-fill activities would be re-vegetated with native meadow sod and willow cuttings. The disturbance during construction could result in potentially significant short-term impacts; however, implementing Alternative 3 would increase wetland acreage. Re-vegetation would utilize hydrophytic species, hydric soils would remain in place or be used for fill, and hydrology would be enhanced, so the three parameters for jurisdictional wetlands would continue to be met in existing wetlands. Wetland hydrology and hydrophytic vegetation would be restored to portions of the project area that currently do not meet the hydrology parameter for jurisdictional wetlands. Replacement of existing channels with more sinuous constructed ones would increase the acreage of Riverine wetlands in Reach 3, and replace Riverine wetlands with Palustrine wetlands in Reaches 5 and 6.

As with Alternative 2, the type of wetlands present would be altered in some areas, from Riverine System to Palustrine System wetlands in Reaches 1 and 2, and from Palustrine Emergent and Scrub-Shrub to Riverine in Reach 3. In Reaches 5 and 6, existing Riverine wetlands would be restored to Palustrine Emergent, Scrub-Shrub and Forested wetlands and new Riverine wetlands would be created.

In Reach 1, fill placed in the gully channels would change approximately 3 acres from Riverine System to Palustrine Emergent and Scrub-Shrub System wetlands. In Reach 2, fill placed in the Old River and tributary gully channels would change approximately 1.2 acres of Riverine System to Palustrine Emergent and Scrub-Shrub System wetlands.

Removal of fill and lowering of the floodplain in Reach 3 would restore wetland hydrology and vegetation to these areas. Construction of a new, more sinuous channel in Reach 3 would increase the amount of Riverine wetlands from approximately 1.9 acres to about 2.5 acres.

In Reaches 5 and 6, the existing channel would be filled and a new, narrower, shallower, and more sinuous channel constructed. Hydrology and hydrophytic vegetation would be restored or enhanced in the Palustrine wetlands in these reaches. Acres of Riverine wetlands would be reduced from approximately 17.3 to 10.1 acres in Reaches 5 and 6. The 7.2 acres lost from the Riverine system would revert to Palustrine system wetlands.

The existing Riverine wetlands have a low level of functional values characterized by a lack of vegetative cover, streambed material smaller than stones, bank instability, and high channel width-to-depth ratios. Further, adjacent Palustrine wetlands are being drained and eroded by downcutting and stream bank erosion in the river channel. Implementation of Alternative 3 would increase the functional values of these wetlands. The enhancement of hydrology from the cut-and-fill work would result in increased plant growth. Banks would be stabilized with vegetation. The enhanced wetlands would slow water discharge from the project area and water quality would be expected to improve. Habitat functions would likewise be improved. Therefore, a change in wetland types in all reaches is not considered a significant adverse impact.

Replacement of the existing bridge in Reach 2 and ford crossing in Reach 3 with other bridge structures may result in placing fill in wetlands and/or waters of the U.S., depending on the final design of these structures. The fill removed by demolition of the existing structures would offset the amount of any fill placed. Design would maintain