Heavenly Mountain Resort
Mitigation and Monitoring Plan
Annual Report

October 2009 – October 2010

Prepared For:

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EXECUTIVE SUMMARY

On April 25, 2007, the Tahoe Regional Planning Agency's Governing Board unanimously approved Heavenly Mountain Resort's 2006 Master Plan Amendment. This annual report summarizes monitoring and evaluation activities conducted at Heavenly Mountain Resort (Heavenly) between October 2009 and October 2010 as a result of the implementation of the Mitigation and Monitoring Plan contained in the approved Master Plan Amendment.

The Mitigation and Monitoring Plan consists of planning measures, construction measures, operations and maintenance measures, and management response to monitoring and evaluation. The content of each measure is developed to mitigate potentially adverse effects from the implementation of Heavenly's Master Plan Amendment. As Heavenly implements the Master Plan Amendment, they must meet each applicable measure and utilize monitoring and evaluation results to adapt the measures if necessary.

Monitoring and evaluation is conducted by Heavenly, the Tahoe Regional Planning Agency, the USDA Forest Service, Lahontan Regional Water Quality Control Board, and local and county offices. Heavenly employs the services of Cardno ENTRIX (formerly ENTRIX, Inc.), Resource Concepts, Inc., j.c. brennan and Associates, Hauge Brueck Associates, and Integrated Environmental Restoration Services, Inc. to conduct monitoring in their field of expertise. The annual report contains a summary of the results of the monitoring and evaluation.

Heavenly has complied with all applicable measures with the exception of partial compliance with measures 7.4-4, 7.5-12, 7.5-13, and 7.5-23 for which it has developed plans to ensure full compliance. Table 1-1 summarizes the measures contained in the MMP, their relevance to the time period of interest, and Heavenly's compliance.

CHAPTER 1

Introduction

Heavenly Mountain Resort is located on the south shore of Lake Tahoe within El Dorado and Alpine Counties of California and Douglas County of Nevada (Figure 1-1). Land ownership is shared between the United States Department of Agriculture Forest Service (Forest Service) and Heavenly. Heavenly operates on National Forest lands through a special use permit, renewed in 2002 for a period of 40 years.

A Mitigation and Monitoring Plan (MMP) was first adopted during the approval of the 1996 Heavenly Master Plan. The MMP was revised based on measures that have been completed, measures that are no longer necessary, and new measures that are required to reduce potential impacts from implementation of the Master Plan Amendment. The amended Master Plan describes the long-range development plans for Heavenly Mountain Resort. An EIS/EIR/EIS was prepared in support of the Master Plan, and contained environmental mitigation conditions, monitoring and reporting requirements.

The MMP requires Heavenly's continued compliance with existing local, regional, state, and national regulatory programs both in and out of the Tahoe Basin (Heavenly, 2007). The MMP also contains planning measures, construction measures, operations and maintenance measures, and management responses to monitoring and evaluation. Table 1-1 summarizes the measures contained in the MMP, their relevance to the time period of interest, and Heavenly's compliance.

The MMP is conducted through the work of numerous agencies and private consultants including Heavenly, Tahoe Regional Planning Agency (TRPA), the USDA Forest Service, Cardno ENTRIX (formerly ENTRIX, Inc.), Resource Concepts, Inc. (RCI), j.c. brennan and associates, Hauge Brueck Associates (Hauge Brueck), and Integrated Environmental Restoration Services, Inc. (IERS). The period of October 2009 to October 2010 was chosen for the Annual Report in order to include the 2009-2010 ski season and the 2010 summer construction season.

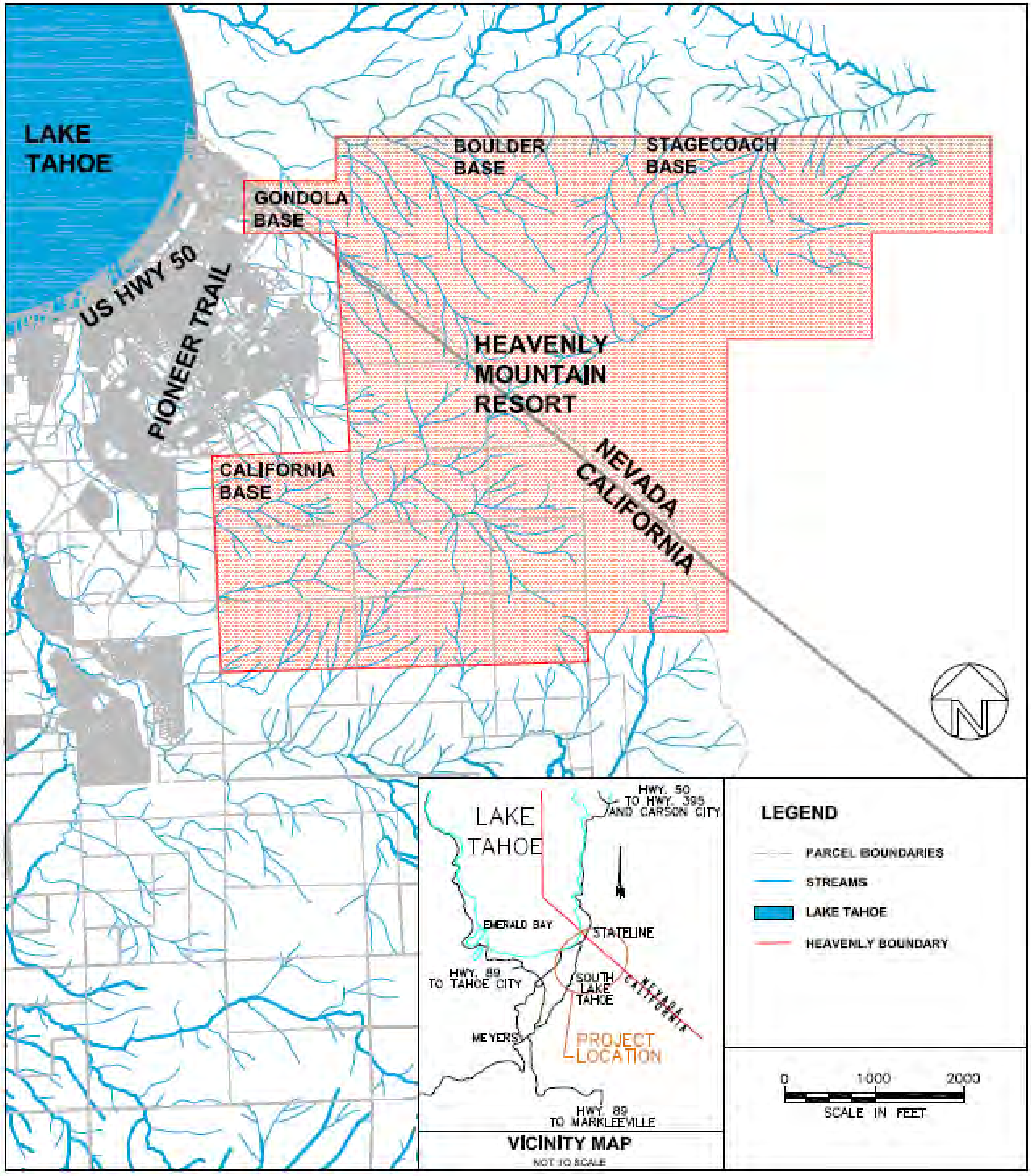

Figure 1-1 Location of Heavenly Mountain Resort (Heavenly 2007)

Table 1-1 Summary of Mitigation and Monitoring Plan Measures

Measure Number	Measure	2009-2010 Applicability	October 2010 Status	Discussed in Current Report	Compliance/ Non-compliance
Planning Measures					
7.3-1	Obtain Summer Day Use PAOT Allocations	None	Project Specific	No	N/A
7.3-2	TRPA Mitigation Monitoring Activities	All Projects and Operations	Complete	Yes	Yes
7.3-3	Design and Site the Proposed Gondola Mid-Station Restaurant to Minimize Visibility From Off-Site Views	None	Not Built	No	N/A
7.3-4	Design and Site the Proposed Angel's Roost Communications Site to Minimize Visibility From Off-Site View	None	Not Built	No	N/A
7.3-5	Reduce Visibility of the Skiways 1 and 2 Trails Through Reduction in Cleared Areas and Retention of Vegetation	Construction Completed in 2007-2008 with final TRPA inspection in 2009	Completed	No	Yes
7.3-6	Design and Site the Proposed Sand Dunes Lodge to Minimize Visibility From Off-Site Views	None	Not Built	No	N/A
Construction Measures					
7.4-1	Revised Construction Erosion Reduction Program	All Projects and Operations	Ongoing	Yes	Yes
7.4-2	Construct Infiltration Facilities	CWE Worklist	Ongoing	Yes	Yes

Measure Number	Measure	2009-2010 Applicability	October 2010 Status	Discussed in Current Report	Compliance/ Non-compliance
7.4-3	(Water-1) Control Runoff for Existing Facilities	All Projects and Operations	Ongoing	Yes	Yes
7.4-4	(Water-2) Meet Water Quality Standards	All Projects and Operations	Ongoing	Yes	Partial
7.4-5	(Water-3) Implement Adaptive Ski Run Prescriptions	Tubing Hill	Ongoing	Yes	Yes
7.4-6	(Water-4) Control Runoff due to Future Construction and Long-Term Operation Facilities	All Projects and Operations	Ongoing	Yes	Yes
7.4-7	Avoid Disturbance to SEZ or Restore/Create SEZ	None	Complete	Yes	Yes
7.4-8	Avoid Disturbance to Wetlands or Restore/Create Wetlands	None	Project Specific	No	N/A
7.4-9	(SEZ-3) Restore Future Disturbed SEZs to Meet MP 96 Mitigation Measure 7.4-3 Requirements	None	Project Specific	No	N/A
7.4-10	(SEZ-4) Restore Future Disturbed Jurisdictional Wetlands and Waters to Meet MP 96 Mitigation Measure 7.4.4 Requirements	None	Project Specific	Yes	Yes
7.4-11	(SEZ-5) Restore Disturbed SEZs due to Construction of Phase I Projects to Meet MP 96 Mitigation Measure 7.4-3 Requirements	Edgewood Creek Watershed Restoration	Partially Complete	Yes	Yes

Measure Number	Measure	2009-2010 Applicability	October 2010 Status	Discussed in Current Report	Compliance/ Non-compliance
7.4-12	(SEZ-6) Restore Jurisdictional Wetlands and Waters Disturbed Due to Construction of Phase I Projects to Meet MP 96 Mitigation Measure 7.4-4 Requirements	None	Project Specific	No	Yes
7.4-13	TRPA Land Coverage Mitigation	Gondola Lodge Completion	Ongoing	Yes	Yes
7.4-14	Reduce and Control Fugitive Dust	Summer Operations	Ongoing	Yes	Yes
7.4-15	Minimize Removal/Modification of Deciduous Trees, Wetlands, and Meadows	None	Project Specific	No	N/A
7.4-16	(BIO-2) Active Raptor and Migratory Bird Nest Site Protection Program	All Projects	Ongoing	Yes	Yes
7.4-17	Monitor and Protect Northern Goshawk	All Projects	Ongoing	Yes	Yes
7.4-18	Prohibit Skier Access on Management Prescription 9 Lands	Winter Operations	Ongoing	Yes	Yes
7.4-19	Evaluate and Monitor Known Archeological Resources Within Comstock Logging Historic District	No Significant Changes	Ongoing	Yes	N/A
7.4-20	Identify and Protect Undiscovered Archaeological Resources	All Projects	Ongoing	Yes	Yes
7.4-21	Protect the Tahoe Rim Trail	None	Not Built	No	N/A
7.4-22	Secure Adequate Water Capacity Prior to Development	Gondola Lodge Completion	Constructed	Yes	Yes
7.4-23	Secure Adequate Sewer Capacity Prior to Development	Gondola Lodge Completion	Constructed	Yes	Yes

Measure Number	Measure	2009-2010 Applicability	October 2010 Status	Discussed in Current Report	Compliance/ Non-compliance
Operations and Maintenance Measures					
7.5-1	Revised Cumulative Watershed Effects Restoration Program	Summer Operations	Ongoing	Yes	Yes
7.5-2	Revised Collection/Monitoring Agreement - Heavenly and Forest Service	All Projects and Operations	Ongoing	Yes	Yes
7.5-3	Maintain Water Rights Balance	All Operations	Ongoing	Yes	Yes
7.5-4	Maintain Water Flows in Heavenly Valley Creek	All Operations	Ongoing	Yes	Yes
7.5-5	Maintain Summertime Flows in Heavenly Valley Creek	All Operations	Ongoing	Yes	Yes
7.5-6	Maintain Water Flows in Daggett Creek	All Operations	Ongoing	Yes	Yes
7.5-7	Maintain Compliance with Water Entitlements	All Operations	Ongoing	Yes	Yes
7.5-8	Reduce Vehicle Emissions	All Operations	Ongoing	Yes	Yes
7.5-9	Snow Grooming Noise Mitigation Methods	Winter Operations	Ongoing	Yes	Yes
7.5-10	Snowmobile Noise Mitigation Methods	Winter Operations	Ongoing	Yes	Yes
7.5-11	Snow Removal Noise Mitigation Methods	Winter Operations	Ongoing	Yes	Yes
7.5-12	Snowmaking Noise Mitigation Methods for Base Areas	Winter Operations	Ongoing	Yes	Partial
7.5-13	Snowmaking Noise Mitigation Methods for Upper Mountain Areas	Winter Operations	Ongoing	Yes	Partial

Measure Number	Measure	2009-2010 Applicability	October 2010 Status	Discussed in Current Report	Compliance/ Non-compliance
7.5-14	(Noise-1) Limit hours of Snowmaking operation and use fan gun technology for the proposed Skyline Trail Snowmaking	None	Not Built	No	N/A
7.5-15	Rock Busting Noise Mitigation Methods	None	Not Built	No	N/A
7.5-16	(Noise-5) Restrict Hours of Amphitheater Operations	None	Not Built	No	N/A
7.5-17	Expanded Bus/Shuttle Access	All Operations	Ongoing	Yes	Yes
7.5-18	Discourage Use of Automobiles	All Operations	Ongoing	Yes	Yes
7.5-19	Implement the Coordinated Transportation System (CTS)	All Operations	Ongoing	Yes	Yes
7.5-20	Reduce Traffic on U.S. Highway 50 at Echo Summit	All Operations	Ongoing	Yes	Yes
7.5-21	Protect Tahoe Draba Populations within Heavenly Mountain Resort	All Operations	Project Specific	Yes	Yes
7.5-22	(VEG 1-A) Tahoe Draba Long-Term Conservation Strategy	All Operations	Ongoing	Yes	Yes
7.5-23	(VEG 1-B) Minimize Loss/Degradation of Sensitive Plant Species	All Operations	Ongoing	Yes	Partial
7.5-24	(VEG 1-C) Noxious Weed Management	All Projects and Operations	Ongoing	Yes	Yes
7.5-25	(VEG 3) Late Seral/Old Growth Forest Enhancement	None	Ongoing	Yes	Yes

Measure Number	Measure	2009-2010 Applicability	October 2010 Status	Discussed in Current Report	Compliance/ Non-compliance
7.5-26	Restrict Vehicle Traffic within the Heavenly Ski Resort MP96 Development Area Description	All Operations	Ongoing	Yes	Yes
7.5-27	Monitor and Protect Nesting and Fledgling Bird Species	None	Not Built	No	N/A
7.5-28	Compliance with Design Review Guidelines Section 7 Exterior Lighting Standards and Code of Ordinances	Gondola Lodge Completion	Project Specific	Yes	Yes
7.5-29	Building and Site Design	Gondola Lodge Completion	Project Specific	Yes	Yes
7.5-30	Maintain Timber Thinning Practices	All Operations	Ongoing	Yes	Yes
7.5-31	Compliance with Existing Health and Safety Practices	All Operations	Ongoing	Yes	Yes
7.5-32	Avalanche Safety Practices	All Operations	Ongoing	Yes	Yes
7.5-33	Provide Employee Housing	All Operations	Ongoing	Yes	Yes
7.5-34	Ensure Adequate Police/Sheriff/Fire Capacity	All Operations	Ongoing	Yes	Yes
Management Response to Monitoring and Evaluation					
7.6-1	Soil and Water Quality	All Projects and Operations	Ongoing	Yes	Yes
7.6-2	Traffic and Parking	All Operations	Ongoing	Yes	Yes
7.6-3	Late Seral/Old Growth Enhancement	All Operations	Ongoing	Yes	Yes

CHAPTER 2
PLANNING MEASURES

Introduction

A majority of the planning measures are addressed within individual Tahoe Regional Planning Agency permits. Table 2-1 provides an update to last season's (October 2008 to October 2009) project list. A few of the projects listed were completed but had yet to receive final inspections for revegetation and Best Management Practices (BMPs).

Table 2-1 Update on Projects Constructed prior to the 2010 Construction Season

Project	TRPA Permit #	Status as of October 2010
Skiways Glade	2007-0104	Completed in 2008
Powderbowl Glade	2007-0104	Completed in 2008
Skyline Trail Re-grade	2005-0412	Complete and Inspected
Lakeview Water System (Phase 1)	Qualified Exempt Maintenance	Partially Completed, Tank removal and road decommissioned scheduled in 2011
California Lodge Best Management Practices (Phase 3)	BMPP 2008-0013	Complete*
Adult Ski School Lift Replacement	ESRP2008-0327	Completed, TRPA agreed to design changes that promote and encourage vegetation growth.
Adventure Peak Zipline	2007-0105	Modifications planned this summer.
Olympic Chairlift Replacement	2005-0411	The Olympic Chair is completed and awaiting final inspection. The North Bowl Chair replacement is not currently scheduled at this time.*
Edgewood Bowl and North Bowl Restoration Projects	2006-0950 & 2006-1190	Completed awaiting final inspection*
Tubing Lift	ERSP 2008-1018	Completed in December 2010. *Summer construction modifications planned in 2011 for year around use.

* The construction is complete. Revegetation and BMPs have not received final inspections. Between October 2009 and October 2010, the following on-mountain improvements were completed:

Table 2-2 Ongoing Projects during the 2009-2010 Construction Season

Project	TRPA Permit #	Status as of October 2010
Gondola Lodge	ERSP 2009-3571 (Draft)	Partially constructed. Completed in December 2010.*

* Construction is now complete. Revegetation and BMP's have not received final inspections, but are expected to occur during 2011.

7.3-1 Obtain Summer Day Use Person at One Time (PAOT) Allocations

Prior to construction of new summer day use facilities, Heavenly needs to obtain TRPA approval for the additional calculated persons at one time (PAOT).

There were no new summer day use facilities constructed during the 2009-2010 season that needed TRPA approval for additional calculated persons at one time allocations.

7.3-2 TRPA Mitigation Monitoring Activities

This measure describes the Mitigation and Monitoring Agreement that Heavenly must enter into with TRPA.

Heavenly, TRPA, and ENTRIX entered a three-party monitoring agreement in January 2008. Heavenly also provides funding to TRPA to conduct all review related to the MMP. This monitoring agreement was renewed through the 2011 calendar year.

7.3-5 (Scenic-6) Reduce Visibility of the Skiways 1 and 2 Trails through Reduction in Cleared Areas and Retention of Vegetation

This measure identifies specific requirements for Skiways Glades. Skiways 1 should be gladed to 50 percent retention of vegetation. Skiways 2 had to be realigned and gladed with 25 percent cleared area and 75 percent vegetation retention.

The Skiways Glades project was completed and inspected during the 2009 construction season (TRPA Permit 20070104). The design and implementation facilitated the requirements of measure 7.3-5.

Conclusion

Heavenly complied with all applicable planning measures during the 2009-2010 construction season. Project specific measures such as 7.3-3, 7.3-4 and 7.3-6 have yet to be constructed and will be discussed in future MMP annual reports.

CHAPTER 3
CONSTRUCTION MEASURES

Introduction

The construction measures contained in the MMP are designed to limit the environmental impacts both during and following the construction of new projects at Heavenly. Resource Concepts Inc. (RCI) assists Heavenly in developing their BMPs and conducts on-mountain monitoring of temporary construction BMPs and permanent BMPs for all of Heavenly's capital projects and Cumulative Watershed Effects (CWE) projects. Integrated Environmental Restoration Services (IERS), along with Heavenly staff, are helping to develop restoration treatments and monitoring plans for disturbed areas during construction and previously constructed CWE projects. IERS is also experimenting and collecting data with regards to different soil cover treatment types and their successful implementation and establishment based on a number of practical criteria.

7.4-1 Revised Construction Erosion Reduction Program

The Revised Construction Erosion Reduction Program (CERP) is intended to minimize the rate of soil loss related to construction activities at Heavenly. The CERP has been upgraded from a mitigation measure to a design feature of each construction project through the Master Plan Amendment.

Heavenly contracted with RCI and IERS to ensure effective BMPs and restoration treatments were designed and implemented in each of their construction projects during the 2010 construction season. RCI performed inspection on both permanent and construction BMPs for implementation and effectiveness. Permanent BMP implementation resulted in 86% of the sites evaluated. Of these implemented permanent BMP's 97% of the BMP's were effective. Temporary BMP implementation resulted in 80% compliant and scored a value of 80% for effectiveness. Recommendations moving forward include increased coordination and communication for prompt responses to BMP concerns. Heavenly staff repairs and/or retrofits existing BMP's with scores that are rated less than fully "implemented", or that are not rated as "effective". More emphasis will be placed on maintaining summer maintenance road BMPs. The team (Heavenly, contracted consultants, and the Forest Service) is addressing improvement towards identifying, prioritizing, and documenting road and ski run BMP retrofit and maintenance projects as part of the monitoring program. Continual monitoring and prioritizing of BMP maintenance and installation sustains BMP effectiveness. RCI's 2010 BMP Effectiveness Monitoring Report is contained in Appendix I. The IERS Restoration and Monitoring 2010 Summary Report is contained in Appendix II.

7.4-2 Construct Infiltration Facilities

This measure states that all new projects contributing to impervious surface shall be designed to infiltrate the 20-year, 1-hour storm.

All infiltration facilities are designed to infiltrate the 20-year, 1-hour storm. Three permanent drip line and infiltration trench BMP's were constructed during the 2010 season located at the Boulder Lift lower terminal, Gondola Yurt, and Gondola Sprung structure. The CWE Project and Work List percentage of recommended projects completed decreased from 86% in 2009 to 45% in 2010. Funding for the CWE work list projects was instead spent on the construction of the new Gondola Lodge. Five of the recommended unconstructed projects for 2010 are included in the 2011 CWE list and another (East Peak Grading Area) was included as a recommended project in 2011. While the percentage decreased, additional BMP projects were completed that were not included on the work list (Canyon Express Upper Lift Terminal, East Peak Well, Gondola Mid-station, Mombo, and at the top of the Gondola Yurt and Sprung structure). Additional details and results can be found in RCI's BMP Effectiveness Monitoring Report in Appendix I. Completion of the Tubing Lift (December 2010) and Gondola Lodge (December 2011) were constructed and designed to infiltrate storm water runoff.

7.4-3 Control Runoff for Existing Facilities

This measure requires Heavenly to install BMPs at all lodges, parking areas, and ski lifts and requires compliance with the Lahontan Updated Waste Discharge Permit for completion of the California Base BMP Retrofit project.

The 1997 CWE list is completed and Heavenly is completing the retrofit installation of permanent BMPs at all lodges, parking areas, and ski lifts. In October 2008, Heavenly completed the BMP retrofit project for the California Base Parking Lot. Though in place, the treatment system is still going through troubleshooting procedures for sampling storm events. Storm frequency sampling, sampling quantities and results are being fine tuned. Once the treatment system is operational and providing valid results, the effective removal of permitted constituents by the treatment system will be validated. A list of BMPs completed during the 2010 construction season is available in Appendix A-1, page 1 of the BMP Effectiveness Annual Report. RCI's BMP Effectiveness Report can be found in this document listed as Appendix I. For more information with regards to the projects completed, please refer to Appendix III for the 2010 CWE work list (projects to be constructed in 2010).

BMPs have been designed for the Stagecoach Base and will be installed as part of the Stagecoach Redevelopment Project. The design was approved by Douglas County, under their stormwater management standards, in the fall of 2008. This area is outside both the TRPA and USDA Forest Service jurisdictions and has yet to be constructed.

7.4-4 (WATER-2) Meet Water Quality Standards

To meet water quality standards, several items are identified in the Master Plan Amendment's MMP. These measures include implementing and maintaining the CWE Restoration Program, implementing the revised CERP, implementing the revised Environmental Monitoring Program, installation of BMPs at all facilities and parking lots, installation of a monitoring site on Daggett Creek, and prohibiting grooming on ski trails deficient of adequate snow cover.

During the 2010 construction season, Heavenly implemented the maintenance phase of the CWE Restoration Program and also continued to implement the Revised CWE Restoration Program. Each year RCI and IERS help Heavenly utilizes adaptive management practices to prioritize maintenance and restoration projects. A list of projects completed during the 2010 construction season is located in Appendix I (Appendix A, page 1). Five projects from the 2010 list were not completed during the 2010 construction season and are included in the 2011 CWE Work List. These projects include: the Gondola Top Station BMP retrofit, the Groove Upper Terminal slope stabilization and grading, the Lakeview Water System tank removal, the Upper Vehicle Maintenance Shop gully stabilization, and retrofitting the East Peak Lodge BMPs. Detailed information concerning maintenance, monitoring, and implementation of CWE projects is located in Appendices I and II.

Heavenly also continues to implement the revised CERP and install BMPs at all facilities as discussed previously.

The Environmental Monitoring Program that has been ongoing since 1991, continued through the 2009-2010 season. Water quality monitoring was conducted monthly between October 1, 2008 and September 30, 2009 and weekly during spring runoff at six sites. One storm sample was collected at the California Parking Lot water quality monitoring site.

New more stringent water quality parameters took effect during the 2008-2009 water year at the California Parking Lot site. Permit conditions stated that once the BMP Retrofit Project and treatment system were in place at the California Parking Lot, more stringent water quality standards would become effective. This was the second year with these new standards in place. Heavenly reported non-compliance annual average violations with regards to total nitrogen, total phosphorus, chloride, oil and grease, and iron levels at the California Parking Lot site. Once fully operational and reliable, automatic samplers at the California Parking Lot treatment system will aid in determining the effectiveness of the parking lot BMPs and in adjusting treatment options to the type and level of constituents measured. Nitrogen, phosphorus, chloride and iron were also in violation at the two Heavenly Valley Creek sites. Results were reported to Lahontan, the Forest Service, and the TRPA according to the requirements of the Environmental Monitoring Program (Appendix IV).

The nitrogen and phosphorus exceedance violations are likely attributable to high basin-wide background levels and can vary with plant uptake and vegetation health. The reference site at Hidden Valley Creek exhibited a similar trend with regards to nitrogen, phosphorus, and chloride levels and this watershed is minimally affected by human development. The 2010 water year was an average water year, after two years of below average winters. Increased stream flow resulted in higher annual loading and non-compliance exceedances. See Appendix IV for further discussion and results from the Environmental Monitoring Program.

The Lahontan Water Quality Board staff is currently amending the monitoring and reporting program to collect a better representation of mountain operations with respect to environmental impact. Heavenly is actively working with IERS to develop both a short and long term sustainability plan addressing nutrient loading and exceedences. The theory being that by reducing soil erosion, nutrient loading should also reduce in the waterway samples. Specific sites and ski run test plots are ongoing at various projects and slope aspects located around the mountain. Results from these test plots will be used to reduce sediment erosion.

Heavenly has installed a flow monitoring station at Daggett Creek and RCI is collecting data at this site. Compliance with water use permits is discussed in Chapter 4. The Nevada Department of Environmental Quality (NDEP) does not require any water quality samples. Appendix V contains the Daggett Creek Flow Monitoring report provided by RCI.

Heavenly requires 12” minimum compacted snow over all obstacles before grooming with snow cats is allowed. This policy protects soil and water resources along with preventing significant damage to snowcats.

7.4-5 (WATER-3) Implement Adaptive Ski Run Prescriptions

This measure requires all new ski runs to be re-vegetated according to the ski trail prescriptions in the Easy Street Run Hazard Reduction Program. It also calls for the evaluation of existing ski trails to determine if the prescription would be appropriate.

With the help of IERS, Heavenly is actively restoring and monitoring each construction area using site-specific soil function improvement and revegetation prescriptions. See Appendix II for detailed information for each project area. During the 2010 construction season, the Gondola Lodge began construction. Completion of the lodge commenced in December 2010. Final inspection and restoration treatments have yet to be implemented. The Tubing Lift was completed in December 2009 and to date has not passed final inspection. Additional information on implementation of adaptive ski run prescription is contained in the BMP Effectiveness Annual Report in Appendix I. Restored areas continue to undergo post-construction monitoring. Monitoring results are contained in IERS Restoration and Monitoring 2010 Summary Report in Appendix II.

7.4-6 (WATER-4) Control Runoff Due to Future Construction and Long-Term Operation Facilities

Both broad and project-specific measures are identified for Heavenly to comply with the MMP. Each new project is to have permanent and temporary BMPs as part of its design and construction. New snowmaking should be underground, with certain exceptions. A formal BMP maintenance program shall be continued. Additionally, the Gondola Mid-Station Road shall have primary uses of limited operations associated with Gondola start-up and shutdown and emergency evacuation.

The Gondola Lodge was the only significant project constructed during 2010. The Tubing Lift was completed in December 2009. Additional work focused on the maintenance of temporary and permanent BMPs on existing facilities. These included slope stabilization at the Canyon Express Upper Lift Terminal, East Peak Well, and Gondola Mid-Station along with infiltration trenches at the Boulder Upper Lift Terminal, Gondola Yurt and Gondola Sprung structure. The 2011 Annual CWE Project and Work List can be found in Appendix VI. All permanent BMPs are designed and maintained to infiltrate at least the 20-year, 1-hour storm. All monitoring of BMP effectiveness and maintenance is performed by RCI as part of the Environmental Monitoring Program. The annual report results are contained in Appendix I.

No new snowmaking equipment was installed in 2010. Snowmaking equipment installed along the Stagecoach Trail in 2008, used revegetation and soil function improvement as BMPs consistent with infiltrating the 20-year, 1-hour storm. This project follows the continuous adaptive monitoring protocol. Results can be found within the Restoration and Monitoring Summary Report found in Appendix II.

The mid-station road, completed in 2008, remains in use only for emergency evacuation and limited daily operations associated with gondola start-up and shut down.

7.4-7 Avoid Disturbance to Stream Environmental Zones (SEZ) or Restore/Create SEZ

This measure identifies specific areas for restoration as well as project-specific SEZ protection components.

All required SEZ restorations have been completed by Heavenly. Heavenly also avoids disturbance to SEZs through its CWE planning process and prioritizes BMP installation and maintenance in areas that could have an impact on SEZs.

Heavenly has completed the 7.65 acres of restoration identified in the Edgewood Creek Watershed Assessment and Restoration Plan through their 2007 Lower Edgewood Restoration Project. Heavenly has also restored 8.75 acres of the Edgewood Bowl and North Bowl areas in 2006 and 2007, and will be working with the TRPA to finalize these projects through inspections.

The restoration of 1.10 acres of SEZ at the Upper Shop was completed in 2006 and continues to be maintained by Heavenly and monitored by RCI.

7.4-8 Avoid Disturbance to Wetlands or Restore/Create Wetlands

This measure requires that Heavenly perform a wetland delineation, avoid development in wetlands, and obtain a Section 404 permit from the United States Army Corps of Engineers (USACE) if development in wetlands is necessary.

There were no plans to develop within or near wetlands during the past construction season. As outlined in the Master Plan Amendment, Heavenly is avoiding disturbance to wetlands through implementation of the mitigation measures listed in 7.4-3.

7.4-9 (SEZ-3) Restore Future Disturbed SEZs to Meet MP 96 Mitigation Measure Requirements

A number of project-specific mitigation measures for avoiding disturbance to SEZs are identified in the MMP.

There were no in-basin or out-of-basin restoration projects implemented during 2010 that were identified in the mitigation measure requirements.

7.4-10 (SEZ-4) Restore Future Disturbed Jurisdictional Wetlands and Waters to Meet MP 96 Mitigation Measure Requirements

This measure requires that any project implemented by Heavenly will be located off jurisdictional wetlands and that Sky Meadows Deck and Boulder Operations be relocated off wetlands. If development within the wetlands cannot be avoided, Heavenly is required to obtain a Section 404 permit from the USACE and comply with all requirements set forth in the permit. Additionally, any tree removal activity needed for ski lifts or trails will be conducted in a fashion that does not disturb wetlands.

There were no projects implemented during 2010 that trigger this measure. This measure will be implemented when the Powderbowl Lodge is built and the Sky Meadows Deck is relocated.

7.4-11 (SEZ-5) Restore Disturbed SEZs Due to Construction of Phase I Projects to Meet MP 96 Mitigation Measure Requirements

This measure is both project-specific and for ongoing summer operations. It specifically provides guidelines towards the design of Skiways Trail, the Edgewood Creek restoration projects, summer road usage, vegetation removal near SEZs, tree removal for lift construction, and permitting.

Generally, Heavenly hand prunes vegetation near SEZs and removes trees over the snow. Where summer roads are not well defined, roped boundaries are erected each summer by Heavenly to protect SEZs and restored areas. At the beginning of each field season, summer employees are required to attend a mandatory orientation about vehicle operation on summer roads and the presence of BMPs in order to protect sensitive areas on the mountain.

As discussed previously, Heavenly's portion of the Edgewood Creek Watershed Assessment and Restoration Plan is complete and is awaiting final inspection from TRPA.

7.4-12 (SEZ-6) Restore Jurisdictional Wetlands and Waters Disturbed due to Construction of Phase I Projects to Meet MP 96 Mitigation Measure 7.4-4 Requirements

This measure requires that any phase I project implemented by Heavenly will be located off jurisdictional wetlands. If development within the wetlands cannot be avoided, Heavenly is required to obtain a Section 404 permit from the USACE and comply with all requirements set forth in the permit. Additionally, any tree removal activity needed for construction will be conducted in a fashion that does not disturb wetlands.

There were no projects implemented in 2010 that triggered this measure.

7.4-13 TRPA Land Coverage Mitigation

To utilize available land coverage within the Heavenly project area, TRPA must make appropriate relocation findings included in the Code of Ordinances and BMPs must be installed and maintained as outlined in the CERP.

Heavenly had 434,580 square feet of available banked land coverage and proposes coverage relocation findings required by the 2007 Master Plan Amendment when applying for individual permits. The following projects have decreased this value to 267,588 square feet of coverage remaining: Northbowl/Olympic Express Lifts, Zip Line Adventure Ride, Gondola Hiking Trails, Mid Station Road, Northbowl/Olympic Express Lifts - Plan Revision, World Cup/East Bowl Snowmaking - Plan Revision, California Base Surface Lift Replacement, Skyline Trail Grading and Snowmaking, Top of the Gondola Lodge, and the Umbrella Bar Relocation.

7.4-14 Reduce and Control Fugitive Dust

During project construction, Heavenly employees and contractors are required to implement mitigation measures to minimize the generation and transport of fugitive dust. These measures may include the use of chemical dust suppressants and/or water on unpaved roads, grading and excavated areas, as well as cleaning onsite paved roadways daily in order to remove excess dirt and mud.

RCI monitors the effectiveness of Heavenly's dust control measures during their temporary and permanent BMP inspections. The frequent use of watering trucks achieved dust control measure on steep roadway slopes. Sheeting was not used to cover the stockpiles generated from the Gondola Lodge construction area due to constant use and a short construction schedule. No dust control issues were noted at this location. More information on dust control is located in Appendix I.

7.4-15 Minimize Removal/Modification of Deciduous Trees, Wetlands, and Meadows

Before any construction project Heavenly must have a qualified biologist conduct a vegetation survey and identify all deciduous trees, wetlands, and meadows located within or adjacent to the proposed construction corridor. Heavenly is then required to implement a final engineered alterative that avoids the loss or degradation of the identified riparian or wetland communities. If these communities are unable to be avoided, Heavenly must mitigate for the impacts.

There were no projects located in areas that contained deciduous trees, wetlands, and meadows during 2010.

7.4-16 (BIO-2) Active Raptor and Migratory Bird Nest Site Protection Program

This measure requires that before construction activities, a migratory bird nest site survey will be conducted to identify any active raptor nest sites within the project area. During initial construction activities, a Forest Service biological monitor is required to be onsite to evaluate if any migratory bird nests are within 100 feet of the construction corridor. If any nests are found, the biological monitor will stop construction and consult with the Forest Service and TRPA staff within 24 hours to determine the next appropriate actions.

Hauge Brueck is approved by the Forest Service to conduct raptor and migratory bird nest surveys. Surveys conducted in 2010 did not detect any active raptor or migratory bird nests within the survey area. Spotted owl protocol states that if there has been no detection for two consecutive years, it can be assumed that the results are accurate for an additional two years without performing additional surveys. A review of the surveyed results can be found in the 2010 Biological Survey Results Summary located in Appendix VII.

7.4-17 Monitor and Protect Northern Goshawk

Any projects that propose to affect or are within half a mile of any suitable northern goshawk habitat are required to have pre-construction surveys completed for northern goshawks. All surveys will be in accordance with the most recent Forest Service Region 5 protocol. Additionally, Heavenly Mountain Resort is required to fund updated northern goshawk habitat maps at 5-year intervals throughout the life of the Master Plan Amendment. These maps will be used when conducting any pre-construction surveys.

Hauge Brueck is approved by the Forest Service to conduct northern goshawk surveys. Both dawn acoustical and broadcast surveys were conducted using the updated habitat map generated by the Forest Service for the environmental analysis of the Master Plan Amendment. While 2010 surveys did not detect any active raptor or migratory bird nests within the surveyed area, due to findings in the past it is recommended that the surveys continue. Results from the surveys are contained in the 2010 Biological Survey Results Summary located in Appendix VII.

7.4-18 Prohibit Skier Access on Management Prescription 9 Lands

This measure requires that Heavenly Mountain Resort prohibits skier access from the gondola mid station.

Heavenly stations employees at the Gondola mid station to explain to skiers and riders that there is one more stop and deters them from skiing from the mid station. If guests with skis or snowboard equipment stop at the mid station, Heavenly employees require them to leave their equipment on a rack near the gondola that can be monitored. During and after larger snow storm events, occasional rider tracks can be seen from the mid station. Heavenly's policy calls for employees to contact dispatch and security to apprehend the violators at the bottom of the Gondola.

The mid station is also a physical barrier to accessing skiable terrain. It is an elevated platform with a 10-15 foot drop to the ground. The stair leading to an area below the mid station are roped off and marked "For Authorized Personnel Only." Heavenly does its due diligence to maintain compliance with this measure prohibiting skier access from the mid station. Detailed information on Heavenly's Boundary Management policies can be found in Appendix VIII.

7.4-19 Evaluate and Monitor Known Archaeological Resources within Comstock Logging Historic District

Prior to construction activities, a qualified professional must formally evaluate the project area for the National Register of Historic Places (NRHP). The LTBMU Heritage Resources staff keeps a record of possible historic sites at Heavenly Mountain Resort.

Communication with LTBMU Heritage Resources staff revealed that evaluations of archeological resources sites within the Comstock Logging Historic District occurred before 2007. Evaluations concluded that all sites but one (the Flume Site) were eligible for the NRHP (Maher, 2010). Monitoring of these eligible sites occurred throughout 2009 and 2010. Monitoring occurred in the Galaxy Pod area, where possible new run construction areas were marked and flagged (Maher 2011). The location of the Gondola Lodge does not conflict with the Comstock Logging Historic District. The LTBMU Heritage Resources staff keeps a record of possible historic sites at Heavenly Mountain Resort. Future construction for the proposed J Lift will need to plan for and avoid a prehistoric site (Maher 2011).

7.4-20 Identify and Protect Undiscovered Archaeological Resources

The LTBMU Heritage Resources staff will spot-check any proposed construction areas in consultation with the appropriate State Historic Preservation Office. If previously undiscovered resources are discovered during construction, all activity will be put on hold until the LTBMU Heritage Resources staff for either California or Nevada assess it for eligibility to the NRHP, compliance with TRPA Code Section 29, and/or (in the event of a prehistoric or ethnographic find) for Native American values.

LTBMU Heritage Resources staff has prepared a comprehensive list of historical sites within the Heavenly boundary. Surveys are done prior to choosing locations for projects. Employees receive training prior to project commencement on the protocol for an encounter with possible archaeological resources.

In 2009, to assist in project scoping and field study, a general meeting at the offices of Heavenly Mountain Resort and a site visit focusing on the Gondola's Area of Potential Effects (APE) was conducted (Lindstrom and Blom 2009). Heritage concerns were addressed by project archaeologist Susan Lindstrom and John Maher, Heritage Resource Coordinator for the USFS-LTBMU. A surface archaeological reconnaissance was conducted by Devin Gonzales Blom and Susan Lindstrom from October 26th through 29th, 2009.

Three project areas were surveyed prior to 2009 and include the Gondola project area, the Snow Beach project area, and the Galaxy Pod project area. No heritage resources were encountered in either the Gondola or the Snow Beach project areas and no additional surveys were conducted in 2009 (Lindstrom and Blom 2009). However, in the Galaxy Pod project area, supplemental field studies were required, to include: (a) additional archaeological reconnaissance, (b) updates of existing archaeological site records, and (c) site boundary flagging. Monitoring continued in 2010 for the Galaxy Pod area. Areas of concern or possibly affected were flagged and re-flagged. Additional surveys in the Mott Canyon/Daggett Creek Road area occurred in 2010 as well. Proposed projects in this area will be sent to the USFS-LTBMU for a detailed survey report (Maher 2011).

Two road segments were discovered as extensions of a Comstock-era wood haul road which was first recorded by S&S Archeological Consultants in 1992, as leading downward from the Mott Canyon area to the upper reaches of the South Fork of Daggett Creek (Lindstrom and Blom 2009). These new heritage resources have been recorded on State of Nevada IMACS archaeological site records in accordance with established guidelines. Updates to these forms were completed. Copies of this report and accompanying site records have been forwarded to the USFS-LTBMU for their review and processing. An additional copy has been placed on file with Nevada State Museum, which maintains the archaeological inventory for the State of Nevada (Lindstrom and Blom 2009).

7.4-21 Protect the Tahoe Rim Trail

In order to protect the Tahoe Rim Trail (TRT) and allow for its continued used during construction of resort facilities, Heavenly Mountain Resort is required to rope off any hazardous areas within or adjacent to the TRT, prohibit construction of permanent structures which may block the use of the trail, as well as inform the public of any potential closures along the TRT.

There were no projects implemented within the vicinity of the TRT during 2010. The Tahoe Rim Trail Association is currently constructing the Van Sickle Connector and modifying the north and south trail along Kingsbury Grade. The Van Sickle Connector will tie in the casino corridor with the rim trail while the portion of trail that currently follows the roadways of North and South Benjamin will be re-routed around the surround neighborhoods off of the pavement. Neither of these projects will interfere with Heavenly Mountain Operations, nor will Heavenly operations prohibit these trail modifications.

7.4-22 Secure Adequate Water Capacity Prior to Development

Prior to development, Heavenly Mountain Resort is required to complete a detailed analysis of on-site water and sewer requirements of the project. South Tahoe Public Utility District (STPUD) and Kingsbury General Improvement District (KGID) will review the analysis and determine if water and sewer system collection and treatment capacity will be available to meet the expansion needs.

The Gondola Lodge construction project secured all water use permits prior to construction in 2010. There were no additional projects implemented during 2010 that increased water demand supplied by STPUD or KGID. For 2011, the removal of the existing ski school yurts and proposed new ski school building will secure all water use permits for construction and future use.

7.4-23 Secure Adequate Sewer Capacity Prior to Development

Heavenly will obtain adequate sewer capacity prior to development of new on mountain facilities requiring sewer units. Heavenly generally uses the sewer capacity outline in the Master Plan of 1996. This capacity will be monitored to ensure that it will meet the requirements of the facilities outlined in the Master Plan Amendment of 2007.

South Tahoe Public Utility District approved the sewer requirements for the constructed Gondola Lodge. Permitting and sewer capacity will be reviewed and accepted by STPUD and KGID prior to construction of the new ski school buildings. Reserve capacity exists for future build out and projects with both STPUD and Douglas County Sewer Improvement District (DCSID) through KGID.

Conclusion

During construction, measures of the MMP are implemented during each project. Heavenly maintained compliance with these measures during the planning, design, construction, and post-construction phases of each project in 2009-2010.

CHAPTER 4
OPERATION AND MAINTENANCE MEASURES

Introduction

The operation and maintenance measures contained in the MMP govern both summer and winter activities necessary to run Heavenly Mountain Resort. While construction measures are project-specific, operation and maintenance measures encompass daily resort operations. These ongoing measures are usually related to either summer or winter activities.

7.5-1 Revised Cumulative Watershed Effects Restoration Program

The preparation of a Cumulative Watershed Effects (CWE) Analysis was required by TRPA guidelines for ski area expansion and was completed in 1991. The CWE Analysis identified areas that produced relatively greater than background erosion and sedimentation levels. Those areas were prioritized for rehabilitation and restoration treatments. Because all of the remedial CWE projects were completed under the 1997 CWE Restoration Program, the revised CWE focuses on long-term maintenance of facility BMPs, road and ski trail projects, site specific and localized needs, and improved implementation and effectiveness monitoring (Heavenly, 2007).

Each year Heavenly prioritizes CWE projects for both maintenance and implementation. RCI is responsible for BMP implementation and effectiveness monitoring. Results from these monitoring efforts are located in Appendix I. The status of this program is ongoing. Appendix III contains a list of CWE projects proposed during the 2010 construction season. Five of the projects listed on the 2010 CWE list were completed last year. An additional seven projects, previously not on the list, were completed as well. The remaining five projects not constructed on the 2010 CWE list were rolled over and are included on the 2011 CWE project list. Appendix V contains the list of proposed CWE projects planned for 2011.

7.5-2 Revised Collection/Monitoring Agreement – Heavenly and Forest Service

The Revised Collection/Monitoring Agreement between Heavenly and the Forest Service commenced in 2005 after adaptive management was used to make changes to the original monitoring agreement. The Collection/Monitoring Agreement requires Heavenly to conduct water quality monitoring, effective soil cover monitoring, BMP effectiveness monitoring, riparian condition monitoring, and condition and trend monitoring. Water quality and BMP effectiveness monitoring are conducted annually, while effective soil cover and riparian monitoring are conducted based on specific work plans approved by the Forest Service. Condition and trend monitoring is conducted every 5 years through the preparation of a comprehensive report. The next comprehensive report will be prepared in 2011 and submitted in January 2012.

The Environmental Monitoring Program continues to be funded by Heavenly, but has been implemented by Cardno ENTRIX and RCI since 2005. Heavenly renewed their contract with Cardno ENTRIX and RCI to complete water quality monitoring and BMP effectiveness monitoring in January 2008.

The Revised Collection/Monitoring Agreement between Heavenly and the Forest Service remains in place, however, it now provides funding for only Forest Service oversight and review of all water quality and BMP-related monitoring.

Water quality monitoring was conducted monthly between October 1, 2009 and September 30, 2010 and weekly during spring runoff at the six sites specified in the 2005 Revised Environmental Monitoring Program. Storm events were also sampled at the California Parking Lot compliance site. Results were reported to Lahontan and the Forest Service in quarterly and annual reports.

The results from BMP effectiveness monitoring are also reported quarterly and annually and have been discussed previously. The effective soil cover program and riparian condition monitoring for 2010 can be found in the 2009/2010 Environmental Monitoring Program Annual Report found in Appendix IV.

An aerial photo analysis was performed in 2009 to determine effective soil cover on existing ski runs. While this methodology was comprehensive, it was not detailed enough to address the effective soil cover objectives. Late in the summer of 2009, ground-truthing using California Native Plant Society's Vegetation Rapid Assessment Protocol was conducted. The ground-truthing methodology continued in 2010. While the results are highly subjective, all five stations showed an increase in vegetation cover. Results can be found in Appendix IV chapter 3. Continued communication between Heavenly, the Forest Service, Cardno ENTRIX and IERS is in order to develop a more appropriate and or alternative measurement system to address ongoing soil stability.

Stream riparian studies were conducted during 2009. Data from these studies were compared to data collected in 2006. Comparisons were made to address whether or not Heavenly mountain operations are affecting stream health. Specific reaches and creek details can be found in chapter 5 of the 2008/2009 Environmental Monitoring Program Annual Report (2008-2009 MMP Annual Report). For the many of the reaches, the channel health remained similar to findings found in 2006. Stream health measurement changes occurred, but may be associated with ephemeral stream morphology and observer subjectivity. The next full stream riparian monitoring round will occur this upcoming summer (2011) with the data to be included in the 2006-2011 Environmental Monitoring Program Annual Report (January 2012).

7.5-3 Maintain Water Rights Balance

This measure specifies that Heavenly shall implement a water use/water rights monitoring program to estimate the quantity of water supplied by each source and where the water is used.

Heavenly has installed all necessary meters to conduct the water use monitoring program and has prepared an annual water use/water balance report. The Water Use Report for the 2009-2010 season contains detailed records on water used for snowmaking and can be found in Appendix IX. The total amount of water used for snowmaking during the 2009-2010 ski season was 149.6 million gallons (459.11 acre-feet). The majority of water for snowmaking was purchased from KGID and STPUD (120.3 million gallons), while the rest was obtained from the California and East Peak Lake reservoirs (29.34 million gallons). Results show that a net of 2.7 million gallons of in-basin water were transferred out of basin during the 2009-2010 snowmaking season. "No changes have been made in the metering locations, configuration, or calculation procedure from the previous year. However, the 2009-2010 annual report includes flow data through 9/3/10. This change allows for Heavenly to better balance the transfer of water over the summer by filling reservoirs from the preferred water source." (Snomatic Heavenly 09-10 Water Report, pg 3). Besides snowmaking, water usage for the remaining operations of Heavenly are distributed either from small wells or purchased from STPUD or KGID. All purchased water supplied by outside utility providers has been provided in compliance with their approved water rights or similar permits. The sources and use of water between October 1, 2009 and September 30, 2010 are as follows:

California Main Lodge: Water for the lodge is supplied by STPUD. No consumption data is provided by STPUD. Annual flat fee charges for STPUD water are based on the size of the water meter.

Lakeview Lodge/Snow Beach Community Water System: Water for these facilities is supplied by an underground well. The estimated consumption for the period is 357,200 gallons (1.10 acre-feet).

Sky Deck Barbeque and Bathrooms: Water for these facilities is supplied by an underground well. The estimated consumption for the period is 421,000 gallons (1.29 acre-feet).

Adventure Peak (Top of Gondola/Gondola Mid-Station): Water for these facilities is supplied by an underground well. The estimated consumption for the period is 815,000 gallons (2.50 acre-feet).

Boulder Lodge: Water for the lodge is supplied by KGID. Estimated consumption for the period based on water invoices from KGID is 237,855 gallons (0.73 acre-feet).

Stagecoach Lodge: Water for the lodge is supplied by KGID. Estimated consumption for the period based on water invoices from KGID is 424,000 gallons (1.30 acre-feet).

East Peak Lodge: Water for this facility is supplied by an underground well. The State of Nevada had allocated 1.2 acre-feet (approximately 391,000 gallons) annually of consumptive water rights for the well that serves the lodge. Previous data provided showed usage above the state allocation value. Heavenly applied for and was granted approved permit 79059 that transferred snowmaking water rights to recreational water rights increasing the total new allocation to 3.2 acre-feet (1,042,719 gallons). Estimated consumption for the period in question is 785,900 gallons (2.41 acre-feet).

7.5-4 Maintain Water Flows in Heavenly Valley Creek

This measure requires a water use/water rights monitoring program specific to the California Reservoir.

Heavenly attempts to maintain flows into and out of the California reservoir in balance continuously to ensure that water rights are not exceeded. New meters discussed previously should allow for continuous monitoring and balance of flows into and out of the California reservoir for the 2009-2010 season.

7.5-5 Maintain Summertime Flows in Heavenly Valley Creek

This measure does not allow the use of water from Heavenly Valley Creek for irrigation in the summer and requires water use balance for the California Reservoir.

Heavenly does not directly take water from Heavenly Valley Creek for summer irrigation. Flows into and out of the California reservoir are maintained in balance continuously to ensure that water rights are not exceeded. One recommendation in the water balance report is to use summer time irrigation water to balance out the winter snow making transfer.

7.5-6 Maintain Water Flows in Daggett Creek

The MMP specifies that Heavenly shall install a flow gauge at East Peak Lake, monitor input via precipitation and output from East Peak Lake, and maintain release rates that satisfy water right permit 50525.

The water rights permit is based on snow making usage as opposed to maintaining flows in Daggett Creek. The permit states that 0.5 cfs of water can be used from November through March for snow making operations. Data from Daggett Creek suggests that the East Peak Lake Dam is operated to satisfy usage rates that are established in the water rights permit (Snomatic 2010). There are a number of inputs to determine this value such as well usage, stream flows out of the dam, water pumped out of the reservoir used for snow making and water pumped into the reservoir. Appendix V contains the 2009-2010 stream flow data collected and prepared by RCI on Daggett Creek. Due to the non-uniform cross section location and low flows in the channel the discharge correlation is not very accurate during low flow measurements. RCI proposes that alternative methods can be used to demonstrate water rights compliance. If an alternative method is approved, by the Nevada Division of Water Resources this measure will be amended.

7.5-7 Maintain Compliance with Water Entitlements

Similar to measure 7.5-3, Heavenly shall implement a water use/water rights monitoring program and comply with existing California, Nevada, and local provider water restrictions on an annual basis.

Heavenly complied with all applicable water rights in 2009 and 2010 and prepared a water use/water rights report which is contained in Appendix IX. The East Peak well became operational in the spring of 2009. The new well's purpose was to secure an additional source of water and reduce the need for the water transfer across watersheds. The East Peak well was fully operational during 09-10 snowmaking season and 54.5 million gallons (167.3 acre-feet) were pumped from the well for snowmaking.

7.5-8 Reduce Vehicle Emissions

Heavenly is to work with responsible agencies to implement a mitigation package that will reduce the potential increase of ambient carbon concentrations. The mitigation package includes using contributions to development of best available control technologies and using these technologies for construction, expansion and improvement of the bus system, and improved parking management. In addition, Heavenly shall consider offering skiers/riders the option of both a morning and afternoon half-day lift ticket to reduce peak parking hour traffic.

To mitigate the resort's contribution to carbon emissions, Heavenly is implementing a carbon mitigation package that is largely centered on reducing vehicular traffic. Heavenly uses low emission vehicles for both transit and operations. The entire fleet of Heavenly snowmobiles has 4-stroke engines. Heavenly also uses state-of-the-art snowcats with Tier 3 California Air Resources Board (CARB) engines. The emissions from Tier 3 snowcats are the cleanest available on the market.

During the ski season, Heavenly provides free shuttle service between all base areas and lodging facilities. They discourage vehicular travel to the gondola by only offering paid parking. Employees can buy subsidized monthly bus passes. Heavenly contributed to the start up and operation of the Coordinated Transit System (CTS) and continues to contribute the 20% required local match for Capital Vehicle Replacement Grants from the Federal Transit Administration. Since 2005, all new and replacement buses on the BlueGo system have been low emission, alternative fuel vehicles.

Heavenly currently offers skiers and riders half-day afternoon lift tickets.

7.5-9 Snow Grooming Noise Mitigation Methods

This measure states that Heavenly shall not groom slopes within 85 feet of a Plan Area Statement (PAS) boundary.

Heavenly did not operate snow-grooming equipment within 85 feet of the PAS boundary during the 2009-2010 ski season. This was confirmed by Heavenly Mountain Operations manager, and there were no complaints received from nearby residents.

7.5-10 Snowmobile Noise Mitigation Methods

This measure encourages snowmobile noise reduction through proper fleet maintenance, replacing 2-stroke snowmobiles with 4-stroke snowmobiles, and operation of snowmobiles away from PAS boundaries.

Heavenly's entire fleet of 45 snowmobiles consists of 4-stroke technology. Studies have shown that 4-stroke engines reduce noise levels by 10 dBA when compared to 2-stroke engines (Bollard & Brennan, Inc., 2001). Heavenly also maintains their fleet regularly and keeps documentation on all maintenance.

Snowmobile use is concentrated in flat areas on the upper mountain and not near PAS boundaries. Snowmobiles are operated during the daytime to have the least effect on the Community Noise Equivalent Level (CNEL), though there is no formal noise measurements conducted. Additionally, no known complaints were filed with the local jurisdiction, Heavenly, TRPA, or the Forest Service.

7.5-11 Snow Removal Noise Mitigation Methods

To reduce noise created from the snow removal process; this measure states that Heavenly should minimize nighttime snow removal and attempt to construct noise barriers along the perimeters of parking lots using snow.

While no formal noise measurements are conducted to determine snow removal operations' effect on the CNEL, no known complaints were filed with the local jurisdictions, Heavenly, TRPA, or the Forest Service. Additionally, Heavenly's snow removal plan calls for constructing barriers on the perimeter of the California Base, Boulder, and Stagecoach parking lots. Additionally, Heavenly's snow removal plan calls for constructing barriers on the outskirts of the California Base, Boulder, and Stagecoach parking lots. Typically snow is removed, early in the morning prior to opening for the public, from areas furthest from adjacent houses first and pushed towards the houses to build noise barriers.

7.5-12 Snowmaking Noise Mitigation Methods for Base Areas

This measure calls for a reduction of CNELs at the base areas to 1982 values or TRPA PAS noise standards, whichever is less, through the implementation of snowmaking technology.

The CNEL is measured annually at each base area by j.c. brennan and associates. Results for the 2009-2010 season are contained in the Heavenly Ski Resort Master Plan Noise Monitoring Survey located in Appendix X.

Heavenly has completely replaced the air-water snowmaking nozzles at the California Base with quieter fan guns; however portions of the lower mountain (Round About and lower Gun Barrel) still continue to utilize air/water nozzle guns. The California Base has a continuous noise meter which recorded sound levels during the ski season on both snowmaking and non-snowmaking days (from November 1st through March 31st). The CNEL value recorded at the monitoring location exceeded the 55 dBA standards for PAS 085 and 087, but was lower than the past two season (59.8 dBA). This also marked the first time a recorded value was below 60 dBA. Though upon further study, there were only two days in which the louder air/water guns were used for snowmaking. The CNEL measured on days without snowmaking decreased from the previous season by 4.2 dBA. The decrease from the previous season is mostly likely associated with the monitoring site being relocated to help dampen the traffic noise from the intersection of Keller Road and Saddle Road. The previous location (northeast corner of Keller Road and Saddle Road adjacent to the Tahoe Seasons Resort) had reached its limitations and usefulness. Traffic noise from the current location (located at the southeast corner of Keller Road and Saddle Road) is reduced due to set back from the intersection. Traffic noise and individuals recreating in the area still influence the noise reading even on non-snowmaking days when CNEL levels were recorded. Short-term CNEL measurements were taken at the Boulder and Stagecoach base areas during snowmaking operations in December 2009. The noise measurement was above the permitted CNEL standard for the plan area statement. Heavenly anticipates replacing the air/water nozzles at these locations after they have replaced all of the nozzles located on the California face. Heavenly is utilizing the best available low energy/low noise snowmaking technology in all new snowmaking installations consistent with the master plan and continues to replace air/water nozzle guns with low noise equipment throughout the entire mountain.

Heavenly has actively pursued several of the mitigation measures for noise reduction at base areas listed in the Master Plan Amendment; however, the measured CNELs are not meeting the scheduled reductions, therefore, this measure is listed as partially compliant.

7.5-13 Snowmaking Noise Mitigation Methods for Upper Mountain Areas

This measure calls for a reduction of existing noise levels where new snowmaking facilities would result in new PAS noise impacts.

The remote measurement for plan area 080 was conducted in January 2010 during a full array of fan gun operations on the upper mountain did not detect any audible noise from snowmaking operations. These noise measurements were conducted at “Party Rock” noise measurement site 7 located on Figure 1 in Appendix X.

However, noise measurements from the remote measurement location for plan area 095 (Noise Measurement Site 6) were conducted during the same time period as above. The snowmaking report indicates that there were 40 air/nozzle and 2 fan guns operating during this time period. These measurements were conducted southeast of Liz’s and Canyon trails and both measuring locations have GPS coordinates. The locations can be found on Figure 1 in Appendix X. The snowmaking operation recorded a noise value of 70 dB Leq. This value exceeds the noise level criteria for plan area 095 located at the top of the Sky Chair area.

Heavenly is partially in compliance with this mitigation measure. As snowmaking equipment is replaced with new low energy/low noise technology, noise levels are expected to decrease.

7.5-14 (NOISE-1) Limit Hours of Snowmaking Operation and Use of Fan Gun Technology for the Proposed Skyline Trail Snowmaking

This measure limits snowmaking on Skyline Trail to daytime hours due to the current CNEL of 78dB.

There was no snowmaking along the Skyline Trail in 2009-2010. This measure is not applicable at this time.

7.5-15 Rock Busting Noise Mitigation Methods

In order to mitigate the impact to a less than significant level, Heavenly must control the number, size and location of "rock busting" blasts (to meet PAS noise standards). Heavenly is to continue to implement Rock Busting Noise Mitigation measure from the 1996 Master Plan.

There were no rock busting activities during the 2010 construction season.

7.5-16 (NOISE-2) Restrict Hours of Amphitheater Operations

This measure restricts the hours of concert nose to the daytime and early evening hours and restricts the concerts to less than 6 hours.

The amphitheater has yet to be constructed. As of 2010, this measure is not yet applicable.

7.5-17 Expanded Bus/ Shuttle Access

To encourage bus and shuttle transportation, Heavenly is to implement the Coordinated Transportation System (CTS) and provide incentives for employees and patrons to use ski shuttle buses.

Heavenly continues to be a leading operator in the CTS system providing operating revenues and local match revenue for capital equipment purchases during the 2009-2010 season. No free parking was available at the gondola and free shuttle service between base areas was readily available during the 2009-2010 ski season. Employees are encouraged to use the free shuttles because employee parking is limited at the Gondola base area and prohibited on weekends, peak weekends and holiday periods at the California base area. Appendix XI has the shuttle schedule and route brochure distributed by Heavenly for the 2009-2010 season.

Additionally, Heavenly is monitoring and collecting feedback about the use of shuttles through their annual employee survey. Heavenly expands the bus system with additional vehicles (between 18-24 vehicles) during peak weekends and holiday periods. During normal mid-week periods, 9-10 vehicles are used. The number of shuttle buses that are in use every day is tied to business volume forecasts. Resort guests are randomly surveyed on a daily basis during the ski season except for the first and last two weeks of the season.

Riders are asked to rate the timeliness of the bus system. Answers to the survey along with ridership numbers are used by Heavenly to ensure that an adequate number of shuttle vehicles are in use to respond to the guests needs. Graphical results from the 2009-2010 Employee Housing and Transportation Survey are located in Appendix XII.

Ridership numbers for Heavenly's free shuttle service are included in Table 4-1. The 2009-2010 ridership numbers are slightly below the previous year's numbers.

Table 4-1 Ridership Numbers for Heavenly Shuttles

2007-2008	419,183*
2008-2009	322,486*
2009-2010	309,960

* includes operation of employee shuttles by transit contractor

7.5-18 Discourage Use of Automobile

To meet this measure, Heavenly is to discourage the use of automobiles as the primary mode of access to the Gondola.

Heavenly runs free shuttle service to and from all of their facilities. See Appendix XI for the 2009-2010 bus schedules and encompassing map. The bus system also makes stops at employee housing. Free parking at the Gondola is not provided. Heavenly has implemented the TRPA Employer Trip Reduction Ordinance by encouraging employees to rideshare, carpool and offering subsidized bus passes to employees for public transit.

7.5-19 Implement the Coordinated Transportation System

This measure states that Heavenly shall continue to implement their portion of the ongoing air quality and traffic mitigation measures contained in the CTS Memorandum of Understanding (MOU).

Heavenly has implemented all measures identified in the Master Plan Amendment and continues to implement its share of the CTS by offering free shuttle service in the summer and paying a fair share of costs associated with operating and maintaining the fleet of buses.

7.5-20 Reduce Traffic on U.S. Highway 50 at Echo Summit

Heavenly is to implement programs that encourage charter bus trips, air travel via Reno, and travel to the basin during off-peak periods to mitigate the possible increase of traffic on Echo Summit.

Heavenly continues to use marketing incentives to help reduce traffic at Echo Summit. Heavenly's marketing team attends ski shows and expos annually in Los Angeles and the Bay Area to promote ski packages that include group transportation discounts. Heavenly also provides page on their website dedicated to organizing and promoting bus trips and offers discount lift tickets to patrons of these services.

(http://www.skiheavenly.com/plan_your_trip/groups/bus_trips/)

The California Department of Transportation performs annual traffic counts at various locations on their state highways. The Mitigation Level identified in the MMP is "Non-degradation of peak hour traffic at U.S. Highway 50 and Echo Summit". The closest location to Echo Summit was at milepost 65.62, Echo Lake Road, with a peak hour vehicle count of 1,900 in 2009. This vehicular traffic number is the exact same value reported in both 2007 and 2008. While all traffic at Echo Summit is not attributable to Heavenly's operations, the average daily vehicle count at milepost 65.62 can be utilized to assist in assessing the effectiveness of Heavenly's efforts.

7.5-21 Protect Tahoe Draba Populations within Heavenly Mountain Resort

Six specific measures to protect Tahoe draba populations are identified for implementation in the MMP: surveys, fencing, avoidance, rock removal, monitoring, and an interpretive program.

During the 2010 summer months and construction season, Heavenly complied with all applicable measure for the protection of Tahoe draba populations. Tahoe draba surveys occurred prior to projects located within potential draba habitat. Surveys were preformed prior to the construction and planning of the Gondola Lodge and proposed J lift, California Ski slope widening, Perimeter re-grade, Mott Canyon bail-out, and the Killebrew Canyon return. No draba populations were found during these studies. Historical populations of draba were recorded around the proposed California Ski Slope widening sites, though no plants were found during the survey.

Final design at the Adventure Peak Zipline area sited summer walkways to avoid sensitive plant populations. Signs educate trail users about the presence of sensitive plants and encourage them to stay on designated trails.

The Powderbowl lodge project has not yet begun.

Every summer, Heavenly places interpretive signs about Tahoe draba along well-used driving and hiking routes to alert employees and visitors. Mandatory summer employee orientation includes a section on Tahoe draba and habitat protection.

7.5-22 (VEG 1-A) Tahoe Draba Long-Term Conservation Strategy

In addition to Measure 7.5-20: Protect Tahoe Draba Populations within Heavenly Mountain Resort, research is being conducted on Tahoe draba ecology through a Memorandum of Understanding (MOU) between the Forest Service Humboldt-Toiyabe National Forest, Forest Service LTBMU, Mount Rose Limited Partnership, Heavenly Valley Limited Partnership, and the TRPA.

Continual studies occurred during the summer of 2010 in conjunction with the 2011 CWE work list. Hauge Brueck worked with the LTBMU on surveying protocol and reporting. No draba populations were found during the surveys.

7.5-23 (VEG 1-B) Minimize Loss/Degradation of Sensitive Plant Species

To protect sensitive plants at Heavenly, projects must be surveyed prior to construction and buffers must be placed around sensitive plants species. Facilities should also be sited to avoid riparian and old growth habitats.

Qualified field biologists from Hauge Brueck conducted sensitive plant surveys at each of the project sites listed below prior to construction and planning. The following sensitive plant surveys were performed:

- Tubing Hill (Constructed in 2009) – August 18, 2009
- Gondola Lodge (Construction in 2010) – August 18, 2009Perimeter Trail Re-grade - Summer 2010
- Mott Canyon Bail Out Trail - Summer 2010

- Killebrew Canyon Return - Summer 2010
- J Lift (surface lift) - Summer 2010
- California Side Trail Widening - Summer 2010
- Tubing Hill Summer Use Modifications (Road) - Summer 2011

During the summer of 2008, Forest Service botanists found one potential new site of the sensitive plant species Galena Creek rock cress (Arabis rigidissima). Heavenly implemented a 100 foot buffer around the sensitive plant area during project construction. While upheld during project implementation, the buffer was not maintained during general maintenance operations. It appears that this population was extirpated. Additional visits should be scheduled during the summer months to confirm (Gross, 2010). Assuming additional surveys prove this statement and finding, Heavenly is in partial compliance with this measure. It is recommended that Heavenly coordinate with the USFS prior to commencing work on maintenance issue projects.

7.5-24 (VEG 1-C) Noxious Weed Management

To prevent the spread of noxious weeds, Heavenly must develop and implement a long-term integrated weed management plan, use clean vehicles and materials for construction and stage them in weed-free areas, monitor new construction for 3 years, and implement an annual employee orientation and training program.

In coordination with the Forest Service, Heavenly has implemented a noxious weed management plan found within the EIR/EIS/EIS to stop the spread of noxious weeds. Equipment used for construction projects must be washed prior to entering Heavenly's property. All revegetation and erosion control materials are certified and inspected to be free of noxious weeds. IERS specifies special native seed mixes that are weed free to be used for revegetation efforts (Appendix II).

Employees are trained to identify the three most prevalent species of noxious weeds, tall whitetop, Canada thistle, and bull thistle, which have previously been found within the Heavenly boundary. Heavenly also has an independent weed monitoring program in areas that mulch and wood chips are applied. As part of Heavenly's post-project monitoring, sites are inspected for noxious weed infestations. No noxious weeds were observed during field surveys last season.

7.5-25 Late Seral/Old Growth Forest Enhancement

To mitigate for any projects that involve the removal of late seral/old growth suitable habitat, Heavenly must enhance or restore twice the area to late seral/old growth characteristics.

Heavenly enhanced/restored a stand of forest equal to twice the area proposed for removal in the Master Plan Amendment. The enhanced forest was restored during the fall of 2007 and is located in the High Meadows area and is undergoing monitoring by the Forest Service every five years for success. The next monitoring report will be conducted in 2012. The Forest Service documentation certifying of completion of this task is located in Appendix XIII.

7.5-26 Restrict Vehicle Traffic within the Heavenly Ski Resort MP 96 Development Area

Vehicular traffic during summer access must be restricted to existing roads only.

At the beginning of the summer, Heavenly employees undergo a mandatory comprehensive training session on summer road use and BMP awareness which includes an educational session on the environmental resources on the mountain. Each employee is required to comply with the summer driving rules.

Heavenly restricts access to the mountain through locked gates with combination locks that change monthly. Only trained Heavenly employees have access through these gates. Non-Heavenly drivers of vehicles with official business on the mountain must first receive an orientation about summer road use, agree to comply with all on-mountain access policies and procedures, and obtain a special pass to access the mountain. Heavenly keeps detailed information about these permits which must be renewed each season. Heavenly escorts are provided to anyone not familiar with the road system or their destination. If the driver or vehicle is found to not be in compliance, Heavenly reserves the right to escort them off of the mountain, and to not issue them future passes. Upon entering each locked gate, a sign is posted alerting travelers to stay on designated roads, obey a 10 mph speed limit, and be alert for potential wildlife crossings. In areas where designated roads are not clear, roped boundaries are erected and stay in place for the duration of the summer. The boundary ropes are maintained throughout the summer.

7.5-27 Monitor and Protect Nesting and Fledgling Bird Species

This measure specifies allowable dates for summer concerts at the Gondola top station.

There were no concerts held at Heavenly in 2009 or 2010.

7.5-28 Compliance with Design Review Guidelines Section 7 Exterior Lighting Standards and Code of Ordinances

This measure requires that all exterior lighting be designed to comply with TRPA Design Review Guidelines Section 7 and Code of Ordinances Exterior Lighting Standards Section 30.8.

All exterior lighting fixtures for the Gondola Lodge were found to be consistent with Section 30.8 and were approved by TRPA.

7.5-29 Building and Site Design Descriptions

All newly constructed or renovated buildings must comply with both TRPA and Forest Service design standards.

The Gondola Lodge building and site design were consistent with both the TRPA Community Design Sub-element of the Regional plan, and the Forest Service Built Environment Guide for buildings on National Forest Land.

7.5-30 Maintain Timber Thinning Practices

Heavenly must work with the Forest Service to determine areas that require timber thinning as established by the LTBMU Land and Resource Management Plan. Practices should help prevent catastrophic wildfire but be consistent with management criteria for maintenance and enhancement of wildlife values.

As needed, Heavenly and Forest Service vegetation management specialists review thinning and hazard reduction needs. During 2009 and 2010 no thinning needs were identified by the Forest Service for treatment, however, this is an on-going measure. When areas are identified for thinning, timber thinning practices will be consistent with the Forest Service management criteria.

7.5-31 Compliance with Existing Health and Safety Practices

This measure requires Heavenly to regularly update and utilize their Hazardous Materials Business Plan, Hazardous Waste and Substance Potential Spill Emergency Plan, and Hazardous Waste Training Program and provide appropriate employee training. Heavenly fully complies with this measure.

Heavenly maintains updated copies of the following health and safety plans or practices as required by other laws:

- Hazardous Materials Business Plan
- Spill Prevention Control and Countermeasures Plan
- Injury and Illness Prevention Plan
- Hazardous Waste Handling Training
- Heavenly Emergency Response Plan
- Blood-borne pathogen training for specific departments

7.5-32 Avalanche Safety Practices

This measure addresses the issue of unexploded ordnances used for avalanche control. The Heavenly avalanche safety team is to document the locations of unexploded ordinances throughout the winter and locate the ordnances during periods of snowmelt for proper disposal.

Heavenly operates avalanche control and snow safety procedures in accordance with the Forest Service Operations and Avalanche Plan. The plan includes an approved procedure to safely dispose of unexploded ordnance. The 2009-2010 plan is included as Appendix XIV and is also on file with the Forest Service. In addition, Heavenly is licensed annually for the storage and use of explosives in connection with reducing avalanche hazards. Specific personnel are individually trained and licensed in the use of avalanche safety explosives. This plan is reviewed and updated annually as needed.

7.5-33 Provide Employee Housing

Heavenly must assist in providing employee housing by collecting information through an employee housing survey and supporting affordable housing through development, purchase, or sponsorship of existing programs.

The 2009-2010 Heavenly maximum employment levels (1,465 employees) are below the 1996-1997 levels (1,607 employees) indicated in the MMP; therefore, no additional mitigation is required. In 2009-2010, Heavenly provided 100 beds of employee housing on the California side. Heavenly also has an employee housing assistance program that matches workers with available housing. Heavenly also participates in the South Lake Tahoe Housing task force. An employee housing survey is conducted annually and is contained in Appendix XII. Results from the survey indicate that a majority of employees are satisfied with their housing situation and are paying affordable rents.

7.5-34 Ensure Adequate Police/Sheriff/Fire Capacity

No significant effects on local law enforcement are expected to result from the implementation of the Master Plan Amendment and no specific mitigation level is required.

Heavenly utilizes in-house security to monitor and respond to the majority of on-mountain issues. City police or county deputy sheriffs handle criminal investigations. Special events may warrant additional security.

Heavenly communicates regularly with city and county fire departments to ensure response time and coordinate resolution of aid issues. First response mutual aid agreements are in place between adjoining fire departments. Heavenly complies with all fire district regulations during the design and operations of on-mountain facilities.

Conclusion

Compliance with the operations and maintenance portion of the MMP is an ongoing process. Heavenly complied with the MMP through careful planning and implementation, utilizing industry experts, and educating employees. Heavenly is in compliance with all of the Operation and Maintenance measures.

CHAPTER 5
MANAGEMENT RESPONSE TO MONITORING AND EVALUATION

Introduction

Heavenly's response to monitoring and evaluation is as important as the monitoring and evaluation itself. This portion of the MMP is to encourage adaptive management through collaboration between Heavenly and relevant interested agencies and parties.

7.6-1 Soil and Water Quality

To comply with measure 7.6-1, the results of various monitoring reports on soil and water quality are contained in this report. Heavenly's response to these reports is integral in achieving environmental improvements. Within 60 days of receiving completed monitoring reports, Heavenly, Forest Service, Lahontan, and TRPA will collaborate as necessary to develop an action plan based on monitoring results.

Heavenly has employed Cardno ENTRIX (formerly ENTRIX, Inc.) in a three-party contract with the TRPA to implement water quality monitoring services. For the 2010 water year (from September 2009 through October 2010) ENTRIX provided Quarterly Reports to Lahontan, the Forest Service, and the TRPA in fulfillment of the monitoring and reporting requirements set forth in the Lahontan permit. Quarterly reports were submitted on the following dates: January 29, April 30, June 30, and November 1 of 2010. An Annual Report for the 2010 water year was submitted on February 15, 2011. This report incorporated the results from each of the quarterly reports into one comprehensive report (included as Appendix IV). The agencies provided feedback for each report and changes were implemented as necessary. Due to the close working relationship of Heavenly staff and field monitors, Heavenly often responds to field directives and corrections immediately before reports need to be issued.

Total nitrogen, phosphorus, chloride and iron exceedances were reported at the two sampling sites along Heavenly Valley Creek. These parameters were also exceeded at the reference site and are not likely due to Heavenly resort operations. New standards for the California Parking Lot compliance site were implemented during the 2008-2009 water year. All of the measured constituents at this site were above permitted levels. However these values were less than or equal to values reported during the previous two years. Chloride levels at the California Parking Lot compliance site remain well above back ground and permitted levels.

Heavenly purchased a new sensor that was added to their spreader truck for the 2009-2010 season. The sensor gages road conditions and temperature to the control the least amount of deicer needed for success. It also reported the volume of deicer applied more accurately. Reducing the deicer applied to the roadways should help reduce chloride levels detected in the runoff. Deicer application and recovery results can be found in appendix D of Environmental Monitoring Program Annual Report (Appendix IV). Heavenly has also installed automatic samplers in the California Parking Lot in order to better assess the effectiveness of the recently installed stormwater treatment system. Troubleshooting of the automatic samplers is ongoing. All the vaults were cleaned last summer and manhole lids were replaced preventing surface flows from entering the treatment system. Once analytical results have been obtained, they will be included in quarterly and annual reports that are made available to Lahontan, TRPA, and the

Forest Service. New monitoring reporting requirements as part of the amended monitoring and reporting program are being considered by the Regional Water Quality Board staff.

BMP effectiveness monitoring is conducted by RCI. RCI submits quarterly and annual reports adhering to the same deadlines to appropriate agencies. These reports are an appendix to the quarterly and annual water quality monitoring reports. RCI's annual report summarizes findings and trends reported throughout the summer season. The annual report also lists recommendations to improve implementation and effectiveness findings in future monitoring seasons. Feedback and comments from each of the agencies, is also incorporated into Heavenly's operational and BMP practices. The overall monitoring goal is to always be in compliance with BMP installation and maintenance with all involved parties being in agreement. The BMP Effectiveness Annual Report is located in Appendix I.

The final piece of adaptive management is the work and Restoration and Monitoring Annual Report completed by IERS. IERS utilizes the results from BMP effectiveness monitoring as well as their own tests and observations done at Heavenly and designs restoration plans for on-mountain project construction areas. The 2010 summer season continued this new approach towards planning, implementing, and monitoring large-scale mountain improvement projects at Heavenly. This was the fourth season that Heavenly operations personnel implemented intensive soil and vegetation restoration treatments. Heavenly's operations staff and construction project managers continue to build on lessons learned. As part of the adaptive management approach, items that address success criteria will be re-defined yearly based on the past season's information collected. Success criteria did not change for the 2010 season. Decreases in plant cover can be attributed to a number of different factors. High carbon soils amendments (such as wood chips) tend to use up available nitrogen and other nutrients for decomposition (IERS 2010). Irrigating during the first year of growth tends to show increased vegetation cover throughout the monitoring period as it helps the seedlings establish. Similar findings around the Tahoe area have validated this finding (IERS 2010). Seed mixes and application could be another factor for successful plant cover.(IERS 2010). Sites that that were not inspected during application and where seed mixes were not verified tend to show less success and cover than those sites in which IERS staff were site to verify.

During the 2010 season pre-performance monitoring data was collected from the Gondola Lodge. Additional planting and post construction monitoring is planned for this upcoming summer (2011). Due to construction activities in the same general area as the new Lodge, post restoration monitoring and completion per specifications at the Tubing Lift, scheduled for 2010, was postponed until this summer (IERS, 2011). The seven projects have been continuously monitored for performance. As results are gathered, recommendations are based on performance are being incorporated into the latest treatment projects. Pre-treatment monitoring data from most project sites indicate: insufficient soil nutrient levels, low to no cover by appropriate vegetation, and high erosion rates/sediment yields. Four year's worth of data suggests that appropriate treatment actions have improved on current conditions (IERS, 2010).

Completion of restoration treatments remains a challenge due to the fact that projects typically start late in the field season. This creates a yearlong lag time from identification and follow-up treatment needs associated with project sign off and completion (IERS 2010). Additional strategies will be developed to shorten this time period. Performance monitoring data suggests there is an overall improvement and decrease in erosion potential on six restoration sites monitored. Observable erosion issues found were directly attributed to concentrated flows and rilling from upslope from roadways. Monitoring data from clearing projects found no measurable changes that affect erosion and coverage. All success criteria has been met at the two clearing sites (Orion II and Northbowl) and no future monitoring is required on these projects beyond rain event monitoring to ensure that no disturbance is occurring (IERS 2010). Results from the Lakeview slope study plot showed promise with regards to wood chip cover. Wood chip cover provided nearly identical results to modified enhanced and amended wood chip cover. This alternative may be a cheaper alternative than commercial compost for native vegetation establishment and sediment source control objectives (IERS, 2010).

IERS recommends that there should be continued scheduled communication between Heavenly staff and IERS to improve results. By maintaining a construction schedule, IERS staff can be onsite during the treatment process. When verified, treatment projects have a better success rate (IERS 2010). Additional schedules, checklists, photos during rain events, targeted irrigation, and the protection of sensitive resources should be incorporated during restoration projects. Additional recommendations can be found in Appendix II. The end goal is to minimize erosion while restoring soil function and coverage with sustainable vegetation. Detailed results and further discussions from the IERS reports are located in Appendix II.

Though this task is currently ongoing, Heavenly is presently in compliance. Agency and public responses to this annual report during the 60-day comment period will be assessed and integrated into an action plan if necessary. No comments were collected for last year's report. Implementation of any action plan items will be discussed in the following year’s annual report.

7.6-2 Traffic and Parking

Heavenly is to prepare a parking monitoring report at the end of each ski season that includes the following:

- *Days during which overflow parking was used on Ski Run Boulevard, South Benjamin Drive, and Galaxy Bowl and any days when overflow parking was full.*
- *The number of parking spaces used at Galaxy Bowl each day this area was used for overflow parking.*
- *An explanation regarding any days during which these overflow parking areas were filled.*

The monitoring reports are to be shared with the TRPA, Douglas County, El Dorado County, and the City of South Lake Tahoe and posted on the appropriate websites, not limited to the Heavenly website. Based on the results of the monitoring reports, an action plan will be devised by Heavenly and interested parties within 60 days.

During the 2009-2010 ski season, Heavenly staff monitored the use of overflow parking areas. Results are shown in Table 5-1. N/A denotes that the site was non-applicable and not in use on the day in question. Holiday weekends impacted offsite parking the most. Weekends that include: New Years Eve (1/1/2010 through 1/3/10), Martin Luther King Day (1/16/10 through 1/18/10), and Presidents Day (2/20/10 through 2/22/10) typically fill all of the onsite parking and overflow into the offsite parking areas. Recent snowfall and storm cycles can also aid in skier visits and parking overflow usage.

Table 5-1 Overflow Parking Area Use

Dates of Use:	Off-Site California Main Lodge	Off-Site Nevada / Galaxy
	Parking Locations:	
1/2/2010	75	10
1/9/2010	20	N/A
1/16/2010	128	15
1/23/2010	245	37
2/20/2010	24	N/A
2/27/2010	55	N/A
3/6/2010	22	N/A
3/13/2010	75	N/A

To assess Heavenly compliance with the mitigation measure to reduce vehicle traffic, data was gathered from Nevada Department of Transportation (NDOT) and the California Department of Transportation (Caltrans) on average annual daily traffic (AADT) on US Highway 50 and Kingsbury Grade. Sites were chosen to represent major points of access to Heavenly. Sites are displayed in Figure 5-1. AADT values from 2006 through 2009 for each site are shown in Table 5-2.

Compared with the previous year, the 2009 values were less than or equal to traffic totals at all of the major access points to Heavenly Mountain Resort. With limited data, it is hard to draw finite conclusions or trends. The four years of data collect show a linear or near identical results. The economical downturn and financial troubles associated with lower skier visits in the previous season are not reflected in these lower values the past two years. Future Annual Monitoring Reports will provide more data allowing for a comparative analysis.

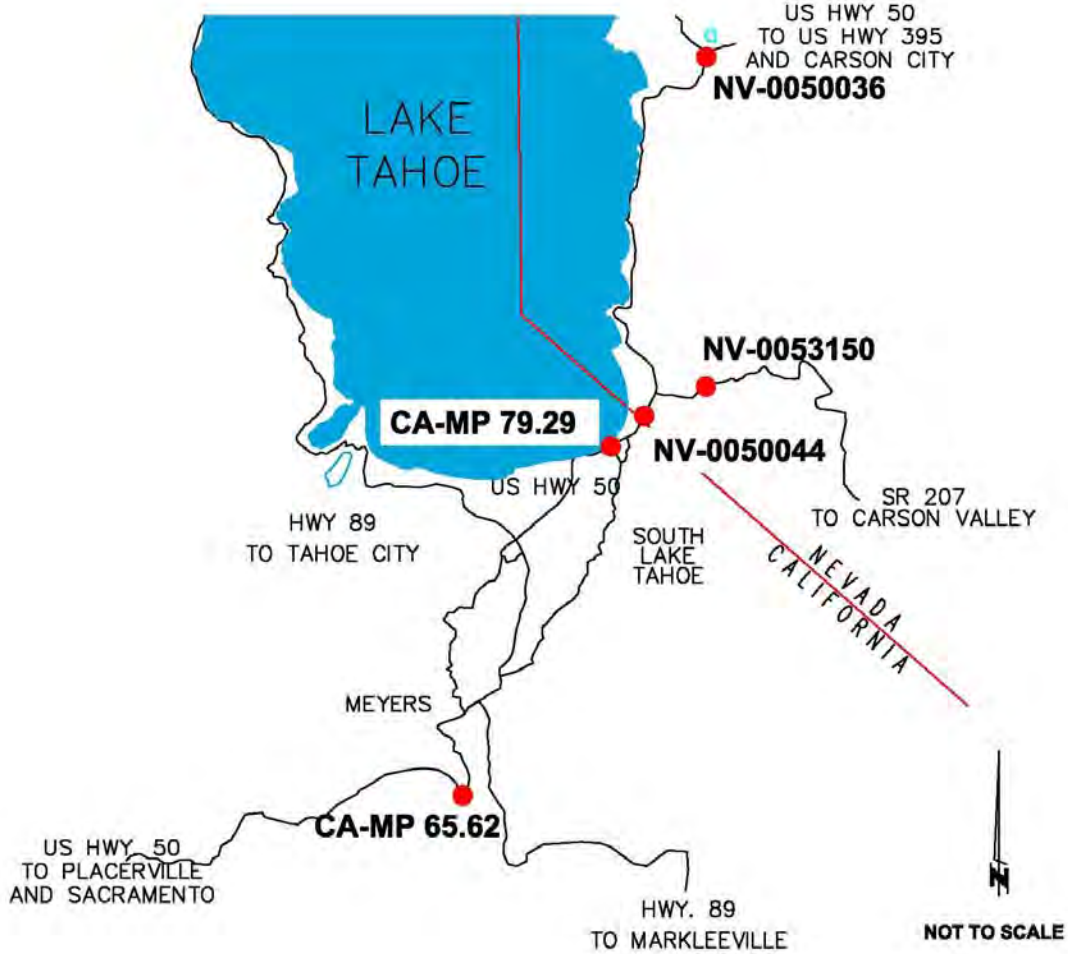

Figure 5-1 Location of Traffic Count Sites

Table 5-2 Traffic Data on US Highway 50 and State Route 207

State - Station	Location	AADT 2006	AADT 2007	AADT 2008	AADT 2009
NV - 0050036	US-50, 0.4 miles West of SR-28 at MP 12	10,900	11,000 [1]	10,000	10,000
NV - 0053150	SR-207 (Kingsbury Grade) 0.5 miles East of US-50	12,100	12,000	11,000	11,000
NV - 0050044	US-50, 300' East of the NV-CA State line	26,500	25,000	25,000	24,000
CA - MP 79.29	US-50 at the intersection of Ski Run Blvd. [2]	32,500	32,500	31,500	31,000
CA - MP 65.62	US-50 at the intersection of Echo Lakes Road [3]	9,000	9,000	8,900	8,900

1 Data Adjusted or Estimated

[2] Annual Average Daily Traffic (Back AADT) Traveling West Bound

[3] Annual Average Daily Traffic (Ahead AADT) Traveling East Bound

NDOT Data:
http://www.nevadadot.com/Documents/2009_Annual_Traffic_Report.aspx

CalTrans Data -
http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm

7.6-3 Late Seral/Old Growth Enhancement

Monitoring is required every 5 years for any forest enhanced or restored under the mitigation measure 7.5-25 described in Chapter 4 of this report.

All work for the forest restored under this measure was completed in 2007. Monitoring will be completed in 2012 and will be evaluated to assess potential triggers that may elicit a management response.

Conclusion

Heavenly works closely with subject-area expert consultants and their own employees to immediately respond to potential problems. This allows changes to be quickly implemented and makes adaptive management more effective. Because Heavenly is so involved in the process, the results of each report usually do not trigger an action plan as action has already been taken to resolve any issues.

The feedback from agencies and interested parties generated from this report should be a valuable tool in assessing any response Heavenly has already implemented and creating new solutions for ongoing problems.

CHAPTER 6
REFERENCES

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Appendix I
2009-2010 BMP Effectiveness Annual Report

Heavenly Mountain Resort
BMP Effectiveness Monitoring

Construction Season Summary - 2010

February 15, 2011

Prepared For:

CardnoENTRIX Inc.
1048 Ski Run Blvd.
South Lake Tahoe, California 96150

Prepared By:

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Heavenly Mountain Resort BMP Effectiveness Monitoring

Construction Season Summary - 2010

February 15, 2011

Prepared For:

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February 15, 2011

INTRODUCTION

The following report summarizes the results of the BMP Effectiveness Monitoring at Heavenly Mountain Resort (Heavenly) for the 2010 construction season. It has been prepared by Resource Concepts, Inc. (RCI) to comply with the *Lahontan Regional Water Quality Control Board Waste Discharge Requirements (Board Order R6T-2003-0032)* requiring submittal of an annual monitoring report. The BMP Effectiveness Monitoring is a component of the Environmental Monitoring Program as set forth in the 1996 Master Plan and the approved Master Plan Amendment (2007).

Best Management Practices (BMPs) are structural and non-structural measures used to reduce soil movement, control surface runoff, and improve runoff water quality. BMPs at Heavenly Mountain Resort are applied to facilities (buildings, utilities, parking lots, etc.), roads, ski runs, and construction projects. They are generally categorized as either Permanent or Temporary BMPs:

- Temporary BMPs are short-term, used during construction and maintenance projects and removed upon project completion.
- Permanent BMPs are used on a long-term basis to control contaminant sources or treat runoff, and require on-going maintenance to be effective.

Monitoring was conducted per the BMP component of the *Revised Environmental Monitoring Program*. Key components of the program include:

- Evaluation forms that focus on implementation and effectiveness consistent with the USDA Forest Service, Region 5, BMP Evaluation Program (Region 5 BMPEP),
- Monitoring frequency for Permanent BMPs: post-construction, 1-year post-construction, 3-, 6-, and 9-year post-construction,
- Monitoring frequency for Temporary BMPs for on-going construction projects: biweekly during construction and after precipitation events, and
- ACCESS database software to manage monitoring results.
- The revised monitoring program “Needs Assessments” have been conducted on the facilities constructed prior to 2000.

BMPs are monitored for both implementation and effectiveness. BMP <u>implementation</u> concerns whether plans/specifications are adequate for resource protection, and if improvements are constructed according to design. BMP <u>effectiveness</u> is determined from observed erosion and sediment transport at sites evaluated.

2010 Responses to 2009 Summary Report

In the past, BMP Effectiveness Monitoring Reports (2004 through 2009) have provided recommendations for improving planning, implementation, effectiveness and monitoring of Temporary and Permanent BMPs at Heavenly. In keeping with the adaptive management approach, Heavenly has used these results and recommendations to improve the BMP retrofit and maintenance program. The following section summarizes the Resort's response to the 2009 report recommendations.

Planning

For the past few years, Heavenly's annual work list has included BMP construction and maintenance items identified through the previous year's BMP Effectiveness Monitoring. Table 1 (Appendix A) lists the 2010 BMP retrofit and maintenance projects initiated based on recommendations made in 2009 and Heavenly's on-going annual inspection of erosion control facilities. Projects were prioritized based on accessibility and potential for erosion. Any projects not completed in 2010 have been included in the recommendations for 2011.

The Revised Construction Erosion Reduction Plan (CERP) has proved a useful tool for identifying appropriate BMPs for projects without detailed sets of plans and specifications. It was recommended that the CERP be updated to add new techniques and incorporate results of the BMP monitoring program. The CERP has been reviewed and comments developed based on the recommendations for temporary and permanent BMPs summarized in Appendix A. RCI has used the draft as supplemental guidance for evaluating project implementation.

Sets of existing road segment data were separately developed under the CWE program and the LTBMU road-monitoring program. Because these monitoring efforts had different objectives and GPS technology was fairly new, the data sets do not correlate well. Additional GPS data was collected by RCI an 2010 and correlation established for future monitoring. As previously noted, though road maintenance is ongoing at the resort, tracking has not been effective. Heavenly coordinated with RCI and the LTBMU regarding methods for tracking activities road maintenance to be implemented in 2011.

Permanent BMPs

Using the adaptive management approach, observations and recommendations made in 2005 through 2009 were used to identify specific projects, incorporate general recommendations, and improve the BMP program at Heavenly. A summary of past recommendations for Permanent BMPs and how they were addressed in 2010 is included in Tables 2 and 3 (Appendix A).

Temporary BMPs

Heavenly has continued to respond to the recommendations for implementation and effectiveness of Temporary construction BMPs developed through the BMP Effectiveness Monitoring program. A summary of past recommendations for Temporary BMPs and how they were addressed in 2010 is included in Tables 4 and 5 (Appendix A).

Monitoring

The BMP Effectiveness Monitoring Program has been reviewed each year to identify possible improvements consistent with an adaptive management approach. In 2009, improved coordination and additional meetings with Heavenly staff were recommended. Over the past year, Heavenly personnel have made themselves available whenever RCI is in the field. Several on-site meetings were held with the foremen for individual projects and the Heavenly BMP Coordinator to discuss site conditions. RCI was kept updated of work in progress and Heavenly promptly implemented BMP repairs and maintenance as needed. Monitoring forms were updated to included project foreman/contact for each construction activity, as well as the implementation and effectiveness scoring results.

2010 MONITORING RESULTS AND DISCUSSION

Permanent BMPs

In 2010, thirty-three (33) permanent BMPs evaluations were performed by RCI at thirty-one (31) different sites. The evaluations were evenly split between post-construction monitoring at 3-year intervals and follow up visits to review BMPs after maintenance activities or after storm events.

Implementation

Permanent BMPs were generally implemented in accordance with the CERP and project specific plans through out the resort. Minor departures for implementation of permanent BMPs were observed in two locations where permanent BMPs were not completed before the resort was closed for the winter, these sites are listed are included in recommendation for work in 2011. At two other locations existing facilities needed minor BMP retrofit to meet the CERP guidelines. Results for implementation of permanent BMPs monitored in 2010 showed that BMPs were fully “implemented” at 86% of the sites scored.

Effectiveness

Effectiveness of permanent BMPs observed in 2010 indicated only one occurrence where a project scored at risk. Due to the intense storm events in October 2010, road runoff circumvented some of the BMPs near the Edgewood SEZ project. Additional work on this area is recommended in 2011. Scoring for 2010 documented 97% of the sites had “effective” Permanent BMPs. The most comment types of “effective” permanent BMPs included rock slope protection, revegetation treatment areas using soil conditioning, pine needle and wood chip mulch, and infiltration/dripline BMPs at facilities.

Precipitation, typically as rain during the month of October, measured between 5 inches and 7 inches using manual rain gauges installed near construction projects at the resort. Infiltration and erosion control BMPs installed at facilities were typically effective at preventing runoff and erosion. Where runoff was evident, erosion was minimal and sediment deposition was typically in sediment basins or catch basin.

Areas at the resort that exhibited damage were primarily related to water bars on roads and some ski runs. Water bars were typically effective at diverting water off the roadways and ski run to more stable undisturbed areas. While this successfully prevented severe erosion on roads and ski runs, erosion at water bar outlets appeared common, extending well below the outlet points in many locations. Techniques to improve road BMP performance might include:

- Reducing runoff concentration in depressed wheel tracks using combinations of filling, grading, and road surfacing.
- Improving outlet protection with energy dissipation and enhanced infiltration capacity at runoff concentration points.
- Exploring innovative road surfacing techniques that could enhance infiltration during intense storm events, yet withstand routine traffic on the steep grades characteristic of the road system.

Temporary BMPs

Temporary BMPs were routinely used for construction projects at Heavenly and multiple construction sites were evaluated in 2010. Each site was evaluated several times depending on the length of time between construction start and completion dates. The monitoring frequency for construction projects is biweekly and after precipitation events. A total of 37 separate Temporary BMP evaluations were conducted at six sites by RCI in 2010.

Implementation

Temporary BMPs on the whole were implemented in accordance with the CERP and project plans. Heavenly's general staging areas were typically well protected with temporary BMPs throughout the construction season. Scores of fully "implemented" for all types of temporary BMPs resulted during 80% of site visits in 2010. Scores less than fully "implemented" occurred primarily where designation of construction limits could have been improved on project plans, so that temporary BMPs delineating access routes and equipment exclusion zones could be located more accurately in the field.

Effectiveness

Temporary BMPs used in 2010 were typically effective at controlling runoff and erosion. As noted above, precipitation events at project areas in October accumulated 5 to 7 inches at RCI rain gauges. Wood chip and pine needle mulch applied as temporary soil stabilization BMPs, were observed to effectively minimize runoff and prevent erosion at the construction sites. Temporary BMP effectiveness scored fully "effective" for 80% of the evaluations performed in 2010. A review of scoring for individual categories shows that designation of exclusion zones for 2010 was the least effective temporary BMP in 2010.

2010 CONCLUSIONS AND RECOMMENDATIONS FOR 2010

Results of the BMP Effectiveness Monitoring during 2010 generated the following conclusions and recommendations with respect to BMPs at Heavenly.

Planning

Heavenly has proactively used the results of the BMP Effectiveness Monitoring Program to improve planning for BMPs at the Resort. Planning should continue to utilize the monitoring results to assist with identifying and prioritizing BMP maintenance and retrofit projects. Recommendations for future improvements and maintenance are summarized in Table 6 and were developed from the 2010 monitoring results. This summary has typically been used by Heavenly Mountain Resort to develop the Annual CWE Work List.

The CERP has proved a useful tool for identifying appropriate Temporary and Permanent BMPs, particularly for projects without detailed sets of plans and specifications, and should continue to be updated consistent with the adaptive management approach.

Heavenly continued to work on maintaining access roads and ski trails through 2010. The resort is working on adopting a method to improve identification, prioritization, and documentation of road and ski run BMP retrofit and maintenance, in coordination with the monitoring program and Heavenly's infrastructure needs.

Implementation

The resort is utilizing the on-going monitoring program to identify and prioritize permanent BMP installation and maintenance projects. Plans and specification continue to incorporate temporary BMPs that are the most effective at Heavenly. Continuing communication between design professionals, field personnel, and agency representatives is critical to success in implementing Temporary and Permanent BMPs. Tables 2 and 4 in Appendix A should be used as a reference for reviewing project BMPs during development.

Implementation improves when BMPs, both Temporary and Permanent, are familiar to field personnel. Heavenly has identified experienced field personnel to be responsible for successfully implementing BMPs, and this practice should be continued for all projects. Heavenly provides training to all new personnel in BMP "awareness" and implementation, which should also be continued to maintain high quality BMP implementation.

Effectiveness

Successful BMP effectiveness is tied to both implementation and technology. Heavenly has a long-term commitment to environmental improvement through both planning and regulatory means. Heavenly has improved the effectiveness of BMPs by implementing new techniques, which are reflected in the monitoring results.

In the past, soil cover achieved the lowest scores for effectiveness, but these scores have improved for recent projects using new approaches for soil conditioning, revegetation, and slope stabilization with rock and mulch combinations. Continued monitoring of these techniques will provide data on long-term effectiveness.

Heavenly has prioritized BMP installation and maintenance in areas where disturbance connects directly to SEZs and storm drains. These areas present the greatest water quality risk and, correspondingly, are locations where BMPs should be the most effective. Future planning should continue to emphasize this priority.

The effectiveness of road-related BMPs could be improved with better coordination regarding objectives and methods for road BMP maintenance. BMP design and methods may need adaptation to the unique conditions existing at the resort.

Monitoring

The BMP Effectiveness Monitoring Program as revised in 2004 has provided useful information for evaluating the BMPs at Heavenly. Results should continue to be incorporated in planning measures consistent with an adaptive management approach. RCI offers the following recommendations for future monitoring:

- There is a continued need for prompt coordination throughout the construction season to ensure that Heavenly can schedule maintenance work in a timely manner. Heavenly staff has responded promptly to repair or retrofit BMPs with less than fully “implemented” or fully “effective” scores in the past.
- As BMP retrofits have been implemented at most of the facilities at Heavenly, the program could consider more emphasis on road BMPs. Ski run BMPs are addressed through other components of the overall Environmental Monitoring Program, but, site-specific projects could be addressed in the BMP effectiveness monitoring.

Appendix A

Tables 1 through 6

Table 1. BMP Projects and Maintenance Completed in 2010

Location	Treatment
Boulder Lift Lower Terminal	Infiltration trenches were replenished, lift terminal roof drip lines were protected, and effective soil cover was increased
Canyon Express Lift Upper Terminal	Refurbished slope protection with riprap, rock slope breaks, and pine needle mulch.
East Peak Well (new)	The slope was stabilized between the road and the well house.
Gondola Mid Station	Slope below deck stabilized with rock slope protection.
Mombo	Reconstructed water bars on road and ski run. Cleaned and enhanced sediment basin at toe of slope.
Olympic Express Lift Lower Terminal	Bare areas were stabilized with rock slope protection.
Top of Gondola Yurt	Installed infiltration BMP and drip line protection.
Top of Gondola Sprung Structure	Installed infiltration BMP and drip line protection.
Zip Line Base Station	Additional mulch was added below the operator's booth and the area under the deck was left in a natural condition with minimal disturbance that provides effective cover.

Table 2. Permanent BMP Implementation – Recommendations and Responses

Observations/Recommendation	Responses/Actions in 2010
Revegetation specifications needed to be updated to present standards in the Lake Tahoe Basin. (2004-2005)	Revegetation specifications in the construction projects were site-specific and consistent with present standards. Projects included: Covered Surface Lift at Top of Gondola, Lodge at the Top of the Gondola, Top of Gondola magic Carpet.
Design of facilities to treat or infiltrate the 20-yr 1-hour event needed to be site-specific (2004-2005). Infiltration areas should be flat bottomed, filled with sufficient gravel or drain rock and bordered with rocks (4 to 8 inch diameter).	Maintenance and reconstruction of infiltration facilities was implemented at the following number of sites: 36 in 2006, 4 in 2007, 7 in 2008, 27 in 2009, and 3 in 2010. Dripline trenches were located to intercept roof runoff. Heavenly staff documented the calculated volumes and facility construction at each structure.
Trench settlement can be prevented by compaction and mounding. (2004-2005)	Trenching was conducted for utilities in Top of Gondola area. Mounding was not feasible given the soil stabilization/revegetation treatments prescribed.
Use fiber rolls for long-term slope stabilization as well as temporary erosion control. (2004-2005)	Permanent fiber roll installation was not used in 2010 projects. Most slopes were protected with riprap rather than revegetation. Fiber rolls were used for temporary erosion control.
Gravel and riprap specifications should include: sizing, gradation, angularity and geotextile installation underneath. (2006)	Riprap used in 2010 projects was installed with geotextile behind it and projects include the Covered Surface Lift and the Lodge at Top of the Gondola, as well as slopes at the Gondola Mid Station and Canyon Express upper lift terminal.
Geotextile fabric installation for slope stabilization must address anchor trenches at fabric edges, overlaps, and appropriate anchor intervals for lined channels and steep slopes. (2006)	Geotextile fabric for slope stabilization was replaced near the new East Peak Well, which performed well during the season.
New prescriptions for soil amendments and revegetation need better coordination regarding timing, accessibility, and materials availability. (2007)	Heavenly reused materials (soil, rock, wood chips, etc.) generated on-site. Site-specific soil amendment depth was identified and coordinated in the field with IERS.
Waterbars should be elongated and installed at an angle to the direction of traffic. (2009)	Waterbars installed throughout the mountain are typically parallel to the direction of traffic. In 2010, an angled waterbar was reconstructed near the upper Powderbowl Lift terminal to divert water away from the Blue Angel Chutes area. The waterbar performed well during October 2010 storm events.
Road base should be applied in areas with steep slopes, water quality concerns (proximity to SEZ/stream crossings), and high traffic areas where rutting and dust may be a problem. (2009)	In 2010, dust control generally improved. Dust control was achieved with frequent watering by water trucks.
Excess fill could be reused on site to build up road base in depressed areas and improve drainage (2010).	Top of Gondola area road reconditioning / maintenance.

Table 3. Permanent BMP Effectiveness – Recommendations and Responses

Observations/Recommendation	Responses/Actions in 2010
Soil cover was not typically achieved with straw mulch after the first construction season. (2004-2005)	Heavenly continued to use different types of mulch on 2010 construction projects to meet effective soil cover objectives, including wood chip mulch and pine needle mulch.
Revegetation develops minor deficiencies after construction that requires on-going correction for several years to provide effective soil cover. (2004-2005)	Several sites were revisited with spot seed and mulch application. Wood chip mulch or gravel, rather than revegetation, continues to appear more effective for high traffic areas.
Fabric installed on steep slopes often slides down in small sections, even anchored securely during installation. Geotextile needs continuing maintenance if vegetation is not established. (2006)	Fabric installed in 2009 was refurbished in 2010 at the East Peak Well. Slopes around the upper Canyon Express lift terminal, previously protected with fabric, were refurbished with riprap and a combination of rock slope breaks and pine needle mulch.
Projects using wood chip mulch and soil amendments appear to provide longer lasting effective cover, particularly in high traffic areas. Heavenly will continue spot treatments at facility sites where barren areas occur. (2006)	Small bare areas throughout the resort were refurbished with wood chip and pine needle mulch, particularly in high traffic areas.
Sediment from outside the project area has the potential to impair the long-term effectiveness of SEZ restoration and soil stabilization projects unless follow-up work is performed. (2007)	Follow-up stabilization work for bare spots on slopes above the Upper Maintenance Shop and Northbowl SEZ Restoration project areas is scheduled for 2011.
Wood borders for infiltration areas and trenches are often caught and pulled out by equipment in the winter, particularly in areas alongside roadways. Rock borders keyed into the soil are a more stable option to prevent movement of gravel. (2009)	Wood borders were replaced with rock borders around infiltration areas. Rock borders were observed to hold up well from the previous year and after October storm events.
Rock armored channels routing runoff from drip lines to infiltration areas are more effective than drip line trenches. Channel low points must be well defined; otherwise, new channels erode around rocks (2009).	Channels were refurbished as routine maintenance.
Water bar outlet protection using energy dissipaters and enhanced infiltration is effective (2010).	Mid Station road water bar outlets captured sediment and minimized down slope erosion during October storm events.

Table 4. Temporary BMP Implementation – Recommendations and Responses

Observations/Recommendation	Responses/Actions in 2010
BMPs should not be disassembled prematurely, because vegetation may take several seasons to be established. Specifically, plans did not specify clearly that fiber rolls were to remain after construction. (2004-2005)	Construction project winterization included removal of sediment fence (which presents a skier hazard and does not typically last through the winter) at the end of the season. Fiber rolls remained in place as needed (Sky Base Staging Area and Top of Gondola projects) and were effective during the late season storm events.
Place BMPs prior to construction, thereby ensuring readiness for summer storms or winter closures. (2004-2005)	BMPs were in place prior to initiation of each 2010 construction project. Focus should continue on installation prior to initiation for small maintenance projects and staging areas, where no plans have been prepared, but BMPs are to be installed per the CERP.
Clean out and repair BMPs after a runoff event. (2004-2005)	After storm events, repairs were made to waterbars throughout the resort. However, due to event timing in late October, the cleaning was not completely finished at some waterbar outlets and catch basins before early snow closed the resort.
Maintain BMPs through the life of the project, again to ensure readiness for summer storms or winter closures. (2004-2005)	Temporary BMPs were in place during the precipitation events and winterization measures were implemented prior to snowfall. Exclusion fence needs more maintenance throughout the construction season.
Temporary BMPs may concentrate runoff to a discharge point (sediment fence, fiber rolls, temporary division swales, temporary culverts, and stream diversion). Provide energy dissipation and stabilization at the point where the temporary BMPs terminate. (2006)	Sediment barriers were used for projects in the Top of Gondola area most of it parallel to the slope. To be effective during large precipitation events, more energy dissipaters are needed at the end of temporary sediment barriers that are not installed parallel to the slope.
If a construction project initially proposed for a single season must be extended over the winter, winterization plans should be appended to the design documents. (2006)	Not applicable.
Maintenance of sediment fence can be reduced by using proper T-Posts for support and adequate burial of fabric edges, particularly for longer-term projects. Project designs need to allow alternative fencing at sites with substantial rock or limited access. (2007)	Fiber rolls were often used in lieu of sediment fence in 2010.
Dust control for soil stockpiles on the mountain can be improved. If water is unavailable from the snowmaking system, stockpiles need to be covered with plastic sheeting. (2007)	Stockpiles typically no covered with sheeting in Top of Gondola area, however no duct control issues noted. Stockpiles were typically in constant use due to short construction time frames.
Location of sediment barriers (silt fence or fiber rolls) shown on project plans needs to be parallel to the slope or with energy dissipaters along the flow line and at discharge points. (2008)	Sediment barriers were shown on the plans for the Top of Gondola Lodge and Covered Surface Lift, typically on the contour. Installation typically per plans.
Staging areas should have Temporary BMPs in place before materials are stockpiled on site. (2009)	BMPs were installed prior to use at staging areas: Boulder Parking Lot, East Peak Borrow Area, and Sky Base Staging Area

Table 5. Temporary BMP Effectiveness – Recommendations and Responses

Observations/Recommendation	Responses/Actions in 2010
Disturbance outside construction limits.	Construction limits were observed where clearly shown on the plans. In some location plans did not clearly show access routes and disturbance occurred outside the project area for the Covered Surface Lift. In some locations existing vegetation was not shown on plans and equipment encroached for Top of Gondola Lodge utilities.
Exposed soils with potential for sediment delivery to SEZ.	Sediment barriers were generally installed and routinely maintained.
Dust control measures for stockpiles are more effective when snowmaking water is available to wet down soils. Plastic sheeting is less effective and is difficult to keep anchored in windy conditions, but may be the only option in some areas.	No projects in 2010 were located in especially wind prone areas so alternatives to plastic sheeting were not required.
Sediment fence is effective in containing excavated stockpiled soils. If stockpiles are larger than initially anticipated, the fence must be extended.	Stockpiles were generally contained with fiber rolls. In some locations the stockpiles overwhelmed rolls as they were built, where sediment fence may have provided better containment.
Despite proper installation, burial of fabric edges does not always prevent wind from pulling the fabric out, and metal mesh backing does not always prevent holes and blowing fabric. Prompt inspection and repair of sediment fence is almost always needed after windy conditions.	Fiber rolls were generally used in lieu of sediment fence for 2010 projects. In staging areas sediment fence was installed properly and held up well over the season.

Table 6. Site-Specific Recommendations For 2010 BMP Projects

Location	Treatment
Priority Projects for Follow Up Maintenance (2010)	
Blue Angel Chutes/Mombo	Improve effective cover (2010).
Edgewood SEZ near Boulder Upper Terminal	Maintain road BMPs, road grading, and redirect road runoff near corner (2010).
Gondola Top Station	Refurbish existing infiltration basin and improve drainage to maintain effectiveness (2007).
Groove Upper Terminal	Improve soil cover to stabilize bare slope (2009).
Mid Station Road	Maintain Water bars and energy dissipaters at outlets (2010).
Lakeview Water System	Remove old tank. Decommission old tank site and road to tank. (2009).
Tubing Lift Maintenance Road	Realign top of tubing access road, stabilize fill bank at top of lift (2010).
Upper Vehicle Maintenance Shop	Stabilization work on gully above SEZ restoration, embankment between road and SEZ, and road intersection at base of SEZ (2010).
Out of Tahoe Basin BMP Needs (2010 to 2011, Low Priority)	
Base of Comet Express Lift	Improve effective cover and refurbish infiltration BMPs (2010).
East Peak Grading Area	Complete drainage and stabilization measures initiated for the area between Comet and Dipper Lift Lower Terminals (2009).
East Peak Lodge	Stabilize drip lines and drainage swales near foundation of building (2007).
East Peak Sewer Holding Tank Area	Improve effective cover and delineate vehicle turn around.

Appendix II
2009-2010 Restoration and Monitoring Annual Report

Heavenly Mountain Resort Restoration and Monitoring 2010 Summary Report

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Integrated Environmental Restoration Services

May 1, 2011

INTEGRATED ENVIRONMENTAL
RESTORATION SERVICES, INC

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Executive Summary

Does replacing a chairlift or clearing trees for a new ski run increase runoff and erosion? Can restoration treatments achieve resilience and self-sustaining sediment source control at high-elevation disturbed sites without requiring ongoing maintenance? Heavenly Mountain Resort is using an adaptive management-based approach to planning, implementing, and monitoring construction and restoration projects that will enable them to answer a number of these important questions. This approach has been supported by the League to Save Lake Tahoe, the USDA Forest Service - Lake Tahoe Basin Management Unit, the Tahoe Regional Planning Agency, and the Lahontan Regional Water Quality Control Board and is an integral component of Heavenly's Master Plan Amendment EIR.

This report describes how adaptive management is being used to plan, implement, monitor and continually improve specific projects at Heavenly. Projects implemented under this program to date include lift replacement, lodge construction, zip line construction, road construction and removal, ski run clearing, waterline and snowmaking line installation, and run widening. In total, 287,885 square feet of erosion control and/or restoration treatments have been implemented at Heavenly between 2007 and 2010 as part of this program (see Table 1). For each project, goals and success criteria have been defined, performance monitoring has been conducted using simulated rainfall and a suite of soil and vegetation measurements, and management responses and follow-up actions have been developed based on the results of monitoring. Despite much discussion about adaptive management in the Lake Tahoe Basin, this program is the only known multi-year example of adaptive management actually being applied to improve the sediment source control effectiveness of on-the-ground restoration projects in the Lake Tahoe Basin.

We have learned many important lessons about restoration of arid, high-elevation sites through this program. Performance monitoring results from six restoration projects using soil-based restoration treatments indicate overall improvements in most measured parameters and substantial decreases in sediment yield within 1-2 years of treatment. Both plant cover and soil TKN (total Kjeldahl nitrogen) decreased at most sites following treatment and remained low in 2010. While neither of these trends are cause for immediate concern, several hypotheses will be tested to better understand these trends. For the two run clearing/glading projects, performance monitoring results indicate no measurable changes to most key parameters that affect erosion potential and slight increases in total cover when compared to uncleared conditions.

Table 1. Restoration treatment summary, 2007-2010.

Project	Treatment Area (ft^2)
Olympic Lift	104,224
Heavenly Flyer	10,514
Mid Station Road	9,940
Skyline Trail	27,964
Lakeview Lodge Water System	34,726
Stagecoach Snowmaking	74,017
Gondola Lodge	26,500
TOTAL	**287,885**

Compared to pre-treatment conditions, restoration treatments have achieved the following improvements within one year of treatment completion:

- 67% - 133% decrease in sediment yields
- 18% - 110% increase in infiltration rates
- 50% - 940% increase in penetrometer depth to refusal
- 30% - 1900% increase in total cover
- 12% - 161% increase in soil organic matter

Initial results indicate that first-year irrigation may be an important step towards establishing self-sustaining vegetation at these high-elevation granitic sites. At the Lakeview Gun Barrel plots, similar levels of vegetation cover were achieved two years following treatment at a plot amended with wood chips compared to an adjacent plot amended with a compost/wood chip blend (both were irrigated). This data, in addition to other examples, suggests that locally-available wood chips may be a cost-effective alternative to commercial compost for achieving both vegetation establishment and sediment source control objectives. Additionally, after testing a variety of native perennial grasses at Heavenly sites, Western needlegrass (*Achnathrum occidentale*) has consistently been the most successful species for upland revegetation sites with soil treatments. While it is more expensive on a per-pound basis than other native grasses, vegetation monitoring at Heavenly indicates that inclusion of western needlegrass in upland seed mixes is the most cost-effective method to establish self-sustaining vegetation at most Heavenly restoration treatment sites.

Heavenly's operations staff continue to demonstrate competence and flexibility in project planning, implementation and treatment documentation and have been expanding capacity to implement challenging restoration projects efficiently. A key challenge of this program has been the relatively long lag time (one year) between identification of follow-up treatment needs (management responses) and implementation of those treatments. This has prevented sign-off on some projects as "complete" this past year. Additionally, concentrated drainage from the road system has caused active erosion on several restoration projects, which have not been identified or resolved yet through use of the USFS' BMP Evaluation Program (BMPEP).

Across all projects, initial monitoring results suggest that restoration treatments have substantially reduced erosion potential and ski run clearing/glading projects have been implemented while protecting the ecological elements and processes responsible for erosion protection. This information is of great value in this region and beyond, as little monitoring of restoration treatment effectiveness has been conducted in high elevation (above 8000 ft) settings with poorly developed soils, particularly those derived from decomposed granite. The Heavenly restoration and monitoring program is demonstrating a new model for land management, one that rethinks and tests assumptions about project outcomes. This program also helps to develop new restoration treatment techniques, expands understanding of treatment effectiveness, defines and refines appropriate success criteria, and shares this information to support similar efforts throughout the region.

Chapter 1: Overview

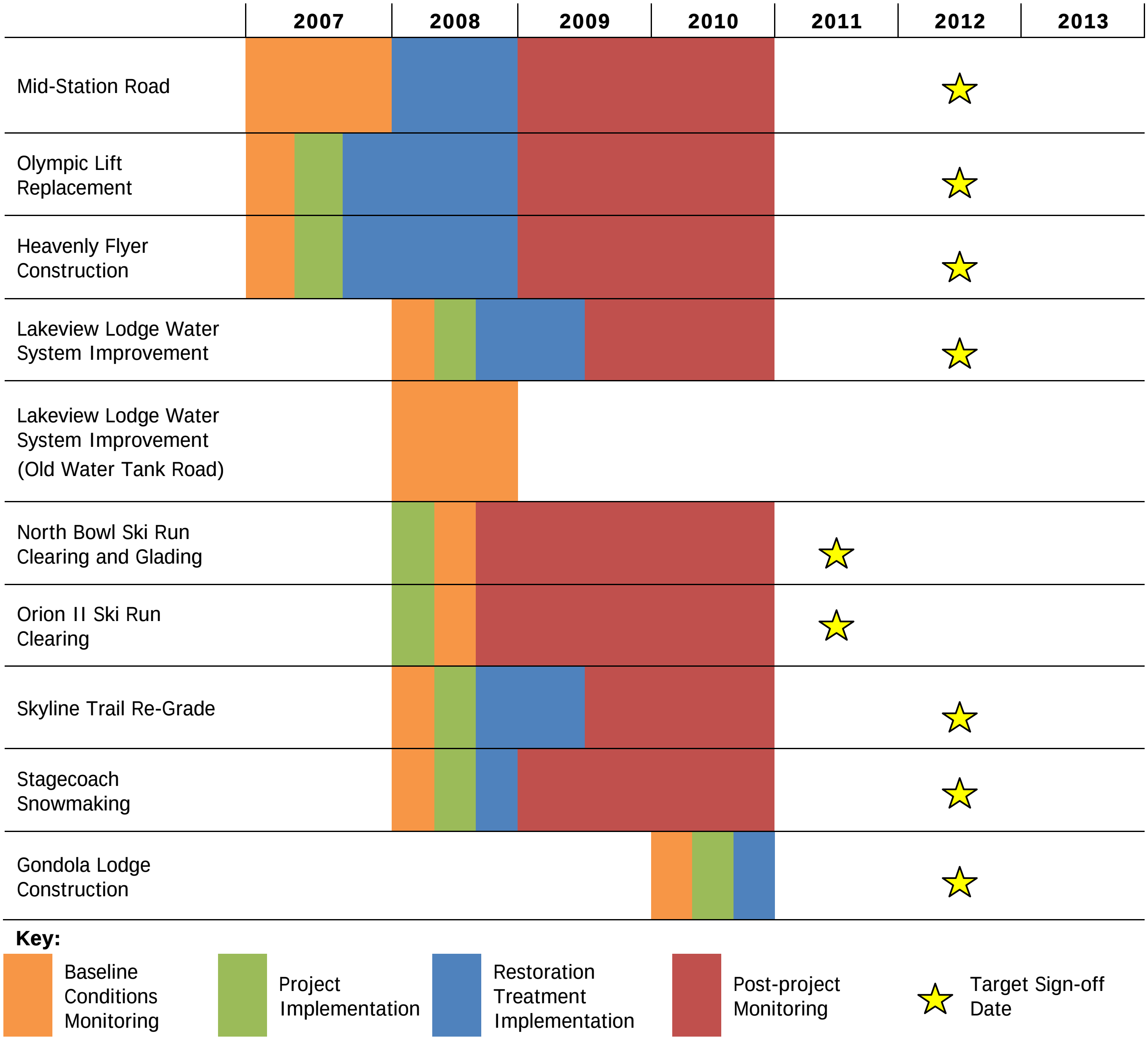
Introduction

This report focuses on 2010 restoration treatments and monitoring results for nine mountain improvement projects at Heavenly Mountain Resort (Figure 1). These projects were approved as part of Heavenly Mountain Resort's 2007 Master Plan Amendment. Integrated Environmental Restoration Services (IERS) principal Michael Hogan began working with Heavenly in 2006 to facilitate an agreement between Heavenly, the USDA Forest Service - Lake Tahoe Basin Management Unit (LTBMU), and the League to Save Lake Tahoe that bridged the gap among the interests of all parties. This agreement laid out a framework for setting clear goals, defining "success" in quantitative terms, developing low-maintenance and effective treatment strategies, and directly measuring the results of project implementation. This framework follows the basic principles of adaptive management (described below).

Project Overview

IERS has been working with Heavenly since 2006 to set goals and objectives, define success criteria, develop soil and vegetation treatment specifications, conduct pre-treatment (baseline) and post-treatment (performance) monitoring to measure whether each project had a net impact on soil, vegetation, or runoff and sediment transport, and to document implementation activities. The five projects implemented in 2007 were: Olympic Lift Replacement, Heavenly Flyer Construction (Zip Line), Mid Station Road Project, North Bowl Ski Run Clearing, and Orion II Ski Run Clearing (Figure 1). Three additional projects were implemented in 2008: Skyline Trail Re-Grade, Lakeview Lodge Water System Improvement Project, and Stagecoach Snowmaking Project. IERS conducted performance monitoring for all of the above projects in 2009 and 2010. In 2009, the Tubing Lift project was constructed (not discussed in this report). After restoration treatments are implemented and post-treatment monitoring is conducted at the Tubing Lift, results will be presented in a summary report. In 2010, the Gondola Lodge project was constructed and restoration treatments (excluding planting) were completed. Pre-treatment monitoring was conducted in 2010 and post-treatment monitoring will be conducted in 2011.

Table 2. Timeline of baseline monitoring, project implementation, restoration treatment implementation, post-project monitoring, and target sign-off date.



Report Structure

Chapter 1 describes the overall site characteristics, lists overall program goals, describes how "success" is defined and measured, and provides a general description of the restoration techniques and monitoring methods employed. **Chapters 2 and 3** describe project-specific objectives, success criteria, monitoring results, and treatment elements implemented for each project. Projects are grouped into one of these two chapters, depending on whether or not performance monitoring has been completed yet. **Chapter 2** covers the 2010 project with pre-treatment monitoring results. **Chapter 3** covers projects with both pre-treatment and performance monitoring results. **Chapter 4** summarizes conclusions and recommendations, and includes literature cited.

Results for each project are presented in the following format:

- Overview – description of the type of project, associated impacts to soil and vegetation, and timing of both treatments and monitoring.
- Site Description – description of the geographic location, physical conditions and ecological characteristics of each project site
- Objectives and Success Criteria – description of specific objectives and success criteria by which each project is being evaluated.
- Restoration Treatments – summary of specific soil and vegetation restoration treatments implemented at each project site.
- Monitoring Results – graphical summary of monitoring results
- Management Response/Follow-up Action – comparison of monitoring results to project success criteria. Summarizes what worked, what did not, and what (if any) management response or follow-up action should be taken to achieve project success criteria.

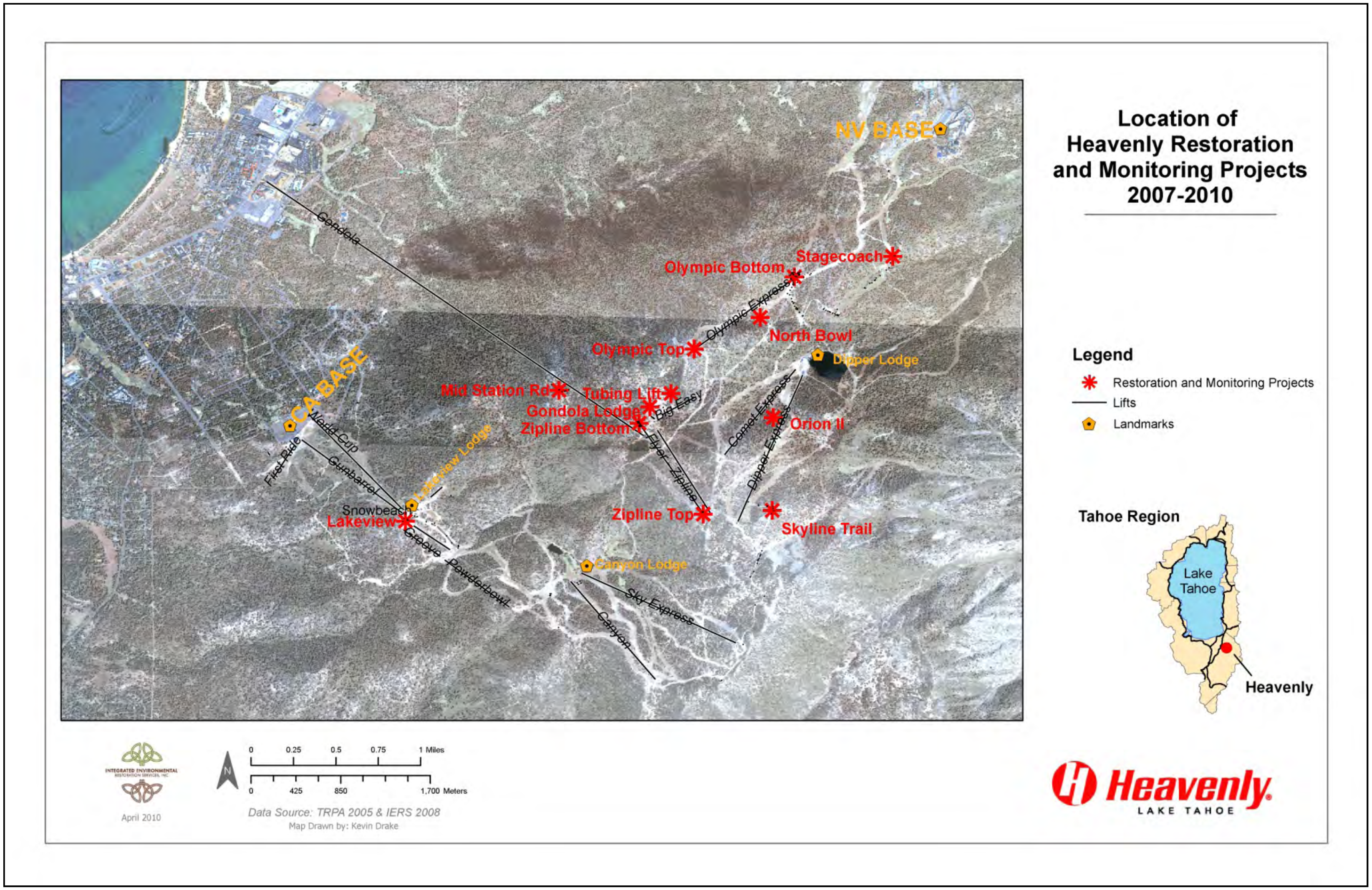
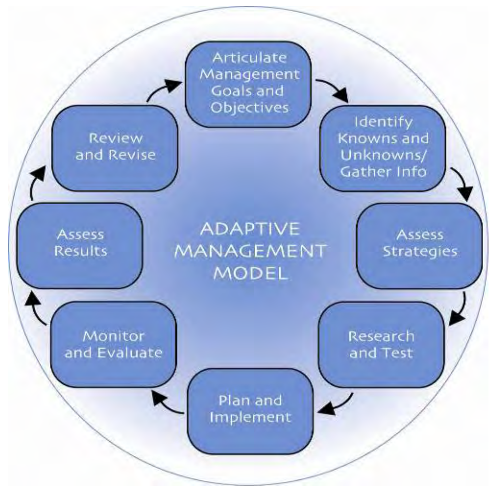


Figure 1. Locations of restoration projects at Heavenly Mountain Resort, 2007-2010.

Adaptive Management Overview

The Heavenly Valley Master Plan Amendment EIR of 2007 included an innovative approach to project implementation known as adaptive management. For many years in the Lake Tahoe Basin, projects have been designed to comply with regulations. In that attempt to comply is embedded the assumption that compliance measures actually attain the goals that they are designed to attain. However, a majority of the BMPs currently approved for a specific project have not been tested or measured for performance in the type of situation or conditions to which they are being applied. In fact, most permanent BMPs are based on output from models, such as the Universal Soil Loss Equation. Thus, we have made little progress toward either understanding or improving performance on many of the standard and accepted BMPs. Heavenly has departed from this approach, and the adaptive management system not only assures compliance, but is also is used investigate the actual performance of both standard and newly developed BMPs. This assures a higher level of environmental performance and cost-effectiveness. Below is a brief description of the adaptive management model being employed at Heavenly.



The concept of adaptive management[1] has been applied for centuries under a number of different names. Physical engineers have used this approach since the first structure or bridge was constructed to continually learn from 'failures' and successes to improve designs. In the realm of applied science, including restoration and erosion control, adaptive management has not, until recently, been widely embraced. This effort at Heavenly Mountain Resort is one of the first truly adaptively-managed projects in the Lake Tahoe Basin.

Adaptive management has a dual nature. First, adaptive management is a philosophical approach toward resource management that acknowledges that we do not completely understand the system that we are working with. It acknowledges that we will proceed with a project or program using existing information while we gather the knowledge that we lack. Second, adaptive management is a structured decision-making process designed to increase knowledge and understanding. That process includes the following components, usually addressed in a stepwise fashion:

1. **Articulate management goals and objectives –** Goals have been set for the entire program with clear objectives and success criteria defined for each project.

[1] The adaptive management approach being applied at Heavenly has been pioneered by the California Alpine Resorts Environmental Cooperative (CAREC) and is described in greater detail in the Sediment Source Control Handbook, which is available at: www.IERStahoe.com or www.sbcouncil.org

2. **Identify "knowns and unknowns"/gather information –** Heavenly's restoration and monitoring program provides a practical framework for translating "knowns," "unknowns," assumptions, and ideas into hypotheses to be tested in the context of new projects. In this manner, Heavenly is able to utilize proven and/or promising treatment approaches while addressing research needs and filling information gaps.
3. **Assess strategies –** Monitoring results from past projects are used as the basis for developing treatment strategies for new projects that are most likely to achieve project objectives and success criteria.
4. **Research and tests –** Test plots are incorporated into project-scale treatments whenever possible to test assumptions and fill information gaps identified in step 2 in order to expand Heavenly's toolkit of effective restoration treatments.
5. **Plan and implement –** All treatments are monitored by IERS staff during implementation in order to ensure that treatments are implemented according to plan and to document as-built conditions to support monitoring and continual improvement.
6. **Monitor and evaluate –** Quantitative, defensible monitoring is conducted before construction and one year following treatment to evaluate treatment effectiveness relative to pre-defined success criteria.
7. **Assess results –** Monitoring data are analyzed, summarized and reported annually (in this report). Management responses are recommended to address treatments that did not meet the project objectives and success criteria. These results are shared with regulatory agencies as well as other regional stakeholders.
8. **Review and revise –** This final and critical step in the adaptive management cycle involves continual reassessment and improvement of treatment practices by incorporating information gained through monitoring into future projects and treatments. This step also includes refinement of success criteria if suggested by new knowledge or understanding. The management responses found in Chapter 3 are part of this review and revise process.

Overall Site Description

Heavenly Mountain Resort (Heavenly) is a ski resort located on the east slope of the central Sierra Nevada Mountains in the Carson Range on the southeast side of the Lake Tahoe Basin. Heavenly spans Nevada and California and has approximately 650 acres of ski runs, 30 ski lifts, 35 structures, and approximately 30 miles of roads within the resort boundary.

Soils are derived from granitic parent material and deposits of decomposed granite rock including quartz, monzonite, and granodiorite. Heavenly is predominantly located within a mixed conifer forest, with some of the upper reaches of the resort within a Western White Pine Series vegetation type (Sawyer and Keeler-Wolf, 1995). Elevations range from 6,225 ft above mean sea level (AMSL) in the Heavenly Village to 10,400 ft AMSL at the top of the Sky Express.

The environment varies from densely forested at the lower elevations to open and exposed slopes at the higher elevations. The overstory is dominated by red fir (*Abies magnifica*), whitebark pine (*Pinus albicaulis*), Western white pine (*Pinus monticola*), lodgepole pine (*Pinus contorta*), and mountain hemlock (*Tsuga mertensiana*). Native plants dominate the understory in undisturbed areas and include pinemat manzanita (*Arctostaphylos nevadensis*) and huckleberry oak (*Quercus vacciniifolia*). Native grasses and forbs are also present. At the higher elevations, plant cover is sparser and large areas of bare soil exist. Ski runs and other disturbed and revegetated areas tend to be dominated by non-native fescue (*Festuca trachyphylla*).

Overall Program Goals

Treatment Goals

- To implement projects that result in no net increase in runoff or sediment transport
- To implement sediment source control treatments that are either self-sustaining (as measured by success criteria, discussed in the next section) OR are accompanied by a plan for ongoing maintenance and management to maintain treatment effectiveness
- To develop and demonstrate an applied adaptive management program for development, management, and maintenance activities in upper watersheds

Monitoring Goals

- To quantitatively assess whether projects result in no net increase in runoff or sediment transport
- To identify and quantify indices of long-term ecosystem sustainability to the greatest extent possible
- To use monitoring data to determine the cost-effectiveness of restoration techniques
- To use monitoring data to improve effectiveness of future treatments

Defining and Measuring Success

Defining Success Criteria

A project without a clearly defined target will not reach that target. The purpose of success criteria is, among other things, to minimize the condition described in the old adage: "If you don't know where you're going, any road will get you there." Success criteria are a set of numerical values or other specific descriptors of the target future condition of an area that are measured or observed in the field to determine whether goals and objectives have been achieved. Success criteria must be explicitly linked to project goals and objectives if they are to be valid and useful. Success criteria are most often defined as a range of acceptable values with upper or lower thresholds rather than a single numeric target in order to account for variability in natural systems and confidence in the accuracy of different measurement and analysis methods. Success criteria should reflect realistic and appropriate targets that are based on measured data whenever possible.

Success criteria are also subject to adjustment or change in some cases, especially when new elements are encountered such as the use of new techniques, ecosystems not previously worked in, or other novel situations where the outcome is not assured. Adjustments may be required if, through careful monitoring, one discovers that the targets set are unattainable, unrealistic and/or not accurate indicators of goal or objective attainment. However, adjusting or changing success criteria must be done in a well-substantiated, carefully considered manner. Defensible reasoning must be presented to support success criteria adjustment with new criteria presented based on monitoring data, rather than simply a desire to change the criteria.

Using Success Criteria within Adaptive Management

In the context of applied adaptive management, unmet success criteria serve as trigger points for actions or "management responses." Success criteria are also adjusted when monitoring and field reality clearly suggest that criteria are unrealistic or physically unattainable. A pre-defined management response represents a commitment by the project owner or manager to take action to achieve the project goals if the success criteria are not met or to review and revise the criteria themselves if justified. Potential management responses should be defined during project planning and directly linked to success criteria and monitoring. Additional management responses may also be developed after project implementation and monitoring are complete, once the sources of the problem and potential solutions are more clearly understood. In some cases, the success criteria themselves may need to be refined so that they reflect the most realistic and appropriate targets possible.

Over time, the success criteria presented in this report will continue to be refined based on the results of monitoring both treatment and reference areas at Heavenly and other similar sites. In this way, success criteria become more representative of the system in which we are working and provide a framework for comparing our initial understanding about that system to what we are learning from ongoing field measurements. Thus, initial success criteria reflect our best understanding of the system and system response to treatment at the outset of the project. In 2009, several changes were made to the success criteria originally developed in 2007, based on the results of the previous season's monitoring. In 2010, no changes were necessary.

Little monitoring of restoration treatment effectiveness has been conducted in high elevation (above 8,000 ft) settings with poorly developed soils, particularly those derived from decomposed granite. Heavenly's adaptive management-based restoration and monitoring program is a rare but sorely needed opportunity to help fill important information gaps and provide a quantitative, defensible basis for defining success for restoration in high-elevation settings at Heavenly and throughout the region.

Developing Appropriate Management Responses

Management responses are developed for each success criteria during project planning in order to describe the types of responses that could be deployed to address unmet success criteria. When a specific success criterion is not met, it triggers an action and that action is based on information gathered through quantitative monitoring, qualitative observations, and field experience, which is not always available during project planning. Within the context of this program, management responses are defined as on-the-ground treatment actions (re-tilling a compacted area, for instance). Other follow-up actions may also be defined to gather additional information, such as photo documentation during rain storms, which is used to inform potential on-the-ground treatment actions (management responses). Effective management responses should be directly linked to goals and objectives. Given the primary program goal at Heavenly of "no net increase in runoff or sediment transport," the scale and intensity of a given management response should be commensurate with the level of certainty that runoff or sediment yield has actually increased. Success criteria for Heavenly projects are based on both direct measurements and indirect indices of erosion potential. For instance, rainfall simulation provides a direct measurement of erosion potential whereas all other monitoring parameters included as success criteria serve as indices or indicators of erosion potential and longer-term resilience of sediment source control treatments. Even the various types of plant cover measurements are intended to be indicators of erosion potential, rather than any sort of direct measurement of erosion.

The various forms of monitoring have been carefully constructed to allow a range of information of various importance or 'weight'. While all of the monitoring measurements offer useful information, not all may be equally useful to determine a trigger point. Greater weight, for instance, is put on the rainfall simulation-derived sediment yield results than on other indirect indices of erosion when evaluating the overall functional condition and erosion risk of a site and the need for a particular type of management response. For example, if the criteria for plant cover or soil organic matter are not met but the criteria for sediment yield and total cover are met, monitoring results would indicate that the overall project outcome is aligned with the project objective (no net increase in runoff or sediment transport) but that further monitoring and/or observations to evaluate the longer-term trajectory of soil organic matter and vegetation response may be needed. Alternatively, if measured sediment yield only slightly exceeds the success criterion, but all other criterion are met, another year of assessment may be recommended before a management response is undertaken.

Success criteria, monitoring, and management responses are used to determine and ensure that site conditions are trending in the intended direction. That is, toward a resilient system that is able to respond to perturbations and continue providing the ecological services such as clean water. Because we are working with complex and dynamic natural systems that we do not fully understand, an unmet success criterion does not always warrant a treatment action. The type, scale and intensity of management responses should be proportionate with the relative erosion risk level of a particular site, which requires integration and interpretation of a range of ecological variables (which are manifested as success criteria). In the context of applied adaptive management, success criteria and management responses provide a useful framework for translating goals into measurable targets, stating and testing assumptions, increasing both flexibility and accountability in project implementation, and ultimately improving the success of erosion control and restoration efforts over time.

Methods and Materials

Restoration Treatment Techniques and Materials

Full Soil and Vegetation Restoration Treatment

Full soil and vegetation restoration treatment includes the following: soil loosening with amendments and/or topsoil, fertilizer, native seed, and mulch applications. These materials and techniques represent an integrated treatment approach that aims to restore key functions of the soil-vegetation system in a cost-effective manner in order to provide low-maintenance, sustainable sediment source control. This combination of treatment elements is also affectionately referred to as the "Full Hogan."

Soil Amendments

Soil amendments, such as wood chips, tub grindings, and compost, are used to add organic matter and nutrients to the soil. When organic matter is incorporated into disturbed soil, it improves the infiltration and water holding capacity of the soil. Organic matter is also necessary to create a soil environment in which a robust microbial community can develop while establishing long-term nutrient cycling that, over time, supports native vegetation. Each amendment serves a different purpose in restoring soil function. Soils are tested prior to treatment to determine the types and quantities of amendments most appropriate for a given site.

Amendments are applied to the soil surface in an even layer before tilling. Soil amendments were generally applied at depths of approximately 3 to 5 inches at Heavenly restoration treatment areas, depending on site conditions, treatment goals and amendment type. Four types of soil amendments were used in Heavenly restoration treatments from 2007 - 2009:

- Full Circle Integrated Tahoe Blend Zero Compost, consisting of 100% composted coarse wood overs ranging in size from 3/8" to 3"
- Wood chips, generated on-site at Heavenly
- Boulder Lodge Blend, consisting of aged wood chips and pine needles from Heavenly's Compost Your Combustibles Program
- Decomposed wood shavings, consisting of well-aged wood shavings from a nearby firewood operation in Meyers. Supplies of this amendment were limited, and it was only used at the Olympic Lift Bottom area.

Figure 2. Soil amendments – wood chips and compost.

Soil Loosening (Tilling)

Soil loosening is used to remove compaction from dense soil and to incorporate amendments into the soil before fertilizing, seeding, and mulching. Soil loosening tends to increase infiltration rates, thereby decreasing runoff and associated sediment transport (Grismer and Hogan 2005). Soil loosening also allows plant roots to penetrate more easily into the soil, therefore allowing them greater access to water and nutrients while helping to stabilize the soil. All soil loosening treatments at Heavenly were implemented using the bucket of a full sized excavator (or a backhoe in a few cases) to till soil and incorporate amendments. Soil tilling is conducted in a manner that mixes the subsurface material with the amendments (such as wood chips or compost) and leaves the subsurface irregular or "scalloped" (i.e. rough, not smooth; Figure 3 and Figure 4).

Figure 3. Tilling/scalloping with full-sized excavator

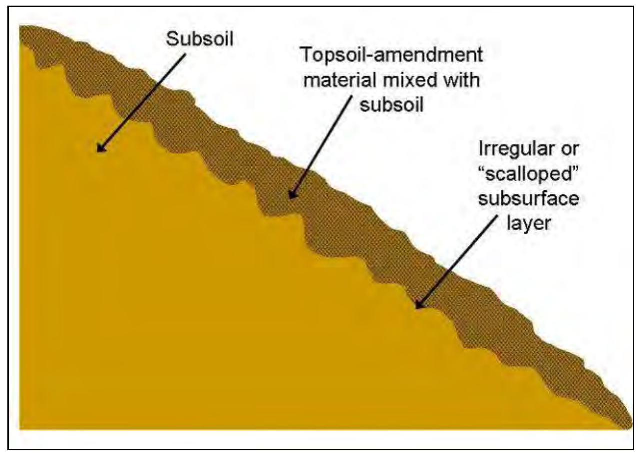


Figure 4. Result of tilling/scalloping

Fertilizer

Fertilizer is typically added to support short-term plant growth while carbon-rich soil amendments, such as wood chips or composted coarse overs, are broken down by soil microbes and provide more available nutrients in the long-term to support plant growth. Biosol (6-1-3) is an organic, slow-release fertilizer, and was the only fertilizer used at the restoration treatment areas. The nutrients present in Biosol are released much more gradually than with most other commercial fertilizers, providing a longer-term source of nutrients to support establishment of native perennial species while reducing the potential for leaching into groundwater. Biosol is applied to the soil surface and incorporated into the top 0.5 to 1 inch of the soil using a rake.

Seed

Two native upland seed mixes were developed for Heavenly projects (Table 3 and Table 4). In addition, a mesic mix was developed for a wetter area on Patsy's Trail for the Lakeview Lodge project (Table 5). A high elevation mix was also used for the Lakeview project (Table 6). The Stagecoach and Gondola Lodge projects also had tailored seed mixes (Table 7 and Table 8) Seed selection is important in any restoration project; however, it is important to note that many sites where vegetation and topsoil have been removed are not capable of supporting robust vegetation. Therefore, seeding should always be a part of a larger process of soil re-capitalization. The other treatments described in this section (tilling, soil amendments, mulch) are an integral part of establishing a sustainable soil and vegetation community that provides long-term sediment source control. Native perennial species with deep root systems were specifically selected because they provide a high level of soil stabilization. Grasses, which dominate the seed mix, have the densest root system of the herbaceous species and are the first to establish in the natural successional process that eventually leads to a mature tree and shrub-dominated community. Seeding is an integral part of full soil restoration, which includes soil loosening, incorporation of amendments into the soil, fertilizer application, and mulch. Seed is applied to the soil and raked lightly to ¼ inch below the surface (Figure 5).

Figure 5. Applying and raking seed.

Table 3. Heavenly Upland Seed Mix

Species (Common Name)	Species (Botanical Name)	Pure Live Seed (%)
Squirreltail	*Elymus elymoides*	46%
Blue wildrye	*Elymus glaucus*	11%
Mountain brome (Mokelumne or El Dorado)	*Bromus carinatus*	29%
Antelope bitterbrush	*Purshia tridentata*	6%
Greenleaf manzanita	*Arctostaphylos patula*	6%
Sulphur flower buckwheat	*Eriogonum umbellatum*	2%

Table 4. Lakeview Upland Seed Mix

Species (Common Name)	Species (Botanical Name)	Pure Live Seed (%)
Squirreltail	*Elymus elymoides*	48%
Western needlegrass	*Achnatherum occidentale*	2%

Species (Common Name)	Species (Botanical Name)	Pure Live Seed (%)
Mountain brome (Mokelumne or El Dorado)	*Bromus carinatus*	20%
Antelope bitterbrush	*Purshia tridentata*	10%
Sulphur flower buckwheat	*Eriogonum umbellatum*	8%
Slender wheatgrass (Revenue)	*Elymus trachycaulus*	12%

Table 5. Lakeview Moist Site Seed Mix

Species (Common Name)	Species (Botanical Name)	Pure Live Seed (%)
Tufted hairgrass	*Deschampsia caespitosa*	20%
Meadow barley	*Hordeum brachyantherum*	20%
Baltic rush	*Juncus balticus*	10%
Nebraska sedge	*Carex nebrascensis*	15%
Rocky mountain iris	*Iris missouriensis*	20%
Purple monkeyflower	*Mimulus lewisii*	5%
Sierra larkspur	*Delphinium glaucum*	10%

Table 6. Lakeview High Elevation Seed Mix

Species (Common Name)	Species (Botanical Name)	Pure Live Seed (%)
Mountain brome (Bromar)	*Bromus carinatus*	20%
Slender wheatgrass (Revenue)	*Elymus trachycaulus*	20%
Big bluegrass	*Poa ampla*	5%
Idaho fescue (Winchester)	*Festuca idahoensis*	5%
Streambank wheatgrass	*Elymus lanceolatus*	15%
Prairie junegrass	*Koeleria macrantha*	15%
Tufted hair grass	*Deschampsia cespitosa*	5%
Sandberg bluegrass	*Poa secunda*	5%
Sheep fescue	*Festuca ovina*	5%

Table 7. Stagecoach Upland Seed Mix

Species (Common Name)	Species (Botanical Name)	Pure Live Seed (%)
Squirreltail	*Elymus elymoides*	52%
Mountain brome (Mokelumne or El Dorado)	*Bromus carinatus*	20%
Antelope bitterbrush	*Purshia tridentata*	20%
Sulphur flower buckwheat	*Eriogonum umbellatum*	8%

Table 8. Gondola Lodge Upland Seed Mix

Species (Common Name)	Species (Botanical Name)	Pure Live Seed (%)
Squirreltail	*Elymus elymoides*	60%
Mountain brome (Mokelumne or El Dorado)	*Bromus carinatus*	20%
Antelope bitterbrush	*Purshia tridentata*	6%
Sulphur flower buckwheat	*Eriogonum umbellatum*	4%
Showy penstemon	*Penstemon speciosus*	6%
Sierra wallflower	*Erysimum capitatum*	4%

Mulch

Mulch is a protective layer of material, spread on the soil surface, that can serve to decrease erosion and sediment transport, decrease evaporation of water from the soil, and contribute to long-term nutrient cycling. Mulches commonly used for erosion control in the Sierra Nevada include pine needles (Figure 6), wood shreds, and rice straw. However, pine needles and wood shreds have proven to be far more durable and effective at reducing sediment transport than rice straw when applied consistently over treated areas. At sites in the Lake Tahoe Basin, a consistent cover of pine needle mulch has been shown to reduce sediment yield by as much as 50% compared to adjacent, partially-treated areas with little mulch (Grismer et al. 2008). Pine needles and wood chips/shreds are the only mulches that were used at Heavenly restoration treatments.

Figure 6. Aged pine needles were applied as mulch at several projects.

Monitoring Methods

Before a discussion of individual methods, it is important to understand sampling during field data collection and to understand how an area is selected for monitoring.

Monitoring Area Selection

Monitoring areas were selected at each project based on the type and magnitude of impacts to soil and vegetation (disturbance and restoration) that were expected, construction plans, and coordination with Heavenly operations personnel. In general, the more complex the project, the greater the level of monitoring effort required to adequately characterize the impacts of the project on runoff and sediment transport (i.e. erosion). Within the general area of interest, a smaller, but representative area is chosen for the monitoring described below.

Monitoring Data Collection: Sampling versus Whole Area Measuring

We define monitoring within an adaptive management context as measurements to detect change in a system or system attributes over time. Monitoring is designed to help understand specific system attributes and to see how they change. Plant cover, soil nutrients, and erosion potential are all attributes that we attempt to measure. However, it is usually impossible to count every plant or blade of grass in an area or to measure all of the soil nutrients. So we take what are intended to be representative samples of those attributes. We measure small subsets of the overall system of interest and we hope to get a representative understanding of the overall system. Unfortunately, natural systems can be extremely variable. Statistics help us to understand whether our measurements are accurate or not. In taking samples, there are a number of places where 'error' occurs and thus, we develop our success criteria with a margin of error or a 'plus or minus' factor. This error is cumulative and comes from measurement instruments themselves, the observers, the statistical methodology, and the laboratory processes, among other things. While we would like to have a sense that numbers represent precise reality, they are, after all, an approximation. Our intent is to develop numbers that we have a certain confidence in. So when we list that plant cover in one area is 10% and in another area it is 15%, the difference is likely to be from the potential 'error' that we've discussed and not a real difference. Therefore, we can only be confident within set limits. Further; we are looking for trends in the data that reflect trends in the attribute of interest.

Rainfall Simulation

The rainfall simulator is a custom-designed monitoring tool used to simulate natural rainfall events and directly measure infiltration, runoff, and erosion rates from disturbed, treated, and reference areas. The rainfall simulator "rains" on a square plot from a height of 3.3 feet (Figure 7 and Figure 8). The rate of rainfall is controlled (typically 4.7 inches per hour) and runoff is collected from a trough at the bottom of a 6.5 ft^2 frame that has been pounded into the ground. The volume of water collected is measured, and then the volume of infiltration is calculated by subtracting the volume of runoff from the total volume of water applied to the plot. If runoff is not observed during the first 30-45 minutes, the simulation is stopped. The average steady state infiltration rate is calculated from three simulation frames and the collected runoff samples are then analyzed for steady state sediment yield (referred to as "sediment yield" throughout this report). Often times, post-treatment simulations were conducted outside the pre-treatment monitoring area to capture a range of the varied treatment applied during restoration. The pre-treatment data was used as a comparison for all post-treatment simulations at a particular site and is presented next to the post-treatment data for each plot.

A cone penetrometer is used to record the depth to refusal (DTR) surrounding the frames before and after rainfall simulations. Soil moisture is also measured in each frame before and after rainfall simulations. After rainfall simulation, the wetting depth is measured at nine locations within the frame to determine how deeply water has infiltrated into the soil column.

Three simulations were conducted at each site pre-treatment in an effort to account for the widely varying soil hydrologic properties within a site. Sediment yields can vary by thousands of lbs/acre/in at a single site, but are more commonly are within a one hundred lbs/acre/in of each other. This variability, along with collection and analysis variability were accounted for in determining the sediment yield success criteria. Infiltration rates, while still variable for the same reasons mentioned above, are generally with 0.5-1 in/hr of each other within a particular site.

At the Gondola Lodge, runoff samples were not collected due to the flat topography of the site. Instead, the steady state infiltration rate of the soil was measured by first setting the rainfall rate of the simulator to 2 L/min, then lowering the rainfall rate until infiltration was achieved.

Figure 7. Rain drops are generated from more than 800 hypodermic needles on the rainfall simulator.

Figure 8. Rainfall simulation in action at the Gun Barrel Top Terminal Slope monitoring area.

Rainfall simulation was conducted at Olympic lift, Lakeview Lodge (except Patsy's trail in 2008), Stagecoach, Tubing Lift, Mid Station Road, Heavenly Flyer top, North Bowl, and the Gondola Lodge. Rainfall simulation was not conducted at Heavenly Flyer bottom due to the presence a rare plant and the high concentration of rocks at the site.

Runoff Simulation

The runoff simulator is a custom-designed tool used to induce surface runoff (such as spring snowmelt). Like the rainfall simulator, this tool is used to directly measure infiltration, runoff and erosion rates from disturbed, treated and reference areas. Runoff simulation was conducted at Skyline Patsy's Trail at the Lakeview Lodge project. Runoff frames are often easier to install than rainfall frames in rocky or highly compacted areas. The runoff simulator is a 3.3 feet wide PVC pipe with 50 evenly spaced holes that are one-sixteenth inches in diameter (Figure 9 and Figure 10).

Figure 9. The runoff simulator at the Skyline trail. The PVC pipe is visible just below the boulder and the collection frame is at the bottom of the photo.

Figure 10. The runoff simulator and test area post-simulation at the Lakeview Lodge Patsy's Trail monitoring plot. The PVC pipe is visible at the top of the photo and the collection frame is at the bottom.

When water is pumped though the pipe and exits the holes, an even flow of water across the entire width of the pipe is produced, thereby simulating snowmelt runoff through sheet flow. Snowmelt can produce a significant amount of runoff and sediment, which can lead to severe erosion problems. The application rate ranges from 2.5 to 5.9 in/hr. A collection trough is installed 6.6 feet down slope from the runoff pipe and all runoff is collected. The same measurements and samples are collected for the runoff simulator as for the rainfall simulator.

Soil and Site Physical Conditions

Penetrometer Depth to Refusal (DTR)

Penetrometer DTR is measured along transects. Penetrometer DTR measurements are used as a surrogate for soil density. A cone penetrometer with a ½ inch diameter tip is pushed straight down into the soil until a maximum pressure of 350 pounds per square inch is reached (Figure 11 and Figure 12). The depth at which that pressure is reached is recorded as the depth to refusal (DTR). The depths are marked in 3 inch increments and can be read to the nearest 1 or 2 inches.

Penetrometer DTRs can only be compared at similar soil moisture levels, because DTR increases with increasing soil moisture. DTRs are not presented if soil moisture levels are not comparable between years.

Soil Moisture

A hydrometer is used to measure volumetric soil moisture content adjacent to the penetrometer readings at a depth of 4.7 inches (Figure 13).

Solar Exposure

Solar radiation measurements are taken using a Solar Pathfinder (Figure 14). Solar input affects evaporation rates and soil temperature, which may affect time of seed germination, germination rate, rate of plant growth, and soil microbial activity. It is an important variable to consider when monitoring plant growth and soil development.

Figure 11. Cone penetrometer dial, showing pressure applied in pounds per square inch.

Figure 12. Conducting cone penetrometer readings along transects.

Figure 13. Conducting soil moisture readings along transects.

Figure 14. Solar pathfinder in use.

Cover

Cover point monitoring is a statistically defensible method of measuring foliar plant cover and total ground cover. Cover is measured along randomly located transects using a metal rod with a laser pointer mounted 3.3 feet high. After the rod is leveled in all directions, the button on the laser pointer is depressed and two cover measurements are recorded (Figure 15 and Figure 16):

- the first hit cover
- the ground hit cover

The first hit cover is the first vegetation intercepted by the laser and measures the foliar cover by plant leaves or stems. The first hit vegetation is moved aside and the ground hit cover is identified. Ground hit cover is litter, mulch, basal (or rooted) plant cover, rocks, woody debris, or bare ground.

Figure 15. Cover pointer in use along transects.

Figure 16. Cover pointer rod with first hit cover and ground cover hit by the laser. The laser pointer hits are circled in red. The first cover hit is a native grass and the ground hit cover is pine needle mulch.

Basal and foliar plant cover is recorded by species and organized into four categories: lifeform, perennial/annual/woody, native/alien, and seeded/volunteer. Each species is classified based on whether it is native to the Tahoe area, and whether it was seeded during treatment. Ocular estimates of species composition are recorded.

Cover point monitoring was conducted at the 80% confidence level in most cases. For areas dominated by bare soil, dozens of transects can be required to reach the 80% confidence level. In these cases, 10 transects were recorded.

Soil Nutrient Analysis

Successful revegetation and soil treatments require adequate nutrient capital in the soil. Readily available sources of nitrogen, sufficient organic matter, and a robust microbial community are necessary to support vigorous and self-sustaining vegetation. Previous studies of soil nutrient levels at revegetation sites throughout the Tahoe area found that high plant cover was associated with high levels of total nitrogen (Claassen and Hogan 2002). Total Kjeldahl nitrogen (TKN) and organic matter are used as indicators of soil condition in this study.

Soil sub-samples are collected from a depth of 0-12 inches following the removal of the mulch layer (Figure 17). Three soil sub-samples are combined and sieved to remove any material larger than 0.08 inches in diameter, then sent to A&L Laboratories (Modesto, CA) for S3C nutrient suite, TKN, and organic matter analysis.

Like soil hydrologic properties, soil nutrient levels can vary widely, even within a small area. Three sub-samples are collected for each sample sent to the lab to help account for some of this natural variability. In addition to the natural variability, each nutrient value is accurate to a certain degree, depending on the analysis method used at the laboratory. The organic matter lab analysis is accurate within 20%, while TKN lab analysis is accurate to within 8%. The success criteria developed for organic matter reflects the variability encountered during the soil sample collection and analysis process. A success criteria was not used for TKN, but the TKN is presented along with the organic matter data.

Figure 17. Soil sub-sample collection.

Chapter 2: Projects with Pre-Treatment Monitoring Only

Gondola Lodge Construction Project

Overview

The Gondola Lodge project includes the construction of a day lodge just north of the existing gondola building (Figure 20). Soil and vegetation impacts associated with construction included tree clearing, grading, soil compaction, and a shallow, broad fill placement in an area that has been subjected to periodic disturbance over time. The fill area just north of the base of the Tamarack chairlift is the primary focus of the monitoring efforts. Construction of the lodge began in summer 2010 with a target completion date of December 2010. Pre-treatment soil, vegetation, and infiltration monitoring was conducted early in the summer of 2010, just before construction began.

Site Description

The staging area lies in a mostly open area with some Western white pine (*Pinus monticola*) and an understory dominated by red fescue (*Festuca rubra*; Figure 18 and Figure 19). No non-native species were observed. Most of the granitic parent material soil was bare; however, there was a sparse mulch cover by woodchips and plant litter. There were some medium to large rocks that are visible above the surface. The site is flat and has a summer solar exposure of 97%. The site elevation is approximately 9,150 feet AMSL.

Figure 18. Gondola Lodge staging area, before use in 2010.

Figure 19. Gondola Lodge staging area, before use in 2010.

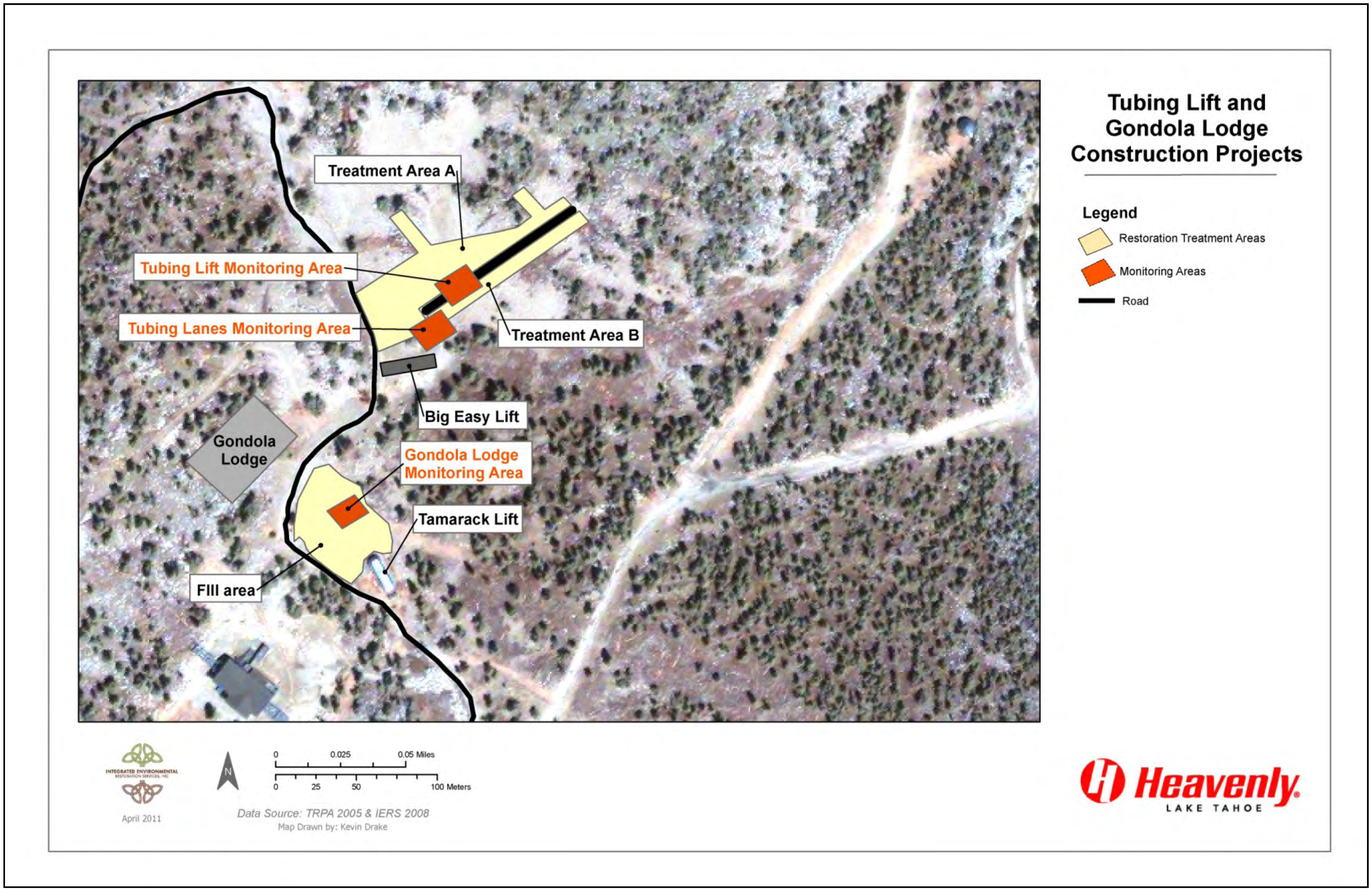


Figure 20. Gondola Lodge Construction Project Map.

Objectives and Success Criteria

Treatment Objective

- no net increase in runoff and/or sediment transport as a result of lodge construction and spoil relocation

Monitoring Objective

- to quantitatively assess whether lodge construction and spoil relocation resulted in a net change in runoff and/or sediment transport

Success Criteria

The following success criteria will be used to determine whether the lodge construction project achieved goals following treatments (Table 9). The success criteria are based on the following indicators: infiltration rate, penetrometer depth to refusal (DTR, used as an index for soil density), total cover, plant cover, organic matter, and visual erosion assessment. A success criterion for sediment yield, which was commonly used for other Heavenly projects, was not used for this project due to the lack of slope for rainfall or runoff simulation. In addition to evaluating short-term treatment success, these indicators represent key information needed to assess the likelihood of long-term sustainability of the soil-plant system, which is the key to long-term sediment source control.

Table 9. Gondola Lodge Success Criteria and Management Responses.

	Bottom of Tamarack Chair	Management Response
Infiltration Rate (in/hr)	Not greater than 0.8 in/hr lower than pre-treatment levels	Soil loosening with amendments
Penetrometer Depth (inches)	Not greater than 4 inches shallower than pre-treatment level	Soil loosening, amendments
Total Cover (%)	70% or greater	Mulching and/or seeding
Plant Cover	10% or greater	Seeding and/or targeted, short-term irrigation
Organic Matter (%)	Not greater than 1.5 percentage points less than pre-treatment level	Additional amendments and soil loosening
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition.	Identify causes of erosion. Develop and implement site-specific management response plan.

Pre-Treatment Monitoring

Infiltration Rate

At the Gondola Lodge, the slope was relatively flat, which did not allow for typical rainfall simulation and runoff sample collection. Instead, the rainfall simulator was used to measure the steady state infiltration rate. Steady state infiltration rates ranged from 0.6 to 2.2 in/hr, with an average infiltration rate of 1.6 in/hr (Figure 21). Typical undisturbed soils of granitic parent material can have infiltration rates greater than 4 in/hr.

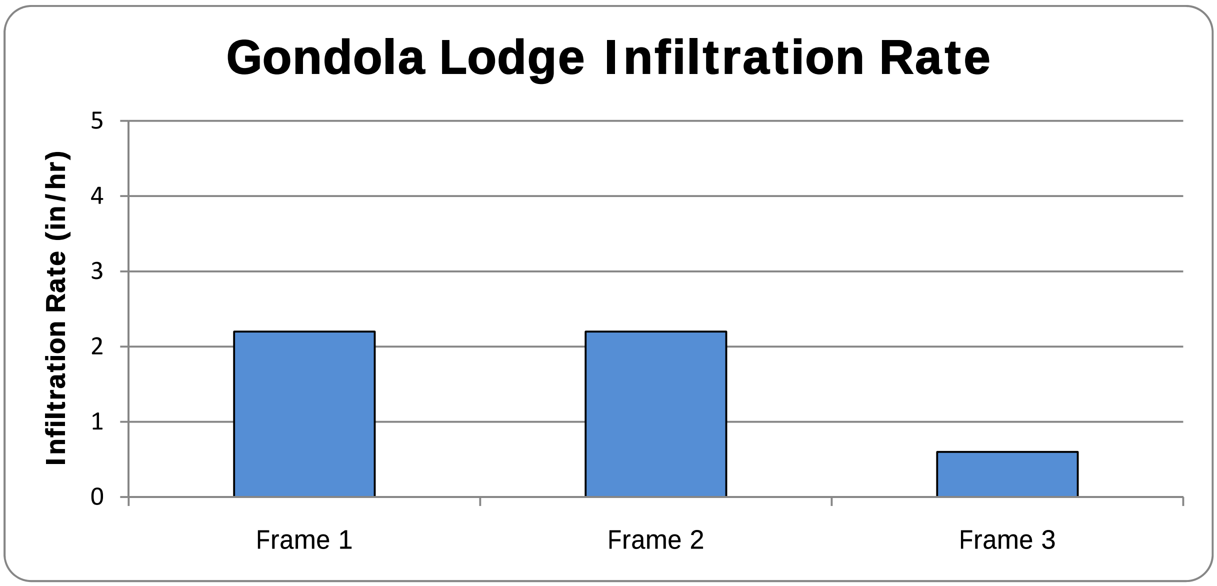


Figure 21. Gondola Lodge Infiltration Rate. Each of the 3 rainfall frames is presented here. Pre-treatment infiltration monitoring was conducted in 2010.

Penetrometer DTR

The penetrometer DTR was 5 inches, with a standard deviation of 0.8 inches. This relatively shallow DTR likely resulted in the low infiltration rates presented above.

Total Cover and Plant Cover

Total cover at the Gondola Lodge was71%, with 58% mulch cover, 11% other cover, and 1% understory plant cover (Figure 22). Bare soil was 29% of the ground composition. Overstory (or foliar) plant cover was 14% (no graph).

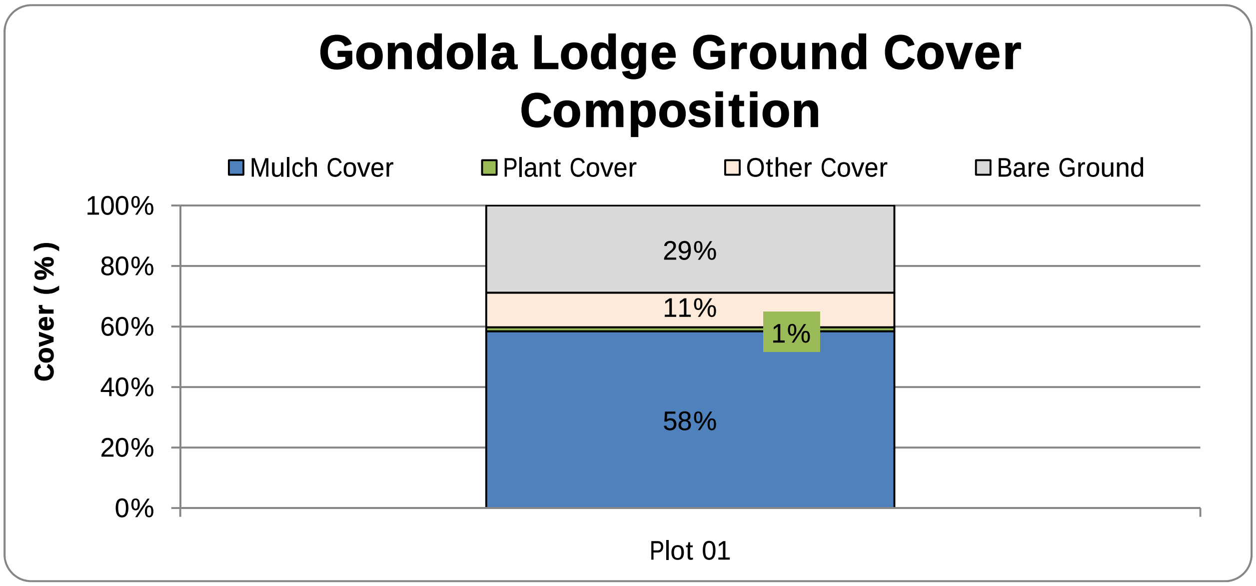


Figure 22. Gondola Lodge Ground Cover Composition. Pre-treatment monitoring was conducted in 2010.

Soil Nutrients

Organic matter content at the Gondola Lodge was 2.1%, while total Kjeldahl nitrogen (TKN) was 410 ppm (no graph).

Visual Erosion Assessment

Splash detachment from a rain event was visible at this site. Pine needle movement and presence in depressions, which can sometimes be an indicator of erosion, was also observed. Pine needle movement can also result from wind erosion. No sediment deposition was observed on the upslope side of the pine needles, suggesting that wind may have been the mechanism for pine needle movement.

Restoration Treatments

The Gondola Lodge project restoration treatment area consists of a large fill placement area near the base of the Tamarack chairlift where spoils material generated during lodge construction was placed (Figure 20, Figure 23, Figure 24, and Figure 25). In 2010, the spoils material was placed in the treatment area and left un-compacted. Four to five inches of wood chips were then placed on the surface of the fill material and incorporated to a depth of 20 to 24 inches using the bucket of an excavator. The entire area was then fertilized, seeded and mulched. The surface of the fill area was left in a slightly roughened condition to reduce the potential for erosion during snowmelt and saturated soil conditions. These treatments are summarized in Table 10. In 2011, the treatment area will be planted with mountain pride (*Penstemon newberryii*) and sulphur flower buckwheat (*Eriogonum umbellatum*) and irrigated using a temporary overhead system.

Table 10. Gondola Lodge Treatment Matrix, 2010.

Amendments	**Type**	WC
	Depth (in)	4-5
Tilling	**Depth (in)**	20-24
Fertilizer	**Type**	Biosol 6-1-3
	Rate (lbs/acre)	2,000*
Seed	**Mix**	Gondola Lodge mix*
	Rate (lbs/acre)	50*
Mulch	**Type**	PNM
	Depth (in)	1
Irrigation	**Frequency/ Duration**	none
Treatment Area	**Square Feet**	26,500

Key
WC = wood chips
PNM = pine needle mulch
* = not verified in field

Figure 23. Gondola Lodge site before construction, July 2010.

Figure 24. Gondola Lodge site, immediately following treatment, October 2010. The treated spoils are visible in the foreground.

Figure 25. Gondola Lodge fill area, immediately following treatment, October 2010.

Chapter 3: Projects with Performance Monitoring

In this chapter, results from projects where performance monitoring has been completed are presented.

North Bowl Ski Run Clearing and Glading Project

Overview

The North Bowl ski run clearing and glading project included the creation of three new ski runs (S8, S9, and S10) near the Olympic Lift (Figure 26). Rather than more traditional smooth grading run construction techniques, clearing and glading methods were implemented. To minimize impacts to soil and vegetation, the clearing and glading were conducted during spring of 2008, while snow was on the ground. Run S8 was cleared: all trees in the run alignment were hand felled, removed by helicopter, and the stumps were flush cut with chain saws. Runs S9 and S10 were gladed, meaning that selected patches of trees were removed to minimize tree removal and create a more natural skiing experience. The same methods were used for glading as for clearing. Clearing and glading are being used as an alternative to smooth grading, which tends to have substantial impacts on soils, vegetation, and erosion potential (Grismer and Hogan, 2005; Burt and Rice, 2009). Soil and vegetation monitoring was conducted on the cleared run, S8, in summer 2008. Additional monitoring, including simulated rainfall monitoring, was conducted in early summer 2009.

Site Description

Cleared Run

The cleared run was cut in a forested area with lodgepole pine (*Pinus contorta*) and Western white pine (*Pinus monticola*; Figure 27). After clearing, there was no canopy cover and very little vegetation. No non-native species were observed. Large boulders, ranging from one to five feet in diameter, and tree stumps that are one to two feet tall, are scattered throughout the cleared area. Tree branches from the clearing process were left on the run, and are up to 15 feet long. Rills and gullies were present at the toe of the ski slope, where it meets the access road. The soil derived is from granitic parent material. The site is moderately sloped (20 degrees), faces 52 degrees northeast, and has a summer solar exposure of 73-79%. The site elevation is approximately 9,025 feet AMSL.

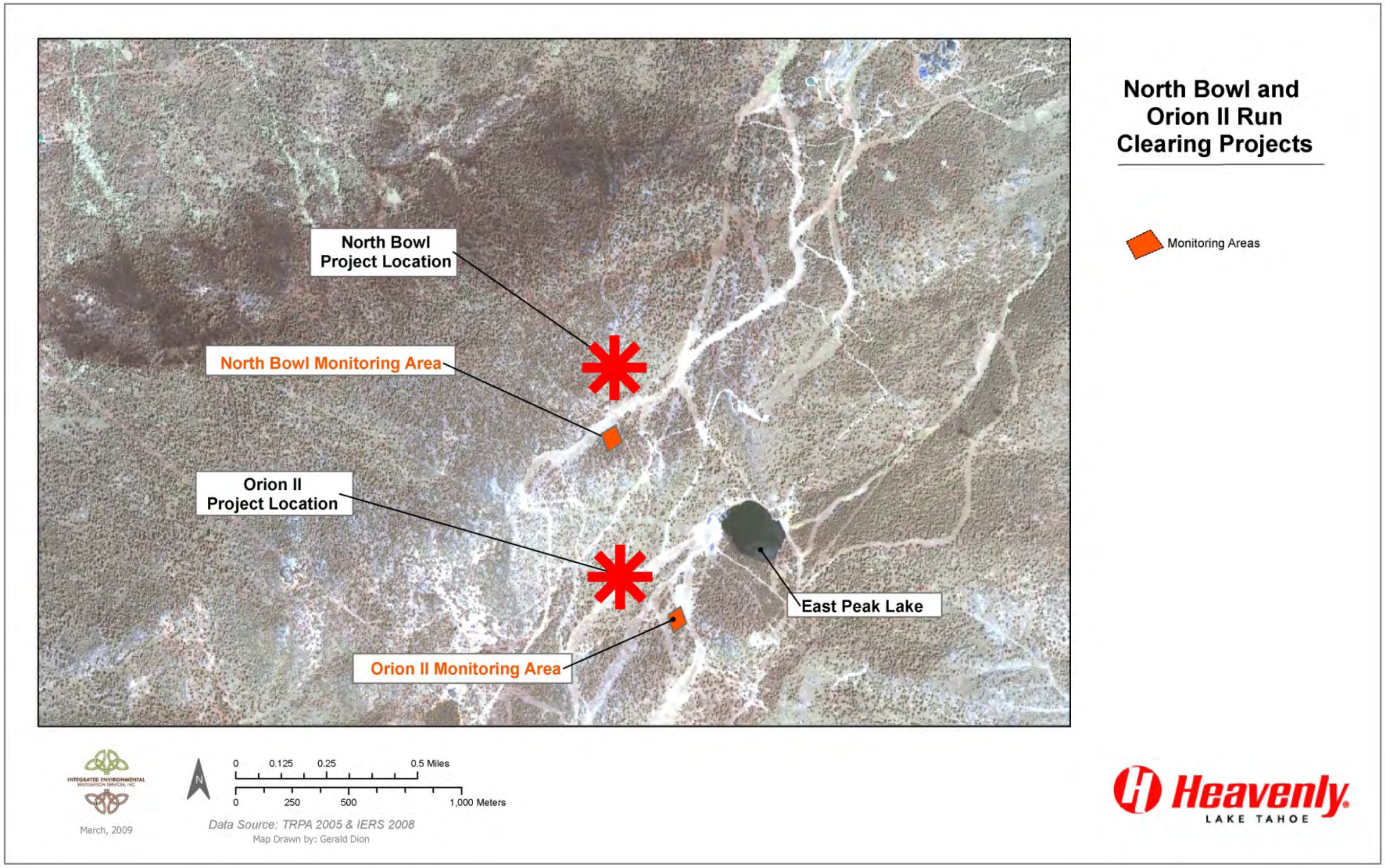


Figure 26. North Bowl Ski Run Clearing and Glading Project Map.

Uncleared Reference

The uncleared reference site is adjacent to the cleared run. The dominant trees are lodgepole (*Pinus contorta*) and western white pine (*Pinus monticola*) and the area contained many large boulders, ranging from one to five feet in diameter (Figure 28). No erosion was observed in the reference area, but animal disturbance was seen throughout. Little understory vegetation was present and no non-native species were observed. The slope, aspect, and elevation are identical to that of the cleared run. The solar exposure at the reference area ranges from 29-35% during the summer months.

Figure 27. North Bowl cleared ski run, 2008.

Figure 28. North Bowl uncleared reference site, 2008.

Objectives and Success Criteria

Treatment Objectives

- no net increase in runoff and/or sediment transport as a result of ski run clearing and glading

Monitoring Objectives

- to quantitatively assess whether run construction resulted in a net change in runoff and/or sediment transport

Success Criteria

The following success criterion will be used to determine whether run construction treatments achieved the project treatment goals following construction (Table 11).

Table 11. North Bowl 2010 Cleared Ski Run Success Criterion Evaluation.

	Cleared Run Success Criteria	Cleared Run Success Criteria Evaluation
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition.	√ Success Criterion Met

Performance Monitoring

Photo monitoring was conducted at the North Bowl ski run clearing project in 2007, 2008, and 2010. In 2008, soil and vegetation monitoring and simulated rainfall were conducted at the cleared run (S8) and at the reference area. However, due to inconclusive results from hydrophobic conditions, it was conducted again in 2009. For data collected in 2008 and 2009, see the Heavenly Mountain Resort Mitigation and Monitoring Plan Annual Report, October 2008-October 2009, Appendix II.

Visual Erosion Assessment

No signs of erosion were present in 2010; however, rodent activity was observed. The success criterion, which states that no visible signs of rills, gullies, sediment transport, or sediment deposition can be present, was met.

Photo Documentation

Photos from the cleared and uncleared ski run show no notable changes in surface conditions or evidence of erosion (Figure 29, Figure 30, Figure 31, and Figure 32).

Figure 29. Northbowl uncleared ski run, 2008 (photo point 3).

Figure 30. Northbowl uncleared ski run, 2010 (photo point 3). Note the fallen tree in the background that was not present in 2008.

Figure 31. Northbowl cleared ski run, 2008 (photo point 1).

Figure 32. Northbowl cleared ski run, 2010 (photo point 1).

Management Responses and Follow-up Actions

In 2010, visual erosion assessment and photo documentation were conducted. No evidence of erosion was observed and no notable changes in site conditions were evident. Therefore, the success criterion was met and no management responses are necessary.

Orion II Ski Run Clearing Project

Overview

The Orion II ski run clearing project includes the creation of a new ski run to connect the Orion ski run with the Upper Dipper Return run near the base of the Dipper Express Chairlift (Figure 33). To minimize impacts to soil and vegetation, the clearing occurred during spring 2008, while snow was on the ground. Upper Dipper Return was cleared: all trees in the run alignment were hand felled, removed by helicopter, and the stumps were flush cut with chain saws. Much like the North Bowl ski run projects, clearing was used as an alternative to smooth grading, which tends to have substantial impacts on soils, vegetation, and erosion potential (Grismer and Hogan, Burt and Rice, 2009). The impacts to soil and vegetation were monitored in 2008. The cleared run was sampled again in 2009, to verify the 2008 findings of shallower penetrometer DTR depths at the cleared run. In 2010, photo monitoring and visual erosion assessment were conducted to evaluate any changes in site conditions or visible erosion.

Site Description

Cleared Run

This cleared run was cut in a forested area with lodgepole pine (*Pinus contorta*) and Western white pine (*Pinus monticola*; Figure 34). After clearing, there was no canopy cover and little understory vegetation present in the cleared area. No non-native species were observed. Large rocks, tree branches, and stumps were scattered throughout the cleared area. The soil is derived from granitic parent material. The site is moderately sloped (19 degrees), faces northwest, and had a summer solar exposure of 68-79%. The site elevation is approximately 8,922 feet AMSL.

Uncleared Reference

This reference site is in a forested area adjacent to the cleared run with lodgepole pine (*Pinus contorta*) and Western white pine (*Pinus monticola;* Figure 35). There is no canopy cover in the area sampled, but variable canopy cover in the surrounding areas. Very little understory vegetation exists. No non-native species were observed. The soil is derived from granitic parent material with approximately 40% coarse fragments greater than 0.5 inches in diameter. The site is moderately sloped (21 degrees), faces northwest, and has a summer solar exposure of 74-86%. The site elevation is approximately 8,964 feet AMSL.

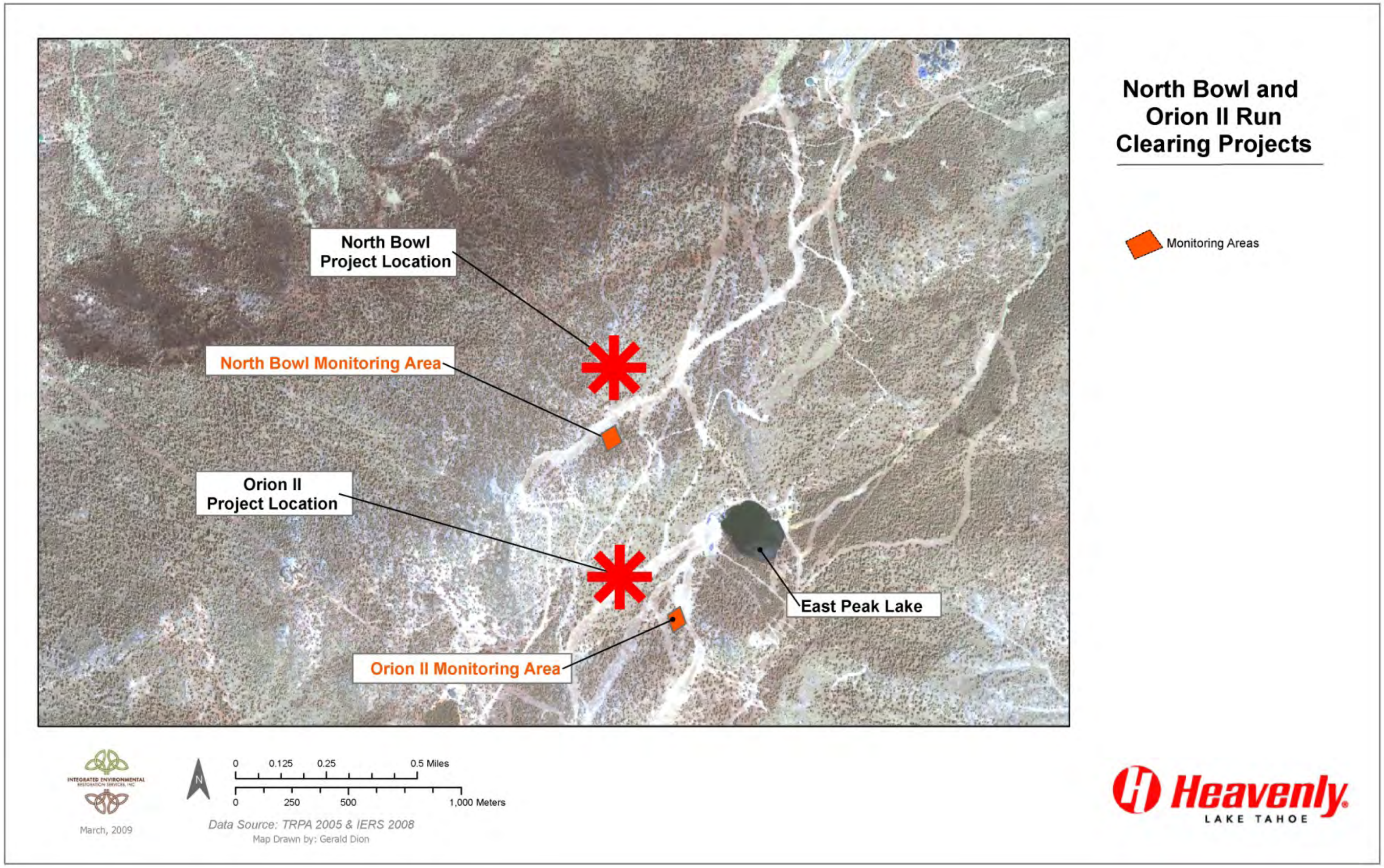


Figure 33. Orion II Ski Run Clearing Project Map.

Figure 34. Orion II run cleared area.

Figure 35. Orion II uncleared reference area. The cleared run is visible just in front of the truck.

Objectives and Success Criteria

Treatment Objectives

- no net increase in runoff and/or sediment transport as a result of ski run clearing

Monitoring Objectives

- to quantitatively assess whether run construction via clearing resulted in a net change in runoff and/or sediment transport

Success Criteria

A visual erosion assessment success criterion was used to determine whether run construction treatments achieved the project treatment goals in 2010 (Table 12).

Table 12. Orion II 2010 Cleared Ski Run Success Criteria Evaluation.

	Cleared Run Success Criteria	Cleared Run Success Criteria Evaluation
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition.	√ Success Criterion Met

Performance Monitoring

In 2008, some soil and vegetation monitoring was conducted at the cleared run and at a nearby uncleared area that was used as a reference area. In 2009, penetrometer monitoring was conducted at the cleared run and at the uncleared reference area to provide more insight into the 2008 penetrometer results. In 2010, visual erosion assessment was conducted. For data collected in 2008 and 2009, see the Heavenly Mountain Resort Mitigation and Monitoring Plan Annual Report, October 2008-October 2009, Appendix II.

Management Responses and Follow-up Actions

In 2010, visual erosion assessment and photo monitoring were conducted and no signs of erosion were observed. Therefore, the success criterion was met and no management responses or follow-up actions are necessary.

Olympic Lift Replacement Project

Overview

The Olympic Lift Replacement Project, completed in 2007, included the replacement of the existing lift towers and the top and bottom lift terminals. Disturbances to soil and vegetation associated with this project included re-grading segments of ski runs, soil compaction from heavy equipment, and trenching for utility lines. Restoration treatments were partially implemented in 2007 and completed in 2008. Performance monitoring was conducted in 2009 and 2010. There are three treatment plots at the top terminal and five treatment plots at the bottom terminal. Three monitoring areas, which are within the treatment areas, were also established for this project – one at the top terminal and two at the bottom terminal. All restoration treatment and monitoring areas are described in detail below and are shown on the project map (Figure 36).

Site Description

Olympic Lift Bottom

Olympic lift bottom is a disturbed area that encompasses the current bottom lift terminal and a portion of the Olympic Downhill ski run that funnels to the lift terminal (Figure 37 and Figure 38). This site is at an elevation of 8,561 feet AMSL on rocky soil derived from granitic parent material and faces northeast. Before treatment, non-native plants were present. The surrounding vegetation includes an overstory of red fir (*Abies magnifica*), whitebark pine (*Pinus albicaulis*), and Western white pine (*Pinus monticola*), with an understory of pinemat manzanita (*Arctostaphylos nevadensis*). The treatment area is dominated by a non-native fescue (*Festuca trachyphylla*). The tree canopy cover is less than 10%, the solar exposure is 70%, and the slope angle is 20 degrees. Rills and gullies caused by water erosion were observed throughout the site pre-treatment.

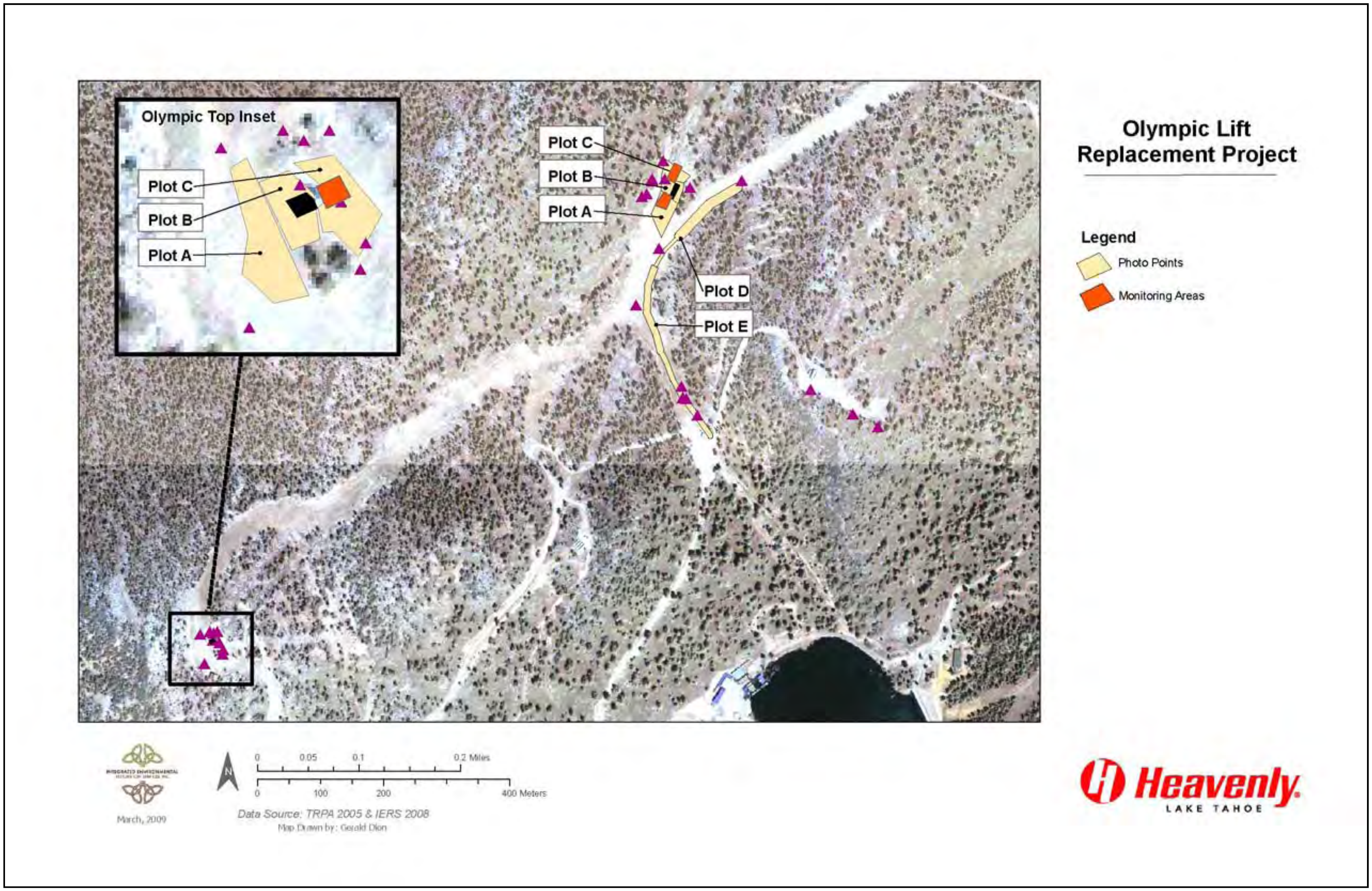


Figure 36. Olympic Lift Replacement Project Map.

Figure 37. Olympic lift bottom, Olympic Downhill ski run, pre-treatment, 2007.

Figure 38. Olympic lift bottom, old bottom terminal, pre-treatment, 2007.

Olympic Lift Top

Olympic lift top is a disturbed area surrounding the top lift terminal (Figure 39 and Figure 40). It is at an elevation of 9,445 ft AMSL on granitic parent material and faces north. The surrounding vegetation includes lodgepole pine (*Pinus contorta*), whitebark pine (*Pinus albicaulis*), and native grasses. Vegetation in the treatment area includes Western needlegrass (*Achnatherum occidentale*) and lodgepole pine. Also present was a non-native grass species, quackgrass (*Elymus trachycaulus*). There is no tree canopy cover and the solar exposure is 99%.

Figure 39. Olympic Lift top, pre-treatment, 2007.

Figure 40. Olympic Lift top, pre-treatment, 2007.

Objectives and Success Criteria

Treatment Objectives

- no net increase in runoff and/or sediment transport as a result of lift terminal replacement and associated site grading
- to establish an appropriate, self-sustaining, native plant communities
- no evidence of erosion caused by lift terminals (i.e. concentrated runoff or dripping)

Monitoring Objective

- to quantitatively assess whether treatments resulted in a net change in runoff and/or sediment transport following lift terminal replacement

Success Criteria

In 2010, the following success criteria were used (Table 13).

Table 13. Olympic Lift Success Criteria Evaluation, 2010.

	Success Criteria	Success Criteria Evaluation
Total Cover (%)	70% or greater	Top: √ Criterion Met A: √ Criterion Met C: √ Criterion Met
Total Plant Cover (%)	10% or greater	Top: √ Criterion Met A: × Criterion Not Met C: × Criterion Not Met
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition. No erosion resulting from runoff or dripping from foundations or decks.	Top: × Criterion Not Met A: √ Criterion Met C: √ Criterion Met

Restoration Treatments

Olympic Lift Bottom

The Olympic lift bottom consists of five individual treatment areas (Figure 36, Table 14, Figure 41, Figure 42, Figure 43, Figure 44, Figure 45, Figure 46, Figure 47, and Figure 48). In 2007, treatments in many of these areas were started, but not completed. In 2008, treatments in all areas were completed in accordance with project specifications. Soil and vegetation treatment specifications varied slightly among the different areas, depending on site conditions and planned future use. However, treatments in all areas included the following elements of full soil restoration: soil amendments, tilling, organic fertilizer, seed, and mulch. Temporary irrigation was also applied in several of these treatment areas to encourage rapid seed germination. Table 14 details the specific treatment elements implemented at each treatment area. The type of disturbance associated with each treatment area is described briefly below:

- Treatment Area A – re-graded ski run upslope of lower lift terminal

- Treatment Area B – saddle where lower lift terminal was replaced
- Treatment Area C – re-graded ski run down slope of lower lift terminal
- Treatment Area D – removed/treated section of Olympic Traverse Road
- Treatment Area E – disturbed area along utility line trench

In 2010, a part of the Olympic lift bottom treatment area A was re-mulched with pine needles and was irrigated on an unknown schedule.

Table 14. Olympic Lift Bottom Treatment Matrix, 2007 and 2008.

		Treatment Area				
		A	B	C	D	E
Amendments	Type	WC, FCZ, DWS	WC	WC, FCZ	WC, FCZ	WC, DWS
	Depth (in)	4	4*	4	4	4
Tilling	Depth (in)	15	10	12	12	20
Fertilizer	Type	Biosol 6-1-3	Biosol 6-1-3*	Biosol 6-1-3	Biosol 6-1-3*	Biosol 6-1-3*
	Rate (lbs/acre)	2,000	2,000*	2,000	2,000*	2,000*
Seed	Mix	Heavenly upland mix*	Heavenly upland mix*	Heavenly upland mix*	Heavenly upland mix*	Heavenly upland mix*
	Rate (lbs/acre)	87*	87*	87*	87*	87*
Mulch	Type	PNM	PNM	PNM	PNM	PNM
	Depth (in)	1	1	1	1	1
Irrigation	Frequency/ Duration	yes – unknown	yes – unknown	no	yes – unknown	no
Treatment Area	Square Feet	16,915	7,805	9,713	24,441	30,437

Key
WC = wood chips
FCZ = Full Circle Integrated Tahoe Blend Zero (composted coarse overs)
DWS = decomposed wood shavings
PNM = pine needle mulch
* = not verified in field

Figure 41. Olympic lift bottom, treatment area A, pre-treatment, 2007.

Figure 42. Olympic lift bottom, treatment area A, post-treatment, 2008.

Figure 43. Olympic lift bottom, treatment area A, post-treatment, 2009.

Figure 44. Olympic lift bottom, treatment area A, post-treatment, 2010. The re-mulched area is on the left.

Figure 45. Olympic lift bottom, treatment area B, pre-treatment, 2007.

Figure 46. Olympic lift bottom, treatment area B, post-treatment, 2008.

Figure 47. Olympic lift bottom, treatment area B, post-treatment, 2009.

Figure 48. Olympic lift bottom, treatment area B, post-treatment, 2010.

Olympic Lift Top

The Olympic lift top area consists of three individual treatment areas surrounding the upper Olympic lift terminal (Figure 36, Table 15, Figure 49, Figure 50, Figure 51, Figure 52, Figure 53, and Figure 54, Figure 55, and Figure 56). Soil and vegetation treatments for areas A and C included the following treatment elements: soil amendments, tilling, organic fertilizer, seed, and mulch. Area B was mulched to provide soil protection, rather than full restoration treatment, as this skier down ramp area is continually impacted by grooming and foot traffic. Rock slope protection was used to stabilize the cut slope between the lift terminal and treatment area C, as soil and vegetation-based treatments were unlikely to be successful due to steep slope angles, poorly developed soils, and likelihood of ongoing disturbance. Because the area near the top of Olympic Lift serves as a popular viewpoint for hikers in the summer, Heavenly constructed a foot trail between treatment areas A and B, fenced off the treatment areas, and posted educational signage to keep visitors from disturbing the recently treated revegetation areas. These treatment area protection measures proved to be very effective during summer 2008 and should be continued. The following treatments were partially implemented in 2007 and completed in 2008.

- Treatment Area A – flat parking area above lift terminal
- Treatment Area B – fill slope (skier down ramp) surrounding upslope side of lift terminal
- Treatment Area C – fill slope below lift terminal

Table 15. Olympic Lift Top Treatment Matrix, 2007 and 2008.

		Treatment Area		
		A	**B**	**C**
Amendments	**Type**	WC, FCZ	n/a	WC, FCZ
	Depth (in)	4	n/a	4
Tilling	**Depth (in)**	12	n/a	10
Fertilizer	**Type**	Biosol 6-1-3	n/a	Biosol 6-1-3
	Rate (lbs/acre)	2,000	n/a	2,000
Seed	**Mix**	Heavenly upland mix	n/a	Heavenly upland mix
	Rate (lbs/acre)	87	n/a	87
Mulch	**Type**	PNM	WC	PNM
	Depth (in)	1	2	1
Irrigation	**Frequency/Duration**	yes – unknown	n/a	yes – unknown
Treatment Area	**Square Feet**	5,165	4,196	5,552

Key
WC = wood chips
FCZ = Full Circle Integrated Tahoe Blend Zero (composted coarse overs)
DWS = decomposed wood shavings
PNM = pine needle mulch

Figure 49. Olympic lift top, pre-treatment, 2007.

Figure 50. Olympic lift top, post-treatment, 2008.

Figure 51. Olympic lift top, pre-treatment, 2007.

Figure 52. Olympic lift top, post-treatment, 2008.

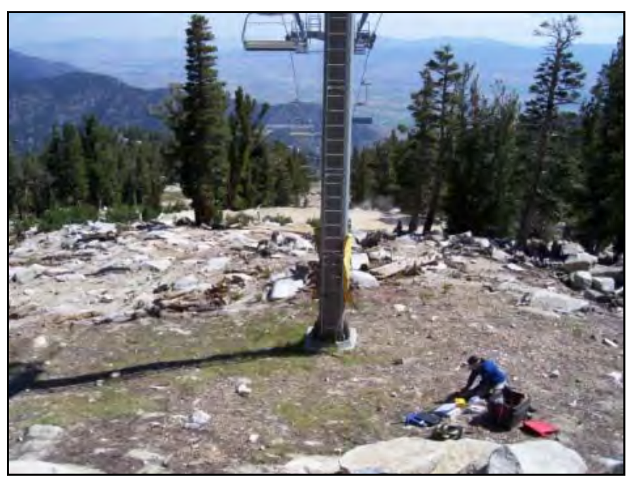


Figure 53. Olympic lift top, post-treatment, 2009.

Figure 54. Olympic lift top, post-treatment, 2010. Note presence of vegetation.

Figure 55. Olympic lift top, post-treatment, 2009.

Figure 56. Olympic lift top, post-treatment, 2010.

Performance Monitoring

In 2009 and 2010, post-treatment monitoring was conducted at one plot at Olympic top and two plots at Olympic bottom. The 2008 pre-treatment data from the sole pre-treatment monitoring plot at the Olympic bottom was compared to both post-treatment plots and therefore appears twice on each graph. For more data collected in 2008 and 2009, see the Heavenly Mountain Resort Mitigation and Monitoring Plan Annual Report, October 2008-October 2009, Appendix II.

Total Cover

The 2009 year 1 post-treatment total cover at the Olympic lift top (98%) was 78% higher than the 2007 pre-treatment total cover (55%; Figure 57). The 2009 year 1 post-treatment total cover at the Olympic lift bottom A (96%) was 75% higher than the pre-treatment total cover (55%). The 2009 year 1 post-treatment total cover at the Olympic lift bottom C (83%) was 51% higher than the pre-treatment total cover (55%). The success criterion, which states that the post-treatment total cover must be greater than 70%, was met for all plots.

In 2010, the year 2 post-treatment total cover was 95% at the Olympic lift top, 100% at Olympic lift bottom A, and 87% at Olympic lift bottom C. The success criterion of 70% total cover was met at each plot.

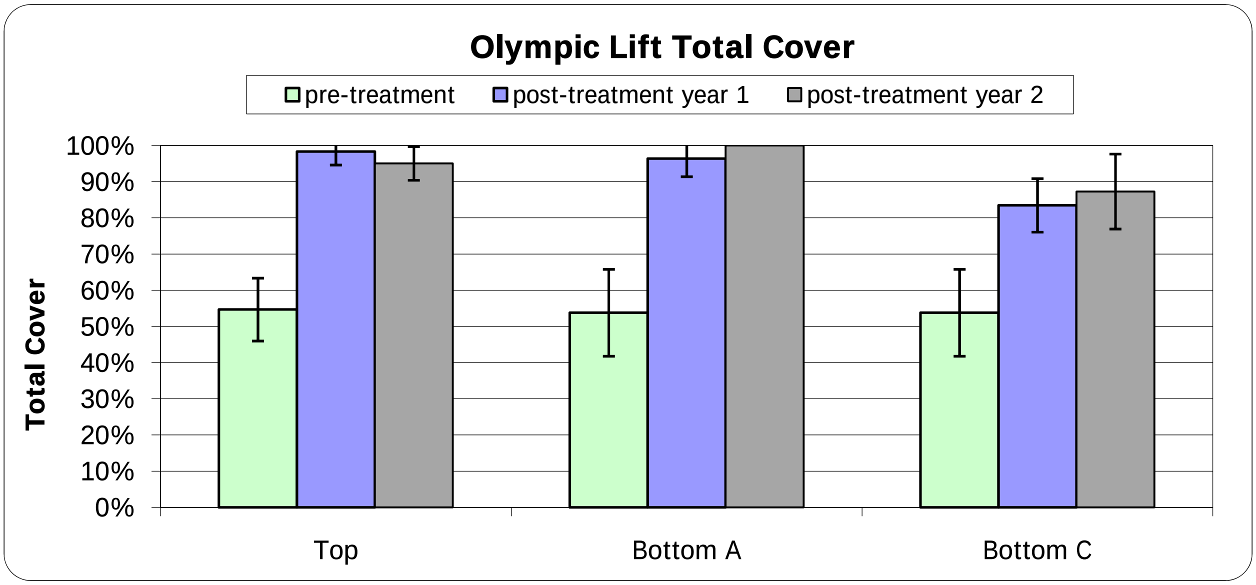


Figure 57. Olympic Lift Total Cover. The error bars denote one standard deviation above and below the mean. Pre-treatment data was collected in 2007 and post-treatment data was collected in 2009 (year 1) and 2010 (year 2).

Plant Cover

The 2009 yea 1 post-treatment plant cover at the Olympic Lift top (5%) was similar to the 2007 pre-treatment total cover (3%, Figure 58). The plant cover was dominated by grasses that were not mature enough to be identified.

The 2009 year 1 post-treatment total cover at the Olympic lift bottom A and C was 0%, compared to 15% pre-treatment in 2007 at both plots. Ocular estimates indicated that there was approximately 2% cover by native plants at both Olympic bottom A and C that was not captured during cover point monitoring. This indicates that native plants are beginning to establish. Although the plant cover was higher before restoration treatments, it was dominated by non-native species, which may not provide long-term protection against erosion when compared to deep-rooting native perennial grasses. The success criterion, which states that the post-treatment plant cover be at least 10%, was not met for the Olympic plots in 2009.

The 2010 year 2 post-treatment plant cover at the Olympic Lift top was 17%, which met the success criterion of plant cover greater than 10%.

The 2010 year 2 post-treatment total cover at the Olympic lift bottom A and C was 0%. Ocular estimates indicated that there was approximately 4% cover by native plants at Olympic bottom C that was not captured during cover point monitoring. However, this cover was by some non-native species, such as clover (*Melilotus sp.*), which could be of concern if the cover increases. Ocular estimates at Olympic lift bottom A indicated no species were present. The success criterion, which states that the post-treatment plant cover be at least 10%, was not met for the Olympic lift bottom plots.

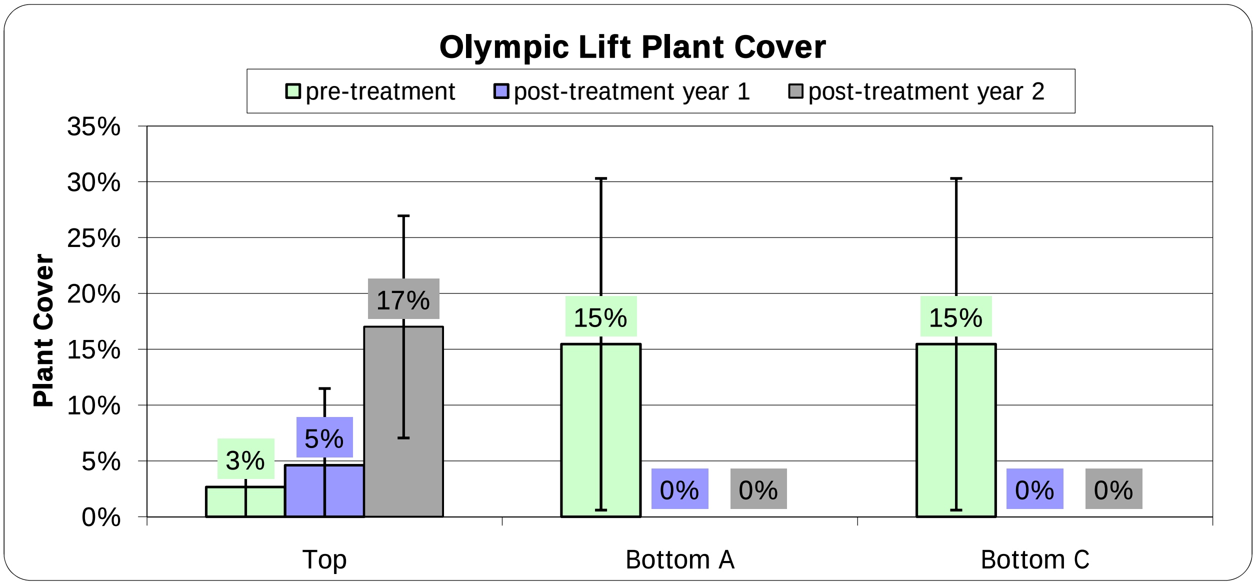


Figure 58. Olympic Lift Plant Cover. The error bars denote one standard deviation above and below the mean. Pre-treatment data was collected in 2007 and post-treatment data was collected in 2009 in 2010.

Visual Erosion Assessment

In 2010, at Olympic lift bottom A, no major evidence of erosion was observed. The tire tracks observed in 2009 were mulched with pine needles and were no longer visible. Animal disturbance and pine needle movement, which is sometimes an indicator of erosion, were observed at Olympic bottom C. No sediment deposition was observed on the upslope side of the pine needles, suggesting that wind transport may be the mechanism for pine needle movement.

In 2010, a leaky sprinkler (likely due to down-draining) near the maintenance building resulted in rill formation, erosion, and sedimentation of soil at the Olympic lift top plot A (Figure 59). Approximately 30-40 square feet of the plot was affected.

In 2010, road erosion resulted in sediment delivery from the road onto the Olympic lift top treatment area C (Figure 60). The sediment originated from several places along the road and overwhelmed a wattle as shown.

Figure 59. Olympic lift top terminal. Erosion and sedimentation from irrigation. The sprinkler head is circled and the red arrow shows the water flow path.

Figure 60. Olympic lift top terminal. Erosion and sedimentation originating from the road and moving towards the restoration area.

Management Responses and Follow-up Actions

In 2010, at the Olympic lift bottom plots, all of the success criteria were met, except for the plant cover criterion. As indicated in 2009, it would have been necessary to see an increasing plant cover trend in 2010 to avoid a management response. This trend was not observed in 2010; therefore, further fertilization, seeding, and irrigation is recommended in 2011 (Table 16). The plant cover criterion was met at the Olympic lift top; however, the plant cover was not equally distributed throughout the entire treatment area. One part of the top plot had less than 5% plant cover throughout. Further seeding, fertilization, and temporary irrigation is also recommended at this area, but only on the portion with low plant cover. It will be crucial to avoid disturbance to the portion of the plot meeting the success criteria.

In 2010, the Olympic lift top did not meet the visual erosion assessment success criterion for two reasons: malfunction with sprinkler equipment and road maintenance/design issues. Both issues should be addressed as soon as possible in 2011. An on-site assessment of the water flows at Olympic lift top should be conducted before proceeding with any of the road improvement work. Care should be taken to fully evaluate and redirect water flow to more appropriate areas, not just fill in rills and clean up sedimentation.

Table 16. Olympic Lift Management Responses and Follow-up Actions, 2010.

	Unmet Success Criterion	Management Response	Follow-up Action
Top	Visual Erosion Assessment	1. Assess water flows to determine the source of the road erosion issue 2. Implement road drainage improvements such that water is collected/infiltrated without causing erosion 3. Remove sediment in treatment areas.	1. Inspection of road drainage improvements during and after implementation 2. Visual erosion assessment after rain events (after road improvements are completed)

	Unmet Success Criterion	Management Response	Follow-up Action
		4. Ensure sprinkler heads and irrigation systems are maintained to preclude leaking. Place heads above water connection point to prevent drain-down leakage	
Top	Plant cover criterion was met in the designated monitoring area; however, large areas of zero plant cover existed and are addressed here	For low cover areas only (as determined and marked by IERS staff): **Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment
Bottom	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment
Top and Bottom	n/a	Install fencing/signage and communicate to staff locations of treatment areas to prevent foot and vehicle traffic	

Newly re-treated areas and the road improvements at Olympic top should be closely watched throughout the season, particularly during and immediately after rain events, to ensure that no erosion is occurring. At Olympic top, it is important ensure that surface runoff is no longer concentrating and causing erosion. The irrigation systems should be regularly inspected to ensure that failures or drain-down leakage is not occurring.

Two alternative approaches are presented to achieve the plant cover success criteria for both the top and bottom treatment areas. Alternative 2 is less labor-intensive than alternative 1. If alternative 2 is implemented, the monitoring after 1 month will indicate whether the low-effort seeding technique was successful, as plants will have germinated in this timeframe. If seed germination is not sufficient one month after implementation of alternative 2, the site will need to be re-treated using alternative 1. Additionally, it is recommended again that Heavenly expand efforts to minimize disturbance of treatment areas by installing temporary fencing and/or signage and communicating the locations of treatment areas to operations staff.

Heavenly Flyer Construction Project

Overview

The Heavenly Flyer construction project includes the installation of top and bottom terminals for a new zip line. Disturbances associated with this project included soil compaction from heavy equipment and some vegetation removal. There are two distinct treatment and monitoring areas: Heavenly Flyer bottom and Heavenly Flyer top. Each restoration treatment and monitoring area is described in detail below and is shown on the project map (Figure 62).

Heavenly Flyer Bottom

Heavenly Flyer Bottom was a relatively undisturbed area before treatment that encompasses the bottom lift terminal construction area (Figure 61). It is at an elevation of 9,151 feet AMSL on rocky soil derived from granitic parent material and faces southeast. The Heavenly Flyer bottom site is an open high elevation conifer forest dominated by white bark pine (*Pinus albicaulis*) with some Western white pine (*Pinus monticola*). The understory includes pinemat manzanita (*Arctostaphylos nevadensis*), and native forbs and grasses. A rare plant, Carson range rockcress (*Arabis rigidissima var. demota*), was present. The tree canopy cover is less than 5%, the solar exposure is 81%, and the slope angle is 15 degrees.

Figure 61. Heavenly Flyer bottom, pre-treatment, 2007.

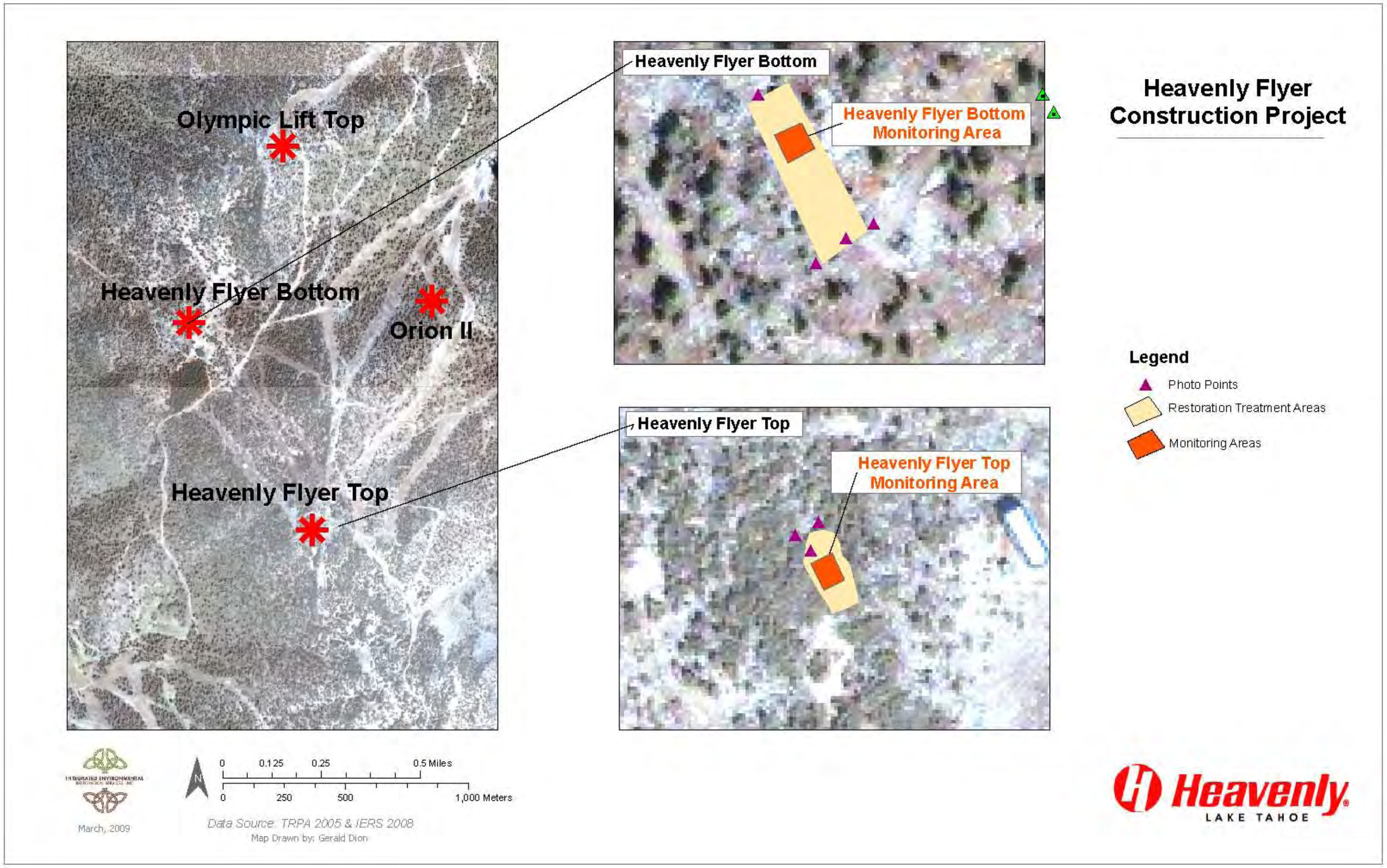


Figure 62. Heavenly Flyer Construction Project Map.

Heavenly Flyer Top

Heavenly Flyer top was a relatively undisturbed before treatment area that encompasses top lift terminal construction area (Figure 63). It is at an elevation of 9,395 feet AMSL on rocky soil derived from granitic parent material and faces north. The Heavenly Flyer top site is dominated by white bark pine (*Pinus albicaulis*) and has a thick layer of pine needle duff. The tree canopy cover is approximately 13%, the solar exposure is 44%, and the slope angle is 15 degrees.

Figure 63. Heavenly Flyer Top, pre-treatment cover point monitoring, 2007.

Objectives and Success Criteria

Treatment Objectives

- no net increase in runoff and/or sediment transport as a result of lift terminal replacement and associated site grading
- to establish an appropriate, self-sustaining, native plant community
- no evidence of erosion caused by zip line deck and foundations (i.e. concentrated runoff or dripping)

Monitoring Objective

- to quantitatively assess whether treatments resulted in a net change in runoff and/or sediment transport following construction of zip line terminals

Success Criteria

In 2010, the following success criteria were used (Table 17).

Table 17. Heavenly Flyer Success Criteria Evaluation, 2010.

	Success Criteria	Success Criteria Evaluation
Total Cover (%)	70% or greater	Top:√ Criterion Met Bottom:√ Criterion Met
Total Plant Cover (%)	10% or greater	Top: × Criterion Not Met Bottom:× Criterion Not Met
Organic Matter (%)	Not greater than 1.5 percentage points less than pre-treatment level	Top:√ Criterion Met Bottom:√ Criterion Met
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition. No erosion resulting from runoff or dripping from foundations or decks.	Top:√ Criterion Met Bottom:√ Criterion Met
*Top = Heavenly Flyer top, **Bottom = Heavenly Flyer bottom		

Restoration Treatments

Heavenly Flyer Top and Heavenly Flyer Bottom

The Heavenly Flyer top and bottom areas each consist of a single, contiguous treatment area encompassing the area of disturbance from the construction of the zip line terminals (Figure 64, Figure 65, Figure 67, Figure 68, Figure 69, Figure 70, and Figure 71). Soil and vegetation treatments for each area included all elements of full soil and vegetation treatment: soil amendments, tilling, organic fertilizer, seed, and mulch (Table 18). In 2007, amendments were incorporated into the soil via hand tilling at both treatment areas and fertilizer and seed were applied. However, no pine needle mulch was applied. In 2008, both treatment areas were completed by applying additional seed and pine needle mulch. Specific treatments implemented for the top and bottom areas are detailed below (Table 18).

Table 18. Heavenly Flyer Top and Bottom Treatment Matrix, 2007 and 2008.

		Top	Bottom
Amendments	**Type**	WC, FCZ	WC, FCZ
	Depth (in)	4 (2” each)	4 (2” each)
Tilling	**Depth (in)**	11	8
Fertilizer	**Type**	Biosol 6-1-3*	Biosol 6-1-3*
	Rate (lbs/acre)	2,000*	2,000*
Seed	**Mix**	Heavenly upland mix*	Heavenly upland mix*
	Rate (lbs/acre)	87*	87*
Mulch	**Type**	PNM	PNM
	Depth (in)	1	1
Irrigation	**Frequency/Duration**	No	No
Treatment Area	**Square Feet**	2,412	7,521

Key
WC = wood chips, FCZ = Full Circle Integrated Tahoe Blend Zero (composted coarse overs), PNM = pine needle mulch, * = not verified in field

Figure 64. Heavenly Flyer top, during construction, 2007. Pre-treatment conditions (very dense trees) were difficult to photograph.

Figure 65. Heavenly Flyer top, post-treatment, 2007.

Figure 66. Heavenly Flyer top, post-treatment 2010.

Figure 67. Heavenly Flyer bottom, pre-treatment, 2007.

Figure 68. Heavenly Flyer bottom, post-treatment, 2009.

Figure 69. Heavenly Flyer bottom, post-treatment, 2010.

Figure 70. Heavenly Flyer bottom, post-treatment, 2009.

Figure 71. Heavenly Flyer bottom, post-treatment, 2010.

Performance Monitoring

For more data collected in 2007, 2008, and 2009, see the Heavenly Mountain Resort Mitigation and Monitoring Plan Annual Report, October 2008-October 2009, Appendix II.

Total Cover

In 2009, at the Heavenly Flyer top, the total cover year 1 post-treatment (98%) was the same as the total cover pre-treatment in 2007 (98%, Figure 72). The cover composition changed from 58% mulch and 40% rocks/sand/gravel to 92% mulch and 6% rocks/sand/gravel. At the Heavenly Flyer bottom, the total cover year 1 post-treatment (88%) was 30% higher than the total cover pre-treatment (68%). Mulch cover increased from 42% to 72% following treatment. The success criterion, which is 70% total cover or greater, was met at both the Heavenly Flyer top and bottom.

In 2010 (year 2), total cover at the Heavenly Flyer top remained essentially unchanged at 96%. Total cover at the Heavenly Flyer bottom increased slightly to 93%. The success criterion, which is 70% total cover or greater, was met at both the Heavenly Flyer top and bottom.

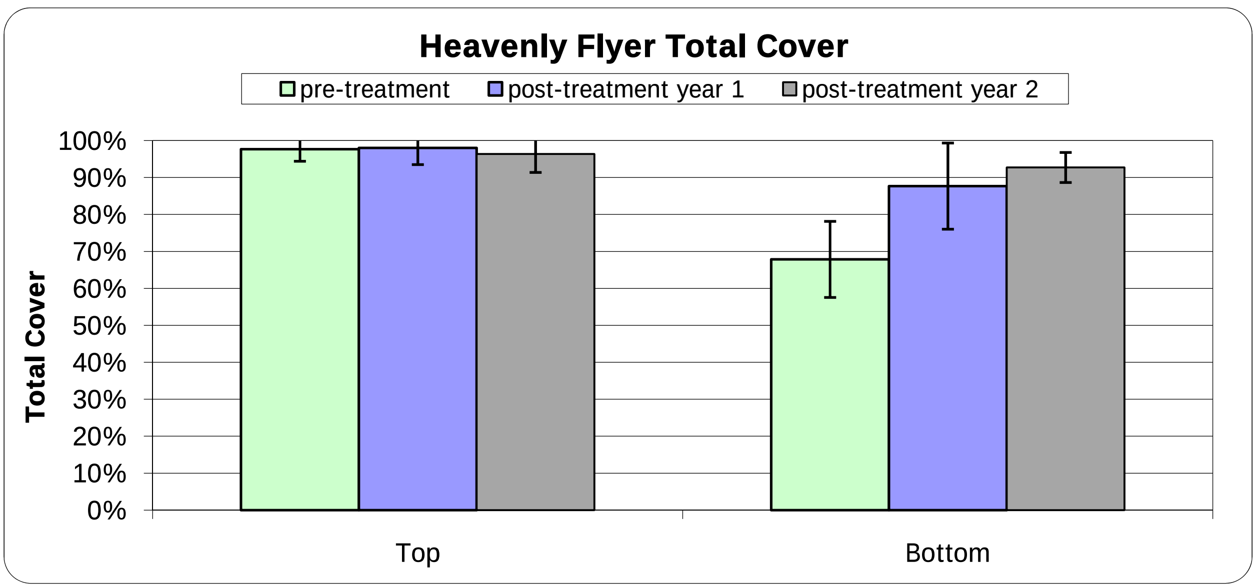


Figure 72. Heavenly Flyer Total Cover. The error bars denote one standard deviation above and below the mean. Post-treatment measurements were conducted in 2009 and 2010 and pre-treatment measurements were conducted in 2007.

Plant Cover

In 2009, the post-treatment year 1 plant cover at Heavenly Flyer top (0%) was similar to the pre-treatment plant cover in 2007 (1%; Figure 58). The post-treatment year 1 plant cover at the Heavenly Flyer bottom was 0%, compared to 12% pre-treatment. Ocular estimates indicated that there were trace amounts of cover by native plants (and one unknown species) at both plots that were not captured during cover point monitoring. This indicates that native plants are beginning to establish. The success criterion, which requires that post-treatment plant cover be at least 10%, was not met for either plot.

In 2010, the Heavenly Flyer top year 2 post-treatment plant cover was zero and the Heavenly Flyer bottom plant cover was 2%. Ocular estimates indicated that there were trace amounts of cover by native plants at the Heavenly Flyer top that were not captured during cover point monitoring. This may indicate that native plants are beginning to establish; however, the plant cover has remained essentially unchanged since 2009. The success criterion, which requires that post-treatment plant cover be at least 10%, was not met for either plot.

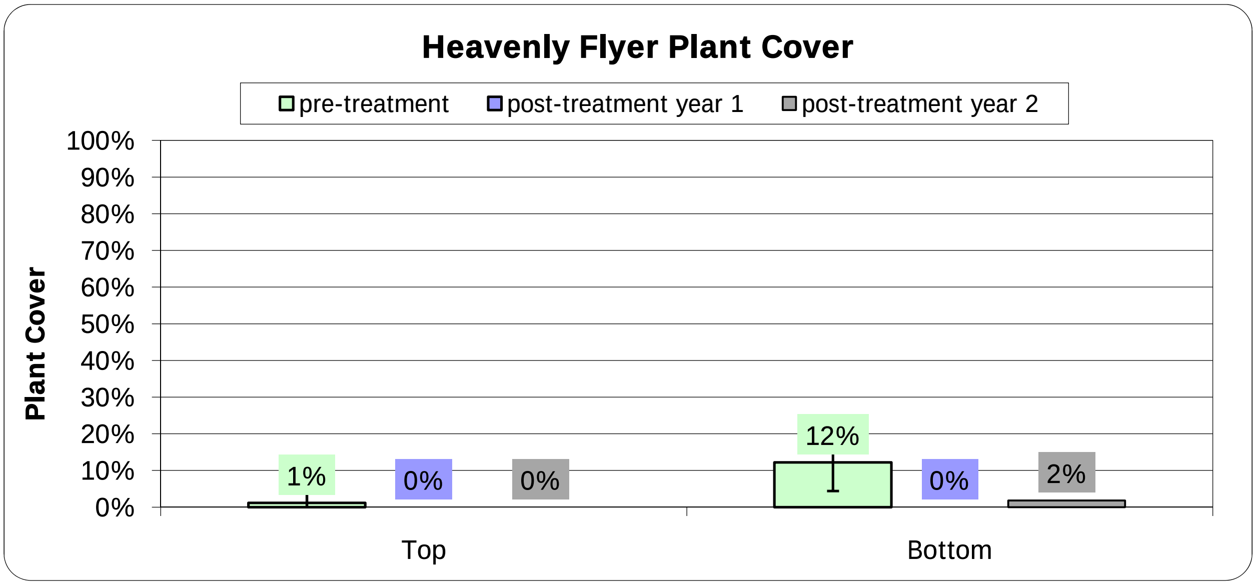


Figure 73. Heavenly Flyer Plant Cover. Post-treatment measurements were conducted in 2009 and 2010 and pre-treatment measurements were conducted in 2007.

Soil Nutrients

Organic Matter

In 2009, at the Heavenly Flyer top, the year 1 post-treatment organic matter (2.2%) was similar to the pre-treatment organic matter in 2007 (2.1%; Figure 74). At the Heavenly Flyer bottom, the organic matter increased by 161% from 1.8% to 4.7%. The success criterion, which states that the post-treatment organic matter must be no more than 1.5 percentage points lower than the pre-treatment organic matter, was met for both the Heavenly Flyer top and bottom in 2009.

In 2010, year 2 post-treatment organic matter content was 2.6% at Heavenly Flyer top and 2.2% at Heavenly Flyer bottom. The success criterion, which states that the post-treatment organic matter must be no more than 1.5 percentage points lower than the pre-treatment organic matter, was met for both the Heavenly Flyer top and bottom in 2010.

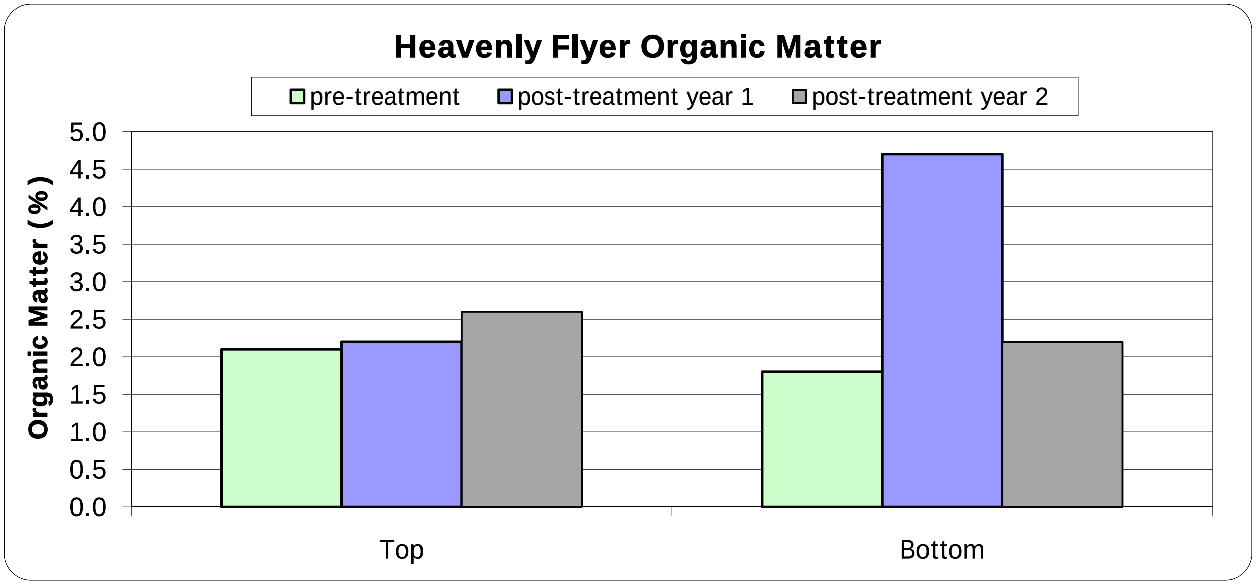


Figure 74. Heavenly Flyer Organic Matter. Post-treatment measurements were conducted in 2009 and 2010 and pre-treatment measurements were conducted in 2007.

Total Kjeldahl Nitrogen

In 2009, at the Heavenly Flyer top, the year 1 post-treatment TKN (523 ppm) was 26% lower than the pre-treatment TKN in 2007(703 ppm; Figure 75). At the Heavenly Flyer bottom, the year 1 post-treatment TKN (682 ppm) was 34% lower than the pre-treatment TKN (448 ppm). A success criterion for TKN was not used in 2009.

In 2010 (year 2 post-treatment), the TKN at the Heavenly Flyer top was 413 ppm, while the TKN at the Heavenly Flyer bottom was 534 ppm. For the same reasons as 2009, a success criterion for TKN was not used in 2010.

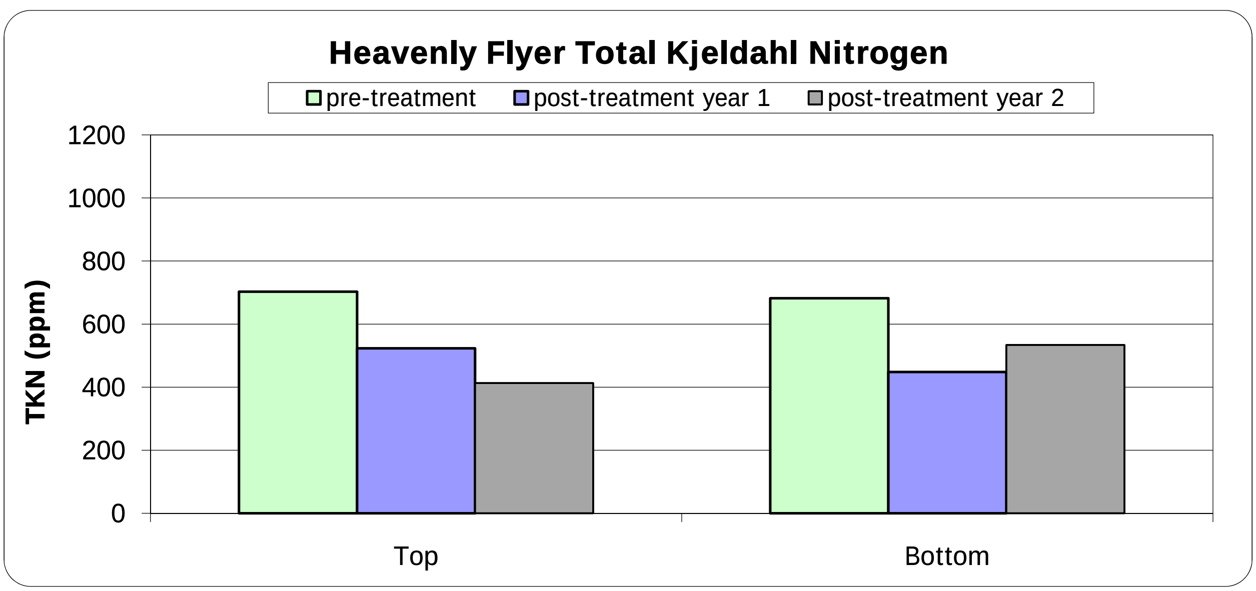


Figure 75. Heavenly Flyer Total Kjeldahl Nitrogen (TKN). Post-treatment measurements were conducted in 2009 and 2010 and pre-treatment measurements were conducted in 2007.

Visual Erosion Assessment

In 2010, at the Heavenly Flyer top and bottom, no major erosion problems were evident, though foot traffic was present at the Heavenly Flyer top. The criterion, which states that no visible signs of rills, gullies, sediment transport, sediment deposition, or erosion from foundations or structures can be present, was met for both plots.

Management Responses and Follow-up Actions

In 2010, most of the success criteria were met for the Heavenly Flyer. However, the success criterion for plant cover was not met for the second year in a row. As indicated in 2009, it would have been necessary to see an increasing plant cover trend in 2010 to avoid a management response. This trend was not observed in 2010; therefore, further fertilization, seeding, and irrigation is recommended in 2011 (Table 19).

Table 19. Heavenly Flyer Management Responses and Follow-up Actions, 2010.

	Unmet Criterion	Management Response	Follow-up Action
Bottom	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment
Bottom	n/a	Install appropriate signage and fencing to prevent foot traffic	
Bottom	n/a	Formalize walking trail if staff will be walking between the lodge and the Flyer	1. Implementation monitoring 2. Visual erosion assessment
Top	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment
Top	n/a	Install appropriate signage and fencing to prevent foot traffic	

Two alternative approaches are presented to achieve the plant cover success criterion for both the top and bottom treatment areas. Alternative 2 is less labor-intensive than alternative

1. If alternative 2 is implemented, the monitoring after 1 month will indicate whether the low-effort seeding technique was successful, as plants will have germinated in this timeframe. If seed germination is not sufficient one month after implementation of alternative 2, the site will need to be re-treated using alternative 1. Additionally, it is recommended again that Heavenly expand efforts to minimize disturbance of treatment areas by installing temporary fencing and/or signage and communicating the locations of treatment areas to operations staff.

Newly re-treated areas should be closely watched throughout the season, particularly during and immediately after rain events, to ensure that no erosion is occurring. The irrigation systems should be regularly inspected to ensure that failures or drain-down leakage is not occurring.

Mid Station Road Project

Overview

Mid Station Road is an unpaved access road that leads from the top of the gondola to the gondola mid station. The road is only used for limited summer and emergency access. As part of the Mid Station Road project, a portion of the road near the mid station was realigned in 2008 and the abandoned segment of the road was removed and treated to restore the soil and vegetation community (Figure 76, Figure 77, and Figure 78). The treatment area is at an elevation of 9,142 feet AMSL. The soil is derived from granitic parent material and the site faces west to southwest. Vegetation was not present in the planned treatment area. Rills and gullies, which were formed by water erosion, were present on the road surface before treatment. The surrounding area has many large rocks and is dominated by white bark pine (*Pinus albicaulis*). There is no tree canopy cover in the treatment area, the solar exposure is 77%, and the slope angle is 9 degrees.

Figure 76. Mid Station Road, pre-treatment, 2007.

Figure 77. Mid Station Road, pre-treatment, with monitoring transects, 2007.

Figure 78. Mid Station Road Project Map.

Objectives and Success Criteria

Treatment Objectives

- no net increase in runoff and/or sediment transport as a result of road construction and partial removal/restoration of existing road segment
- to establish an appropriate, self-sustaining, native plant community in the existing road segment to be removed/treated

Monitoring Objective

- to quantitatively assess whether treatments resulted in a net change in runoff and/or sediment transport from the site following road construction and partial removal/restoration of existing road segment

Success Criteria

In 2010, the success criteria in Table 20 were used.

Table 20. Mid Station Road Success Criteria Evaluation, 2010.

	Success Criteria	Success Criteria Evaluation
Total Cover (%)	70% or greater	√ Criterion Met
Total Plant Cover (%)	10% or greater	× Criterion Not Met
Organic Matter (%)	Not greater than 1.5 percentage points less than pre-treatment level	√ Criterion Met
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition.	× Criterion Not Met

Restoration Treatments

In 2008, vehicle traffic was excluded from the abandoned segment of the Mid Station Road and soil and vegetation restoration treatments were implemented to functionally remove the road and restore the area to surrounding undisturbed conditions. The abandoned road segment was divided into two treatment areas, one upslope of the realigned road (area A) and one down slope of the realigned road (area B; Figure 78). The treatment for area A included all elements of full soil and vegetation treatment: soil amendments, tilling, organic fertilizer, seed, and mulch. The treatment for area B included soil amendments, tilling, and mulch. Area B's treatment is intended to maximize infiltration, thereby reducing runoff and erosion, but did not including seeding or fertilizer. This treatment area has a low slope angle and is surrounded by mature forest; therefore, it presented a low-risk opportunity to test a lower-intensity treatment. The lower-intensity treatment was focused on optimizing soil conditions and relying on natural seed cast from the surrounding vegetated areas to assist in reestablishing vegetation. The specific treatment elements implemented at each treatment area are detailed in Table 21 and photos are in Figure 79, Figure 80, Figure 81, Figure 82, Figure 83, and Figure 84.

Table 21. Mid Station Road Treatment Matrix, 2008.

		Treatment Area	
		A	B
Amendments	Type	WC	WC
	Depth (in)	4	4
Tilling	Depth (in)	18	16
Fertilizer	Type	Biosol 6-1-3	n/a
	Rate (lbs/acre)	2,000	n/a
Seed	Mix	Heavenly upland mix	n/a
	Rate (lbs/acre)	50	n/a
Mulch	Type	PNM	PNM
	Depth (in)	1-2	1-2
Irrigation	Frequency/Duration	no	no
Treatment Area	Square Feet	5,815	4,125
Key WC = wood chips PNM = pine needle mulch * = not verified in field			

Figure 79. Mid Station Road, treatment area A, pre-treatment with monitoring transects, 2007 (photo point 6).

Figure 80. Mid Station Road, treatment area A, post-treatment, 2008 (photo point 6).

Figure 81. Mid Station Road, treatment area A, post-treatment, 2009 (photo point 6).

Figure 82. Mid Station Road, treatment area A, post-treatment, 2010 (photo point 6). Bare areas can be seen.

Figure 83. Mid Station Road, treatment area B, post-treatment, 2008.

Figure 84. Mid Station Road, treatment area B, post-treatment, 2010.

Performance Monitoring

For more data collected in 2007, 2008, and 2009, see the Heavenly Mountain Resort Mitigation and Monitoring Plan Annual Report, October 2008-October 2009, Appendix II.

Total Cover

In 2009, at Mid Station Road, the post-treatment year 1 total cover (88%) was 159% higher than the total cover pre-treatment in 2007 (34%, Figure 85). The mulch cover increased by 252% from 25% to 88%. The success criterion, which states the total cover must be greater than 70% post-treatment, was met for 2009.

In 2010, the total post-treatment year 2 cover was 83%. The success criterion, which states the total cover must be greater than 70% post-treatment, was met for 2010.

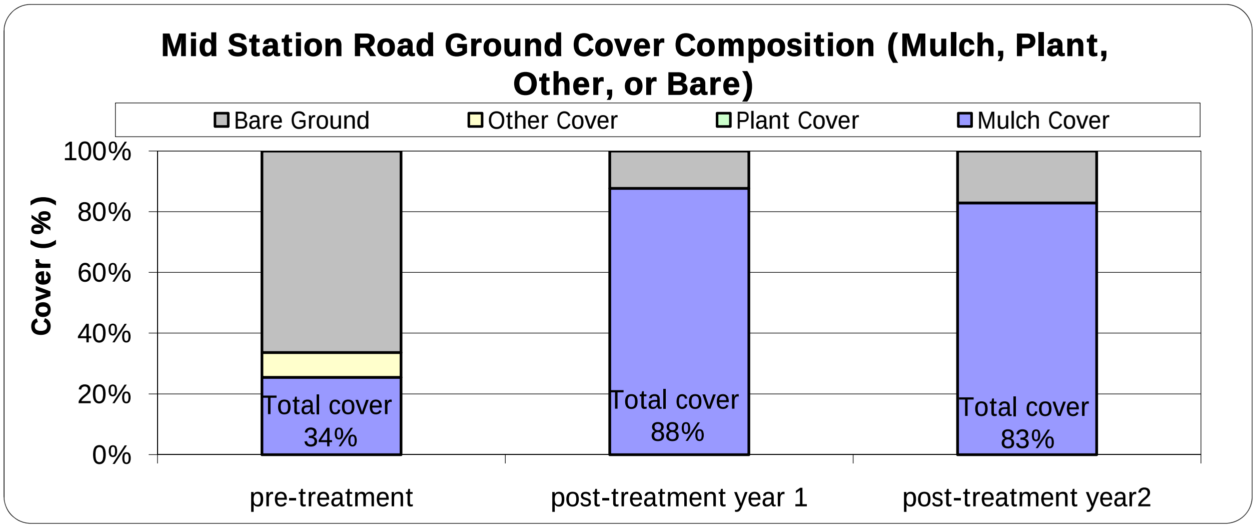


Figure 85. Mid Station Road Total Cover. Post-treatment measurements were conducted in 2009 and 2010 and pre-treatment measurements were conducted in 2007.

Plant Cover

In 2009 and 2010, plant cover did not change and remained at zero post-treatment; therefore the criterion of 10% plant cover or greater was not met (no graph).

Soil Nutrients

Organic Matter

In 2009 and 2010, at Mid Station Road, the post-treatment organic matter contents (0.9% and 0.6% respectively) were similar to the pre-treatment organic matter in 2007 (0.6%; Figure 86). The success criterion, which states that the post-treatment organic matter must no more than 1.5 percentage points below the pre-treatment organic matter content, was met in both 2009 and 2010. The organic matter content from an undisturbed reference area is presented alongside the 2007-2010 data.

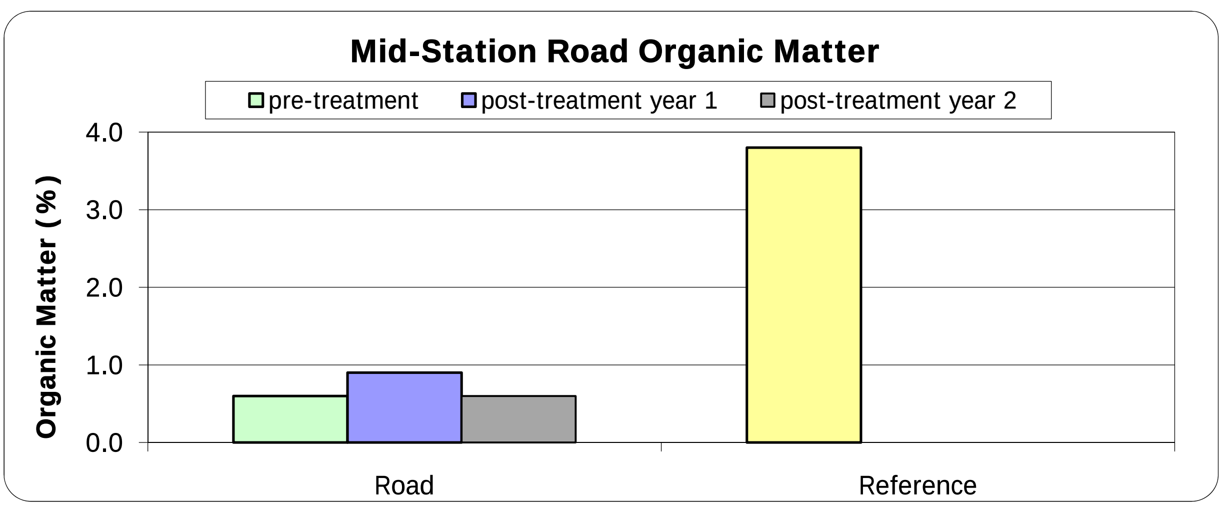


Figure 86. Mid Station Road Organic Matter. Post-treatment measurements were conducted in 2009 (year 1) and 2010 (year 2) and pre-treatment measurements were conducted in 2007.

Total Kjeldahl Nitrogen

In 2009, at Mid Station Road, the year 1 post-treatment TKN (182 ppm) was 40% or 122 ppm lower than the pre-treatment TKN in 2007(304 ppm; Figure 87). In 2010, at Mid-Station Road, the year 2 post-treatment TKN was 165 ppm. A success criterion for TKN was not used in 2009 or 2010. The TKN from an undisturbed reference area is presented alongside the 2007-2010 data.

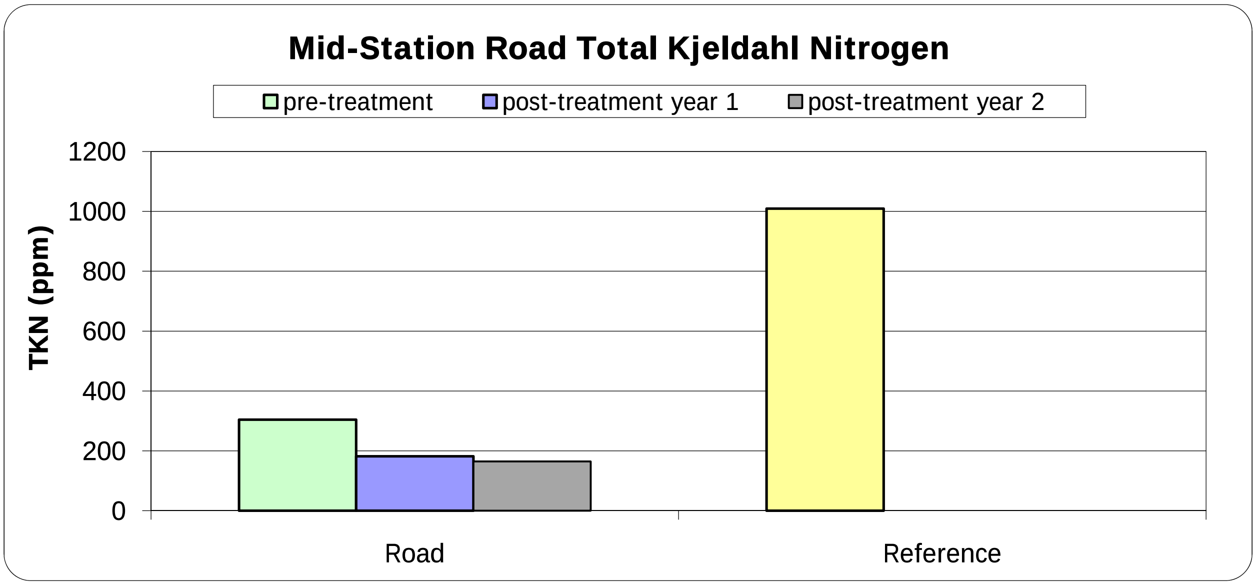


Figure 87. Mid Station Road Total Kjeldahl Nitrogen (TKN). Post-treatment measurements were conducted in 2009 (year 1) and 2010 (year 2) and pre-treatment measurements were conducted in 2007.

Visual Erosion Assessment

In 2010, a large visual change occurred at Mid-Station Road. Many small mounds of bare soil appeared in the upper part of plot A (Figure 82). These mounds are likely a result of rodent or small animal activity, though the source is not entirely clear. A small number of these mounds were present in 2009 and one rainfall simulation frame was unknowingly placed on one of these mounds, creating a high level of sediment in the runoff. In 2010, splash detachment from rain events was evident on the mounds, indicating water erosion. The mounds/bare soil covered approximately 35% (ocularly estimated) of the entire plot, which encompasses a larger area than the monitoring plot than where cover was conducted on transects. There was a lower concentration of mounds where the transects were placed (Figure 85).

Management Responses and Follow-up Actions

In 2010, the plant cover remained unchanged at zero, while the ocularly estimated mulch cover in some areas of the plot decreased and the ocular estimate of bare soil increased. Low or no plant cover, decreasing mulch cover and increasing bare soil are all indications that this site is not resilient and is prone to increasing erosion over time. It is recommended to undertake fertilizing, seeding, mulching, and irrigation in 2011 to achieve project success criteria (Table 22). Creative solutions may be necessary to implement irrigation at Mid Station road, as snowmaking lines are not in close proximity.

Table 22. Mid Station Road Management Responses and Follow-up Actions, 2010.

	Unmet Criterion	Management Response	Follow-up Action
Road	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment
Road	Visual Erosion Assessment	Additional mulching after implementing alternative 1 or 2 above to achieve total cover criterion. Mulch should be applied to 2 inches.	1. Implementation monitoring during mulching activities 2. Visual erosion assessment (captured above as follow-up for plant cover criterion)

Newly re-treated areas should be closely watched throughout the season, particularly during and immediately after rain events, to ensure that no erosion is occurring. Any sign of rodent activity should be immediately noted and followed closely. The irrigation systems should be regularly inspected to ensure that failures or drain-down leakage is not occurring.

Two alternative approaches are presented to achieve the plant cover success criteria. Alternative 2 is less labor-intensive than alternative 1. If alternative 2 is implemented, the monitoring after 1 month will indicate whether the low-effort seeding technique was successful, as plants will have germinated in this timeframe. If seed germination is not sufficient one month after implementation of alternative 2, the site will need to be re-treated using alternative 1.

Skyline Trail Re-Grade Project

Overview

The Skyline Trail re-grade project consisted of re-grading, widening, and realigning the Skyline Trail ski run to achieve a more consistent slope throughout the length of the trail. There are two distinct monitoring areas on the Skyline Trail: road cut and road shoulder. In addition, one area near the bottom of the Dipper chairlift, the Dipper bottom slope, was also monitored pre-treatment. Large rocks removed during grading at Skyline Trail were placed at the Dipper bottom. Post-treatment monitoring was not conducted at the Dipper bottom, as there were a sufficient number of large rocks to cover the entire area and soil restoration treatments were not necessary. The Skyline Trail re-grade project map shows the locations of treatment and monitoring areas associated with this project (Figure 88).

Site Description

Cut Slope

The cut slope, as the name implies, is a slope created from the construction the Skyline Trail (Figure 89). It is very steep (approximately 33 degrees) and exhibited evidence of wind and water erosion pre-treatment. Rills were visible throughout the slope and pine needle movement from water erosion was apparent. Located at approximately 9,600 feet AMSL on an east-facing slope, it is in an exposed area that has greater than 90% solar exposure in the summer months. The soil is derived from granitic parent material and has a low proportion of rocks. Little vegetation is present at this high elevation site. Whitebark pine (*Pinus albicaulis*) is present with an understory of penstemon (*Penstemon sp.)* and buckwheat (*Eriogonum sp.*). Tahoe draba (*Draba asterophora var. asterophora*), a rare native plant, is present in the surrounding area.

Figure 88. Skyline Trail Re-Grade Project Map.

Figure 89. Skyline Trail cut slope, pre-treatment, 2008.

Road Shoulder

The road shoulder treatment area is located along the same road as the cut slope, just downhill at approximately 9,580 feet AMSL (Figure 90). Pre-treatment, it was a very disturbed area, with evidence of foot traffic and tire tracks. Both rills and gullies were present. The area is gently sloped at approximately 8 degrees, faces west, and has a summer solar exposure of greater than 90%. The soil is derived from granitic parent material and has a low proportion of rocks. No vegetation was present within the sampling area and little vegetation is present in the surrounding area at this high elevation site, especially in the understory. Trees that are present include whitebark pine (*Pinus albicaulis*) and mountain hemlock (*Tsuga mertensiana*). Tahoe draba (*Draba asterophora var. asterophora*), a rare native plant, is present in the surrounding area.

Figure 90. Skyline Trail road shoulder monitoring area, pre-treatment, 2008.

Dipper Bottom Slope

The Dipper bottom slope is located near the bottom terminal of the Dipper chairlift in a disturbed area (Figure 91 and Figure 92). Pre-treatment, there was evidence of water erosion, including rills and a drainage gully with sedimentation. There was also disturbance from small and large animals, including burrowing and grazing. This area is frequented by deer and coyotes, as feces were present throughout the site. The site is located on a west-facing slope at an elevation of 8,636 feet AMSL. The solar exposure for this gently sloped site (6 degrees) is greater than 95% during the summer because no canopy cover is present. The soil is derived from granitic parent material with approximately 40% composition by rocks greater than 0.5 inches in diameter. Species present in the surrounding area include greenleaf manzanita (*Arctostaphylos patula*), tobacco brush (*Ceanothus velutinus*), red fir (*Abies magnifica*), and Western white pine (*Pinus monticola*). There were three invasive species present within the monitoring area: common sheep sorrel (*Rumex acetosella*), creeping bentgrass (*Agrostis stolonifera*) and orchard grass (*Dactylis glomerata*). A mix of approximately 50% native species and 50% non-native species of forbs and shrubs were present. The high proportion of non-native species may be attributed to the straw mulch present at the site. Non-native seeds are often present in straw. A few native shrubs and tree seedlings were also present in the plot.

Figure 91. Skyline Trail Dipper bottom slope monitoring area, pre-treatment, 2008.

Figure 92. Skyline Trail Dipper bottom slope, pre-treatment, 2008.

Figure 93. Skyline Trail Dipper bottom slope, pre-treatment, 2008.

Figure 94. Skyline Trail Dipper bottom slope, after rock application, 2009.

Objectives and Success Criteria

Treatment Objectives

- no net increase in runoff and/or sediment transport as a result of the trail widening, re-aligning, and grading
- no net increase in runoff and/or sediment transport as a result of rock placement at the bottom of the Dipper chairlift

Monitoring Objective

- to quantitatively assess whether treatments resulted in a net change in runoff and/or sediment transport following the trail modification

Success Criteria

In 2010, the following success criteria were used (Table 23).

Table 23. Skyline Trail Success Criteria Evaluation, 2010.

	Success Criteria	Success Criteria Evaluation
Total Cover (%)	70% or greater	√ Criterion Met
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition.	× Criterion Not Met

Restoration Treatments

Restoration treatments were conducted in 2008 (Figure 95, Figure 96, Figure 97, Figure 98, Figure 99, Figure 100, Figure 101, Figure 102, Figure 103, Figure 104, and Figure 105). The primary areas that were affected by grading and trail improvement activities as part of the Skyline Trail project were road shoulders and cut slopes. Rock slope protection was used to stabilize cut slopes, as soil and vegetation-based treatments were unlikely to be successful due to steep slope angles, poorly developed soils, and the high elevation nature of the project area. Infiltration strips (4-8 feet wide) were constructed in all roadside areas where the road is outsloped and concentrated road runoff has the potential to cause erosion down slope. Infiltration strips were created by "tucking" 2-3 inches of wood chips into the soil using the teeth on the bucket of a full size excavator. This treatment loosened the soil to a depth of approximately 6 inches and incorporated a portion of the wood chips into the soil. This left some wood chips on the surface to function as mulch/surface protection and roughened the soil surface. The overall goal of this treatment type is to slow down and infiltrate runoff from the road surface. This treatment was also implemented in the upper portion of the Milky Way ski run, which is adjacent to Skyline Trail and was also disturbed during re-grading. Some segments of road shoulder infiltration strips with low mulch cover were mulched with pine needles in spring 2009 by Heavenly operations staff. Lastly, spoil materials (primarily large rocks) generated during the re-grading of Skyline Trail were placed near the bottom of the Dipper lift. No soil and vegetation treatments were implemented in this area, as the spoil materials were composed of primarily large boulders.

Table 24. Skyline Trail Treatment Matrix, 2008 and 2009.

Amendments	**Type**	Woodchips, Boulder Lodge blend
	Depth (in)	3
Tilling	**Depth (in)**	6
Fertilizer	**Type**	n/a
	Rate (lbs/acre)	n/a
Seed	**Mix**	n/a
	Rate (lbs/acre)	n/a
Mulch	**Type**	WC, BLB
	Depth (in)	0-1
Irrigation	**Frequency/Duration**	n/a
Treatment Area	**Square Feet**	27,964

Figure 95. Skyline Trail cut slope, pre-treatment, 2008 (photo point 1).

Figure 96. Skyline Trail cut slope, post-treatment, 2009 (photo point 1).

Figure 97. Skyline Trail cut slope, post-treatment, 2010 (photo point 1).

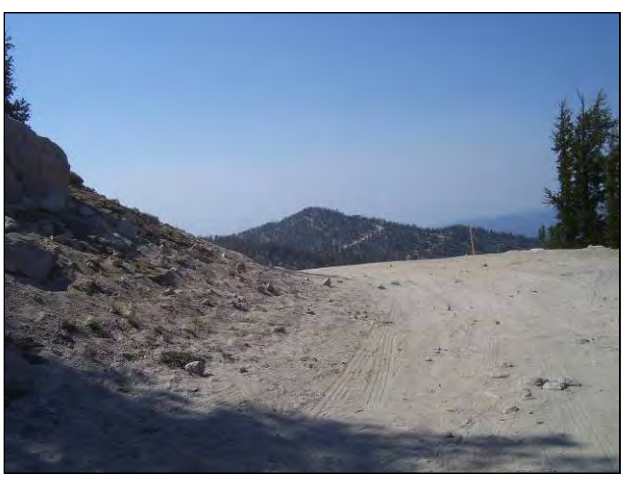


Figure 98. Skyline Trail cut slope and road shoulder, pre-treatment, 2008 (photo point B).

Figure 99. Skyline Trail cut slope and road shoulder, post-treatment, 2009 (photo point B).

Figure 100. Skyline Trail cut slope and road shoulder, post-treatment, 2010 (photo point B).

Figure 101. Skyline Trail road shoulder monitoring area, pre-treatment, 2008 (photo point 1).

Figure 102. Skyline Trail road shoulder monitoring area, post-treatment, 2009 (photo point 1).

Figure 103. Skyline Trail road shoulder monitoring area, post-treatment, 2010 (photo point 1).

Figure 104. Skyline Trail Dipper bottom slope, pre-treatment, 2008.

Figure 105. Skyline Trail Dipper bottom slope, post-treatment.

Performance Monitoring

In 2008, pre-treatment monitoring was conducted at the Skyline Trail cut slope and road shoulder and at the bottom of the Dipper chairlift. Post-treatment monitoring was conducted solely at the Skyline Trail road shoulder. The rock slope protection treatments applied at the Skyline Trail cut slope and the Dipper chairlift did not require post-treatment monitoring because soil restoration treatments were not conducted. For more data collected in 2008 and 2009, see the Heavenly Mountain Resort Mitigation and Monitoring Plan Annual Report, October 2008-October 2009, Appendix II.

Total Cover

In 2009, the year 1 post-treatment total cover at the Skyline Trail road shoulder (100%) was approximately 1900% greater than the pre-treatment ocular estimate of total cover in 2008 (5%; Figure 106). The criterion, which states that the post-treatment total cover must be greater than 70%, was met.

In 2010, the year 2 post-treatment total cover ocular estimate at the road shoulder was 95%. The criterion, which states that the post-treatment total cover must be greater than 70%, was met.

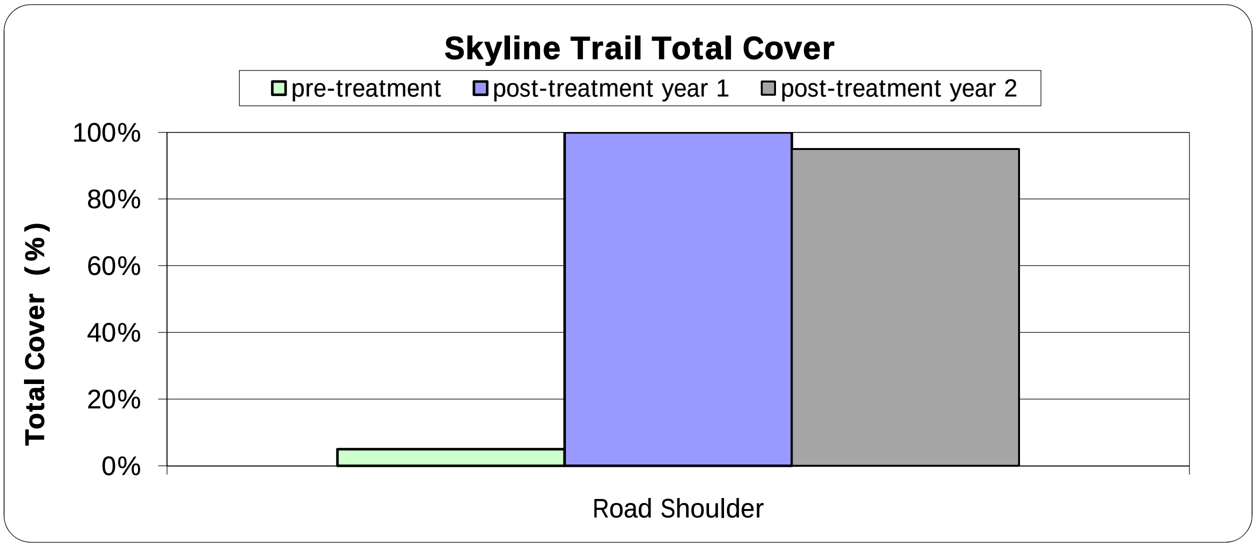


Figure 106. Skyline Trail Total Cover. The pre-treatment and post-treatment year 2 total covers are ocular estimates. Pre-treatment measurements were conducted in 2008, while post-treatment measurements were conducted in 2009.

Visual Erosion Assessment

In 2010, erosion on the road next to the road shoulder plot, and sedimentation in the road shoulder plot were observed. Some of the mulch at the road shoulder plot was under sediment from the road (Figure 107).

Figure 107. Sediment from road erosion on the road shoulder plot. Arrow shows the direction of water flow.

Management Responses and Follow-up Actions

In 2010, the total cover criterion was met; however, the visual erosion assessment criterion was not met. Concentrated drainage from the road had cut through the roadside infiltration strip. An on-site assessment of road drainage should be conducted before implementing any treatments (Table 25).

Annual visual erosion assessment is recommended for the road shoulder infiltration strips to determine where targeted maintenance may be necessary, as regular impacts by both vehicles and foot traffic are expected. These road shoulder infiltration strips are expected to require annual targeted maintenance (e.g. re-mulching, soil loosening) to maintain their intended function of slowing and infiltrating runoff from out-sloped road surfaces. The woodchip incorporation treatment was intended to increase microbial activity and increase the resilience of these areas to disturbance; however, continual disturbance by vehicles and foot traffic will quickly reduce their functional life. It is recommended that Heavenly expand efforts to minimize disturbance of these treatment areas by continuing to communicate their locations and intended functions to operations staff. During routine inspections of road shoulder infiltration strips, Heavenly staff should have mulch (preferably wood chips) on hand to re-apply mulch in bare areas and a pick mattock to loosen compacted soil areas (particularly tire tracks).

Table 25. Skyline Trail Management Responses and Follow-up Actions, 2010.

	Unmet Criterion	Management Response	Follow-up Action
Road Shoulder	n/a	Targeted maintenance (mulching, soil loosening, etc.)	Visual erosion assessment after rain events to ensure maintenance is effective
Road Shoulder	Visual Erosion Assessment	1. Identify areas of concentrated road drainage 2. Implement road drainage improvements such that water is collected/infiltrated in a stable manner 3. Remove deposited sediment in treatment areas.	1. Inspection of road drainage improvements during and after implementation 2. Visual erosion assessment and photo monitoring after rain events (after maintenance is completed)

Lakeview Lodge Water System Improvement Project

Overview

The Lakeview Lodge Water System Improvement project includes a range of improvements to the water infrastructure near the Lakeview Lodge at the top of the tram. The project includes removal of the existing water tank, construction of a new water tank, and construction of new underground waterlines to tie into existing infrastructure. Construction activities are primarily taking place in previously disturbed areas. Trenching was the primary impact to soil and vegetation during the 2008 construction season. Seven treatments and three monitoring areas were established at this project in 2008 (Figure 108). In 2010, the ADA trail from Lakeview Lodge to the top of the tram was completed. In 2011, the second phase of the Lakeview Lodge Water System Improvement project is planned to be implemented, which will include the removal of the existing water tank and restoration of the associated access road.

Site Description

Gun Barrel Top Terminal Slope

The Gun Barrel top terminal slope (Gun Barrel top slope) is a disturbed slope with a summer road that switchbacks through it (Figure 109 and Figure 110). The site is located on a northeast facing slope at an elevation of 8,303 feet AMSL. The site is moderately sloped (14 degrees), does not have any canopy cover, and has a solar exposure of greater than 95% during the summer months. The soil is derived from granitic parent material with a low proportion of rocks greater than 0.5 inches in diameter. Conifers surround the area, which is dominated by red fir (*Abies magnifica*), Jeffrey pine (*Pinus jeffreyi*), and Western white pine (*Pinus monticola*). Greenleaf manzanita (*Arctostaphylos patula*) dominates the understory in the surrounding area. The monitoring area contains a variety of native and non-native forbs and grasses, with a few native shrub and tree seedlings. None of the non-native species before treatment were classified as invasive or noxious.

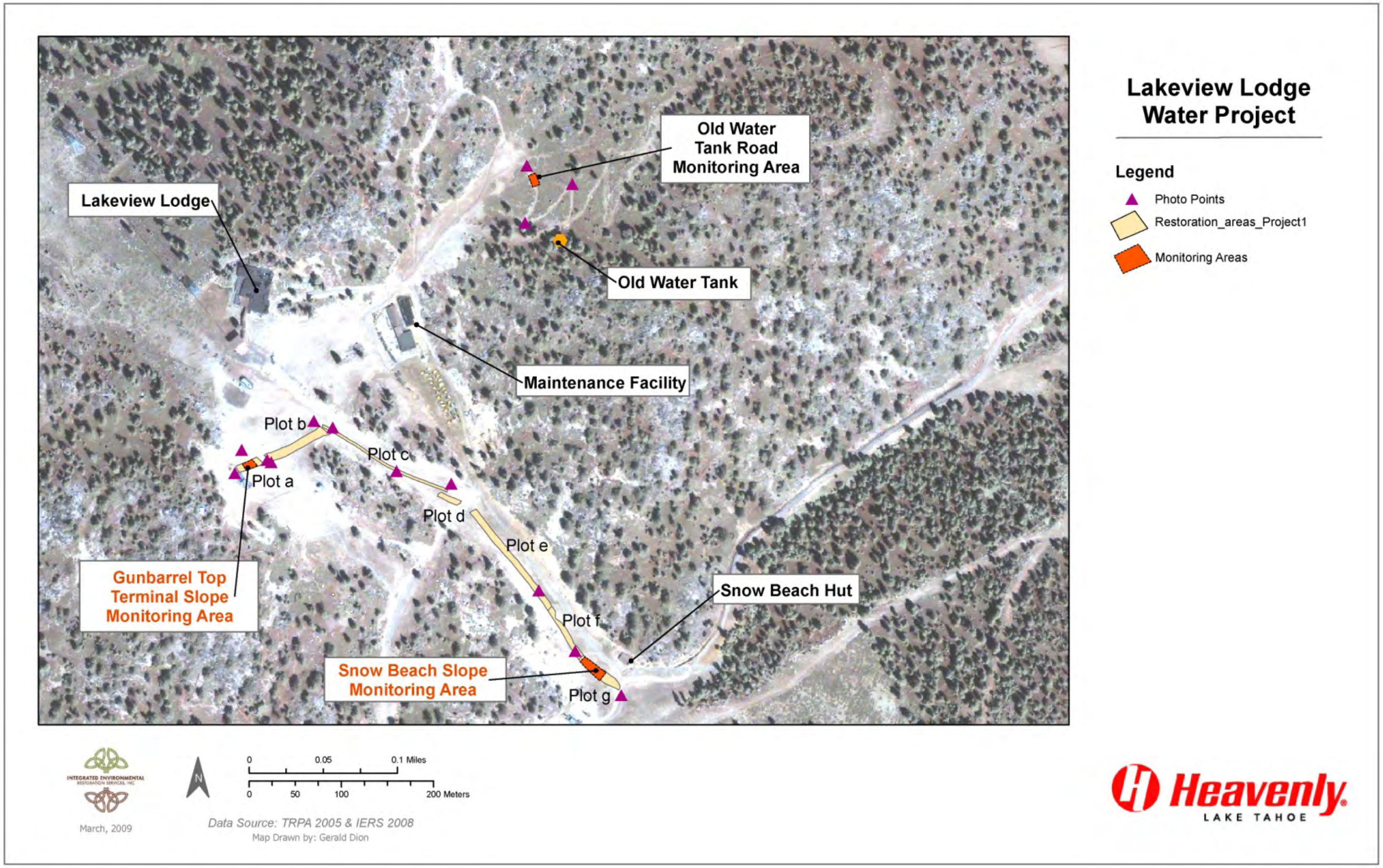


Figure 108. Lakeview Lodge Water System Improvement Project Map.

Figure 109. Gun Barrel top terminal slope monitoring area, pre-treatment, August 2008.

Figure 110. Gun Barrel top terminal slope, pre-treatment, August 2008. Water line installation area is between the T-stakes.

Old Water Tank Road

The old water tank road is an unpaved road that will be restored after the water tank is removed in 2011 (Figure 111 and Figure 112). Most of the road faces north-northwest at an elevation of approximately 8,261 feet AMSL. The road is gently sloped in mostly places, approximately 6 degrees. There is no canopy cover and the solar exposure is about 90% during the summer months. The solar exposure is lower at the southern part of the road near the existing water tank. The soil is derived from granitic parent material with a low proportion of rocks greater than 0.5 inches in diameter. Conifers surround the area, which is dominated by red fir (*Abies magnifica*), Jeffrey pine (*Pinus jeffreyi*), and Western white pine (*Pinus monticola*). Greenleaf manzanita (*Arctostaphylos patula*) dominates the understory, which also contain a variety of native forbs and grasses.

Figure 111. Old Water Tank Road, pre-treatment, looking downhill from the water tank site.

Figure 112. Old Water Tank Road, pre-treatment, looking uphill at the water tank.

Patsy's Trail

Patsy's Trail is the ski run directly above the Snow Beach area (Figure 113 and Figure 114). The conditions vary from dry to wet throughout the site. The slope faces 130 degrees east and the slope angle is moderate at 10 degrees. The approximate elevation is 8,096 feet AMSL and the solar exposure is 90% during the summer months. There is no canopy cover, but the surrounding area is dominated by Jeffrey pine (*Pinus jeffreyi*) and red fir (*Abies magnifica*). A mix of native and non-native plant forbs and grasses were present; however, three non-native invasive plants were also found at this site: orchard grass (*Dactylis glomerata*), curly dock (*Rumex crispus*), and woolly mullein (*Verbascum thapsus*).

Figure 113. Patsy's Trail, looking up from the Snow Beach area, pre-treatment, 2008.

Figure 114. Patsy's Trail, looking down at the Snow Beach area, pre-treatment, 2008.

Objectives and Success Criteria

Treatment Objectives

- no net increase in runoff and/or sediment transport as a result of the waterline installation, the old water tank removal, or the new water tank construction
- to establish an appropriate, self-sustaining, native plant community
- no evidence of erosion from any of the waterline or water tank installation activities

Monitoring Objective

- to quantitatively assess whether treatments resulted in a net change in runoff and/or sediment transport following the trail modification

Success Criteria

In 2010, the follow success criteria were used (Table 26).

Table 26. Lakeview Project Success Criteria Evaluation, 2010.

	Success Criteria	Success Criteria Evaluation
Penetrometer Depth (inches)	Not greater than 4 inches shallower than pre-treatment level	PT:√ Criterion Met
Total Cover (%)	70% or greater	GB:√ Criterion Met PT:√ Criterion Met
Plant Cover (%)	10% or greater	GB:√ Criterion Met PT:√ Criterion Met
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition	GB:× Criterion Not Met PT:√ Criterion Met
*GB=Gun Barrel top slope **PT=Patsy's Trail		

Restoration Treatments

The Lakeview Lodge Water System Improvement project consists of nine individual treatment areas (Table 27, Table 28, Figure 108, Figure 115, Figure 116, Figure 117, Figure 118, Figure 119, Figure 120, Figure 121, Figure 122, Figure 123, Figure 124, Figure 125, Figure 126, and Figure 127). Areas A though F were treated in 2008; however, disturbance of areas E and F required re-treatment in 2009. Soil and vegetation treatment specifications varied slightly among these areas, depending on site conditions and planned future use. Additionally, treatment elements were varied to test a few different treatment types. Treatments in areas A, B, E1, F1, and G included the following elements: soil amendments, tilling, organic fertilizer, seed, and mulch. Treatments in areas C, D, E2, and F2 were less intensive, and included mulch or soil loosening with mulch. These areas include road shoulders and other areas that are expected to be subject to future or ongoing disturbance.

- Treatment Area A – trench line on Gun Barrel Top Terminal Slope
- Treatment Area B – trench line on Gun Barrel Top Terminal Slope
- Treatment Area C – trench line on road shoulder
- Treatment Area D – utility box installation area
- Treatment Area E1/E2 – trench line down Patsy's Trail
- Treatment Area F1/F2 – trench line down Patsy's Trail
- Treatment Area G – trench line down Patsy's Trail

Table 27. Lakeview Project Treatment Matrix, 2008 and 2009.

		Treatment Area			
		A	B	C	D
Amendments	**Type**	WC, FCZ	WC	n/a	n/a
	Depth (in)	4 (2" of each)	4	n/a	n/a
Tilling	**Depth (in)**	18	14	n/a	n/a
Fertilizer	**Type**	Biosol 6-1-3	Biosol 6-1-3*	n/a	n/a
	Rate (lbs/acre)	2,000	2,000*	n/a	n/a
Seed	**Mix**	Lakeview upland mix	Lakeview upland mix	n/a	n/a
	Rate (lbs/acre)	50	50	n/a	n/a
Mulch	**Type**	PNM	PNM	WC	WC
	Depth (in)	1	1	2	4
Irrigation	**Frequency/ Duration**	yes - unknown	no	n/a	no
Treatment Area	**Square Feet**	2,449	7,033	4,697	10,057

Key: WC = wood chips, FCZ = Full Circle Integrated Tahoe Blend Zero (composted coarse overs), PNM = pine needle mulch, * = not verified in field

Table 28. Lakeview Project Treatment Matrix 2008-2009, continued.

		Treatment Area				
		E1	**E2**	**F1**	**F2**	**G**
Amendments	**Type**	WC	n/a	WC	BLB	WC
	Depth (in)	4	n/a	4	4	4
Tilling	**Depth (in)**	12	n/a	12	14	12
Fertilizer	**Type**	Biosol 6-1-3	n/a	Biosol 6-1-3	n/a	Biosol 6-1-3
	Rate (lbs/acre)	2,000	n/a	2,000	n/a	2,000
Seed	**Mix**	High Elevation Mix/Moist Mix	n/a	High Elevation Mix/Moist Mix	n/a	High Elevation Mix
	Rate (lbs/acre)	50	n/a	50	n/a	50
Mulch	**Type**	PN	WC	PN	BLB	PN
	Depth (in)	1	4	1	1	1
Irrigation	**Frequency/ Duration**	Yes 4 hr/day	no	Yes 4 hr/day	no	Yes 4 hr/day
Treatment Area	**Square Feet**	2,750	8,300	2,750	1,175	14,375

Key: WC = wood chips, BLB = Boulder Lodge Blend (well-aged wood chips and pine needles), PNM = pine needle mulch.

Figure 115. Treatment area A, pre-treatment, August 2008.

Figure 116. Treatment area A, post-treatment, August 2008.

Figure 117. Treatment area A, post-treatment, August 2009.

Figure 118. Treatment area A, post-treatment, 2010.

Figure 119. Treatment area B, pre-treatment, August 2008 (photo point B).

Figure 120. Treatment area B, post-treatment, September 2008 (photo point B).

Figure 121. Treatment area B, post-treatment, August 2009 (photo point B).

Figure 122. Treatment area B, post-treatment, 2010 (photo point B).

Figure 123. Treatment areas E, F and G, pre-treatment, August 2008 (photo point A).

Figure 124. Treatment areas E, F and G, post-treatment, October 2008 (photo point A).

Figure 125. Treatment areas E, F and G, post-treatment, August 2009. Heavy machinery tracks are visible (photo point A).

Figure 126. Treatment areas E, F and G, post-second treatment, October 2009 (photo point A).

Figure 127. Treatment areas E, F and G, post-second treatment, 2010 (photo point A).

Performance Monitoring

For more data collected in 2008 and 2009, see the Heavenly Mountain Resort Mitigation and Monitoring Plan Annual Report, October 2008-October 2009, Appendix II.

Penetrometer Depth to Refusal (DTR)

In 2008, the pre-treatment penetrometer DTR at the old water tank road was 2.0 inches (Figure 128). In 2009, the year 1 post-treatment penetrometer DTR at Patsy's trail (6.4 inches) was 5.1 inches deeper than the pre-treatment DTR in 2008 (1.3 inches). The post-treatment penetrometer DTR at the Gun Barrel top slope (15.1 inches) was 12.1 inches deeper than the pre-treatment penetrometer DTR (3.0 inches). The success criterion, which states the post-treatment DTR cannot be more than 4.0 inches shallower than the pre-treatment DTR, was met.

In 2010, the year 2 post-treatment penetrometer DTR at Patsy's trail was 9 inches, which was 7.7 inches deeper than the pre-treatment DTR in 2008 (1.3 inches). The success criterion, which states the post-treatment DTR cannot be more than 4.0 inches shallower than the pre-treatment DTR, was met.

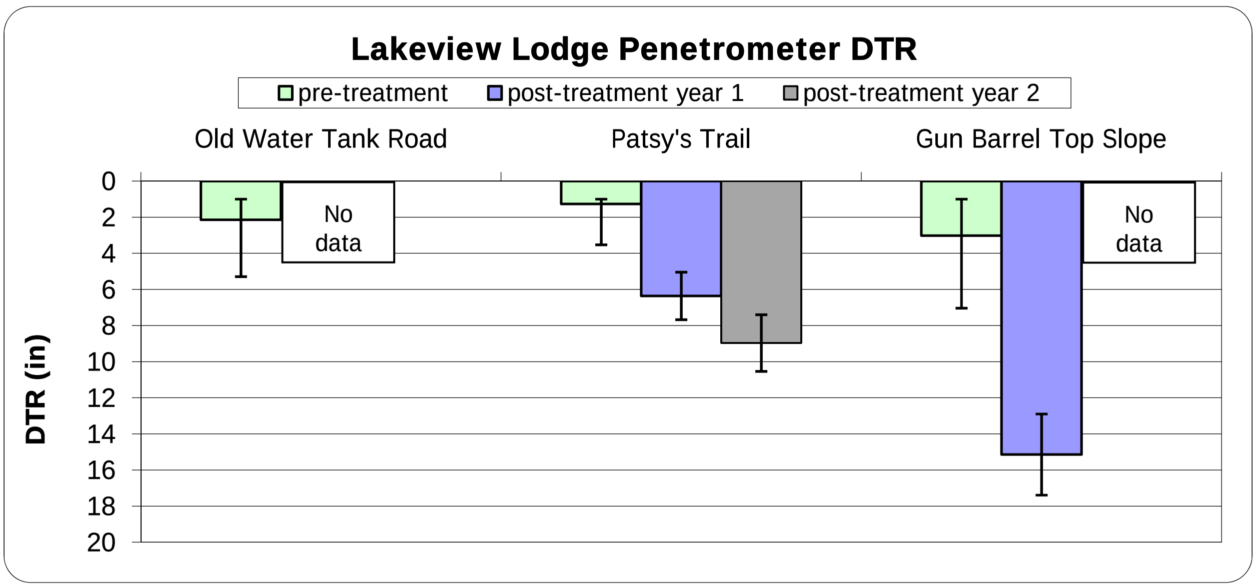


Figure 128. Lakeview Penetrometer Depth to Refusal (DTR). Post-treatment measurements were not taken at the old water tank road. Error bars represent one standard deviation above and below the mean. Pre-treatment measurements were conducted in 2008, while post-treatment measurements were conducted in 2009 and 2010. Post-treatment data collection for the old water tank road is planned for 2012.

Total Cover

In 2007, the pre-treatment total cover at the old water tank road was 48% (Figure 129). The total cover consisted of 11% cover by mulch and 36% cover by gravel/rocks. In 2009, the year 1 post-treatment total cover at Patsy's Trail (79%) was 58% higher than the pre-treatment total cover in 2007 (50%). The mulch cover, which increased from 33% to 76%, accounted for most of the gain in total cover. In 2009, the year 1 post-treatment total cover at the Gun Barrel top slope (95%) was 228% higher than the pre-treatment total cover in 2007 (29%). The mulch cover increased from 24% to 95% post-treatment. The success criterion, which states that the total cover must be greater than 70%, was met for both plots.

In 2010, the year 2 post-treatment cover was 85% at Patsy's trail and 94% at the Gun Barrel top slope. The success criterion, which states that the total cover must be greater than 70%, was met for both plots.

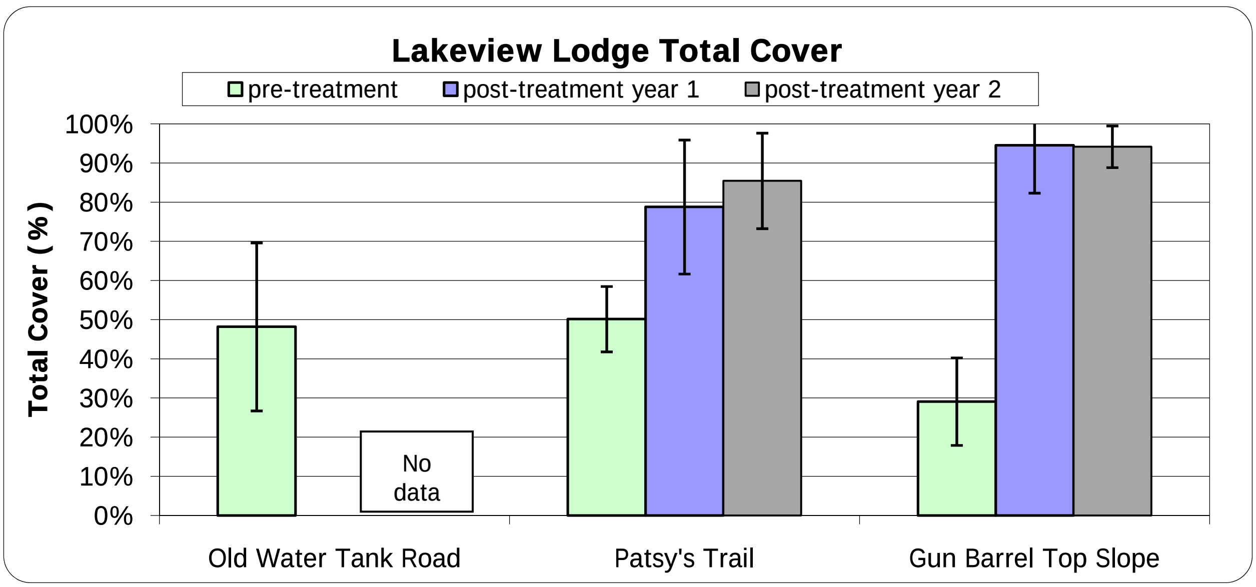


Figure 129. Lakeview Lodge Total Cover. Post-treatment measurements were not taken at the old water tank road. The error bars denote one standard deviation above and below the mean. Pre-treatment measurements were conducted in 2008, while post-treatment measurements were conducted in 2009 and 2010. Post-treatment data collection for the old water tank road is planned for 2012.

Plant Cover

In 2008, the pre-treatment plant cover was 5% at the old water tank road (Figure 130). In 2009, the year 1 post-treatment plant cover at Patsy's Trail (2%) was 91% lower than the pre-treatment plant cover in 2007 (22%). In 2009, the year 1 post-treatment plant cover at the Gun Barrel top slope (9%) was 36% lower than the pre-treatment plant cover in 2008 (14%). The success criterion, which states the post-treatment plant cover must be at least 10%, was not met for either plot.

In 2010, the year 2 post-treatment plant cover at Patsy's Trail was 15% while it was 33% at the Gun Barrel top slope. The success criterion, which states the post-treatment plant cover must be at least 10%, was met for both plots.

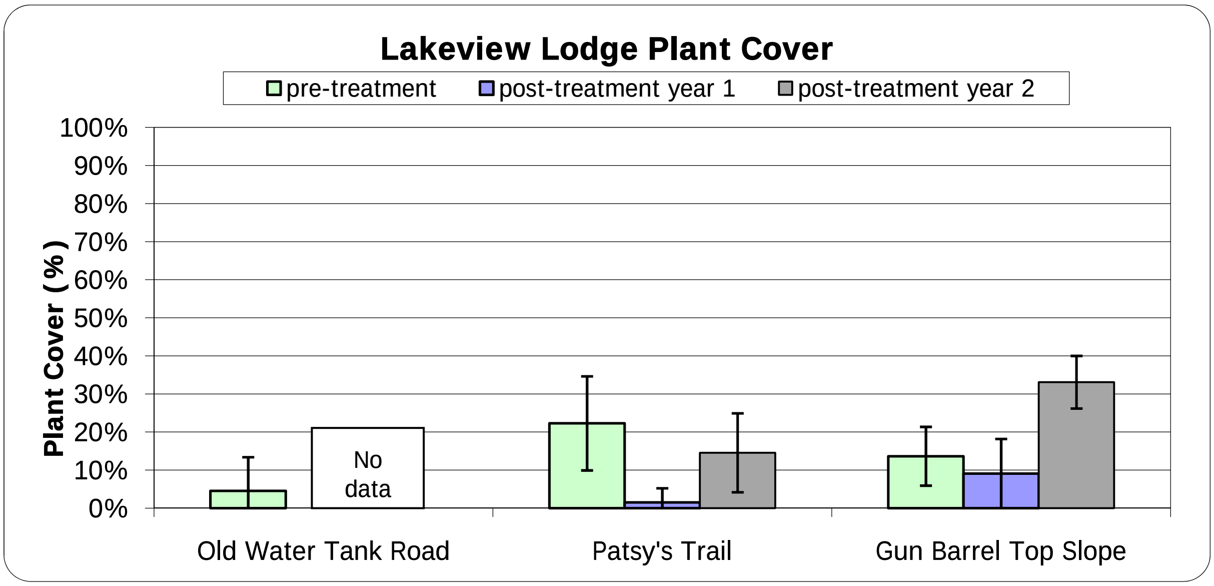


Figure 130. Lakeview Lodge Plant Cover. The error bars denote one standard deviation above and below the mean. Pre-treatment measurements were conducted in 2008, while post-treatment measurements were conducted in 2009 and 2010. Post-treatment data collection for the old water tank road is planned for 2012.

Visual Erosion Assessment

In 2010, erosion issues were observed at the Gun Barrel top slope. Sediment was carried from the upper most access road, across the road, over a wattle, and onto the restored slope (Figure 131). In addition, splash detachment was observed in the bare areas.

In 2010, at both the Gun Barrel top slope and Patsy's trail, non-native plant species were present. At the Gun Barrel top slope, *Melilotus officinalis* (yellow clover), *Bromus techtorum* (cheatgrass), and *Dactylis glomerata* (orchard grass) were found. At Patsy's trail, the above species, plus *Agrostis stolonifera* (creeping bentgrass), *Rumex crispus* (curly dock), and *Cirsium vulgare* (bull thistle) were found.

Figure 131. Lakeview Lodge. Sediment from the road at the top of the Gun Barrel top restoration site at the Lakeview Lodge project. Sediment is visible both above and below the wattle. An area of approximately 3 m^2 was affected. The red arrow shows the path of sediment movement.

Management Responses and Follow-up Actions

In 2010, the Gun Barrel top slope did not meet the visual erosion assessment success criterion as a result of concentrated runoff from the road entering the treatment area. An on-site assessment of the water flows on the road above the Gun Barrel top slope should be conducted before proceeding with any of the road repair work. Care should be taken to fully evaluate and redirect water flow to more appropriate areas, such as the rock-lined ditch further down the slope.

In 2010, both the Gun Barrel top slope and Patsy's trail contained non-native and invasive plant species. These species should be removed at the start of the growing season and during any site visits to prevent spreading and reduce competition with native species.

Visual erosion assessment is recommended on a yearly basis to identify small problems before they become larger problems and to develop appropriate treatment responses. Additional assessment can be particularly useful during and immediately after rain events, as evidence of erosion is difficult to observe even several days after a rain storm, particularly on decomposed granite soils. It is recommended that Heavenly expand efforts to minimize disturbance of treatment areas by installing temporary fencing and/or signage and communicating the locations of sensitive treatment areas to operations staff. Currently, no fencing or signage has been installed at either area.

Table 29. Lakeview Lodge Management Responses and Follow-up Actions, 2010.

	Unmet Criterion	Management Response	Follow-up Action
Patsy's Trail	Plant cover criterion was met in the designated monitoring area; however, areas of zero plant cover existed and are addressed here	For low cover areas only (as determined and marked by IERS staff): **Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment
Patsy's Trail	n/a	Treatment area protection (fencing, signage, etc)	Implementation monitoring after fencing/signage installation
Patsy's Trail	n/a	Removal of invasive species	Implementation monitoring
Gun Barrel Top Slope	Visual Erosion Assessment	1. Assess water flows to determine the source of the road erosion issue 2. Implement road drainage improvements such that water is collected/infiltrated in a stable manner 3. Remove sediment deposited in treatment area. 4. Place irrigation heads above connection point so drain-down leakage does not occur.	1. Inspection of road drainage improvements during and after implementation 2. Visual erosion assessment after rain event (after road improvements are completed)
Gun Barrel Top Slope	n/a	Removal of invasive species	Implementation monitoring

Newly re-treated areas and road drainage improvements should be closely monitored throughout the season, particularly during and immediately after rain events, to ensure that no erosion is occurring. The irrigation systems should be regularly inspected to ensure that failures or drain-down leakage is not occurring. Although irrigation issues were not observed in this site at 2010, rills were observed in past years on the Gun Barrel top slope.

Two alternative approaches are presented to achieve the plant cover success criterion. Alternative 2 is less labor-intensive than alternative 1. If alternative 2 is implemented, the monitoring after 1 month will indicate whether the low-effort seeding technique was successful, as plants will have germinated in this timeframe. If seed germination is not sufficient one month after implementation of alternative 2, the site will need to be re-treated using alternative 1. Invasive species should be removed as soon as spring growth is apparent and throughout the season if necessary.

Stagecoach Snowmaking Project

Overview

The Stagecoach snowmaking project includes the installation of a snowmaking line that runs from the top of the Stagecoach lift down the Stagecoach ski run and along the shoulder of Nevada Trail. The snowmaking line includes both above-ground and below-ground segments. The below-ground segments were installed on unpaved roads and the above-ground segments were installed along the edge of a cleared ski run (Stagecoach) with large boulders and a dense shrub understory. Soil impacts associated with this project included trenching for snowmaking pipes, soil compaction, and vegetation disturbance in temporary vehicle and equipment travel paths and staging areas. Three different treatments areas were implemented and three monitoring areas were established at this project site in 2008. These treatment areas and monitoring areas are described in detail below and are shown on the project map (Figure 134).

Site Description

Upper Slope

The upper slope is located on the edge of a cleared ski run (Figure 132 and Figure 133). The site faces 30 degrees northeast and has a moderate slope of 16 degrees. The approximate site elevation is 8,362 feet AMSL. The canopy cover is 5% and the solar exposure ranges from 82 to 86% during the summer months. The soil is derived from granitic parent material with a low proportion of rocks greater than 0.5 inches in diameter. The surrounding area is dominated by red fir (*Abies magnifica*) and Western white pine (*Pinus monticola*), while the ski slope is mostly greenleaf manzanita (*Arctostaphylos patula*) with some chinquapin (*Chrysolepis sempervirens*). Non-native species were not observed in this area.

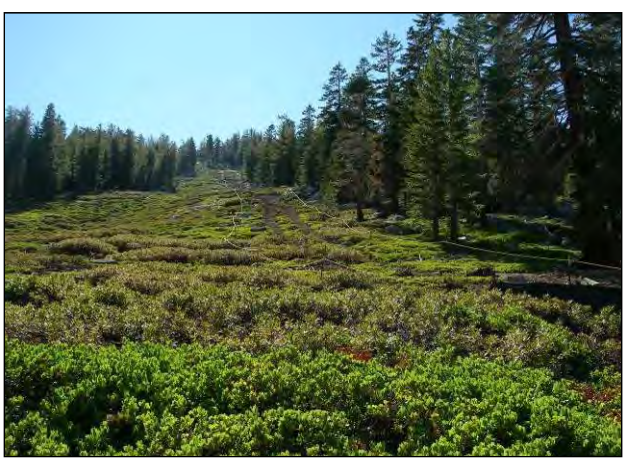


Figure 132. Stagecoach snowmaking upper slope, pre-treatment, October, 2008.

Figure 133. Stagecoach snowmaking upper slope, during treatment, October, 2008.

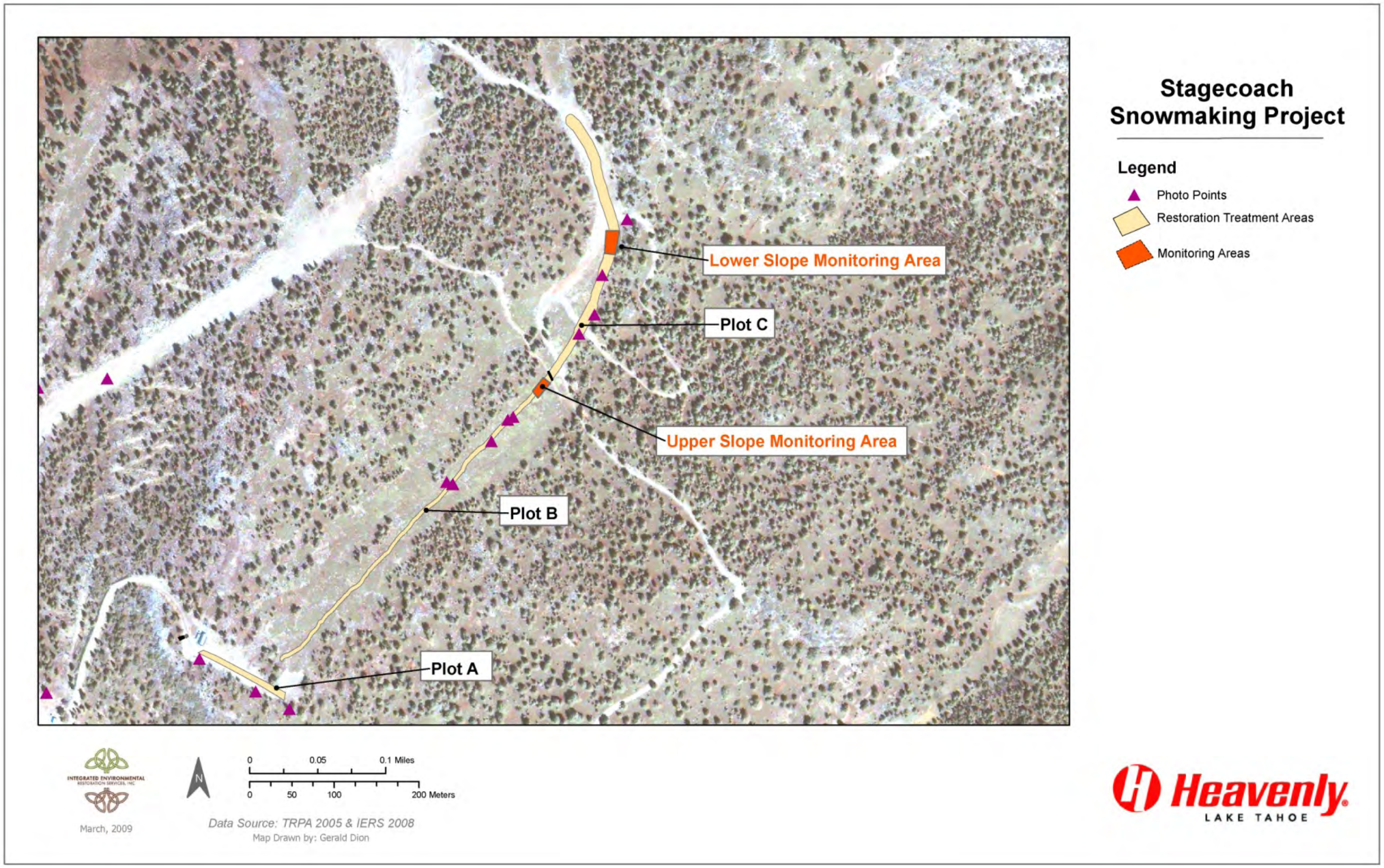


Figure 134. Stagecoach Snowmaking Project Map.

Lower Slope

The lower slope is located on the edge of a cleared ski run (Figure 135 and Figure 136). The site faces north and has a slope of 24 degrees. The approximate site elevation is 8,224 feet AMSL. There is no canopy cover and the solar exposure ranges from 55 to 70% during the summer months. The soil is derived from granitic parent material with a low proportion of rocks greater than 0.5 inches in diameter. The surrounding forested area is dominated by red fir (*Abies magnifica*), white fir (*Abies concolor*) and Western white pine (*Pinus monticola*), while the ski slope has pinemat manzanita (*Arctostaphylos nevadensis*), Western white pine, and some native grasses and forbs. Non-native species were not observed in this area.

Figure 135. Stagecoach snowmaking lower slope monitoring area, pre-treatment, August, 2008.

Figure 136. Stagecoach Snowmaking lower slope monitoring area post-treatment, November, 2008.

Objectives and Success Criteria

Treatment Objectives

- no net increase in runoff and/or sediment transport as a result of the snowmaking line installation
- to establish an appropriate, self-sustaining, native plant community
- no evidence of erosion from any of the snowmaking line installation activities

Monitoring Objective

- to quantitatively assess whether treatments resulted in a net change in runoff and/or sediment transport following the snowmaking line installation

Success Criteria

The following success criteria were used in 2010 (Table 30).

Table 30. Stagecoach Snowmaking Line Success Criteria Evaluation, 2010.

	Stagecoach Success Criteria Evaluation	Stagecoach Success Criteria
Penetrometer Depth (inches)	Not greater than 4 inches shallower than pre-treatment level	L: × Criterion Not Met
Total Cover (%)	70% or greater	U:√ Criterion Met L:√ Criterion Met
Total Plant Cover (%)	10% or greater	U:× Criterion Not Met L: × Criterion Not Met
Organic Matter (%)	Not greater than 1.5 percentage points less than pre-treatment level	U:√ Criterion Met L:√ Criterion Met
Visual Assessment	No visible signs of erosion including rotational failures, rilling, gullying, or other sediment transport and deposition.	U:√ Criterion Met L:× Criterion Not Met
*U=Upper slope **L=Lower Slope		

Restoration Treatments

The Stagecoach snowmaking project, treated in 2008, consists of three treatment areas – A, B, and C (Table 31, Figure 137, Figure 138, Figure 139, Figure 140, Figure 141, Figure 142, Figure 143, Figure 144, Figure 146, Figure 147, and Figure 148). Areas A and C include unpaved roads, road shoulders and other previously disturbed areas where below-ground snowmaking segments were constructed. Due to the soil disturbance associated with trenching and the general lack of ecological "capital" in areas A and C, full soil and vegetation restoration treatments were implemented to rebuild a self-sustaining soil and vegetation community. The full restoration treatment included the following elements: soil amendments, tilling, organic fertilizer, seed, and mulch. Area B is a cleared ski run where above-ground snowmaking was constructed. The run clearing activities were intended to leave the topsoil and understory vegetation relatively intact; therefore, treatments were less intensive at area B than those implemented in areas A and C. The treatment at area B was designed to remove soil compaction and replace vegetation and mulch in the equipment travel corridor. Additionally, equipment travel was deliberately limited to a very narrow corridor in order to minimize impacts to soil and vegetation during construction.

Table 31. Stagecoach Snowmaking Treatment Matrix, 2008.

		Treatment Area		
		A	B	C
Amendments	**Type**	WC, BLB	n/a	WC, BLB
	Depth (in)	4	n/a	4*
Tilling	**Depth (in)**	20	14	18*

		Treatment Area		
		A	B	C
Fertilizer	Type	Biosol 6-1-3*	Biosol 6-1-3*	Biosol 6-1-3*
	Rate (lbs/acre)	1,000*	1,000*	1,000*
Seed	Mix	Stagecoach upland mix*	Stagecoach upland mix*	Stagecoach upland mix*
	Rate (lbs/acre)	25*	25*	25*
Mulch	Type	PNM, WC*	PNM*	PNM*
	Depth (in)	1*	1*	1*
Irrigation	Frequency/Duration	No	no	no
Treatment Area	Square Feet	5,111	6,009	2,969
Key WC = wood chips BLB = Boulder Lodge Blend (well-aged wood chips and pine needles) PNM = pine needle mulch * = not verified in field				

Figure 137. Stagecoach snowmaking, seeding at treatment area B, November 2008.

Figure 138. Stagecoach snowmaking, treatment area B, pre-treatment, August 2008.

Figure 139. Stagecoach snowmaking, treatment area B, during construction, September 2008.

Figure 140. Stagecoach snowmaking, treatment area B, October 2009.

Figure 141. Stagecoach snowmaking, treatment area B, August 2010.

Figure 142. Stagecoach snowmaking, treatment area C, pre-treatment, August 2008

Figure 143. Stagecoach snowmaking, treatment area C, post-treatment, November 2008.

Figure 144. Stagecoach snowmaking, treatment area C, post-treatment, August 2009.

Figure 145. Stagecoach snowmaking, treatment area C, post-treatment, August 2010.

Figure 146. Stagecoach snowmaking, treatment area C (roadside), pre-treatment, August 2008

Figure 147. Stagecoach snowmaking, treatment area C (roadside), post-treatment, October 2009.

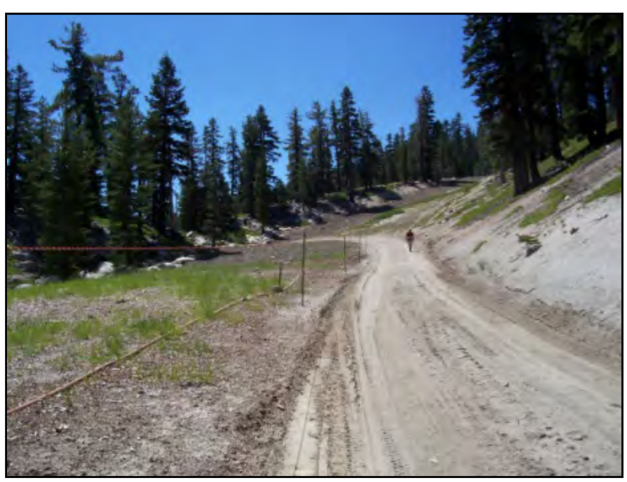


Figure 148. Stagecoach snowmaking, treatment area C (roadside), pre-treatment, August 2010.

Performance Monitoring

For more data collected in 2008 and 2009, see the Heavenly Mountain Resort Mitigation and Monitoring Plan Annual Report, October 2008-October 2009, Appendix II.

Total Cover

In 2009, the year 1 post-treatment total cover at the Stagecoach upper slope (96%) was similar to the pre-treatment total cover in 2008 (95%; Figure 149). The 2009 year 1 post-treatment total cover at the Stagecoach lower slope (93%) was nearly double the pre-treatment total cover in 2008 (47%). The 2010 year 2 post-treatment total cover was 82% at the lower slope and 80% at the upper slope (ocularly estimated). The success criterion, which states that the post-treatment total cover must be greater than 70% post-treatment, was met for both plots in 2009 and 2010.

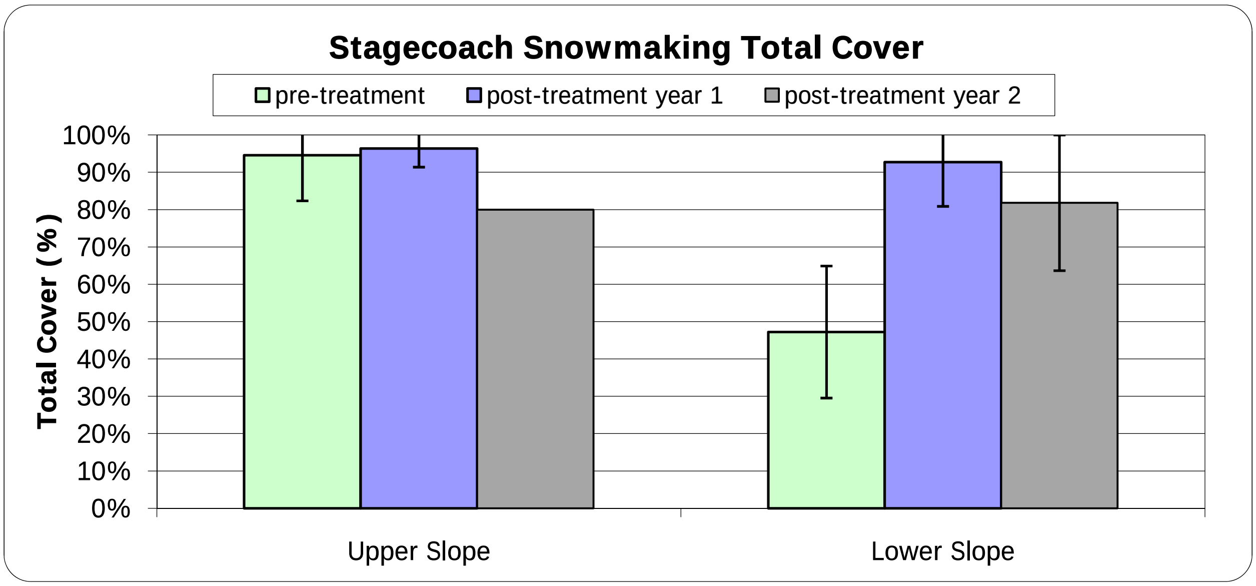


Figure 149. Stagecoach Snowmaking Total Cover. Error bars denote one standard deviation above and below the mean. Pre-treatment data was collected in 2008 and post-treatment data was collected in 2009 and 2010. The upper slope post-treatment year 2 data was ocularly estimated.

Plant Cover

In 2009, the year 1 plant cover at the Stagecoach upper slope decreased from 49% pre-treatment (2008) to zero post-treatment (Figure 150). The plant cover at the Stagecoach lower slope decreased from 3% to zero in year 1 post-treatment. In 2010, the Stagecoach lower slope year 2 plant cover at was 4% and the upper slope year 2 plant cover was 1% (ocularly estimated). The success criterion, which states that the post-treatment plant must be 10% or greater, was not met for either plot in either 2009 or 2010.

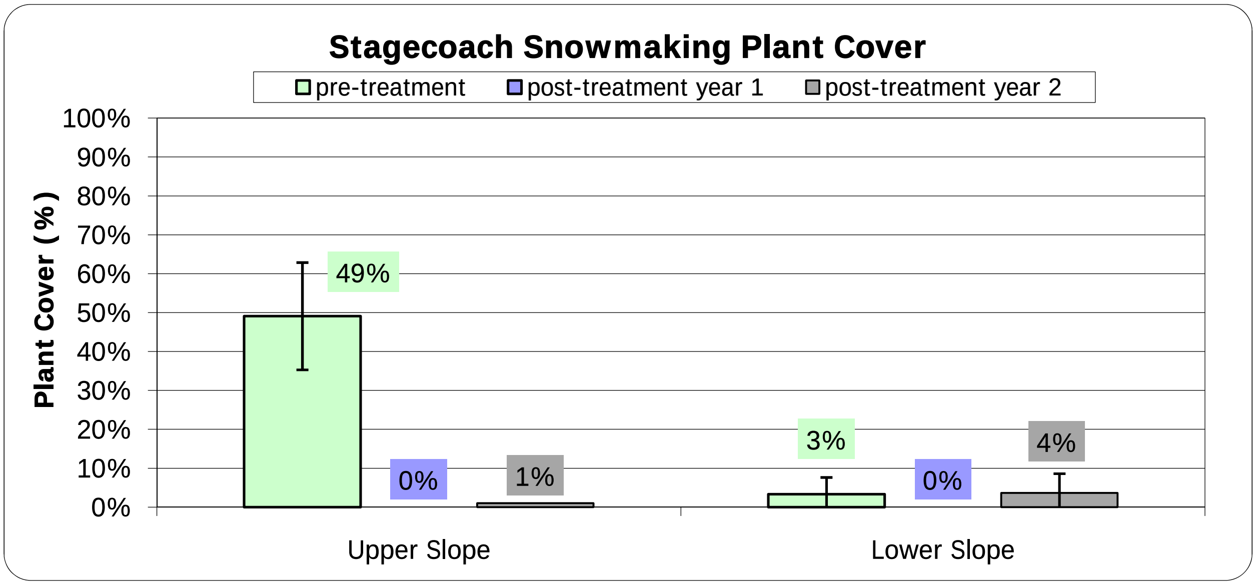


Figure 150. Stagecoach Snowmaking Plant Cover. The error bars denote one standard deviation above and below the mean. Pre-treatment data was collected in 2008 and post-treatment data was collected in 2009 and 2010. The plant cover data in 2010 was collected on transects for the lower slope and was ocularly estimated for the upper slope.

Soil Nutrients

Organic Matter

In 2009, the year 1 post-treatment organic matter content at the Stagecoach upper slope (1.8%) was 46% or 1.5 percentage points lower than the pre-treatment organic matter content in 2008 (3.3%; Figure 151). The 2009 year 1 post-treatment organic matter content at the Stagecoach lower slope (2.8%) was 12% higher than the pre-treatment organic matter content in 2008 (2.5%).

In 2010, the Stagecoach upper slope year 2 post-treatment organic matter content was 2.4% and the lower slope post-treatment organic matter content was 1.8%.

The success criterion, which states the post-treatment organic matter content must be no more than 1.5 percentage points lower than the pre-treatment organic matter content, was met for both the upper slope and the lower slope in both 2009 and 2010.

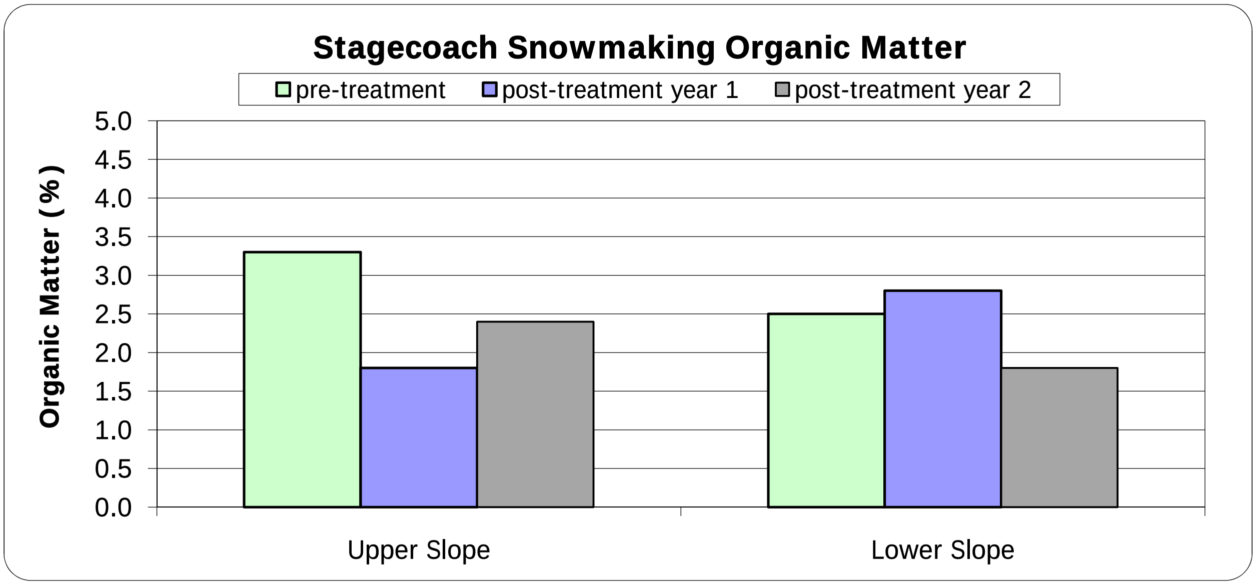


Figure 151. Stagecoach Organic Matter. Pre-treatment samples were collected in 2008 and post-treatment samples were collected in 2009 and 2010.

Total Kjeldahl Nitrogen

In 2009, the year 1 post-treatment TKN at the Stagecoach upper slope (324 ppm) was 60% or 484 ppm lower than the pre-treatment TKN in 2008 (808 ppm; Figure 152). The 2009 year 1 post-treatment TKN at the Stagecoach lower slope (310 ppm) was 39% or 198 ppm lower than the pre-treatment TKN in 2008 (508 ppm). In 2010, the year 2 post-treatment TKN was 389 ppm at the upper slope and 337 ppm at the lower slope. A success criterion for TKN was not used in 2009.

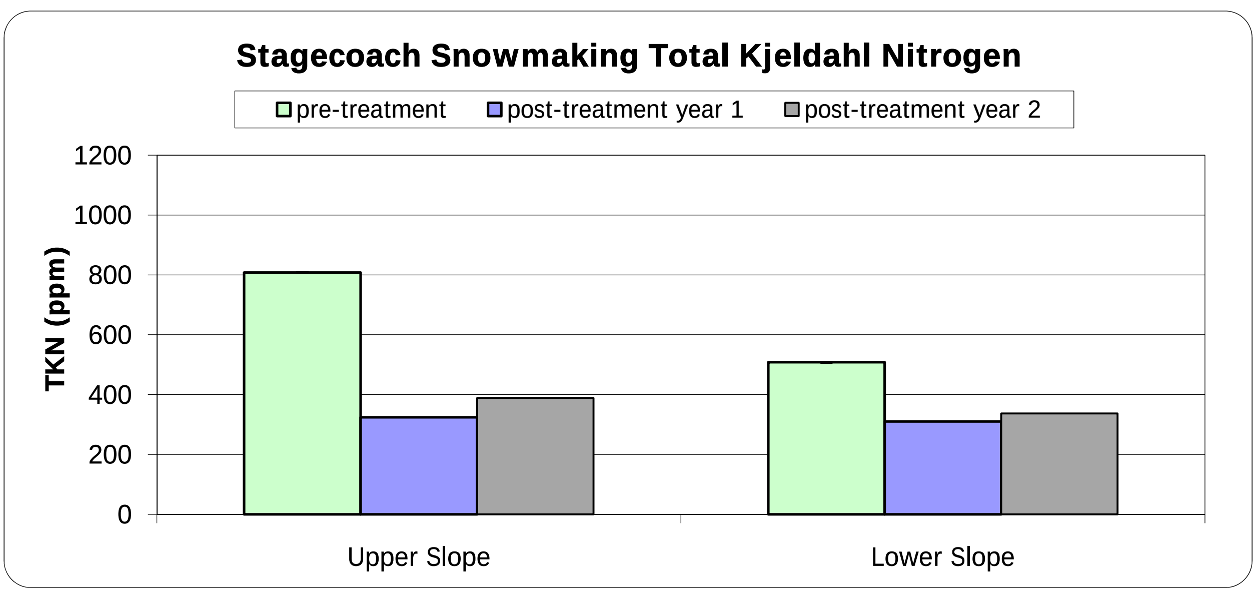


Figure 152. Stagecoach Snowmaking Total Kjeldahl Nitrogen (TKN). Pre-treatment samples were collected in 2008 and post-treatment samples were collected in 2009 and 2010.

Visual Erosion Assessment

In 2010, at the upper slope, no major signs of erosion were present. However, at the lower slope, several areas of concern were documented. Tire tracks were observed going both across and up the slope (Figure 153 and Figure 154). Additionally, concentrated drainage from the road upslope of the lower treatment area caused rilling, gullying, and deposition in the lower treatment area (Figure 155, Figure 156, Figure 157 and Figure 158). The success criterion, which states that no visible signs of rills, gullies, sediment transport, or sediment deposition can be present, was met for the upper slope, but was not met for the lower slope in 2010. Concentrated drainage from roads has also caused erosion problems on several other restoration projects at Heavenly.

Figure 153. Stagecoach lower slope, August 2010. Red arrow points to tire tracks headed up the slope.

Figure 154. Stagecoach lower slope, August 2010. Red arrow points to tire tracks headed across the slope.

Figure 155. Concentrated road drainage causing erosion at the top of the Stagecoach lower slope, October 2010.

Figure 156. Rill from road drainage heading toward Stagecoach lower slope treatment area, August 2010.

Figure 157. Gully along Stagecoach lower treatment area, August 2010. This gully was caused by concentrated drainage from the road upslope.

Figure 158. Deposition near the bottom of the Stagecoach lower treatment area, August 2010.

Management Response and Follow-up Action

In 2010, the plant cover success criterion was not met for either plot. Additionally, at the Stagecoach lower slope, penetrometer monitoring (triggered by unmet success criteria in 2009) confirmed that there is a large area of compacted soil that does not meet the penetrometer (soil compaction) success criterion. Two alternative treatment approaches are presented in Table 32 to achieve the plant cover success criterion for the upper slope treatment area. However, alternative 1 is recommended for the lower 10-30 meters of the lower slope treatment area because soil loosening is required to meet the penetrometer success criterion. Alternative 2 is less labor-intensive than alternative 1. If alternative 2 is implemented at the upper slope or the upper part of the lower slope, the germination assessment after 1 month will indicate whether the low-effort seeding technique was successful, as plants will have germinated in this timeframe. If seed germination is not sufficient one month after implementation of alternative 2, the site will need to be re-treated using alternative 1.

In 2010, the Stagecoach lower slope did not meet the visual erosion assessment success criterion as a result of concentrated runoff from the road upslope, which caused substantial erosion for 200-300 feet and deposited sediment on the treatment area. Road drainage patterns in this area should be fully assessed to generate treatment alternatives before implementing drainage improvements.

Continued observation of the area where the rills, gullies, and sedimentation occurred in 2009 and 2010 is necessary during and immediately after rain events, even after road repairs. The entire area should closely watch to ensure that the water flow assessment was correct and that the proper road repairs were conducted. It is recommended that Heavenly expand efforts to minimize disturbance of the lower slope plot by installing fencing and signage, particularly due to its close proximity to the Tahoe Rim Trail and its history of vehicle traffic.

Table 32. Stagecoach Management Responses and Follow-up Action, 2010.

	Unmet Criterion	Management Response	Follow-up Action
Upper Slope	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact, then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment

	Unmet Criterion	Management Response	Follow-up Action
Lower Slope	Plant Cover	**Alternative 1 (necessary for compacted lower 10-30 meters and optional for the rest of the slope):** Remove mulch, apply amendments, till amendments to 12”, apply fertilizer, apply seed, replace mulch, then irrigate with low-flow heads (MP rotator or equivalent) for one season. **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment
Lower Slope	Visual Erosion Assessment	1. Assess road drainage patterns and treatment alternatives 2. Implement road drainage improvements such that water is collected/infiltrated without causing erosion 3. Remove sediment deposited in treatment areas 4. Place irrigation heads above connection point so drain-down leakage does not occur	1. Inspection of road drainage improvements during and after implementation 2. Visual erosion assessment after rain event (after road improvements are completed)
Lower Slope (compacted bottom 10-30 meters with sedimentation and tire tracks)	Penetrometer (soil compaction)	Tilling and incorporation of wood chip amendments to 12” (to be completed in conjunction with Alternative 1 treatments described in the plant cover criterion above)	1. Implementation monitoring to ensure correct tilling and amendment application depths

Chapter 4: Conclusions, Recommendations and Management Responses

Conclusions

Overall Process

2010 marked the fourth year of a new approach to planning, implementing, and monitoring large-scale mountain improvement projects at Heavenly with a commitment to minimizing runoff and erosion. We have learned a great deal about the restoration of high-elevation disturbed sites. Heavenly's operations staff continue to demonstrate competence and flexibility in project planning, implementation, treatment documentation. They also have expanded capacity to implement challenging restoration projects efficiently. A key challenge of this program has been the relatively long lag time (one year) between identification of unmet success criteria/management responses and the implementation of those management responses/treatments. This lag time has prevented sign-off on most projects as "complete" this past year. We are committed to developing a strategy to close this gap and shorten response time in 2011 in order to reduce the time between project implementation and sign-off.

Figure 159. Jim Larmore measures tilling depth with a cone penetrometer.

Additionally, concentrated drainage from the road system has caused erosion issues on several projects (Olympic lift top, Lakeview Lodge Gun Barrel slope, and Stagecoach lower slope). Heavenly staff are constantly improving drainage on the roadway network throughout the resort. However, greater emphasis should be placed on evaluating and improving road drainage near recently completed restoration projects (i.e. not only at stream crossings). Areas of erosion caused by roadway drainage (Olympic lift top, Lakeview Lodge Gun Barrel slope, and Stagecoach lower slope) should be prioritized for BMPs and added to the 2011 summer maintenance work list.

Restoration Projects

Over four years, a total area of 287,885 ft^2 (6.6 acres) was treated at seven project sites. Combined performance monitoring data from the six sites (performance data has not yet been collected at the seventh site) indicates overall improvements in ecological function and decreases in erosion potential. Compared to pre-treatment conditions, restoration treatments resulted in the following, one year after treatment completion:

- 67% - 133% decrease in sediment yields
- 18% - 110% increase in infiltration rates

- 50% - 940% increase in penetrometer depth to refusal
- 30% - 1900% increase in total cover
- 12% - 161% increase in soil organic matter

Two years following treatment completion, total cover remained fairly steady and plant cover exhibited increases at most sites. Some decreases in plant cover are attributable to vegetation removal during soil tilling treatments and the time required for vegetation to re-establish. Low plant cover is also common during the first 1-3 years on projects that use high-carbon soil amendments such as wood chips because availability of nitrogen and other nutrients are reduced during decomposition of wood chips. The plots with the highest plant cover (e.g. Lakeview Gun Barrel slope) were irrigated in the first season. This is a promising finding, as similar results were achieved on other projects throughout the Tahoe area. This indicates that targeted, year 1 irrigation may expedite achievement of plant cover success criterion. At many of the sites with low or no plant cover after 2-3 seasons, IERS was not onsite to verify correct seed mix and application rate (in addition to other key treatment variables). Therefore, the cause of the low plant cover is unclear. Several alternative treatment approaches are recommended for these projects. However, targeted, year 1 irrigation is recommended for all sites where plant cover success criterion was not met, as initial results suggest that this is an important step in establishing self-sustaining vegetation at Heavenly sites.

Another promising finding from the Lakeview Gun Barrel slope is that similar levels of vegetation cover were achieved two years following treatment at a treatment area amended with wood chips compared to an adjacent treatment area amended with a compost/wood chip blend (both were irrigated). This initial data suggests that locally-available woodchips may be a cost-effective alternative to commercial compost for achieving both native vegetation establishment and sediment source control objectives.

Erosion issues were observed at several treatment areas. However, most were related to drainage problems originating from concentrated drainage from roads outside the treated areas. Other rodent-related erosion issues should be tracked and addressed on a site-by-site basis.

After testing a variety of native perennial grasses at Heavenly sites, western needlegrass (*Achnathrum occidentale*) has consistently been the most successful species for upland revegetation treatment sites. While it is more expensive on a per-pound basis than other native grasses, vegetation monitoring at Heavenly to date indicates that inclusion of western needlegrass in upland revegetation treatment seed mixes it is the most cost-effective method to establish self-sustaining vegetation at most Heavenly sites.

Ski Run Clearing Projects

Monitoring data from both run clearing projects (Orion II and North Bowl) suggest that low-impact clearing and glading treatments – helicopter logging with hand felling and stump cutting – resulted in no measurable changes to the measured key parameters that affect erosion potential. When compared to uncleared conditions, clearing and glading treatments resulted in:

- No measurable change in sediment yields
- No measurable change in infiltration rates
- No measurable change in penetrometer depth to refusal
- No measurable change in total cover
- No measurable change in soil organic matter
- No observable erosion issues

Visual erosion assessment and photo monitoring were conducted at both run clearing projects in 2010. No signs of erosion or notable changes in site conditions were observed. All success criteria have been met for these projects and no future monitoring is required on these projects. However, it is recommended that Heavenly staff visit these sites during and after rain events to confirm that no erosion or ongoing disturbance is occurring.

Success Criteria

In 2008, success criteria were revised based on the information gained from the results of the 2009 monitoring. Results from 2010 monitoring indicated that the refinements made in 2009 were appropriate and no further refinements were necessary.

Recommendations

Overall Process

- **Implement recommended management responses during the field season in which they are identified**, rather than waiting a full year before action is taken. This should accelerate the timeline between project implementation and final sign-off.
- **Continue weekly coordination conference calls** between IERS and Heavenly operations staff during field season in order to review and prioritize treatment and maintenance activities for the week.
- **Continue field coordination between implementation staff (Heavenly) and monitoring staff (IERS)** to ensure that monitoring plots are delineated with a complete understanding of both planned projects and treatment types/areas (for pre-treatment monitoring) and implemented treatment types/areas (for performance monitoring).

Restoration Projects

- **Commit to treatment implementation schedules** during weekly coordination calls so that IERS is onsite during key steps in the treatment process. In general, treatments verified in the field by IERS have met success criteria far more often than unverified treatments.
- **Conduct annual and rain-event erosion assessment and photo documentation at all restoration projects.** Develop a schedule and checklist for all restoration projects (use Summary of Management Responses, below, as a starting point).
- **Inspect and photo document treatment areas during rain events** so that minor drainage or erosion issues can be resolved before escalating to large erosion problems.
- **Develop an annual maintenance plan for road shoulder infiltration strips** along Skyline Trail, which are likely to require spot mulching and/or targeted loosening to address ongoing disturbance.
- **Identify, assess and resolve road system drainage issues**, particularly those that are impacting recently treated areas. Nearly all erosion issues observed at restoration projects were related to concentrated run-on from roads upslope of treatment areas.
- **Protect treatment areas from human disturbance.** Identify treatment areas that are in close proximity to trails or regular foot traffic and implement measures to minimize disturbance (signage, fencing, etc).
- **Incorporate test areas into selected future restoration projects** to evaluate management questions such as:
  - Effects of amendment concentration (combination of amendment application depth and tilling depth) on soil nutrients, infiltration rate, and plant growth

    - Effects of fertilizer application rate on soil nutrients and plant growth
    - Effects of mulch type and depth on sediment yield
    - Effects of different irrigation regimes on plant establishment (year 1), plant growth over time, and species composition
- **Develop a targeted irrigation strategy** for 2011 field season including: low-flow heads, site-specific schedules (frequency and duration), documentation protocol for test sites (irrigation field log), and a plan to prevent erosion caused by leaking heads.
- **Measure fertilizer and seed application rates** - expand use and understanding of standardized measurement protocols to ensure accurate and consistent application rates for seed and fertilizer (such as 5-gallon buckets marked with volumes that correspond to seed or fertilizer weight). This should be a consistent practice across all projects.
- **Document treatments -** continue to work with IERS to use and refine treatment documentation forms. Documentation of site-specific treatments is critical to understanding and improving treatment cost-effectiveness.
- **Assess cost-effectiveness of different treatments** by tracking treatment implementation costs and comparing to monitoring results (e.g. reduced sediment yield).
- **Develop a plan to manage and maximize wood chip availability** that considers anticipated restoration project needs, regional and on-mountain sources (on-mountain fuel reduction and run clearing, local defensible space contractors), minimizes hauling (import and export), and accounts for long-term storage/staging/aging.
- **Include 10-15% western needlegrass (*Achnathrum occidentale*) in upland revegetation treatment seed mixes**, particularly at high elevation sites. Western needlegrass is well-adapted to arid, high elevation sites and was the dominant grass observed during monitoring at the Canyon test plots from 2006-2008 (Arst, 2008). While it is more expensive on a per-pound basis than other native grasses, vegetation monitoring at Heavenly to date indicates that inclusion of western needlegrass in upland revegetation treatment seed mixes is the most cost-effective method to establish self-sustaining vegetation at most Heavenly sites.

Ski Run Clearing Projects

- **Conduct annual and rain-event erosion assessment and photo documentation at all run clearing projects.** Develop a schedule and checklist for all run clearing projects (use Summary of Management Responses, below, as a starting point).
- **Document snow depth and map clearing areas for all future over-the-snow run clearing projects.**

Summary of Management Responses by Project

The following table summarizes recommended management responses and follow-up actions to be completed by either Heavenly staff or IERS in 2011 for each project and site (Table 33).

Table 33. Summary of management responses and follow-up actions by project and site

Project	Treatment Area	Unmet Success Criterion	Management Response	Follow-up Action	Completion Date, Name and Signature
Olympic Lift	**Top**	Visual Erosion Assessment	1. Assess water flows to determine the source of the road erosion issue 2. Implement road drainage improvements such that water is collected/infiltrated without causing erosion 3. Remove sediment in treatment areas. 4. Ensure sprinkler heads and irrigation systems are maintained to preclude leaking. Place heads above water connection point to prevent drain-down leakage	1. Inspection of road drainage improvements during and after implementation 2. Visual erosion assessment after rain event (after road improvements are completed)	
Olympic Lift	**Top**	Plant cover criterion was met in the designated monitoring area; however, large areas of zero plant cover existed and are addressed here	For low cover areas only (as determined and marked by IERS staff): **Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment	

Project	Treatment Area	Unmet Success Criterion	Management Response	Follow-up Action	Completion Date, Name and Signature
Olympic Lift	**Bottom**	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment	
Olympic Lift	**Top and Bottom**	n/a	Install fencing/signage and communicate to staff locations of treatment areas to prevent foot and vehicle traffic		
Heavenly Flyer	**Bottom**	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment	
Heavenly Flyer	**Bottom**	n/a	Install appropriate signage and fencing to prevent foot traffic		
Heavenly Flyer	**Bottom**	n/a	Formalize walking trail if staff will be walking between the lodge and the Flyer	1. Implementation monitoring 2. Visual erosion assessment	

Project	Treatment Area	Unmet Success Criterion	Management Response	Follow-up Action	Completion Date, Name and Signature
Heavenly Flyer	**Top**	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment	
Heavenly Flyer	**Top**	n/a	Install appropriate signage and fencing to prevent foot traffic		
Mid Station Rd	**Road**	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment	
Mid Station Rd	**Road**	Visual Erosion Assessment	Additional mulching after implementing alternative 1 or 2 above to achieve total cover criterion. Mulch should be applied to 2 inches.	1. Implementation monitoring during mulching activities 2. Visual erosion assessment (captured above as follow-up for plant cover criterion)	
Skyline Trail	**Road Shoulder**	n/a	Targeted maintenance (mulching, soil loosening, etc.)	Visual erosion assessment after rain events to ensure maintenance is effective	

Project	Treatment Area	Unmet Success Criterion	Management Response	Follow-up Action	Completion Date, Name and Signature
Skyline Trail	**Road Shoulder**	Visual Erosion Assessment	Annual Visual Erosion Assessment, including: 1. Identifying areas of concentrated road drainage 2. Implementing road drainage improvements such that water is collected/infiltrated in a stable manner 3. Removing deposited sediment in treatment areas.	1. Inspection of road drainage improvements during and after implementation 2. Visual erosion assessment and photo monitoring after rain events (after maintenance is completed)	
Lakeview Lodge	**Patsy's Trail**	Plant cover criterion was met in the designated monitoring area; however, areas of zero plant cover existed and are addressed here	For low cover areas only (as determined and marked by IERS staff): **Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment	
Lakeview Lodge	**Patsy's Trail**	n/a	Treatment area protection (fencing, signage, etc)	Implementation monitoring after fencing/signage installation	
Lakeview Lodge	**Patsy's Trail**	n/a	Removal of invasive species	Implementation monitoring	
Lakeview Lodge	**Gun Barrel Top Slope**	Visual Erosion Assessment	1. Assess water flows to determine the source of the road erosion issue 2. Implement road drainage improvements such that water is collected/infiltrated in a stable manner 3. Remove sediment deposited in treatment area. 4. Place irrigation heads above connection point so drain-down leakage does not occur.	1. Inspection of road drainage improvements during and after implementation 2. Visual erosion assessment after rain event (after road improvements are completed)	

Project	Treatment Area	Unmet Success Criterion	Management Response	Follow-up Action	Completion Date, Name and Signature
Lakeview Lodge	**Gun Barrel Top Slope**	n/a	Removal of invasive species	Implementation monitoring	
Stagecoach	**Upper Slope**	Plant Cover	**Alternative 1:** Remove mulch, apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment	
Stagecoach	**Lower Slope**	Plant Cover	**Alternative 1 (necessary for compacted lower 10-30 meters and optional for the rest of the slope):** Remove mulch, apply amendments, till amendments to 12", apply fertilizer, apply seed, replace mulch then irrigate with low-flow heads (MP rotator or equivalent) for one season. **Alternative 2:** Apply seed over mulch, then use spring rake to ensure soil-seed contact then irrigate with low-flow heads (MP rotator or equivalent) for one season	1. Implementation monitoring during seeding, fertilizing, or mulching activities 2. Germination assessment after 1 month of irrigation 3. Visual erosion assessment	
Stagecoach	**Lower Slope**	Visual Erosion Assessment	1. Assess road drainage patterns and treatment alternatives 2. Implement road drainage improvements such that water is collected/infiltrated without causing erosion 3. Remove sediment deposited in treatment areas 4. Place irrigation heads above connection point so drain-down leakage does not occur	1. Inspection of road drainage improvements during and after implementation 2. Visual erosion assessment after rain event (after road improvements are completed)	

Project	Treatment Area	Unmet Success Criterion	Management Response	Follow-up Action	Completion Date, Name and Signature
Stagecoach	**Lower Slope (compacted bottom 10-30 meters with sedimentation and tire tracks)**	Penetrometer (soil compaction)	Tilling and incorporation of wood chip amendments to 12" (to be completed in conjunction with Alternative 1 treatments described in the plant cover criterion above)	Implementation monitoring to ensure correct tilling and amendment application depths	

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Appendix III
2010 CWE Work List

HEAVENLY MOUNTAIN RESORT
2010 ANNUAL CWE PROJECT & WORK LIST
February 4, 2010

Project #	Source*	Location	Treatment
Watershed: CA-1 Heavenly Valley Creek			
1	M	Gondola Top Station	Refurbish existing infiltration basin and improve drainage to maintain effectiveness.
2	M	Groove Upper Terminal	Improve soil cover to stabilize steep slope and redirect runoff to channel and infiltration area.
3	P	Lakeview Water System	Remove old tank. Decommission old tank site and road to tank.
4	M	Upper Vehicle Maintenance Shop	Confirm effectiveness of stabilization work on gully above SEZ restoration site.
5	M	Zipline Base Station	Confirm effectiveness of existing soil cover and add cover beneath operator's booth.
Watershed: NV-3 Edgewood Creek			
6	B	Boulder Lift Upper Terminal	Install infiltration areas and improve effective cover around terminal.
7	B	Boulder Lift Lower Terminal	Install infiltration areas and improve effective cover around terminal.
8	P	Olympic Express Lift Lower Terminal	Stabilize area with bare soil below access road to terminal.
Watershed: NV-2 + 5 Daggett Creek			
9	P	East Peak Grading Area	Complete drainage and stabilization measures initiated for the area between Comet and Dipper Lift Lower Terminals.
10	B	East Peak Lodge	Stabilize driplines and drainage swales near foundation of building.
11	M	East Peak Well	Stabilize slope between road and well house.
Resort Wide			
12	M	Resort-Wide	Install and maintain closure signs on Ellie's Swing Trail, Betty's Return Trail, Powderbowl tower road, Lower Cal Trail below Hellwinkle's trail, East Peak Dam Road and West Round-a-bout
13	M	Resort-Wide	Develop a process to treat priority areas with long-term soil cover needs on ski runs and to identify and perform road maintenance needs. Note: This replaces the treatment listed in previous Annual CWE Work Lists as "Reseed and fertilize degenerating grassy areas on +/- 1/5th of ski runs

			(all runs are reviewed/reseeded over 5 years)”
14	M	Resort-Wide	Inspect and restore all areas damaged affected by winter resort operations, including hydrants & pipe failures, and areas affected by snowcat operations; document areas treated.
15	M	Resort-Wide	Erect and maintain vehicles barriers and/or fences to prevent unauthorized vehicle access off of designated summer roads and facility parking areas.
16	M	Resort-Wide	Inspect and maintain all drainage structures.
17	M	Base Areas	Erect and maintain vehicle barriers and/or fences to prevent unauthorized vehicle access from base areas.
***Source Codes**			
	M B P MMP	Maintenance Needed Project need determined from BMP Effectiveness Monitoring Master Plan Development Project Master Plan Monitoring & Mitigation Plan Requirement	

Appendix IV
2009-2010 Environmental Monitoring Program Annual Report

Shaping the Future



Heavenly Mountain Resort Ongoing Collection/Monitoring Agreement

Annual Report for the 2010 Water Year

February 15, 2011

Prepared For

Heavenly Mountain Resort

Annual Monitoring Report

Heavenly Mountain Resort Ongoing Collection/Monitoring Agreement

Annual Report for the 2010 Water Year

February 15, 2011

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Acronyms

BMI	Benthic macro-invertebrate
BMPs	Best Management Practices
BMPEP	Best Management Practices Effectiveness Program
CNPS	California Native Plant Society
CWE	Cumulative Watershed Effects
ESC	Effective Soil Cover
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
GIS	Arc-Geo Information Systems
LTBMU	Lake Tahoe Basin Management Unit
LWD	Large woody debris
mg/L	milligrams/liter
MUSLE	Modified Universal Soil Loss Equation
NDEP	Nevada Department of Environmental Protection

NTU	Nephelometric Turbidity Units
RCI	Resources Concepts Inc.
SCI	Stream Control Inventory
SOP	Standard Operating Procedure
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TRPA	Tahoe Regional Planning Agency
TSS	Total Suspended Sediment
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
VRAP	Vegetation Rapid Assessment Protocol

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Chapter 1

Introduction

This annual report is submitted in partial fulfillment of monitoring and reporting requirements set forth in the Lahontan Regional Water Quality Control Board Order R6T-2003-0032. It summarizes monitoring and evaluation activities conducted at Heavenly Mountain Resort (Heavenly) during the 2010 water year as a result of the implementation of the Water Quality and Best Management Practices Monitoring Program. This program is a component of the Heavenly Mountain Resort Master Plan (Heavenly 1996) and the Heavenly Mountain Resort Master Plan Amendment (Heavenly 2007).

Heavenly Mountain Resort is located on the south shore of Lake Tahoe within El Dorado and Alpine Counties of California and Douglas County of Nevada (Figure 1.1). Land ownership is shared between the U.S.D.A. Forest Service (USDA Forest Service) and Heavenly. Heavenly operates on National Forest lands through a special use permit, renewed in 2002 for a period of 40 years.

The Water Quality and Best Management Practices Monitoring Program was initiated at Heavenly in 1995 in conjunction with the completion of the Heavenly Mountain Resort Master Plan (Heavenly 1996). The need for such a monitoring program was established during preparation of a Cumulative Watershed Effects (CWE) Analysis required by Tahoe Regional Planning Agency (TRPA) guidelines for ski area expansion. Implementation of the monitoring program was a condition of the Master Plan approval by the USDA Forest Service and TRPA. An amendment to the Heavenly Mountain Resort Master Plan approved by TRPA on April 25, 2007, is currently being implemented by Heavenly in collaboration with Lahontan Regional Water Quality Control Board (Lahontan), the USDA Forest Service, and TRPA. Modifications resulting from the Master Plan Amendment include incorporating all monitoring into a single report that was submitted May 15, 2009 to the TRPA, USDA Forest Service, and Lahontan. This monitoring report is on an ongoing schedule due yearly. The requirements of the 2009/2010 Annual Water Quality and Best Management Practices Monitoring Report remain the same following approval of the Master Plan Amendment.

The Master Plan represents a comprehensive twenty-year development plan for Heavenly Mountain Resort. Master Plan and Master Plan Amendment implementation objectives of Heavenly, TRPA, and the USDA Forest Service regarding protection of the environment include (Heavenly 1996):

- Making optimal use of the natural attributes of the site without creating a significant impact on the environment (Heavenly);
- Restoring the health of sub-watersheds and other natural resource values disturbed by past activities (Heavenly);
- Protecting the environmental quality of the area (USDA Forest Service);

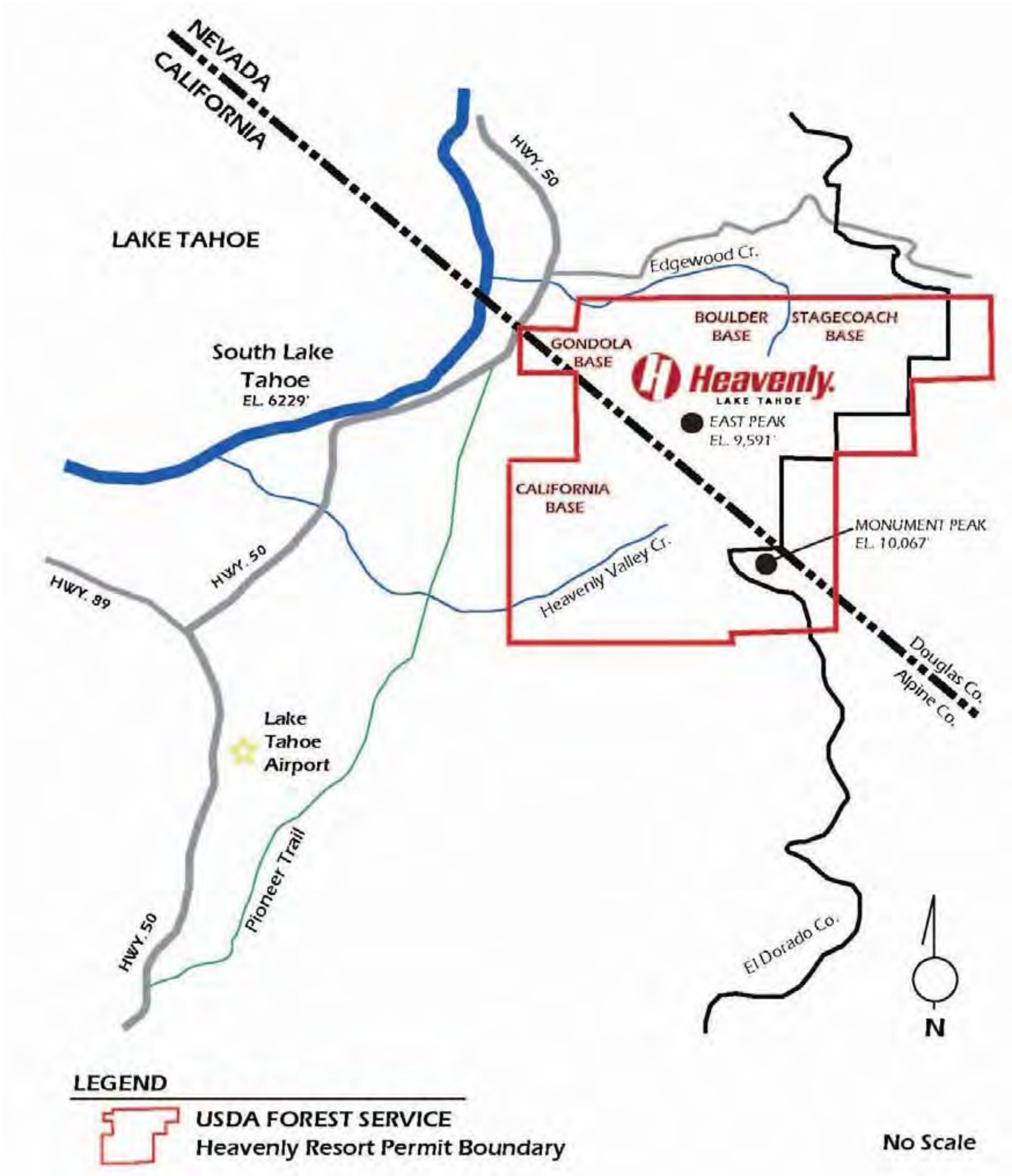

Figure 1.1 Location of Heavenly Mountain Resort (Heavenly 2007)

- Providing a quality ski resort with ski runs and other disturbed areas stabilized to reduce the potential for soil erosion (USDA Forest Service);
- Improving the visual quality of the area (USDA Forest Service); and
- Providing for long-term preservation and restoration of Stream Environment Zones (TRPA).

Implementation of the Collection/Monitoring Agreement between Heavenly and the USDA Forest Service (Monitoring Program) will provide data sufficient to determine compliance with agency water quality standards and validate the efficiency of management practices in protecting against adverse cumulative watershed effects.

1.1 Environmental Monitoring Program

The overall objective of the Environmental Monitoring Program is to evaluate and monitor water quality and overall ecological health of Heavenly creeks and watersheds while satisfying California, Nevada, and TRPA regulatory water quality requirements. The Environmental Monitoring Program is made up of five major components (Heavenly 1996):

- Water quality monitoring to comply with regulatory monitoring requirements;
- Soil cover monitoring to gain understanding of how to prevent soil loss and protect water quality;
- Monitoring to determine BMP effectiveness under the various conditions at the ski area;
- Riparian condition monitoring to determine riparian area response to Heavenly Mountain Resort activities; and,
- Overall watershed condition and trend monitoring.

1.2 Monitoring Plan

The Environmental Monitoring Program Plan is in Chapter 7 of the 2005 Draft Master Plan Amendment. The Monitoring Program was designed to satisfy the requirements of Lahontan Board Order No. 6-91-36. The Monitoring Plan addresses the five components stated above. Key plan requirements are summarized here.

1.3 Water Quality Monitoring

The waste discharge requirements, monitoring, and reporting program were updated by Lahontan Board Order No. R6T-2003-0032 in 2003. Currently, the Monitoring Program includes water quality monitoring at 6 stations. Two stations are located on Edgewood Creek, in Nevada. Sampling occurs monthly except during the spring snowmelt period when sampling occurs weekly or when flows are too low to measure. Results and discussion are to be reported to Heavenly, TRPA, and Lahontan in this annual report. Additionally, water quality sampling results are reported quarterly to Lahontan as required by Order No. 6-91-36.

Several constituents are identified in the Monitoring Program for sampling at each of the stations. The following primary list of constituents is monitored at each station:

- Discharge
- Specific Conductivity
- Turbidity
- Suspended Sediment
- Total Nitrate/Nitrite as Nitrogen
- Total Kjeldahl Nitrogen

- Dissolved Orthophosphate
- Total Phosphorus
- Dissolved Phosphorus
- Chloride
- Total Iron

The following secondary list of constituents is typically monitored only during storm events at stations associated with parking lots:

- Oil and Grease
- Total Petroleum Hydrocarbons
- Ammonia
- Total Lead

1.4 Effective Soil Cover Monitoring

The Monitoring Program includes soil cover monitoring to determine requirements and effectiveness of various soil covers under different slopes and conditions. Monitoring examines the effectiveness of past and current projects. Soil cover monitoring conducted from 1995 to 2003 was based on the use of random transects at elevations above 7,000 ft. The results were reported in the 2003 Comprehensive Report. Collection of the data was too time-intensive, making it difficult to obtain data for the entire resort and the 2003 Comprehensive Report recommended that the measurements be discontinued. The report also recommended development of new protocol. A new general methodology was developed in 2005 by Cardno ENTRIX (formerly ENTRIX, Inc.) and approved by the USDA Forest Service.

In the 2007 Annual Report and later in the 2008 Effective Soil Cover Workplan, a new protocol was presented that combined the California Native Plant Society’s (CNPS) Vegetation Rapid Assessment Protocol (VRAP) and the establishment of permanent photo points. After discussions with the USDA Forest Service, it was determined that the CNPS VRAP method should support an aerial survey, rather than being the only data collected. Heavenly and the USDA Forest Service agreed to share the cost of an over-flight. An infrared aerial flyover of Heavenly Mountain Resort was conducted by 3DiWest in conjunction with the USDA Forest Service in July of 2009. The flight produced a 1:8,000 resolution infrared aerial photo of the entire mountain and was used along with Geographic Information Systems (GIS) and field verification (i.e. ground-truthing) to produce an accurate picture of the soil cover at Heavenly. The VRAP method was augmented in 2009 with the establishment of permanent photo points to better track variability over time. This new methodology is discussed in Chapter 3.

1.5 BMP Effectiveness Monitoring

The Monitoring Program includes BMP monitoring to determine the effectiveness of the BMPs in preventing soil erosion and protecting water quality under various conditions. Based on recommendations contained in the 2003 Comprehensive Report, the USDA Forest Service designed and implemented a new BMP monitoring strategy modeled after Region 5's Best Management Practices Effectiveness Program (BMPEP) protocols (USDA Forest Service 2002). The BMP monitoring program is currently being implemented by Resource Concepts Inc. (RCI) and is presented in Chapter 4.

1.6 Riparian Condition Monitoring

The Monitoring Program includes riparian and channel condition monitoring, as well as macro-invertebrate monitoring which includes the following objectives:

- Determine which, and by how much, various creek parameters fluctuate between monitoring periods
- Evaluate the impacts of Heavenly management practices on riparian system health

In 2003, the USDA Forest Service made a number of recommendations to improve channel condition monitoring. These recommendations are reflected in the Riparian Conditions Monitoring Plan developed by ENTRIX in 2005. The revised plan was implemented in 2006 and most recently in 2009. Channel condition monitoring occurred only at the Edgewood Creek reaches in 2010 and is discussed in Chapter 5. Macro-invertebrate monitoring occurred in 2006, 2007, 2010, and will continue in 2011. The proposed amended monitoring permit states that an electronic format of the results shall be submitted in accordance the Surface Water Ambient Monitoring Program (SWAMP) template. Results of this study will be included in a separate submittal in May 2011. The second year of monitoring is scheduled for the summer of 2011.

1.7 Condition and Trend Monitoring

Condition and trend evaluations will be conducted on each of the data elements of the monitoring program both individually and cumulatively to gauge overall watershed condition, trends, and to determine if ski area management activities are improving or degrading water quality and ecological health. These evaluations are evaluated in 5-year intervals in Comprehensive Reports. The next Comprehensive Report was scheduled to be completed in June 2011; however revisions to the permit have pushed the due date of this report until January 2012. This comprehensive report will cover six water years (2006-2011) and will better align the monitoring program with the reporting sequencing.

Chapter 2

Water Quality

2.1 Station Descriptions

For the 2010 water year, a set of water quality parameters were measured at six stations on four creeks to determine the effects of ski area development on background conditions (Table 2.2). Stations and sampling rationale are given in Table 2.1. Approximate locations of stations are shown in Figure 2.1.

Table 2.1 Heavenly Valley Mountain Resort Monitoring Program Water Quality Stations

Station ID	Station Name	Rationale
HV-C2	Heavenly Valley Creek Below Patsy's and Groove Lifts	Characterize water quality in Heavenly Valley Creek draining developed ski area
HV-C3	Forest Service Property Line	Characterize water quality in Heavenly Valley Creek leaving National Forest Lands below Heavenly Mountain Resort
HV-C4	Heavenly California Base Parking Lot	Characterize water quality in Bijou Park Creek below California Main Lodge and parking area
HV-E1	Edgewood Creek Above Boulder Parking Lot	Characterize water quality in Edgewood Creek above Boulder parking lot and below ski runs
HV-E2	Edgewood Creek Below Boulder Parking Lot	Characterize water quality at Edgewood Creek below Boulder parking lot
HV-H5	Hidden Valley Creek Baseline Station	Characterize water quality in creek draining a similar, but mostly undeveloped watershed

2.2 Precipitation Summary

Precipitation for the year is shown in Figure 2.2. Data was taken from the National Resource Conservation Service, National Water and Climate Center website (http://www.wcc.nrcs.usda.gov). This graph represents accumulated precipitation and snow water content measured at SNOTEL Station 19L24S ("Heavenly Valley"), operated by the USDA Natural Resource Conservation Service. This station is located in the upper watershed of Heavenly Valley Creek near Sky Meadows, the former HV-C1A monitoring station at latitude 38° 56' N, longitude 119° 54' W, and elevation 8,850 ft.

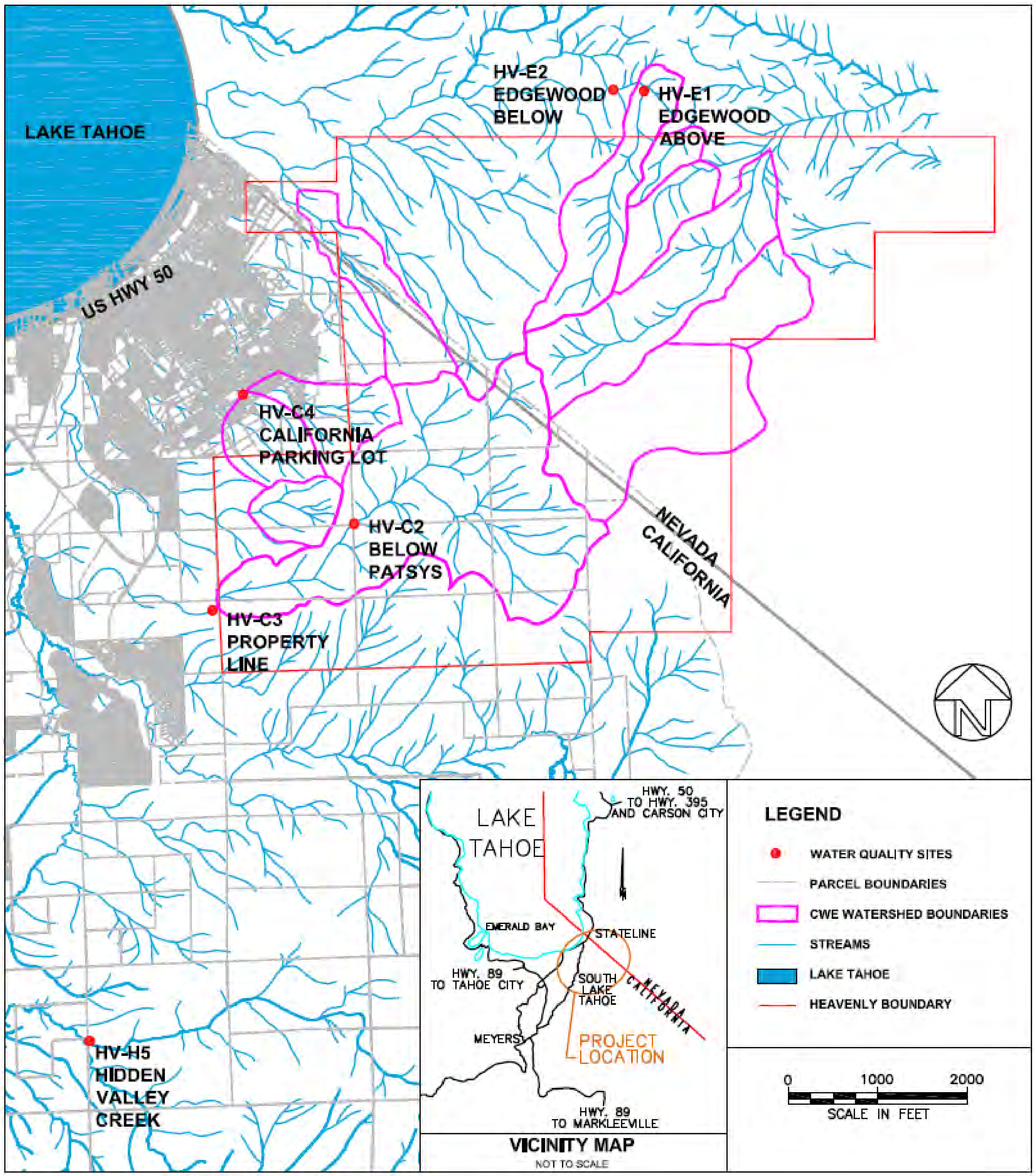

Figure 2.1 Approximate location of water quality sampling sites (MapQuest 2009) (USDA Forest Service 2001)

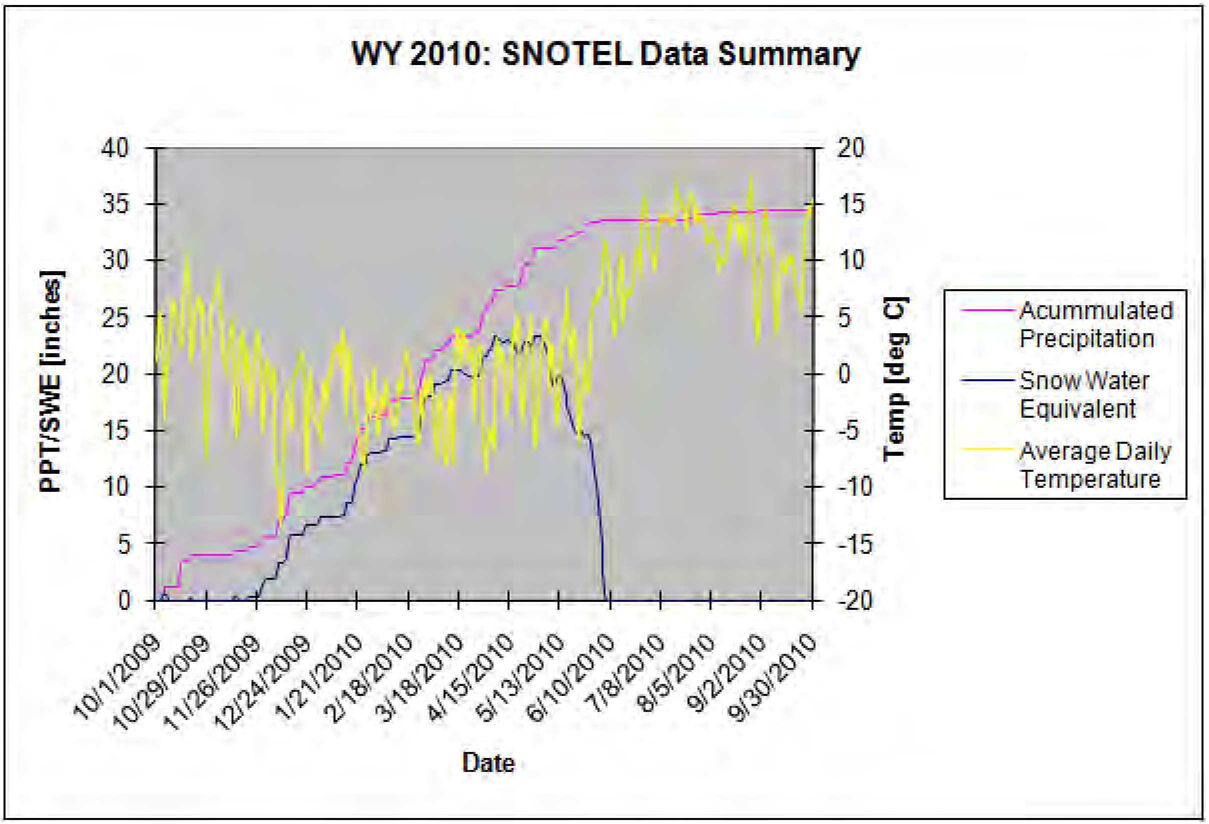

Figure 2.2 SNOTEL weather graph for water year 2010

2.3 Sampling Frequency and Analysis

A total of 78 samples were collected during the 2010 water year. Two of these samples were collected during storm events, one from the California Parking Lot Station (HV-C4), and the other storm sample was from Hidden Creek (HV-H5). All stations were sampled weekly during spring runoff and monthly during baseflow conditions, as flow levels permitted. Table 2-2 provides a summary of sampling and analyses for the 2010 water year.

Analyses for specific conductivity, turbidity, suspended sediment, nitrate/nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus, soluble reactive phosphorus, and dissolved phosphorus were performed by High Sierra Water Lab located in Truckee, CA. Analyses for iron, lead, oil and grease, and chloride were performed by Western Environmental Testing Laboratory (WETLab) in Reno, NV. Analytical results by station are provided in Appendix A.

Table 2.2 Summary of Sampling and Analysis Conducted at Heavenly Mountain Resort for the 2010 Water Year.

Station ID	Station Name - abbreviated	Number Samples	Constituents*
HV-C2	Heavenly Below Patsy's	15	Full suite
HV-C3	Heavenly at Property Line	15	Full suite

Table 2.2 Summary of Sampling and Analysis Conducted at Heavenly Mountain Resort for the 2010 Water Year.

Station ID	Station Name - abbreviated	Number Samples	Constituents*
HV-C4	California Parking Lot-Bijou Park Creek	16	Full suite, oil, grease, TPH, Fe, Pb, Cl, NH_3
HV-E1	Edgewood Creek Above	8	Full suite, Dissolved P
HV-E2	Edgewood Creek Below	8	Full suite, Dissolved P
HV-H5	Hidden Valley Creek	16	Full suite

*Full suite = Discharge, specific conductivity, turbidity, suspended sediment, nitrate/nitrite, TKN, total nitrogen, total phosphorus, soluble reactive phosphorus. Storm and quarterly samples are included in the "full suite" count. Storm and quarterly sampling may also include chloride and iron as additional constituents.

2.4 Results and Discussion

2.4.1 Discharge

The rate of stream flow was measured using a Marsh-McBirney meter at all sites except HV-C2 where flow was calculated from stage values in Parshall flumes. The Heavenly Valley (HV-C2 and HV-C3) and Hidden Valley Creek (HV-H5) stations exhibited peak streamflow discharge values in June. The Bijou Park Creek station (HV-C4) exhibited peak streamflow discharge during a storm event in mid-October; otherwise, exhibited peak flows at the end of April. The peak flows from Heavenly Valley and Hidden Valley Creeks (HV-C2 and HV-H5) were significantly higher than 2009 measurements, and also peaked several weeks later than last year. On the contrary, Heavenly Valley Creek (HV-C3) reported a discharge peak below what was reported in 2009, and peaked approximately slightly earlier than last year. Bijou Park Creek (HV-C4) also reported a discharge peak below last year's, while the timing of the peak flows occurred approximately one month later.

The peak streamflows at the Edgewood Creek sites (HV-E1 and HV-E2) occurred in May, with HV-E1 exhibiting peak discharges in early May, and HV-E2 in late May. These values are much lower than the reported peaks of 2009 since last year's peak discharges occurred as a result of a storm event. Samples from the lower Edgewood site (HV-E2) consistently reported discharge values higher than the upper sampling site (HV-E1). Edgewood Creek is known to have tributaries adding flow to the downstream site from surrounding neighborhoods. In addition, below the Boulder parking area the creek is established in a small ravine which collects groundwater recharge from the adjacent hillside slopes. During storm events, the discharge values are in reverse order. This is most likely the result of the Boulder Parking Lot Treatment System installed in 2005 attenuating flow as it runs downstream to the lower site. In addition, the Lower Edgewood Creek Stream Environment Restoration Project completed in 2007, created plunge pools to increase retention time contributing to the attenuation.

The 2010 water year was an average winter for precipitation. Both the precipitation values and snow water equivalent peak measurements were higher than the past two years, which were a below average winters. Above average temperatures in May and June fueled peak discharge values at a majority of the sampling locations (See Figure 2.2). Figures 2-3, 2-4, and 2-5 are hydrographs representing all six sampling stations.

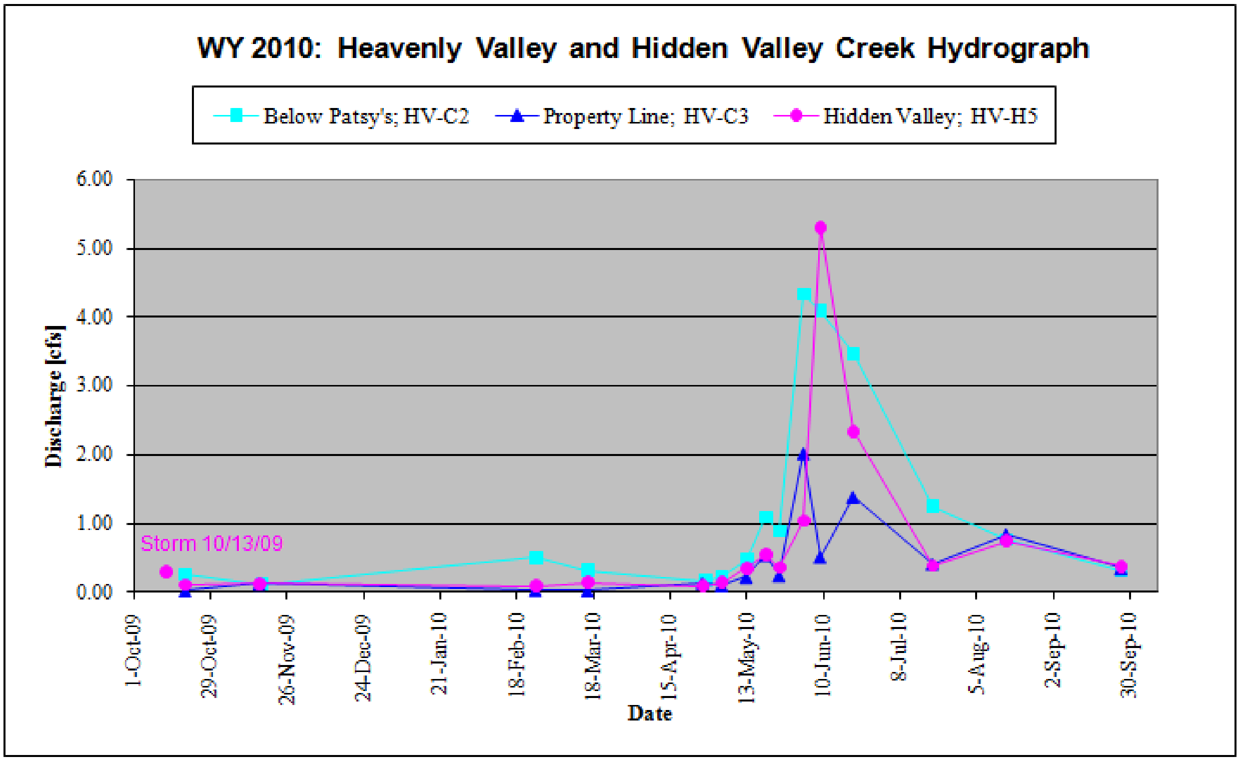

Figure 2.3 Hydrographs for Heavenly Valley and Hidden Valley Creeks during water year 2010. The two Heavenly Valley Creek monitoring sites are depicted in shades of blue. The one Hidden Valley Creek monitoring site is depicted in magenta.

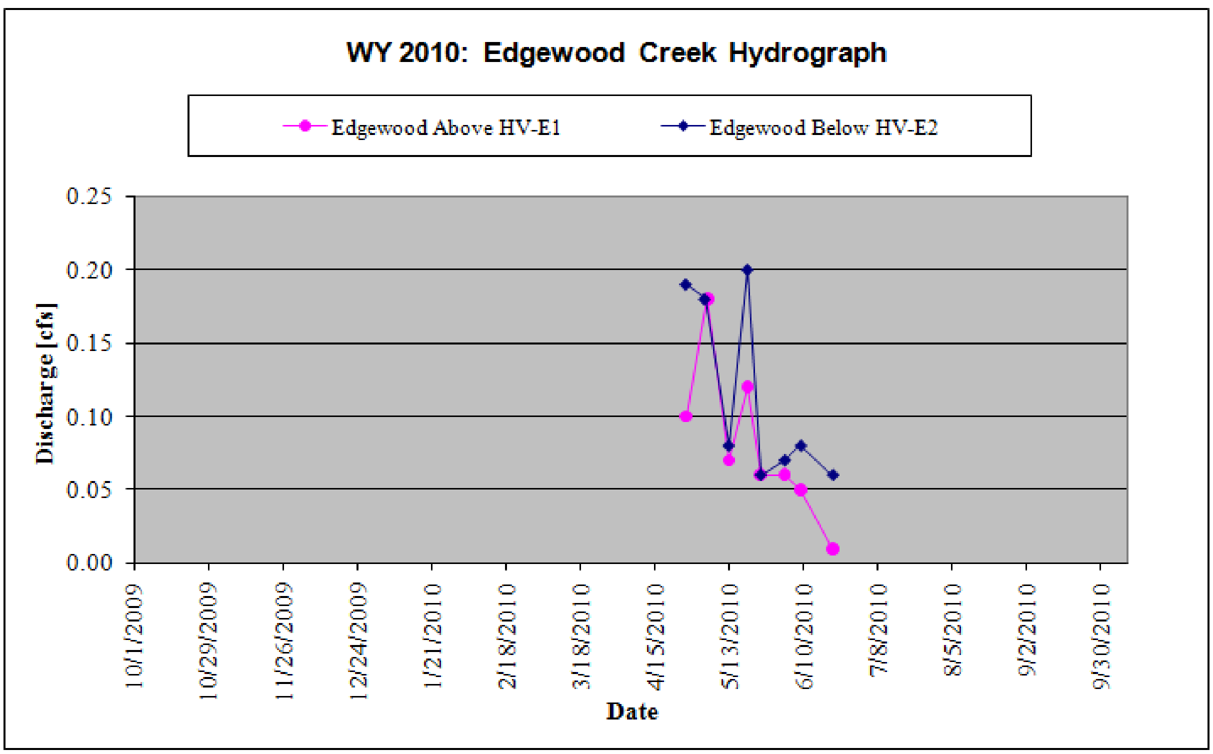

Figure 2.4 Hydrographs for Edgewood Creek during water year 2010.

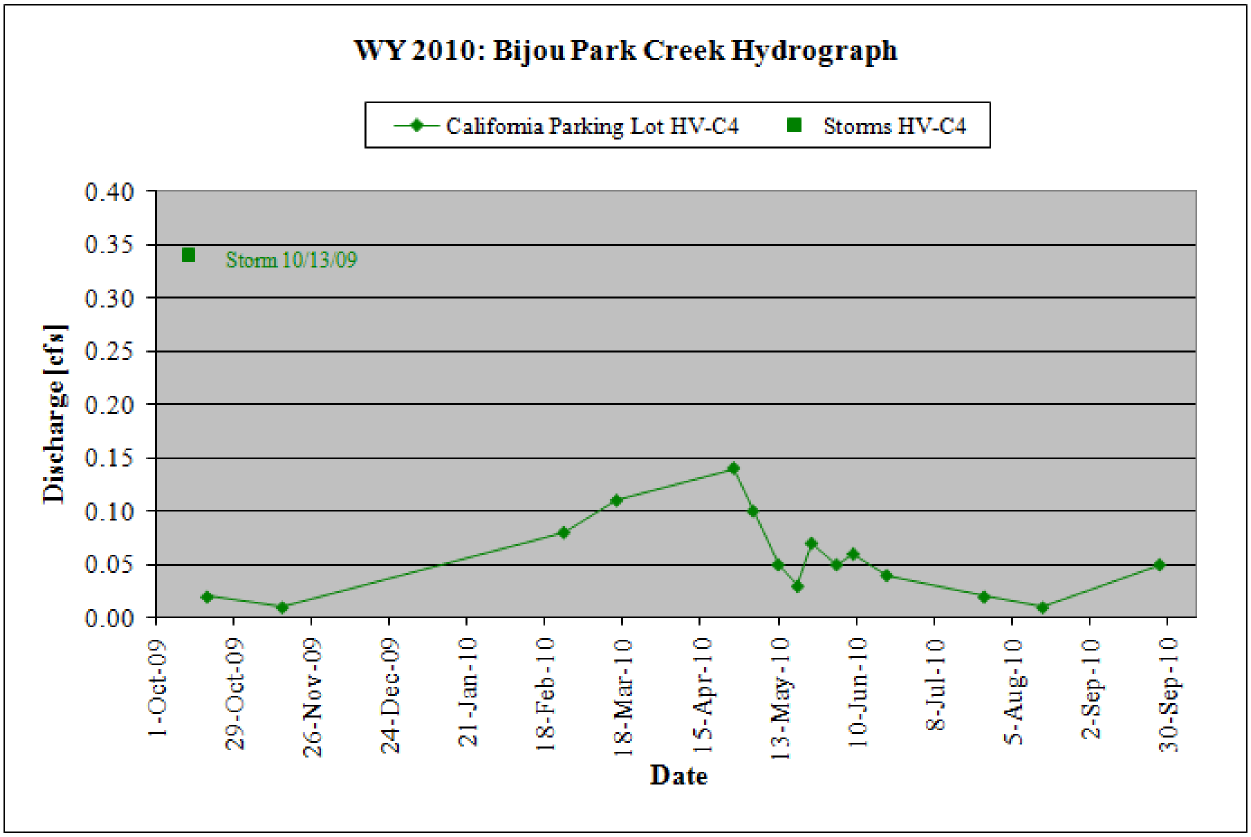

Figure 2.5 Hydrograph for Bijou Park Creek during water year 2010.

2.4.2 Annual Load Estimates

Table 2.3 presents the annual load values calculated from flow-weighted concentration data for total nitrogen, total phosphorus, and suspended sediments at Heavenly Valley Creek's Property Line station and the Hidden Valley Creek baseline station for water year 2010. Annual load values are calculated from flow-weighted concentration data for constituents. The previous Total Maximum Daily Load (TDML) for sediment at Heavenly Valley Creek was 58 tons/year (based on a five-year rolling average). The newly calculated five year average from 2006-2010 is shown in Table 2.4 and equals 12.6 tons/year. This new rolling average is considerably lower than 58 tons/year and is mostly likely associated with below average precipitation and flows from the past three seasons. In addition, this lower rolling average value could also be attributed to BMP implementation and effectiveness throughout the watershed. Although compliance is not determined until the Comprehensive Report, which will include water years 2006-2011, Heavenly continues to fall below the TMDL standard for suspended sediment. The last comprehensive report found that Heavenly was in compliance for the TMDL standard during that monitoring period. This average was verified in the Lahontan TMDL status report.

The method used to calculate annual load values is based on constituent concentrations, discharge, and days between samples. This is the same method that has been used in previous annual reports and verified with Lahontan staff last spring. Storm data was not used in load calculations. The 2010 water year can be considered an average precipitation year, and since last several years (2006-2009) were low precipitation years, the annual load values are considerably higher than the 2006-2009 water years. Values for total nitrogen, total phosphorus, and suspended sediment are significantly higher than those reported in 2009.

Table 2.3 Annual load values at Heavenly Valley Creek Property Line and Hidden Valley Creek Stations.

Year	Discharge m^3/yr	Total N kg/yr	Total P kg/yr	Suspended Sediment tons/yr
Property Line (HV-C3)				
2010	297,626	180	44	21.6
Hidden Valley Creek (HV-H5)				
2010	455,308	90	18	5.8

Table 2.4 Five Year Rolling Average of Suspended Sediment for Heavenly Valley Creek Property Line and Hidden Valley Creek Stations.

Year	Property Line (HV-C3) Suspended Solids (tons/year)	Hidden Valley Creek (HV-H5) Suspended Solids (tons/year)
2006	39.0	34.0
2007	1.0	3.0
2008	1.0	2.0
2009	0.5	1.6
2010	21.6	5.8
5 Year Rolling Average	12.6 (tons/year)	9.3 (tons/year)

2.5 Heavenly Valley and Hidden Valley Creeks

2.5.1 Summary Statistics for Water Quality Constituents: Water Year 2010

The statistical summary for Heavenly Valley and Hidden Valley Creeks for water year 2010 is contained within Tables 2.5 through 2.7, while raw data is referenced in Appendix A. Annual average standards that were exceeded by the stations on Heavenly Valley Creek were also exceeded by the Hidden Valley Creek reference station. Therefore, the exceedances are likely due to background conditions unrelated to operation of Heavenly. Total phosphorus, chloride and total iron all exceeded the State standard annual averages.

The concentration of Total Suspended Sediment (TSS) at Heavenly Valley and Hidden Valley Creeks fell well below the State Standard of 60mg/L at the 90th percentile. The Below Patsy's (HV-C2) and Property Line station (HV-C3) TSS values were higher than the value of the Hidden Valley Creek reference station (HV-H5) due to exceedances from the June 3rd sampling event. This sampling event resulted in the highest flows at Heavenly Creek for water year 2010, and likely mobilized suspended bed material above normal stage heights.

Lahontan's standard for total nitrogen, 0.19 mg/L, is the sum of the total nitrite/nitrate plus total Kjeldahl nitrogen. Both stations (HV-C2 and HV-C3) on Heavenly Valley Creek exhibited annual averages above the State standard; however, total nitrogen values were similar to that of the reference station, Hidden Valley Creek (HV-H5), which also exceeded the State standard, suggesting that resort operations have a less-than-significant impact on total nitrogen concentrations.

Annual averages for total phosphorus are required to be below the 0.015 mg/L Lahontan standard. Both stations on Heavenly Valley Creek exhibited levels that exceeded the standard. Average values for these stations are as follows: Below Patsy's (HV-C2) 0.13 mg/L, and Property Line (HV-C3) 0.089 mg/L. The reference station on Hidden Valley Creek (HV-H5) also exceeded the annual average standard at 0.043 mg/L. Although vegetation removal at the resort could contribute to phosphorus levels, the levels are only slightly higher than that of the primarily forested and relatively undeveloped watershed of Hidden Valley Creek.

The chloride standard of 0.15 mg/L was also exceeded by all stations on Heavenly Valley and Hidden Valley Creeks. Below Patsy's (HV-C2) and Property Line (HV-C3) exhibited annual averages of 1.34 mg/L, and 0.965 mg/L, respectively. By comparison, the reference station on Hidden Valley Creek (HV-H5) exhibited a chloride value of 0.40 mg/L. Causes for high chloride levels are unknown. The application of salt in the watershed upstream is a possible cause, but does not explain the high background concentrations. The chloride levels at the sample site Below Patsy's (HV-C2) could be attributed to application of sodium chloride on nearby terrain parks on the mountain. The Property Line site (HV-C3) is downstream of the Below Patsy's site and could be affected by salt application on terrain parks also. Chloride results for Heavenly Valley Creek (HV-C2 and HV-C3) are similar to values in previous water years.

The reference station on Hidden Valley Creek (HV-H5) exhibited a chloride value of 0.40 mg/L that was below last year's value of 1.02 mg/L. Although the chloride value dropped from last year, it is not entirely understood why the reference watershed continues to exhibit high background values compared with the State standard. The maximum chloride level measured at Hidden Valley Creek (HV-H5) was 0.75 mg/L on 10/13/09 during a storm event. There is no evidence or knowledge of salt or deicers being used in this remote relatively undisturbed watershed. The high value sampled from the reference station at Hidden Valley Creek (HV-H5) may indicate relatively high background concentrations. Heavenly is investigating practices that will reduce chloride in runoff such as alternative deicers, application practices, and deicer storage. If the reference station (HV-H5) continues to exhibit high chloride levels further management measures and implementation at resort sites may still not meet the water board standard.

Iron was the fourth constituent to be exceeded by all stations. The iron standard is 0.03 mg/L. Below Patsy's (HV-C2) and Property Line (HV-C3) had average values of 1.74 mg/L, and 0.064 mg/L respectively. The reference station on Hidden Valley Creek (HV-H5) exhibited 0.13 mg/L. The high value in the reference station may indicate high background concentrations. Groundwater below the Heavenly Tram was sampled on December 9, 2008 to investigate whether background iron concentrations exceeded the standard. This sample produced an iron level of 0.046 mg/L, which exceeded the standard. Further augmenting the possibility that iron levels are naturally high in Lake Tahoe groundwater is U.S. Geological Survey (USGS) data for Basin streams from 1991 through 2003 (USGS 2000). Data from streams such as Ward Creek, Blackwood Creek, Logan Creek, and First Creek, among others, demonstrate exceedances of the iron standard on a regular basis. Though this data ceased to be collected after 2003, it offers some insight on background iron levels in the Lake Tahoe Basin. Iron levels at Property Line (HV-C3) and the reference station were slightly lower than last year, although iron levels increased at Below Patsy's (HV-C2). The iron level collected on October 20, 2009 was a value of 6.3 mg/L, which is an unusually high exceedance. Iron levels above 1.0 mg/L have not been reported in previous sampling years (2006-2009), so this sampling event resulted in an annual average above previous water years.

Table 2.5 Below Patsy's Water Year 2010 Statistical Summary.

Exceedances of California Lake Tahoe Receiving Water Limits and Water Year 2010 Summary Statistics for Below Patsy's (HV-C2)

	Q (cfs)	Turbidity (NTU)	TSS (mg/L)	S Cond (mmhos)	Total Phos (mg/L)	SRP (mg/L)	Total Nitrogen (mg/L)	Chloride (mg/L)	Iron (mg/L)
CA State Standard		-	60.00	-	0.015	-	0.19	0.15	0.03
# Samples	15	15	15	15	15	15	15	3	3
Min	0.12	0.40	0.40	28.20	0.016	0.001	0.11	0.64	0.18
Max	4.34	3.00	533.00	120.00	1.07	0.021	3.30	2.10	6.30
Mean	1.22	1.12	41.25	51.31	0.13*	0.005	0.41*	1.34*	1.74*

*Indicates the average annual mean exceeded the state standard

Table 2.6 Property Line Water Year 2010 Statistical Summary

Exceedances of California Lake Tahoe Receiving Water Limits and Water Year 2010 Summary Statistics for Property Line (HV-C3)

	Q (cfs)	Turbidity (NTU)	TSS (mg/L)	S Cond (mmhos)	Total Phos (mg/L)	SRP (mg/L)	Total Nitrogen (mg/L)	Chloride (mg/L)	Iron (mg/L)
CA State Standard		-	60.00	-	0.015	-	0.19	0.15	0.03
# Samples	15	15	15	15	15	15	14	4	4
Min	0.03	0.48	0.27	30.80	0.012	0.001	0.055	0.100	0.031
Max	2.02	102.00	506.00	54.50	1.051	0.008	4.314	1.600	0.130
Mean	0.47	7.71	36.38	43.20	0.089*	0.005	0.387*	0.965*	0.064*

*Indicates the average annual mean exceeded the state standard

Table 2.7 Hidden Valley Creek Water Year 2010 Statistical Summary.									
Exceedances of California Lake Tahoe Receiving Water Limits and Water Year 2010 Summary Statistics for Hidden Valley Creek (HV-H5)									
	Q (cfs)	Turbidity (NTU)	TSS (mg/L)	S Cond (mmhos)	Total Phos (mg/L)	SRP (mg/L)	Total Nitrogen (mg/L)	Chloride (mg/L)	Iron (mg/L)
CA State Standard		-	60.00	-	0.015	-	0.19	0.15	0.03
# Samples	16	16	16	16	16	16	16	5	5
Min	0.09	0.32	0.80	18.35	0.018	0.002	0.016	0.16	0.01
Max	5.31	10.20	54.40	66.80	0.200	0.042	0.973	0.75	0.38
Mean	0.78	2.58	9.19	45.33	0.043*	0.010	0.221*	0.40*	0.13*

*Indicates the average annual mean exceeded the state standard

2.6 Bijou Park Creek (California Parking Lot)

2.6.1 Summary Statistics for Water Quality Constituents: Water Year 2010

The California Parking Lot site (HV-C4), is sampled for compliance with California state effluent standards for urban runoff and water quality objectives for maximum concentrations for discharge to surface waters, as stated in Lahontan Board Order No.R6T-2003-0032. Prior to November 30, 2008 effluent limits for discharge at this site were regulated under the permit as maximum concentrations for discharge to land treatment values. The new standards were reduced by approximately a factor of ten compared to the land treatment values (see Table 2.8). Proposed, constructed, and implemented improvements to the California Base parking lot dictated by the Lahontan permit triggered these more stringent objectives. California State effluent standards and exceedances are outlined in Table 2.9, while raw data is referenced in Appendix A.

Table 2.8 Lake Tahoe Hydrologic Unit Surface Runoff Effluent Limits			
Constituent	Units	Maximum Concentrations for Discharge to Land Treatment [1]	Maximum Concentration for Discharge to Surface Waters [2]
Total Nitrogen	mg/L as N	5.0	0.5
Total Phosphorus	mg/L as P	1.0	0.1
Total Iron	mg/L	4.0	0.5
Turbidity	NTU	200	20
Oil and Grease	mg/L	40	2

[1] The effluent limits for discharge to land were effective for discharges from the California Base area on December 31, 2004.

[2] The effluent limits for discharge to surface waters shall be effective for discharges from the California Base area on November 30, 2008.

The annual average for total nitrogen for the station at Bijou Park Creek (HV-C4) was recorded at 0.733 mg/L. This value exceeds the newly adopted maximum concentration of 0.5 mg/L and demonstrates noncompliance with this new lower imposed standard. The highest calculated value (the sum of nitrate, nitrite and total Kjeldahl nitrogen) was recorded during the October 13, 2009 storm event at 1.436 mg/L. The 2010 annual average value for total nitrogen at HV-C4 is less than that recorded for the previous five years. While only three of the sixteen samples collected were below the State standard; total nitrogen background levels (average annual mean) recorded at the reference site (HV-H5) also exceeded the State standard and have increased from last year. Plant uptake and decay may explain seasonal spikes throughout the year for nitrogen readings, but it doesn't explain the relatively high background readings or the increase in the readings from the 2009 water year.

The total phosphorus annual average for the Bijou Park Creek station (HV-C4) was 0.120 mg/L. This value exceeds the standard of 0.1 mg/L, but is less than half of the 2009 annual mean. Only three of the total sixteen samples collected were above the State standard. The storm sampling spike of 1.45 mg/L, and 1.479 mg/L pushed the annual average well above the standard. Phosphorus and nitrogen constituents can vary with plant uptake and subsequent vegetation removal, however the 2010 annual average is lower than the reported averages for the past four water years.

The annual average standard of 0.5 mg/L for total iron was exceeded for the Bijou Park Creek (HV-C4) 2010 water year. The 2010 annual average was 2.88 mg/L. Of the 16 samples collected, one was below the Lahontan standard. The 2010 annual average was less than the previous four water years. These relatively high iron readings are likely attributed to naturally occurring iron in the soils and nearby springs, as noted in the general permit (Section 12 California Base Area Runoff, page 6). An additional test was performed in December 2008 to test iron levels in and around the parking lot. The iron concentration from the tram sump water measured 0.046 mg/L, while the iron concentration at the parking lot outlet was 12 mg/L. The increase in iron concentration indicates that something in or on the California Parking Lot is contributing iron to the groundwater, which then enters Bijou Park Creek as surface water at the intersection of Saddle and Wildwood. The 5-year comprehensive report will include a trend analysis of the types of deicers used, including the proportion of cinders in the deicing mix, over the period.

The 2010 annual average for turbidity at the Bijou Park Creek station (HV-C4) was 15.41 NTU. This value is below the State standard of 20 NTU. While three of the 16 samples collected exceeded the Lahontan standard, the annual average for turbidity was below the State standard and dropped substantially compared to last year's annual average of 88.74 NTU.

The 2010 annual average for oil and grease at the Bijou Park Creek station (HV-C4) was 4.12 mg/L, slightly higher than last year's annual average. This value is in exceedance of the Lahontan standard of 2.0 mg/L. Two of the 16 samples collected were above the new standard. While these samples were not collected during storm events, these two sampling events (February 25th and March 16th 2010) contained the largest readings collected for the constituents that exceeded the State standard (total nitrogen, total phosphorous, chloride, oil and grease, total iron). Continued monitoring and trouble shooting of the treatment systems should provide better data and further understanding of these values.

The 2010 suspended sediment annual average at the Bijou Park Creek (HV-C4) station was measured at 20.29 mg/L, substantially lower than last year's annual average. This value is below the Lahontan standard of 65 mg/L for the 90th percentile for receiving waters into Lake Tahoe (page 22 of the Board Order Number R6T-2003-0032). Only one of the 16 samples collected exceeded the new standard, which occurred during the February 25, 2010 sampling event. The decrease in suspended sedimentation is likely the cause of decreased nutrient loading (nitrogen and phosphorous). The addition of two treatment systems above the sampling location has decreased this value from previous years (prior to 2008 and 2009). Continued monitoring and regular maintenance of the treatment systems should stabilize this value in the coming quarters and years.

The annual average standard of 94.88 mg/L for chloride, for receiving waters of Lake Tahoe (Table 3 of the Board Order Number R6T-2003-0032), was exceeded for this site (HV-C4). All 16 samples collected were above the Lahontan standard, the highest of which was measured during the February 25, 2010 sampling event. Excess chloride is most likely due to deicer application that includes sodium chloride. Applications to the California Base Lodge Parking area and surrounding city roads helps to prevent ice build-up and ensure public safety. Summer measurements occurred when no deicers were applied to the California Base Lodge Parking area or surrounding area (June-October); however, chloride levels were still above the State standard. For example, no deicers were applied to the California Parking Lot in June of 2010 when chloride concentrations were measured at 98 mg/L. It is possible that deicer residuals from the previous season had accumulated and were flushed during summer thunderstorms. With the installation of automatic samplers at the influents and effluent locations of the California Parking Lot treatment system, Heavenly should be better able to determine whether chloride originates from the resort application, city road application, or occurs naturally. Heavenly is actively investigating practices that will reduce chloride in runoff such as alternative deicers, application practices, and deicer storage.

Single value non-compliance values are discussed in the pertinent quarterly report and are displayed in Appendix A.

Table 2.9 Exceedances of CA Standards and Water Year 2010 Summary Statistics for HV-C4.

Exceedances of California Effluent Standards and Water Year 2010 Summary Statistics for Bijou Park Creek (HV-C4) below California Parking Lot

	Q (cfs)	Turbidity (NTU)	TSS (mg/L)	S Cond (mmhos)	Total Phos (mg/L)	SRP (mg/L)	NO_2/ NO_3 (mg/L)	TKN (mg/L)	Total N (mg/L)	Chloride (mg/L)	Oil/ Grease (mg/L)	Total Iron (mg/L)	Total Lead (mg/L)
CA State Standards		20.0	65	N/A	0.10	N/A	N/A	N/A	0.5	3.0	2	0.5	N/A
# Non-compliance		3	1	N/A	5	N/A	N/A	N/A	13	16	2	15	N/A
% Non-compliance		19%	6%	N/A	31%	N/A	N/A	N/A	81%	100%	13%	94%	N/A
# Samples	16	16	16	16	16	16	16	16	16	16	16	16	16
Min	0.01	3.10	2.40	151.00	0.043	0.004	0.190	0.014	0.365	21.00	1.20	0.18	ND
Max	0.34	80.00	176.67	1667.00	0.616	0.029	1.436	1.235	1.479	540.00	17.00	6.40	<0.010
Mean	0.07	15.41	20.29	408.31	0.120	0.012	0.466	0.268	0.733	94.88	4.12	2.88	N/A

2.7 Edgewood Creek

2.7.1 Summary Statistics for Water Quality Constituents: Water Year 2010

Although Edgewood Creek is located in Nevada, outside of Lahontan jurisdiction, Edgewood Creek data is included for compliance with the Master Plan Amendment because it is within TRPA's jurisdiction. The Edgewood Creek sites are sampled for compliance with the Nevada Department of Environmental Protection (NDEP) standards. Data are summarized in Tables 2.10 and 2.11, while raw data is referenced in Appendix A. The annual average standard for total nitrogen and total phosphorous was met at both stations during water year 2010.

The not to exceed standard for turbidity was exceeded at the Edgewood Below station (HV-E2) on April 27, 2010. The not to exceed standard for total suspended solids was also exceeded at the HV-E2 station on June 3 and 9th, 2010. The levels of the constituents trended downward after the first sampling event of the season (April 27, 2010), which exhibited high flows, and was likely a spring flush. The initially high values decreased throughout the month of May, and spiked up again in early June in association with higher temperatures and precipitation. As vegetation from the 2007 restoration project continues to mature, the restoration project should help stabilize these temporal shifts in turbidity and suspended sediments.

Table 2.10 Exceedances of Standards and Water Year 2010 Summary Statistics for HV-E1.

Exceedances of State (NDEP) Standards and Water Year 2010 Summary Statistics for Edgewood Creek (HV-E1) Above Boulder parking lot

	Q (cfs)	SC (mmhos)	Turbidity (ntu)	SS (mg/L)	NO_2/ NO_3 (mg/L)	TKN (mg/L)	TN (mg/L)	TP (mg/L)	SRP (mg/L)	DP (mg/L)
NDEP Standards[1]	N/A	N/A	10.00	25.00	N/A	N/A	0.6 [2]	0.10	N/A	N/A
# Noncompliance	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
% Noncompliance	N/A	N/A	0%	0%	N/A	N/A	0%	0%	N/A	N/A
# Samples	8	8	8	8	8	8	8	8	8	8
Min	0.01	58.2	1	0.8	0.001	0.081	0.083	0.016	0.003	0.009
Max	0.18	83.4	5.5	20.8	0.002	0.279	0.280	0.083	0.009	0.021
Mean	0.081	68.950	2.27	5.46	0.002	0.150	0.152	0.030	0.004	0.014

[1]NDEP Standards are from the Nevada Administrative Code (NAC) Chapter 445A.1915. All listed numbers are standards for single values no greater than a given parameter unless otherwise noted.

[2]Annual Average

Table 2.11 Exceedances of Standards and Water Year 2010 Summary Statistics for HV-E2.

Exceedances of state (NDEP) Standards and Water Year 2010 Summary Statistics for Edgewood Creek (HV-E2) below Boulder parking lot

	Q (cfs)	SC (mmhos)	Turbidity (NTU)	SS (mg/L)	NO_2/ NO_3 (mg/L)	TKN (mg/L)	TN (mg/L)	TP (mg/L)	SRP (mg/L)	DP (mg/L)
NDEP Standards[1]*	N/A	N/A	10.00	25.00	N/A	N/A	0.6 [2]	0.10	N/A	N/A
# Noncompliance	N/A	N/A	1	2	N/A	N/A	0	0	N/A	N/A
% Noncompliance	N/A	N/A	13%	25%	N/A	N/A	0%	0%	N/A	N/A
# Samples	8	8	8	8	8	8	8	8	8	8

Table 2.11 Exceedances of Standards and Water Year 2010 Summary Statistics for HV-E2.										
Exceedances of state (NDEP) Standards and Water Year 2010 Summary Statistics for Edgewood Creek (HV-E2) below Boulder parking lot										
Min	0.06	92.50	0.98	2.00	0.018	0.118	0.136	0.022	0.002	0.011
Max	0.20	134.60	14.00	32.80	0.038	0.390	0.426	0.090	0.010	0.021
Mean	0.12	113.31	6.39	14.05	0.028	0.182	0.210	0.035	0.005	0.015

[1]NDEP Standards are from the Nevada Administrative Code (NAC) Chapter 445A.1915. All listed numbers are standards for single values no greater than a given parameter unless otherwise noted.
[2]Annual Average

2.8 Conclusions and Recommendations

The 2010 water year was an average year of precipitation. Increased precipitation results in higher annual loads, and the number of non-compliance exceedances based on annual averages increased by one from last year. Heavenly's operations are consistent with meeting water quality objectives and there is an overall water quality improvement trend. Some of the constituents of non-compliance in this year's monitoring are attributable to background conditions. The reference stream that is unaffected by Heavenly operations in a primarily forested watershed also exceeded specific standards. Other problem constituents are actively being addressed by Heavenly's completion of CWE projects. The following sections include a summary of the monitoring program and the 2010 findings for each creek and any applicable recommendations.

2.8.1 Heavenly Valley Creek

Annual average standards for phosphorus, nitrogen, chloride, and iron were exceeded by both stations on Heavenly Valley Creek (HV-C2 and HV-C3). The same standards were also exceeded at the Hidden Valley Creek reference station (HV-H5). Therefore, these exceedances may not be attributable to Heavenly resort operations and could be a background characteristic of the watersheds.

Chloride and iron exceedances increased from last year's values at Below Patsy's (HV-C2), while levels of both constituents decreased compared to last year's values at Property Line (HV-C3). Chloride and iron levels may be affected by mountain operation of snow condition enhancement. It should be noted that chloride values at the reference site (HV-H5) have been above the water board annual standard since 2005. While snow enhancement may be increasing the chloride readings, mountain operations is not the sole cause for these higher measurements.

Total phosphorous and total nitrogen levels at both Heavenly Valley Creek sites and at Hidden Valley Creek increased compared to last year. Phosphorous, exceedances have been ongoing for the past several water years for Heavenly Valley Creek (HV-C2 and HV-C3) and Hidden Valley Creek; however, the total nitrogen exceedance is a new one for all three sites. Therefore, the next Comprehensive Report (2012) should review the possibility and feasibility of nitrogen treatment/removal. Treatment plants use the use of different filter media cartridges and or the use of some sort of coagulant for nitrogen removal. Research into feasible nitrogen reduction alternatives will be evaluated in the comprehensive report.

The Below Patsy's site (HV-C2) is valuable in assessing the effects of upper mountain management on water quality. The Property Line site (HV-C3) is the TMDL compliance point and will continue to be valuable to monitoring protocol. Heavenly Valley Creek continues to be well within the TMDL limits for suspended solids and all other permitted constituents.

2.8.2 California Parking Lot / Bijou Creek

Water quality constituent results from the Bijou Creek sampling site (HV-C4) have been lower than last year's results. This trend is exemplified as BMP improvement projects and retrofits were completed. While exceedances remain for total phosphorous, total nitrogen, chloride, oil and grease, and total iron, the annual mean for each of these constituents has decreased from last year, resulting in improved water quality. Further, turbidity and suspended sediments have also decreased, and are no longer in exceedance of the State standard as they were last year. The 2009 water year was the first full year where all BMPs for the California Base were installed and operational providing the second year of sampling data with the completed projects in place. A small area of the California Parking Lot was retrofit with storm treatment vaults that have functioned since November 2007. The majority of the California Parking Lot runoff is now treated by large vaults which were installed in 2007, but were not treating water until the filter media cartridges were installed on April 15, 2008. The final piece of the treatment system that collected the remaining parking lot runoff was installed at the intersection of Saddle and Wildwood Roads, just above the sampling site, and became operational on October 24, 2008. In addition to sampling the historical surface water site, three additional sites associated with the automatic samplers, one at each of the two inlets and one at the outlet, are sampled during storm events.

Troubleshooting of the automatic samplers is ongoing. In the fall of 2009, an inspection of the treatment vault systems found sediment in the outlet bay, which should be free of all debris. The exact entry point of the sediment source is unknown, but one possibility is that there were not proper seals on the manhole lids allowing sediment to fall into the system after treatment. In the summer of 2010, each manhole lid was replaced. Additionally, the outlet vaults were cleaned, thoroughly removing all sediment from the treatment system. Unfortunately, data collected from autumn thundershowers was inconclusive. In all cases, not all three of the samplers collected data. In some cases, the two inlet vaults were sampled, but the outlet bay was not. At other times, one inlet and the outlet were sampled, but in all cases there was not one complete sample collected. The goal moving forward is to further refine the sampling tools to ensure grab samples are taken. This may include additional assistance from the vault manufacturer this spring and the possibility of adding a remote modem to signal and trigger sample collection. New permit requirements will require sampling and reporting from the vault system. Inclusion of the data will be included in the annual report next year. If the system is still problematic, grab samples will be collected at all three sampling locations. With complete samples, the vault system may help Heavenly isolate the source of exceedances such as iron and chloride.

Total nitrogen values from the past few water years remain right around 1 mg/L, almost twice the new standard limit of 0.5 mg/L. Now that both treatment systems are in place, monitoring shall continue at this site. If this trend or value remains well above the standard further investigation into nitrogen removal should be looked into to meet compliance standards. The next Comprehensive Report (2012) should review the possibility and feasibility of further nitrogen treatment/removal.

To address the ongoing chloride exceedances, Heavenly has investigated alternative deicers and deicer application and storage practices. Magnesium chloride was examined, but found to be both a human health and safety risk and an environmental hazard (Transportation Research Board 1991 and Chambers 2008). Already banned in Aspen, Colorado, magnesium chloride has been found to have adverse effects on the life cycles of micro- and macro-invertebrates (Lewis 1999). Calcium magnesium acetate (CMA) was also examined, but was found to be prohibitively expensive and required in greater quantities (Transportation Research Board 1991). With the current available research, the combination of sodium chloride and sand or cinders is the least harmful to the environment and water quality. Research has shown that applying deicers before predicted storms and pre-wetting the deicing agents during application increases effectiveness and reduces the amount of deicers required. Along with implementing the aforementioned application practices, Heavenly has been testing the reduction of salt to cinder ratio. The ratio during the 2010 season was two parts cinder to one part deicer. Current application practices include a ratio of one part deicer to three parts cinder. Monitoring of chloride at both the compliance point and with the automatic sampler locations will continue in 2011.

2.8.3 Edgewood Creek

The treatment system, completed in 2005, was constructed to collect and treat runoff originating from the Boulder Parking Lot and Lodge that flows into Edgewood Creek. Additional stream improvements and creek restoration occurred in 2006 and 2007. As vegetation associated with these restoration efforts matures, additional nutrient uptake and subsequent water quality should improve. The next Comprehensive Report (2012) will evaluate these improvements with regards to water quality. For 2011, the current monitoring protocol will continue with an increased effort in collecting more samples to get a better idea of the runoff hydrograph.

Chapter 3

Effective Soil Cover

3.1 Introduction

Vegetation and other organic and inorganic soil cover materials are known to reduce the potential erosivity of soil particles, increase percolation, and reduce runoff rates. The construction of ski trails and access roads requires the removal of vegetation and other obstacles (boulders, tree stumps, etc.) thereby reducing the effective soil cover (ESC). Efforts to stabilize disturbed areas by increasing effective soil cover or increasing the infiltration rate has resulted in reduction of erosion rates, thereby decreasing sediment and nutrient input into adjacent streams, and ultimately Lake Tahoe.

3.2 Background and Objectives

Evaluation of effective soil cover focuses on types and percentages of cover, and identification of erosion features. A Cumulative Watershed Effects (CWE) analysis was initiated in 1991 by the United States Department of Agriculture (USDA) Forest Service to predict soil loss as determined from the modified universal soil loss equation model (MUSLE) and its parameters. Field measurements were taken to evaluate ESC at Heavenly by conducting surveys of fixed plots and random transects from 1995 through 2003. These field measurements were intended to verify the accuracy of the predicted values from the CWE model. The model assumed that 70% ESC is adequate for erosion control on ski slopes (USDA Forest Service 2003).

Findings from the field evaluations, summarized in the 2003 Comprehensive Monitoring Report, indicated that there has been a 21 percent increase in effective soil cover on ski runs at the resort since 1991 (USDA Forest Service 2003). This increase is resulting from a resort wide estimated total percent cover from 49 percent in 1991 and 69 percent in 2003 (USDA Forest Service 2003). However, in many cases transect data was either not statistically significant or did not adequately address the original monitoring objectives. Issues with record keeping, such as mitigation practices, data collection, such as data sheets, and inconsistent data collection, along with database management made processing and analyzing data cumbersome and time-intensive (USDA Forest Service 2003).

A revised methodology was developed by ENTRIX in the Effective Soil Cover Plan (ENTRIX 2005). The revised monitoring plan adopted conclusions and recommendations from the 2003 Comprehensive Monitoring Report and greatly simplified ESC evaluation objectives. Primary objectives of the revised methodology are:

1. Determine if changes in cover result in changes in runoff and sediment volume from ski runs and other project infrastructure.

2. Evaluate utilization of soil amendments/treatments to increase infiltration capacity for those areas resistant to revegetation efforts, or where revegetation is ineffective.

The revised methodology intended to use data derived from remote sensing (originally IKONOS satellite imagery) with limited ground-truthing. No successful evaluations were conducted in 2006 or 2007, although the revised methodology was attempted. In general, suitable satellite images or aerial photographs were either not available for the necessary spatial or temporal periods, and/or pixel resolution was not sufficient for soil cover analysis.

In the 2007 Annual Report and later in the 2008 Effective Soil Cover Workplan, a new protocol was presented that combined the CNPS VRAP and the establishment of permanent photo points.

After discussions with the USDA Forest Service, it was determined that the CNPS VRAP method should support an aerial survey, rather than being the only data collected. Heavenly and the USDA Forest Service agreed to share the cost of an over-flight. An infrared aerial flyover of Heavenly Mountain Resort was conducted by 3DiWest in conjunction with the USDA Forest Service in July of 2009. The flight produced a 1:8,000 resolution infrared aerial photo of the entire mountain and was used along with Geographic Information Systems (GIS) and field verification (i.e. ground-truthing) to produce an accurate picture of the soil cover at Heavenly.

Due to inclement weather conditions and scheduling of the aerial flyover, only half of the field verification was completed using the CNPS VRAP methodology. Therefore, in 2009, only five of the 10 monitoring sites were evaluated and served as the “baseline” for ESC for 2010 field verification. All 10 monitoring sites were evaluated in 2010, so the five sites that were not evaluated in 2009 will be considered the baseline for next year’s (2011) ESC monitoring. Over-flights to take infrared photographs will occur approximately every five years. The next shared purpose over-flight will occur in approximately 5 years (July or August 2014).

3.3 Monitoring Methods

The aerial photographs were used to characterize and map soil cover along and near projects facilities (including ski runs). Mapping was completed using Arc-Geo Information Systems (GIS). Once the images were combined into a representative map covering Heavenly Mountain Resort, a ratio of bare soil verses vegetation was deduced using Arc GIS. This ratio will be used in conjunction with field verifications to extrapolate the effective soil cover in other areas on Heavenly. This will allow for a more efficient and less time consuming way of reporting the general ESC of Heavenly Mountain Resort, by only using the aerial flyover images and limited field information. After baseline studies performed in 2009 and 2010, a comparative analysis will be conducted in five year intervals with a focus on explaining areas resistant to establishing effective soil cover.

The methods used to conduct field verification were derived from the VRAP developed by the California Native Plant Society (CNPS 2004). The VRAP is a semi-quantitative method of vegetation and habitat sampling (CNPS 2004). Quantitative vegetation and site data recorded include, but are not limited to: topography, soil, rock and litter (size and percent cover), vegetation association and alliance, and vegetation cover (by percent cover, stratum and species) (Sawyer and Keeler-Wolf 1995). These data are not based on established test plots, but on a broader scale unit that is appropriate for the vegetation type found on the landscape. VRAP allows enough flexibility to respond to site-specific attributes of the areas, combined with enough quantitative observation to allow comparison between years. These measurements will be conducted over time, and trends will be analyzed to meet the ESC study objectives. The VRAP method was augmented with the establishment of permanent photo points to better track variability over time. A biologist with experience in botany and soil cover analysis made judgments while conducting the VRAP measurements

In 2009, ten sites were selected on Heavenly Mountain Resort in order to ground-truth the aerial images. Sites were selected as a representative sample of ski run slopes, aspects, and soil types, as well as the erosion control treatment methods applied up to the present. The ten selected sites are outlined in Table 3-1.

Table 3.1 Ten Selected Effective Soil Cover Monitoring Locations

Landscape Unit*	Ski Run Name	Aspect	Ski Run Difficulty	Treatment
3	Gunbarrel	Northwest	Black	Hand raking in seed
6	Groove	Southeast	Green	Rock lined channel between roads
11	Ellie's Swing	North	Blue	Decommissioned road-tilling, mulch, amendments, revegetation
14	Edgewood Meadow	Northeast	Blue	Riparian/Wetland
16	Boulder Chute	North	Blue	Re-seeding
17	Lower Olympic	Northeast	Blue	Revegetation Treatments
18	Cloud Nine	Northeast	Blue	"Lop and Scatter" and Easy Street
24	Double Down/ Lower High Roller	Northwest	Black	Bottom of run has test plots
25	Lower Cal Trail	Southwest	Blue	Decommissioned Road, no treatment
23	Rope Tow Area near Big Easy and Gondola	Southeast	Green	Easy Street Treatment

*Landscape Units from ENTRIX, Inc. 2008 Workplan (ENTRIX 2008).

A field team, which included one biologist with experience in botany and soil cover estimation, visited all 10 of the field verification sites on October 18 and 19, 2010. For the five sites that were not visited in 2009 (Landscape Units 11, 18, 24, 25, and 23), the field crew established a photo point (or points) to enhance comparison of site attributes between measurement periods. Establishment of permanent photo points at selected runs would allows for semi-quantitative assessment of effective soil cover over time. Each photo point was located at a fixed point (GPS location and permanent marker). All photos were from a landscape perspective and the bearing of the camera in relation to the slope was recorded. The area of the photograph was recorded using a long tape measure for length and camera zoom information for width. Recording effective soil cover (i.e., live and dead vegetative cover, substrate, etc.) erosion features, and any mitigation work performed in the area, was the primary focus of the field of view. Photo documentation considered the elements outlined in the Stream Photo Documentation Procedure of the Standard Operating Procedure (SOP) (SWRCB 2001). The field crew also visited the established photo points taken in 2009 for five of the monitoring sites (Landscape Units 3, 6, 14, 16, and 17) to take updated photos for documenting the vegetation and reassess the ESC.

The size of the landscape unit was estimated as an area that received a certain type of treatment to abate erosion. Boundaries of the landscape units were also defined by “stands”, which are the basic physical unit of vegetation in a landscape (CNPS 2004). Stands are defined by two main unifying characteristics, composition and structural integrity. Compositional integrity means that throughout a site, the combination of species is similar (CNPS 2004). A stand is therefore differentiated from adjacent stands by a discernable boundary of changing dominant vegetation types (CNPS 2004). Structural integrity means that a site has a setting that presents similar horizontal and vertical spacing of plant species (CNPS 2004). Additionally, for an area of vegetated ground to meet the requirements of a stand, it must be homogenous; therefore, all boundaries were defined by homogenous vegetation types (CNPS 2004).

After photo documentation and boundary establishment, the field crew assessed the site’s soil cover using the CNPS field form. A copy of the field form used during onsite verification can be seen in Figure 3.1. The field crew took notes on their observations at each of the sites and filled out the CNPS field form in as much detail as possible. After the field data was collected, it was recorded into a Microsoft Excel database.

In the summer of 2011, the five field verification sites (Landscape Units 11, 18, 24, 25, and 23) will be assessed based on the methodology above. During field activities in 2011, Cardno ENTRIX will incorporate, to the extent relevant, other studies of soil cover and erosion conducted within the basin. Cardno ENTRIX will contact Michael Hogan at Integrated Environmental Restoration Services in order to include some of his study sites on Heavenly into the field verification efforts. All ten verification sites will be revisited, reassessed, and photographed annually beginning in 2011 for the duration of the 5-year Mitigation and Monitoring Plan. Percentages of effective soil cover and eroded areas for each site will be recorded and reported annually along with qualitative observations made by the field crew. In 2015 another aerial flyover will be conducted over the Project area in coordination with the USDA Forest Service.

CALIFORNIA NATIVE PLANT SOCIETY - VEGETATION RAPID ASSESSMENT FIELD FORM
(Revised Sept. 20, 2004)

For Office Use:	Final database #:	Final vegetation type name:	Alliance____ Association

I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

Polygon/Stand #:	Air photo #:	Date:	Name(s) of surveyors:
____________	____________	____________	____________

GPS waypoint #: _________ GPS name: ______________ GPS datum: (NAD 27) _______ Is GPS within stand? Yes / No

If No, cite from GPS point to stand, the distance ______(in meters) and bearing ______(in degrees) GPS Error: ± _____ ft / m

UTM field reading: UTME ___ ___ ___ ___ ___ ___ UTMN ___ ___ ___ ___ ___ ___ ___ UTM zone: ____________

Elevation: _________ ft / m Photograph #'s: ____________

Topography: convex____ flat____ concave____ undulating____ | top____ upper____ mid____ lower____ bottom____

Geology: _______ Soil Texture: _______ Rock: %Large____ %Small ____ %Bare/Fine: ____ %Litter: ____ %BA Stems: ____

Slope exposure (circle one and/or enter actual °): NE______ NW______ SE______ SW______ Flat__ Variable__

Slope steepness (circle one and enter actual °): 0°__ 1-5° _____ 5-25°_____ > 25°_____ Upland or Wetland/Riparian (circle one)

Site history, stand age, and comments: ____________

Type/ Level of disturbance (*use codes*): ____/____ ____/____ ____/____ ____/____ ____/____ ____/____ ____/____ ____/____

II. VEGETATION DESCRIPTION

Field-assessed vegetation alliance name: ____________

Field-assessed association name (optional): ____________

Size of stand: <1 acre___ 1-5 acres___ >5 acres___ Adjacent alliances: ____________

Tree: T1 (<1" dbh), T2 (1-6" dbh), T3 (6-11" dbh), T4 (11-24" dbh), T5 (>24" dbh), T6 multi-layered (T3 or T4 layer under T5, >60% cover)

If Tree, list 1-3 dominant overstory spp.: ____________

Shrub: S1 seedling (<3 yr. old), S2 young (<1% dead), S3 mature (1-25% dead), S4 decadent (>25% dead)

Herbaceous: H1 (<12" plant ht.), H2 (>12" ht.) Desert Palm/Joshua Tree: 1 (<1.5" base diameter), 2 (1.5-6" diam.), 3 (>6" diam.)

Desert Riparian Tree/Shrub: 1 (<2ft. stem ht.), 2 (2-10ft. ht.), 3 (10-20ft. ht.), 4 (>20ft. ht.)

% Overstory Conifer/Hardwood Tree cover: _____/_____ Shrub cover: _____ Herbaceous cover: _____ Total Veg cover:______

Overstory Conifer/Hardwood height: _____/_____ Tall Shrub/Low Shrub height: _____/_____ Herbaceous height: _____

Height classes: 01=<1/2m 02=1/2-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m

Species (List up to 12 major species), Stratum, and Approximate % cover: (Jepson Manual nomenclature please)

Stratum categories: T=tall, M=medium, L=low; *% cover intervals for reference*: <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%

Strata	Species	% cover		Strata	Species	% cover

Major non-native species - With % cover: ____________

Unusual species: ____________

III. PROBLEMS WITH INTERPRETATION

Confidence in identification: (L, M, H) _____ Explain ____________

Other identification problems (describe): ____________

Polygon is more than one type: (Yes, No) _______ (Note: type with greatest coverage in polygon should be entered in above section)

Other types: ____________ ____________ ____________

Has the vegetation changed since air photo taken? (Yes, No) _____ If Yes, how? What has changed (write N/A if so)? ______

Figure 3.1 CNPS Vegetation Rapid Assessment Field Form, 2004.

3.4 Results

An aerial flyover was conducted by 3DiWest in July 2009. Infrared photographs from the flyover were transmitted to the USDA Forest Service and ENTRIX, Inc. in October 2009. A composite map of the Heavenly Mountain aerial photos is shown in Figure 3.2. The composite map has been modified to represent the area of Heavenly Mountain Resort that is subject to effective soil cover monitoring. The colored area of the map approximates the boundary of Heavenly Mountain Resorts operations. From this composite map, land cover was broken down into four types: 1. shadow, 2. tree/shrub, 3. mix, and 4. bare ground. Area of these land types (in both square feet and acres) is summarized in Table 3.2.

Table 3.2 Land Cover Types and Associated Areas within the Boundary of Heavenly Mountain Resort Operations.

Number	Land Cover Type	Area (Square Feet)	Area (Acres)
1	Shadow	51,559,916	1,183.65
2	Tree/Shrub	146,747,952	3,368.87
3	Mix	33,194,162	762.03
4	Bare Ground	108,758,126	2,496.74

Field verification of the ten monitoring sites was conducted on October 18 and 19, 2010. A summary of results from the field verification efforts conducted in 2010 are presented in Table 3.3. Due to field efforts being conducted at the end of the growing season, it was difficult to observe and record all vegetation species occurring at each site; however, for those that were documented, the field crew was able to identify plant species with high confidence.

3.4.1 2009-2010 Data Comparison

As stated in Section 3.3 above, the field crew visited five of the 10 monitoring sites (Landscape Units 3, 6, 14, 16, and 17) for which photo points were established in 2009. The ESC assessment in 2009 serves as the baseline for the 2010 vegetation reassessment of the five sites. Photographs taken in 2009 and 2010 at the photo points are provided in Appendix F.

According to the CNPS VRAP field forms, the effective soil cover (vegetative cover, substrate, etc.) varied dramatically between 2009 and 2010. For example, the percent total vegetative cover at all five stations (Gun Barrel, Groove, Edgewood Meadow, and Lower Olympic) increased between 25% (at Edgewood Meadow) to 100% (at Boulder Chute). The ESC assessment is highly subjective, so documentation of vegetation and other environmental descriptions can vary significantly. Further, snow cover was prominent during the 2009 assessment, while there was no snow cover in the 2010 reassessment.

Table 3.3 Field Verified ESC Sites and Associated Characteristics.

Landscape Unit	Ski Run Name	Slope Exposure	Topography	Geology	Soil Texture	Slope Steepness	Dominant Veg.	Secondary Veg.	% Rock/Litter	% Veg	% Bare
3	Gunbarrel	NW 310°	Convex, bottom of ski run	Decomposed Granite	Coarse to Medium Sand	25°	Mixed grasses	*Ceanothus velutinus var. hookeri* (Tobacco Brush)	15%	90%	15%
6	Groove	SE 140°	Concave, bottom of ski run	Decomposed Granite	Coarse Sand	20°	Mixed grasses	*Pinus jeffreyi* (Jeffrey Pine) and mixed forbs	36%	70%	15%
11	Ellie's Swing	NW 280°	Flat, mid to upper part of ski run	Decomposed Granite	Coarse to Medium Sand	10°	Mixed grasses	N/A	87%	10%	10%
14	Edgewood Meadow	NE 10°	Flat, bottom of the ski run	Decomposed Granite	Moderately fine silty clay loam	1-5°	*Juncus spp.* (Rush)	*Salix* spp. (Willow)	11%	100%	0%
16	Boulder Chute	N 0°	Concave, bottom of ski run	Decomposed Granite	Medium Sand	15°	*Arctostaphylos nevadensis* (Pinemat Manzanita)	*Salix* spp. (Willow); *Ceanothus velutinus var. hookeri* (Tobacco Brush); and mixed grasses	40%	60%	25%
17	Lower Olympic	NW 340°	Flat & concave, bottom of ski run	Decomposed Granite	Medium Sand	>25°	*Elytrigia intermedia* (Wheatgrass)	*Festuca brevipila* (Hard Fescue)	28%	80%	20%
18	Cloud Nine	NE 40°	Flat & convex, middle of ski run	Decomposed Granite	Coarse to Medium Sand	20°	No vegetation	No vegetation	95%	0%	5%
24	Double Down/Lower High Roller	NW 310°	Concave, bottom of ski run	Decomposed Granite	Coarse to Medium Sand	32°	Mixed conifer seedlings	*Elytrigia intermedia* (Wheatgrass)	45%	55%	5%
25	Lower Cal Trail	SE 140°	Flat & concave, top part of ski run	Decomposed Granite	Coarse to Medium Sand	5°	*Elymus elymoides* *(*Squirreltail*)*	*Elytrigia intermedia* (Wheatgrass)	45%	50%	5%
23	Rope Tow Area near Big Easy and Gondola	SW 230°	Concave & undulating, lower part of ski run	Decomposed Granite	Coarse Sand	20°	*Elymus elymoides* *(*Squirreltail*)*	N/A	95%	<2%	5%

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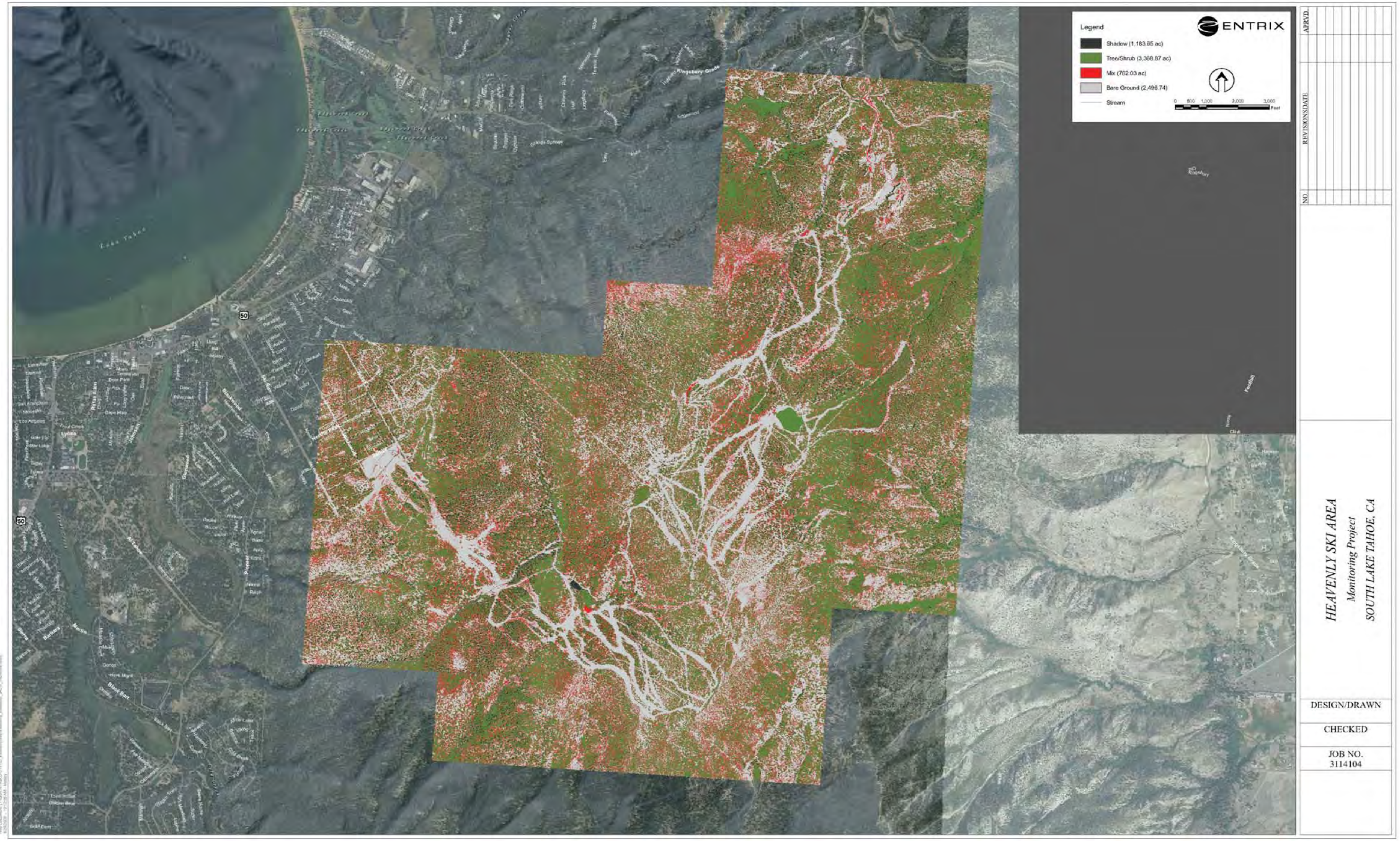

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Figure 3.2 Composite Map of the Heavenly Mountain Aerial Photos, Highlighting the Heavenly Mountain Resort's Operational Area, Broken Down by Land Cover Types

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3.5 Discussion and Conclusions

In their 2003 Comprehensive Monitoring Report, the USDA Forest Service concluded that the method of detailed transect measurement did not meet CWE model's 70% soil cover assumption. The USDA Forest Services' methods were deemed too time consuming and expensive to continue utilizing.

In 2008, ENTRIX with input from the USDA Forest Service completed an Effective Soil Cover Workplan that included monitoring objectives to be accomplished. These objectives are as follows:

1. Maintain and restore soils with favorable infiltration characteristics and diverse vegetative cover to absorb and filter precipitation and to sustain favorable conditions of stream flows.

2. Determine if changes in cover result in changes in runoff and sediment volume from ski runs and other project infrastructure.

3. Evaluate utilization of soil amendments/treatments to increase infiltration capacity for those areas resistant to revegetation efforts, or where revegetation is ineffective.

The use of the air photo analysis combined with ground-truthing, while providing useful information regarding the overall soil cover, does not effectively meet these monitoring objectives. In 2009 an infrared aerial flyover of Heavenly Mountain Resort was conducted in accordance to the USDA Forest Service's recommendations. The imagery from the flyover was useful in that it provided a general overview of soil conditions at Heavenly Resort. From this image it was possible to breakdown soil cover types into four categories; shadow, tree/shrub, mixed, and bare ground. Although useful in a general context, the imagery was not of a high enough resolution to identify grasses and large rock which are both considered soil cover. Additionally, the imagery resolution did not allow staff to see any significant signs of erosion such as rills. Signs of erosion identified on the images would have provided field staff with specific ski runs on which to target for effective soil cover monitoring. As it was, field staff selected a representative sample of ski runs throughout Heavenly in order to gain general knowledge of soil cover conditions.

The CNPS VARP method of ground truthing proved to be effective for obtaining subjective, general information about ski slopes at Heavenly. This methodology however, would be time consuming if needed to be implemented at every ski run at Heavenly in order to determine if soil cover is improving from year to year. Additionally, this methodology is not quantitative, but more qualitative in nature, which means the data is vulnerable to observer subjectivity.

Over the years of attempting to quantitatively measure changes in effective soil cover at Heavenly, the various methods applied have not effectively met the monitoring objectives. In the 2009 Annual Report, ENTRIX recommended following a Best Management Practices (BMP) approach for soil cover, similar to the practices used for erosion control measures. Such BMPs would help deter erosion, enhance infiltration, and promote vegetation growth along ski slopes, and monitoring of the BMPs would focus on the effectiveness of each measure. Soil amendment studies being performed by Integrated Environmental Services at Heavenly should also be incorporated into the BMP development and monitoring. Specific BMPs will be determined in 2011 through a collaborative effort between Cardno ENTRIX, Integrated Environmental Services, USDA Forest Service, and Heavenly, and will be identified in the Comprehensive Report (2012).

Chapter 4

Best Management Practices (BMP) Implementation and Monitoring

BMP monitoring was completed by Resources Concepts Inc. (RCI) and is included in Appendix B.

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Chapter 5

Riparian Condition Summary

5.1 Introduction

This chapter discusses the stream channel monitoring activities that were conducted in July 2010 in accordance with the *Work Plan for Riparian Condition Monitoring* (Work Plan) (ENTRIX 2005). Monitoring on Edgewood Creek was conducted this year in accordance with the work plan that states that monitoring will occur yearly at stream locations that have had significant restoration within the affected watershed. The objective of this continual monitoring is to assess the effectiveness of erosion control measures and restoration activities on stream health. Monitoring is conducted to characterize stream and riparian conditions along selected stream reaches within the Heavenly Mountain Resort area and reference reaches unaffected by Resort activity. The monitoring data is used in conjunction with data from previous monitoring events to assess potential alterations of stream and riparian conditions and, if changes are encountered, determine whether the alterations are associated with operations at the Resort.

Monitoring is conducted every three years on each of the three sites on Heavenly Valley Creek and the two sites located on Hidden Valley Creek. Additional monitoring occurs on the two sites on Daggett creek and a single site on Mott Creek. As discussed above annual monitoring occurs on the two Edgewood Creek sites. The next scheduled round of full monitoring will occur in 2011. This revised schedule was agreed to by all interested parties to synchronize the benthic macro-invertebrate (BMI) and SCI data collection. The next complete survey will not happen again until 2016. The new schedule states that SCI data will be collected during the second year of BMI collection. A new permit formalizing this schedule will be released sometime in 2011.

Stream monitoring follows the protocols and methods outlined in the United States Department of Agriculture Forest Service (USFS) *Stream Condition Inventory Technical Guide: Pacific Northwest Region, Version 5.0* (USFS Technical Document) (2005). The SCI method was developed to collect intensive and repeatable data from stream reaches to monitor conditions over time. In this chapter potential changes along upper and lower Edgewood Creek's instream and riparian conditions are evaluated by comparing the monitoring data collected in 2010 with the data collected in 2006, 2008, and 2009. Due to restoration construction, monitoring during the 2007 season was not collected.

The SCI methodology also includes benthic macro-invertebrate (BMI) sampling, which was conducted in 2006, 2007 and in 2010 on Heavenly Valley and Hidden Valley Creeks in support of bioassessment monitoring required by the 2003 Heavenly Valley Creek Total Maximum Daily Load (TMDL) Bioassessment Monitoring Plan. The next scheduled BMI sampling will occur in 2011, following the two year on and two year off schedule. New protocols and procedures regulated by the California Water Board (Lahontan) require electronic data submittal results due on May 15 of the year after sampling occurred. A short memo will accompany the data set verifying submittal of the data requested, and is not discussed further in this report.

The data included in this report was collected in July 2010 and compares it to data collected in previous years. The locations of both Edgewood sites are shown in Figure 5-1. Upper Edgewood data includes a long profile and cross sections. Data collected for Lower Edgewood consists of cross sections, a long profile encompassing the cross sections, and SCI stream health data shown in Appendix G (Table 5-3).

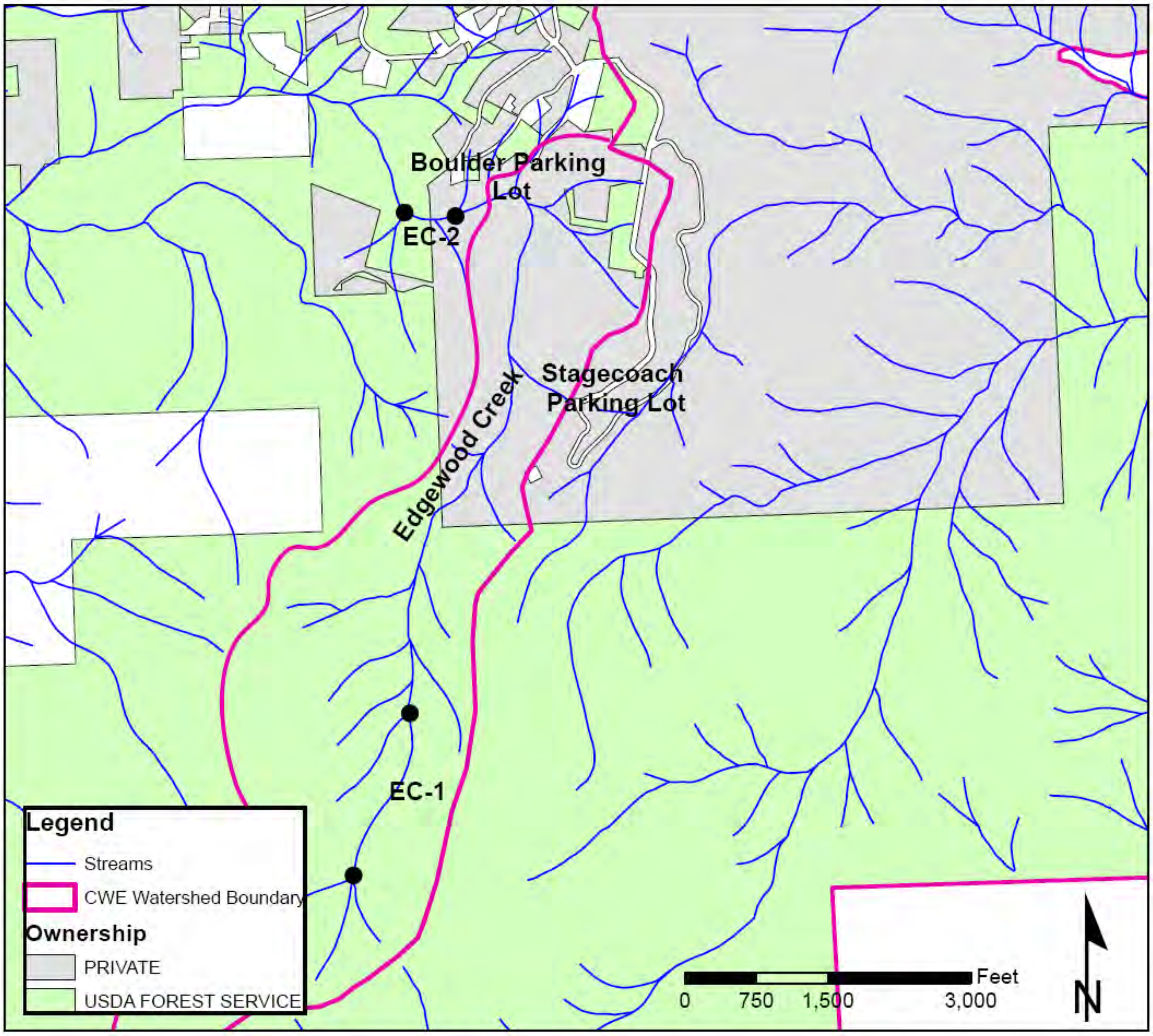

Figure 5-1 Locations of Upper (EC-1) and Lower (EC-2) Edgewood Creek monitoring sites.

5.2 Methodology

During 2010, two reaches on Edgewood Creek were evaluated using SCI methods. The next surveys of all ten reaches will be completed in 2016, though all California sites will be survey this summer (2011). Survey protocols can be referenced in the USDA Forest Service *Stream Condition Inventory Technical Guide: Pacific Northwest Region, Version 5.0* (2005).

The locations of the Edgewood Creek reaches are shown in Figure 5-1 (USDA Forest Service 2009). The Upper Edgewood Creek reach, EC-1, was established upstream of current restoration activities under the proposed alignment for the new North Bowl Express Lift. The Lower Edgewood Creek reach, EC-2, has its downstream limit at the established Edgewood Below water quality site, downstream from the Boulder Lodge parking lot. The full SCI evaluation was only completed for the Lower Edgewood Creek reach because the Upper Edgewood Creek reach contained no water. Stream channel conditions were assessed at EC-1 by surveying permanent cross-sections and a longitudinal bed profile. This data can be compared to the pre-restoration cross-sections and profile observed in 2006.

The USDA Forest Service *Stream Condition Inventory Technical Guide: Pacific Northwest Region, Version 5.0, 2005* (USDA Forest Service SCI protocol) can be referenced for more detailed explanations of methods; however, a synopsis of the full SCI evaluation is as follows. Three cross-sections were established at representative locations within all reaches, permanently marked with monuments, and surveyed. A water surface profile was surveyed for a distance of several channel widths up and downstream of each cross-section to calculate channel gradient. Large woody debris (LWD) counts were completed by tallying all single pieces of wood, aggregates, and root wads. This method differs from past protocol where the LWD was also measured for diameter. Pebble counts were completed with a gravelometer at the locations of bioassessment sites, where applicable. Bankfull measurements were taken at up to eight transects on each reach including the three permanent cross-sections. Stream habitats were documented and measured with a hip chain. Pools were determined using the USDA Forest Service SCI protocol. In order to be considered a pool, water velocity must be slow or not moving. The feature must occupy most of stream width and include the thalweg. Backwater and sidewater pools were not measured. Other criteria include: the length of pool must be greater than wetted width, the depth must be greater than non-pools, and the maximum depth is more than twice pool tail depth. Where pools were identified, pool depth and tail fine sediment measurements were taken. Bank stability and shading evaluations were also completed as part of the full SCI. Per protocol, bank angle and stream shore depth were only measured at streams with gradients greater than two percent. In addition to bank angle and stream shore depth, other evaluations that are normally part of a full SCI may not have been completed due to stream type and conditions. Any individual exceptions to completing a full SCI evaluation are noted in the Results and Discussion Section.

5.3 Upper Edgewood Creek

The Edgewood Creek watershed has been the location of multiple restoration projects. The restoration project in the portion of Edgewood Creek including riparian monitoring site EC-1 is referred to as the North Bowl Restoration Stream Environment Project. Phase 1 of the North Bowl Restoration Stream Environment Project, consisting of the downstream two-thirds of the project, was completed in 2006. Other activities in 2006 included gabion structures added as gully improvements upstream of the North Bowl Restoration Stream Environment Project and best management practices installed on the road that descends from Boulder Parking Lot along Edgewood Creek. Phase 2 of the North Bowl Restoration Stream Environment Project, which contains riparian monitoring site EC-1, was completed in the summer of 2007. Phase 2 involved the installation of more gabion structures, strategic placement of large woody debris, and vegetation establishment. For a more thorough assessment, please reference the Final Edgewood Watershed Assessment and Enhancement Plan: Upper Edgewood Creek (Swanson 2006).

Reach one of Edgewood Creek, know as Upper Edgewood (EC-1), was dry at the time of stream condition analysis. Therefore, a full SCI could not be completed. The USFS SCI protocol version 5.0 provides measures of channel morphology most applicable to low gradient streams (USFS 2005). Because this reach is a high gradient stream only a longitudinal bed profile (Figure 5-2) and cross section analysis (Figures 5.3) were conducted. The three permanent cross sections extend across the entire valley floor width and were selected in 2006 as to avoid construction disturbance.

The EC-1 reach exhibits characteristics of an “Aa+” type channel using the Rosgen channel classification method (Rosgen 1996). It is very steep (14 percent), somewhat entrenched, and confined. The channel resembles a gully and has a step/pool morphology resulting from the large number of downed trees in the channel (Rosgen 1996). This classification has not changed since the 2006 monitoring of EC-1.

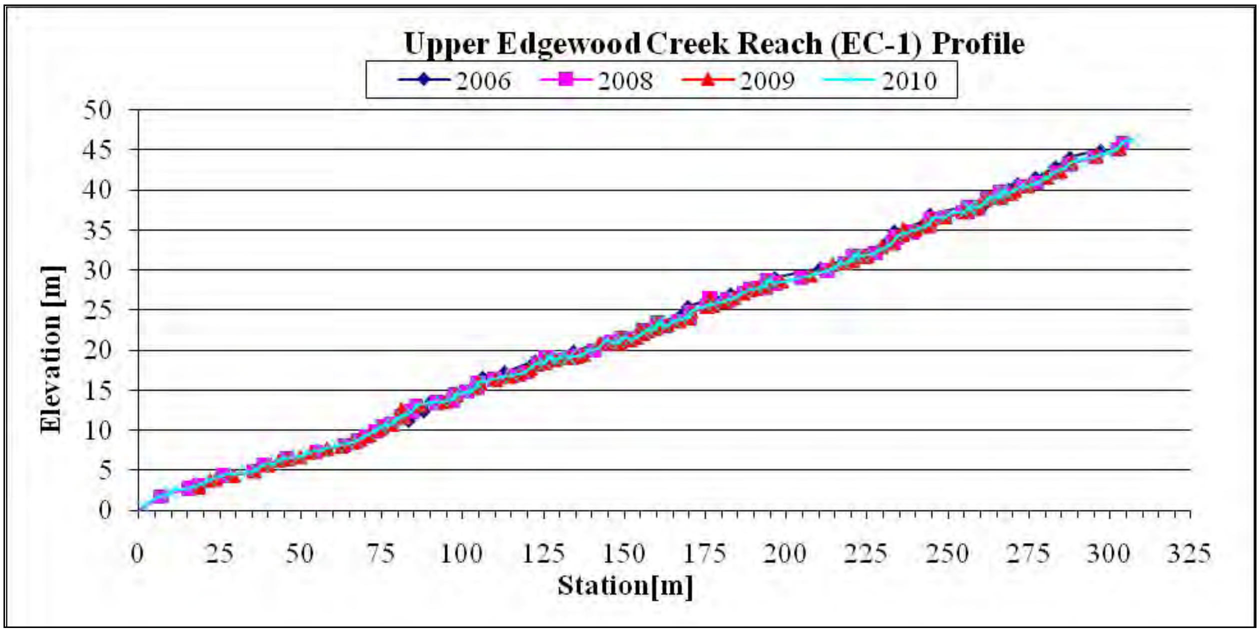

Figure 5-2 Upper Edgewood Creek Reach (EC-1) Profile

Established in 2006, the profile was taken along the entire reach length along the dry bed. Elevation and station measurements are graphed relative to the downstream end of the reach. The downstream end of the reach is point zero, zero. The profile of the Upper Edgewood Reach shows a fairly uniform slope throughout the surveyed reach.

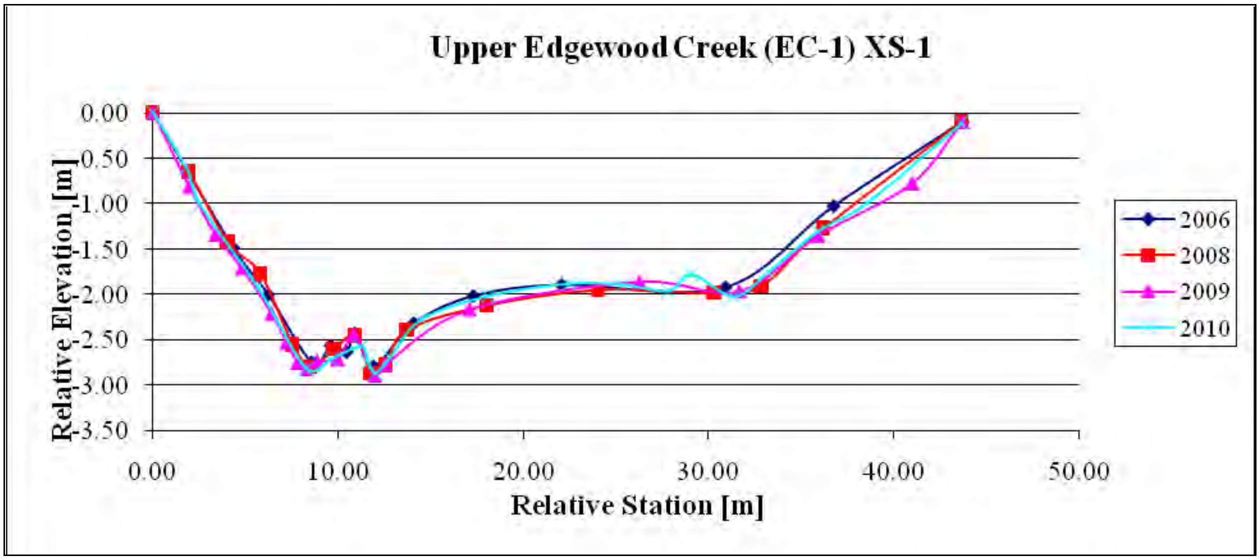

Figure 5-3a Permanent cross-sections for reach EC-1, Upper Edgewood, along Edgewood Creek. Established in 2006, cross-section XS-1

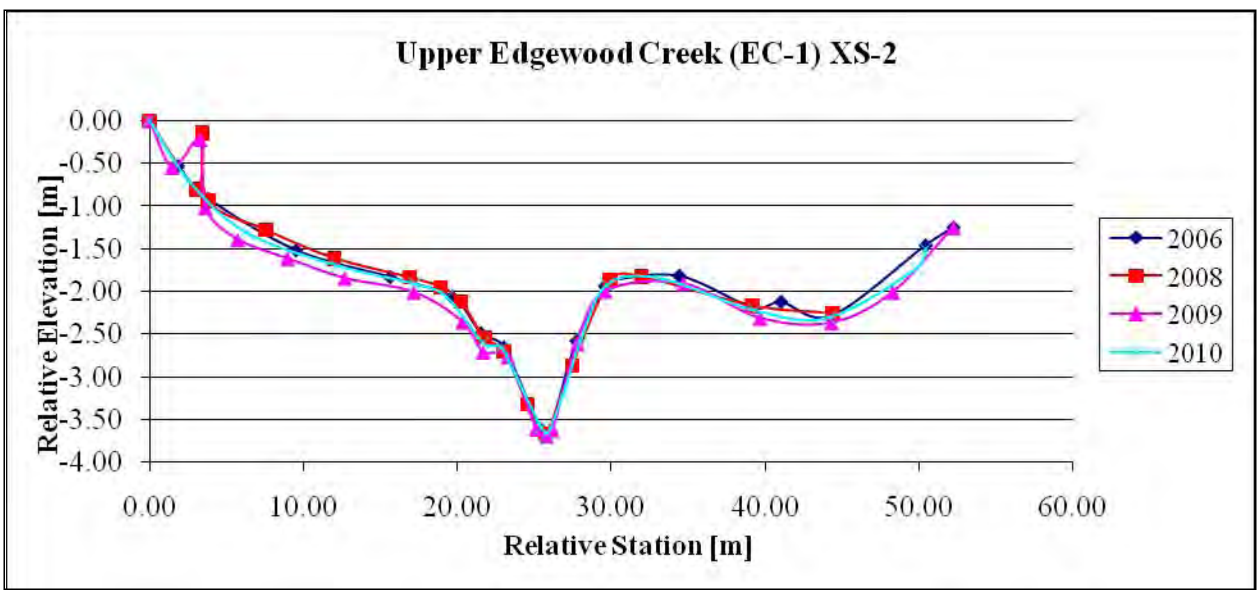

Figure 5-3b Permanent cross-sections for reach EC-1, Upper Edgewood, along Edgewood Creek. Established in 2006, cross-section XS-2

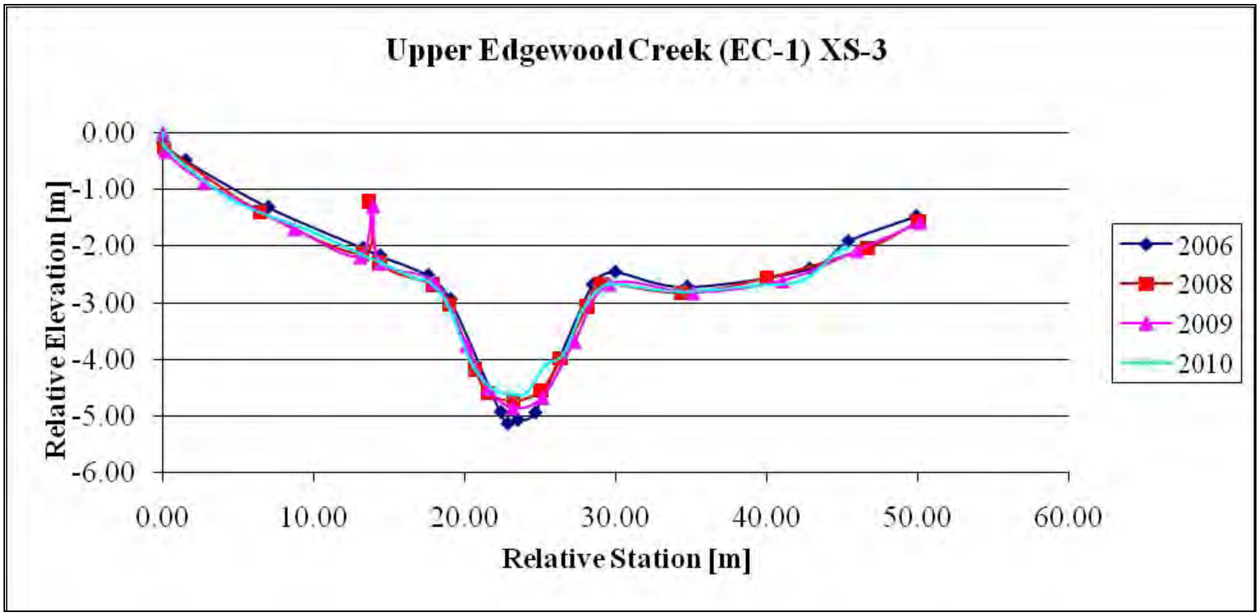

Figure 5-3c Permanent cross-sections for reach EC-1, Upper Edgewood, along Edgewood Creek. Established in 2006, cross-section XS-3

Figures 5-3a through 5-3c represent permanent cross-sections for reach EC-1, Upper Edgewood, along Edgewood Creek. Established in 2006, cross-sections XS-1, XS-2, and XS-3 are graphed from rebar monuments. Elevation and station measurements are graphed relative to the left bank (as viewed looking downstream) rebar stake. The top of the rebar stake on the left bank is the zero elevation, zero point (starting station). The graphical representation of these cross sections show very minute changes in the channel shape.

5.4 Lower Edgewood Creek

Edgewood Creek below Boulder Parking Lot also underwent restoration in 2007. These restoration activities included repair of a headcut by constructing plunge pools and riparian planting. The restoration of Lower Edgewood Creek occurred directly upstream of EC-2, incorporating the upstream cross-section of the riparian monitoring site. A vault treatment system was installed in the Boulder parking lot in 2005.

Lower Edgewood exhibits characteristics of a “G” type channel using the Rosgen channel classification method. "G" channel types typically have very high bank erosion rates and a high sediment supply. Channel degradation and sideslope rejuvenation processes are also typical (Rosgen 1996). A pebble count was not completed because all sediment was less than 8 mm. The dominant pebble class is coarse sand. There were no pools in the reach as defined by the SCI protocol version 5.0.

Table 5-2 (Appendix G) presents the results for full SCI evaluation completed in 2010 and compares these results from 2006, 2008 and 2009 for EC-2. A pebble count was not completed because all sediment was less than 8mm. The dominate pebble class is assumed to be sand. There were no pools as defined by the USFS SCI protocol, therefore the mean pool length, mean residual pool depth, and percent fines were not measured. Most of the collected data is similar to past years results excluding the following measurements:

1. Mean Width to Depth Ratio - This value increased from the previous year's data set since the mean channel depths decreased at some of the cross-sections due to sediment deposition. The decrease in mean channel depth with a constant bankfull width results in a higher width to depth ratio. This trend is evident in cross section two where the depth has decreased in past years.

2. Percent Stable/Vulnerable Banks - This value decreased from last year's assessment, and has a similar value to the 2006 and 2008 assessment.

Table 5-3 (Appendix G) presents the cross sections associated with bankfull width, width-to-depth ratio, and entrenchment ratio for 2006, 2008, 2009, and 2010. All four measurements have changed slightly since 2006. Some of the values in last year's report have been revised to make the calculation methods consistent with this year and previous years by changing the stations used to define the bankfull width. This change was made so that reported differences in channel morphology are attribute to actual erosion and sedimentation of the channel geometry rather than differences in calculation procedure.

Permanent cross-sections XS-1 and XS-2 for Edgewood Creek's Lower Edgewood reach, EC-2, are graphed and presented in Figures 5-4a through 5-4c. The most upstream cross-section, XS-3, had to be relocated in 2008 due to restoration activities destroying the permanent monument. The new location is directly below the rock grade control structure constructed as part of the Lower Edgewood Restoration Project completed in 2007. The cross-sections for XS-3 are graphed and presented in Figure 5-4c. Lower Edgewood Creek's channel morphology is highly influenced by dense riparian vegetation that supplies a large amount of wood to the channel which creates complex channel morphology. The plot for cross-section XS-2 (Figure 5-4b) illustrates how banks along the reach are often undercut on both sides. Some of these undercuts are caused by large tree roots on the banks. All three cross sections show a decrease in the mean depth of the channel due to sediment deposition. Cross-section XS-3 (Figure 5-4c), new in 2008, has undercutting on its left bank as the result of a large root from a nearby mature aspen tree. This cross-section is located directly downstream of the last constructed plunge pool in the Lower Edgewood Restoration Project. Future years of data collection at this point will reveal the effects of the restoration upstream.

Table 5-4 (Appendix G) outlines the positive and negative changes that have occurred in the Lower Edgewood channel (EC-2) since 2008.

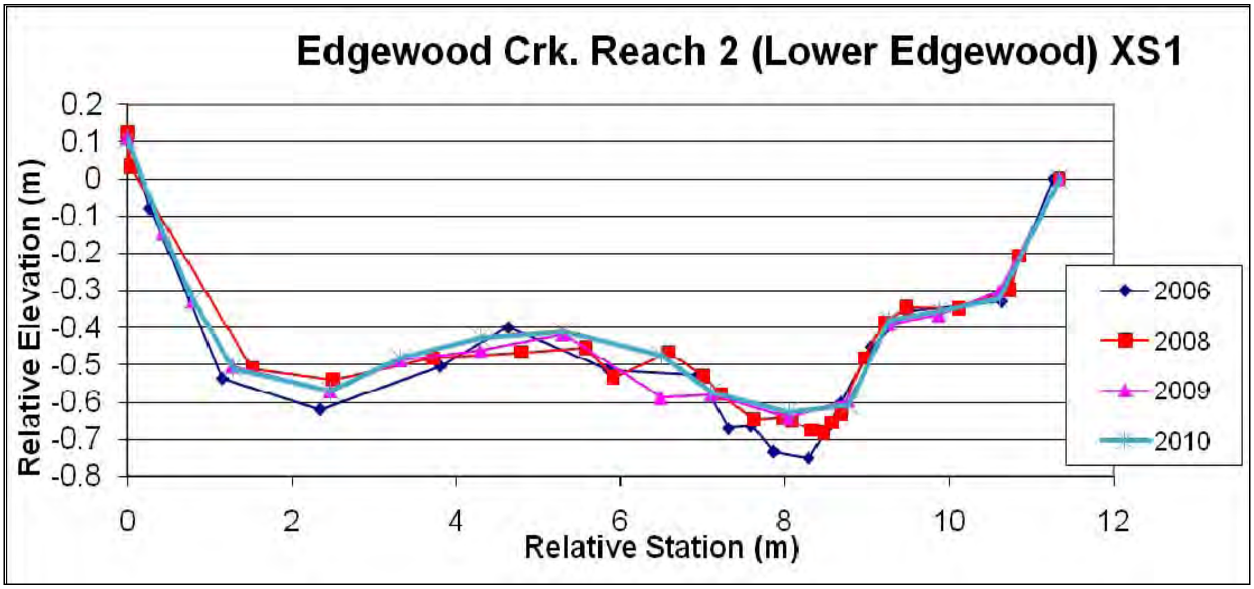

Figure 5-4a Permanent cross-sections for reach EC-2, Lower Edgewood, along Edgewood Creek, XS1.

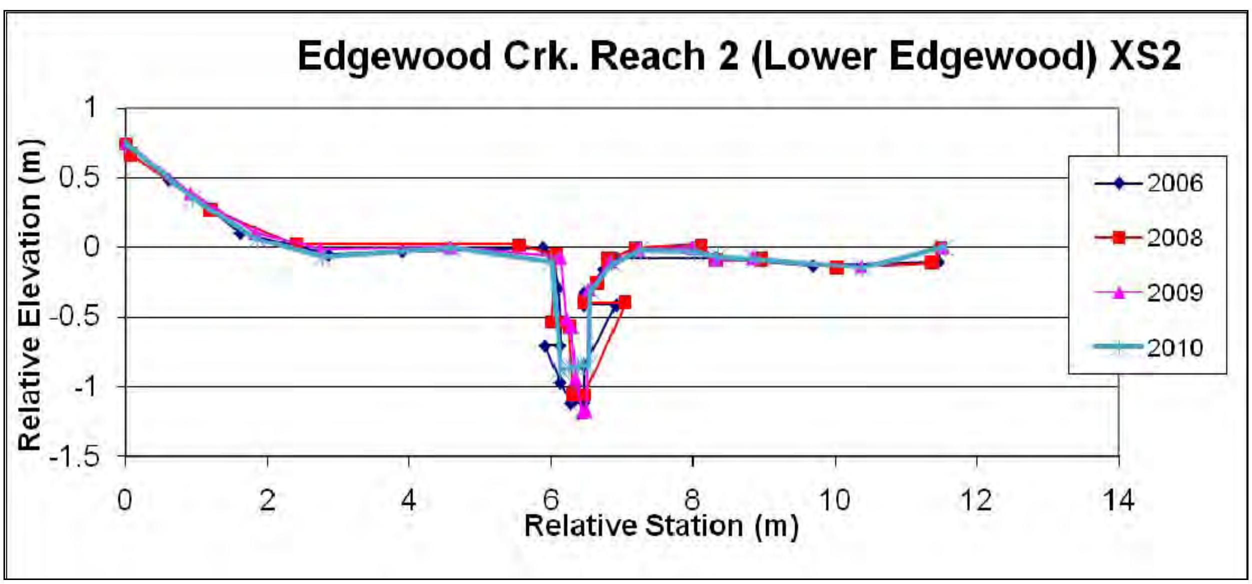

Figure 5-4b Permanent cross-sections for reach EC-2, Lower Edgewood, along Edgewood Creek, XS2.

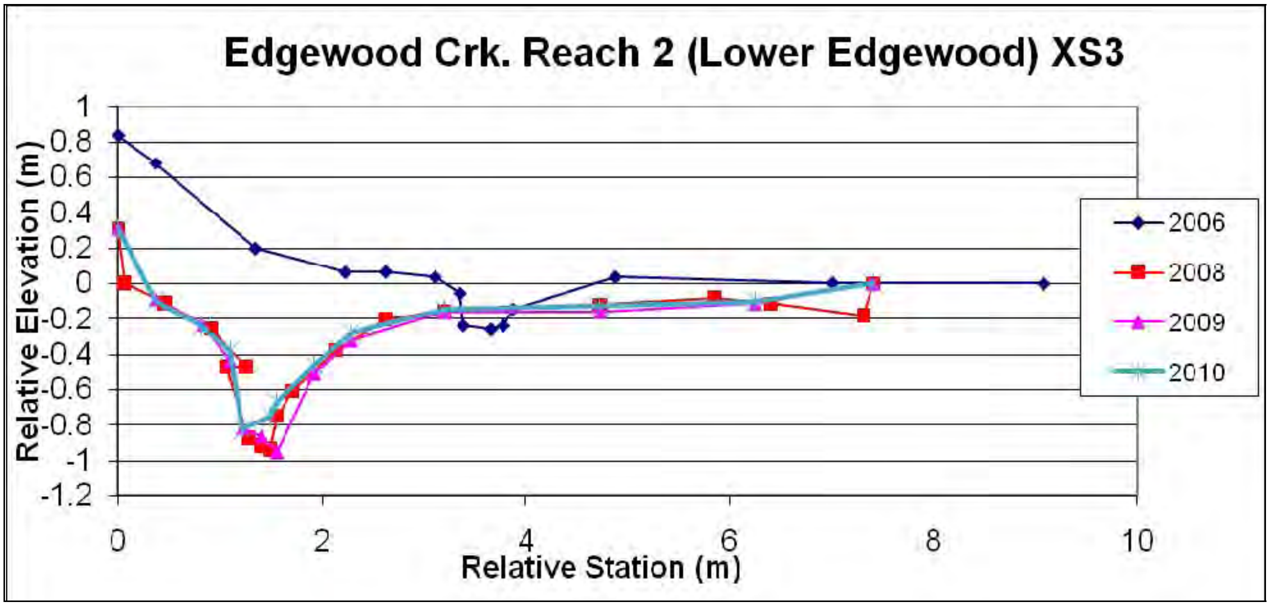

Figure 5-4c Permanent cross-sections for reach EC-2, Lower Edgewood, along Edgewood Creek, XS3. The cross-section location was moved in 2008, after a restoration project was completed in 2007.

Permanent cross-sections for reach EC-2, Lower Edgewood, along Edgewood Creek. Established in 2006, cross-sections are graphed from rebar monuments. Elevation and Station measurements are graphed relative to the left bank (as viewed looking downstream) rebar stake. The top of the rebar stake on the left bank is the zero elevation, zero point (starting station).

5.5 Conclusions

One issue encountered while performing and analyzing field data is observer variability. The following parameters are those that were most subjective on these sites:

- Bankfull Stage (width)
- Width to Depth Ratio
- Entrenchment Ratio
- Bank Stability / Vulnerability

Table 5.1 Data Measurements Subject to Field Interpretation

Measurement	2006 Data	2010 Data	Explanation
Bankfull Stage	1.6	1.38	Bankfull stage was identified in 2010 based on various indicators including changes in bank slope, vegetation, bank material size, and water stains or lichen lines on the substrate. These determining factors may be interpreted differently depending on the observer. These values were standardized for the Lower Edgewood sites and re-calculated (see Table 5-3)
Width to Depth Ratio	4.6	7.83	Width to Depth Ratios depend heavily on the bankfull stage measurement. The bankfull stage measurement can be determined using multiple factors, and can vary depending on the observer (see above). Therefore, width to depth ratios can also vary depending on the observer and the random locations chosen.
Entrenchment Ratio	15.2	16.13	Entrenchment ratio, like width to depth ratio, is highly dependent on bankfull stage, and is therefore affected by observer variability. Additionally, floodprone width is included in this

Table 5.1 Data Measurements Subject to Field Interpretation

Measurement	2006 Data	2010 Data	Explanation
			measurement. Floodprone width is determined by the same indicators as bankfull width. This adds another element of observer variability to entrenchment ratio.
Bank Stability / Vulnerability	40-60	50-50	Bank stability is a measurement of percent cover and includes stability components. Depending on the location chosen and the observers idea of percent cover and bank instability indicators, this measurement could be skewed.

The measurements bulleted above represent wide-spread changes across the monitoring reach. A discussion on the reach and how it's changed since 2006 is provided below.

5.5.1 Upper Edgewood Creek

The topographic surveying of Upper Edgewood Creek shows that the channel elevations are essentially unchanged in 2010 compare with previous surveys. Both the longitudinal profile and the cross-sections surveys surveyed in 2010 plot nearly directly on the previous data. The monitoring results show that the rock gabions constructed to prevent additional channel degradation are performing as intended in terms of maintaining existing bed elevations.

5.5.2 Lower Edgewood Creek

Topographic surveying and other channel attributes were measured along Lower Edgewood Creek in 2010. The monitoring results show that the channel has not experienced unnatural change. The dimensions of the three surveyed cross-sections are similar to surveys from previous years. Channel bed elevations have decreased in 2010 and are showing sediment deposition and mean depth decreasing in the channel. The channel may be recovering from prior downcutting by dropping out sediment and reducing the unnaturally large cross-sectional area in some reaches. Riparian vegetation conditions along the reach are largely unchanged as indicated by the percent shading results.

Chapter 6

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Appendix A

Raw Data for Water Quality Constituents, Water Year 2010

Appendix A

Raw Data for Water Quality Constituents, Water Year 2010

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Table A-1:		Heavenly Mountain Resort water year 2009/2010 water quality monitoring data from station HV-C2, Heavenly Valley Creek below Patsy's Chair. This station is located just beyond ski area development within this watershed at an elevation of 8,000 feet.												
Date	**Time**	**Discharge (cfs)**	**Specific Conductivity (mmhos)**	**Turbidity (ntu)**	**Suspended Sediment [2] (mg/L)**	**Total Nitrite/Nitrate (mg/L)**	**Total Kjeldahl N (mg/L)**	**Total Nitrogen (mg/L)**	**Total Phosphorus (mg/L)**	**Soluble Reactive P (mg/L)**	**Chloride (mg/L)**	**Total Iron (mg/L)**	**Average Temperature (Deg C)**	**Precipitation (in)**
Lahontan Standards[1]		N/A	N/A	N/A	**60**	N/A	N/A	**0.190**	**0.015**	N/A	**0.15**	**0.03**	N/A	N/A
First Quarter WY 2009-2010														
091020	11:30	0.26	119.3	120.00	38.00	0.059	0.295	**0.354**	**0.487**	0.021	**2.10**	**6.30**	1.3	0.5
091117	11:00	0.12	86.8	0.7	0.40	0.075	0.187	**0.262**	**0.058**	0.007	-	-	3.2	0
091201	no samples taken in December 2009; low flow or no flow													
Second Quarter WY 2009-2010														
100101	no samples taken in Janurary 2010; low flow or no flow													
100225	11:00	0.5	72.3	1.50	1.60	0.017	0.091	0.108	**0.019**	0.005	**1.7**	**0.18**	-2.78	0.5
100316	11:20	0.32	57.6	1.10	1.60	0.025	0.095	0.120	**0.019**	0.006	-	-	3.61	0
Third Quarter WY 2009-2010														
100428	10:42	0.17	47.0	1.10	1.40	0.071	0.113	0.184	**0.020**	0.007	**0.93**	**0.23**	0.28	0.5
100504	11:10	0.23	47.40	2.00	4.00	0.105	0.112	**0.217**	**0.025**	0.007	-	-	4.78	0
100513	11:00	0.47	42.80	2.10	6.40	0.095	0.174	**0.269**	**0.025**	0.001	-	-	2.16	0
100520	11:00	1.09	41.30	7.75	8.00	0.093	0.167	**0.260**	**0.030**	0.005	-	-	4.22	0
100525	10:55	0.89	40.80	1.25	2.40	0.102	0.153	**0.255**	**0.018**	0.003	-	-	-1.00	0
100603	11:15	4.34	35.70	85.00	**533.00**	0.083	3.218	**3.301**	**1.066**	0.004	-	-	7.50	0.1
100609	11:00	4.09	32.50	2.50	7.60	0.048	0.141	0.189	**0.037**	0.004	-	-	9.72	0
100621	11:00	3.47	28.20	0.85	6.40	0.032	0.091	0.123	**0.016**	0.003	-	-	7.00	0
Fourth Quarter WY 2009-2010														
100720	10:35	1.25	36.20	0.55	1.60	0.040	0.157	0.197	0.017	0.002	**0.64**	**0.23**	14.6	0
100816	11:00	0.76	36.70	0.75	3.60	0.050	0.071	0.121	**0.023**	0.002	**-**	**-**	12.1	0
100927	10:50	0.31	45.10	0.72	2.80	0.060	0.056	0.116	**0.020**	0.001	**-**	**-**	13.6	0
Annual Summary	**Minimum**	0.12	28.20	0.55	0.40	0.017	0.056	0.108	0.016	0.001	0.64	0.18	-	-
	Maximum	4.34	119.30	120.00	533.00	0.105	3.218	3.301	1.066	0.021	2.10	6.30	-	-
	Average	**1.22**	**51.31**	**15.19**	**41.25**	**0.064**	**0.341**	**0.405**	**0.125**	**0.005**	**1.34**	**1.74**	**-**	**-**
	Std Error	1.47	24.34	36.10	136.35	0.028	0.798	0.804	0.286	0.005	0.67	3.04	**-**	**-**
	90th Percentile		**-**	**-**	26.00	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

[1]Standards are annual averages for the receiving waters of Trout Creek.

[2]Standards are for receiving waters of Trout Creek, 90th Percentile.

Table A-2:	Heavenly Mountain Resort water year 2009/2010 water quality monitoring data from station HV-C3, Heavenly Valley Creek at the Property Line. This station is located just above the Forest Service property line and subdivision development at an elevation of 6,620 feet.													
Date	**Time**	**Discharge (cfs)**	**Specific Conductivity (mmhos)**	**Turbidity (ntu)**	**Suspended Sediment [2] (mg/L)**	**Total Nitrite/Nitrate (mg/L)**	**Total Kjeldahl N (mg/L)**	**Total Nitrogen (mg/L)**	**Total Phosphorus (mg/L)**	**Soluble Reactive P (mg/L)**	**Chloride (mg/L)**	**Total Iron (mg/L)**	**Average Temperature (Deg C)**	**Precipitation (in)**
Lahontan Standards[1]		N/A	N/A	N/A	**60**	N/A	N/A	**0.190**	**0.015**	N/A	**0.15**	**0.03**	N/A	N/A
First Quarter WY 2009-2010														
091020	13:15	0.03	50.0	0.85	0.40	<.001	0.065	0.065	**0.018**	0.004	**1.6**	**0.04**	1.3	0.5
091116	11:28	0.13	54.5	0.52	0.27	<.001	<0.035	-	**0.019**	0.005	-	-	1.3	0
091201	no samples taken in December 2009; low flow or no flow													
Second Quarter WY 2009-2010														
100101	no samples taken in Janurary 2010; low flow or no flow													
100225	13:00	0.04	50.4	0.65	2.80	0.001	0.062	0.063	**0.016**	0.003	**1.5**	**0.031**	-2.78	0.5
100316	13:05	0.03	49.9	0.58	2.40	0.002	0.060	0.062	**0.025**	0.006	-	-	3.61	0
Third Quarter WY 2009-2010														
100427	11:20	0.14	43.7	0.81	0.80	0.001	0.062	0.063	**0.018**	0.007	0.10	**0.053**	5.28	0
100504	13:00	0.11	44.10	0.55	1.00	0.002	0.056	0.058	**0.016**	0.006	-	-	4.78	0
100513	14:00	0.23	42.70	0.48	1.40	0.003	0.074	0.077	**0.017**	0.006	-	-	2.16	0
100520	12:45	0.55	43.30	1.50	2.40	0.018	0.097	0.115	**0.024**	0.008	-	-	4.22	0
100525	12:00	0.25	40.40	0.62	1.60	0.023	0.085	0.108	**0.018**	0.006	-	-	-1.00	0
100603	13:00	2.02	37.70	102.0	**506.00**	0.060	4.254	**4.314**	**1.051**	0.007	-	-	7.50	0.1
100609	13:30	0.52	34.30	4.20	15.20	0.023	0.155	0.178	**0.040**	0.005	-	-	9.72	0
100621	13:30	1.39	30.80	1.00	5.60	0.004	0.107	0.111	0.012	0.002	-	-	7.00	0
Fourth Quarter WY 2009-2010														
100720	12:30	0.42	39.5	0.63	1.60	0.012	0.071	0.083	0.015	0.004	**0.66**	**0.13**	14.6	0
100816	12:25	0.85	41.80	0.70	2.20	0.012	0.043	0.055	**0.028**	0.005	**-**	**-**	12.1	0
100927	13:17	0.35	44.90	0.52	2.00	0.010	0.051	0.061	**0.022**	0.001	**-**	**-**	13.6	0
Annual Summary	**Minimum**	0.03	30.80	0.48	0.27	0.001	0.043	0.055	0.012	0.001	0.10	0.031	-	-
	Maximum	2.02	54.50	102.00	506.00	0.060	4.254	4.314	1.051	0.008	1.60	0.130	-	-
	Average	**0.47**	**43.20**	**7.71**	**36.38**	**0.013**	**0.374**	**0.387**	**0.089**	**0.005**	**0.97**	**0.064**	**-**	**-**
	Std Error	0.56	6.33	26.10	129.97	0.016	1.117	1.131	0.266	0.002	0.71	0.045	**-**	**-**
	90th Percentile		**-**	**-**	11.36	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

[1]Standards are annual averages for the receiving waters of Trout Creek.

[2]Standards are for receiving waters of Trout Creek, 90th Percentile.

Table A-3:	Heavenly Mountain Resort water year 2009/2010 water quality monitoring data from station HV-C4, Bijou Park Creek below California Parking Lot. This station is located 1/4 miles below the culvert outlet draining the parking lot off of Wildwood Avenue at an elevation of 6,530 feet.																			
Date	**Time**	**Discharge (cfs)**	**Specific Conductivity (mmhos)**	**Turbidity (ntu)**	**Suspended Sediment[1] (mg/L)**	**Total Nitrite/ Nitrate (mg/L)**	**Total Kjeldahl N (mg/L)**	**Total Nitrogen (mg/L)**	**Total Phosphorus (mg/L)**	**Soluble Reactive P (mg/L)**	**Chloride[1] (mg/L)**	**Oil and Grease (mg/L)**	**Total Iron (mg/L)**	**Total Lead (mg/L)**	**Dissolved Ammonia NH_3 (mg/L)**	**Temp (C)**	**pH**	**TPH (mg/L)**	**Average Temperature (Deg C)**	**Precipitation (in)**
Lahontan Standards[1]		N/A	N/A	**20.0**	**65**	N/A	N/A	**0.5**	**0.1**	N/A	**3.0**	**2.0**	**0.5**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
First Quarter WY 2009-2010																				
091013 [3]	1000	0.34	151.0	19.00	26.00	1.436	0.014	**1.450**	**0.341**	0.014	**21.0**	1.8	**4.0**	<0.010	0.027	-	-	ND	3.11	0
091020	12:00	0.02	271.0	4.65	2.40	0.254	0.111	0.365	0.046	0.013	**48.0**	<1.0	**1.1**	<0.010	0.055	-	-	ND	1.3	0.5
091116	11:00	0.01	266.0	3.10	3.20	0.190	0.195	0.385	0.059	0.008	**45.0**	<1.0	**1.8**	<0.010	0.050	-	-	ND	1.3	0
091201	no samples taken in December 2009; low flow or no flow																			
Second Quarter WY 2009-2010																				
100101	no samples taken in Janurary 2010; low flow or no flow																			
100225	11:45	0.08	1667	**80.0**	**176.67**	0.244	1.235	**1.479**	**0.616**	0.004	**540**	**17**	**6.4**	<0.010	0.020	-	-	ND	-2.78	0.5
100316	11:50	0.11	453.0	**25.0**	35.33	0.258	0.458	**0.716**	**0.146**	0.010	**110**	**2.2**	**3.5**	-	0.062	-	-	ND	3.61	0
Third Quarter WY 2009-2010																				
100427	11:20	0.14	275.0	11.0	18.33	0.243	0.336	**0.579**	**0.119**	0.029	**54**	1.3	**2.2**	<0.010	0.059	-	-	ND	5.28	0
100504	10:15	0.10	326.0	7.50	5.20	0.420	0.225	**0.645**	0.059	0.024	**66**	<1.0	**2.6**	<0.010	0.085	-	-	ND	4.78	0
100513	11:30	0.05	357.0	7.58	4.80	0.561	0.295	**0.856**	0.050	0.014	**75**	<1.0	**2.1**	<0.010	0.079	-	-	ND	2.16	0
100520	11:30	0.03	382.0	9.95	4.40	0.502	0.124	**0.626**	0.057	0.015	**81**	<1.0	**2.3**	<0.010	0.093	-	-	ND	4.22	0
100525	10:45	0.07	384.0	8.25	4.40	0.508	0.225	**0.733**	0.046	0.013	**82**	<1.0	**2.0**	<0.010	0.092	-	-	ND	-1.00	0
100603	12:00	0.05	379.0	7.30	3.60	0.428	0.267	**0.695**	0.049	0.009	**81**	<1.0	**4.8**	<0.010	0.103	-	-	ND	7.50	0.1
100609	11:45	0.06	427.0	**30.00**	14.40	0.533	0.188	**0.721**	**0.103**	0.005	**98**	<1.0	**5.3**	<0.010	0.075	-	-	ND	9.72	0
100621	11:30	0.04	375.0	6.25	8.80	0.570	0.151	**0.721**	0.043	0.006	**77**	<1.0	**2.4**	<0.010	0.081	-	-	ND	7.00	0
Fourth Quarter WY 2009-2010																				
100726 [4]	12:45	0.02	298.0	7.0	7.83	0.548	0.261	**0.809**	0.058	0.011	**53**	1.2	**2.2**	<0.010	0.078	-	-	ND	14.6	0.3
100816	11:35	0.01	274.0	6.0	6.00	0.399	0.117	**0.516**	0.063	0.009	**47**	<1.0	0.18	<0.010	0.080	-	-	ND	12.1	0
100927	11:20	0.05	248.0	14.0	3.20	0.355	0.078	0.433	0.072	0.010	**40**	1.2	**3.2**	<0.010	0.047	-	-	ND	13.6	0
Annual Summary	**Min**	0.01	151.00	3.10	2.40	0.190	0.014	0.365	0.043	0.004	21.00	1.20	0.18	ND	0.020	-	-	N/A	-	-
	Max	0.34	1667.00	80.00	176.67	1.436	1.235	1.479	0.616	0.029	540.00	17.00	6.40	<0.010	0.103	-	-	N/A	-	-
	Average	**0.07**	**408.31**	**15.41**	**20.29**	**0.466**	**0.268**	**0.733**	**0.120**	**0.012**	**94.88**	**4.12**	**2.88**	**N/A**	**0.068**	**-**	**-**	N/A	**-**	**-**
	Std Error	0.08	365.18	18.89	45.01	0.294	0.296	0.306	0.154	0.007	126.24	5.83	1.68	N/A	0.024	**-**	**-**	N/A	**-**	**-**
	90th Percentile	-	-	-	30.67	-	-	-	-	-	-	-	-	-	-	**-**	**-**	**-**	**-**	**-**

ND=Non-detect

[1]Standards are maximum concentration for discharge to surface waters, effective November 30, 2008. Suspended Sediment Limits based on the 90th Percentile of receiving waters to Lake Tahoe.

[2]Chloride standards are from Table 3, LRWQCB WDID No. 6A090033000 (Lake Tahoe Receiving Water Limits).

[3]Storm Event

[4]Sample collected on a different day than other samples due to scheduled vault cleaning.

Table A-4:		Heavenly Mountain Resort water year 2009/2010 water quality monitoring data from station HV-H5, Hidden Valley Creek baseline station. This station is located just above the confluence with Trout Creek, at an elevation of 6,680 feet.												
Date	**Time**	**Discharge (cfs)**	**Specific Conductivity (mmhos)**	**Turbidity (ntu)**	**Suspended Sediment (mg/L)**	**Total Nitrite/Nitrate (mg/L)**	**Total Kjeldahl N (mg/L)**	**Total Nitrogen (mg/L)**	**Total Phosphorus (mg/L)**	**Soluble Reactive P (mg/L)**	**Chloride (mg/L)**	**Total Iron (mg/L)**	**Average Temperature (Deg C)**	**Precipitation (in)**
Lahontan Standards[1]		N/A	N/A	**20**	**60**	N/A	N/A	**0.19**	**0.015**	N/A	**0.15**	**0.03**	N/A	N/A
First Quarter WY 2009-2010														
091013 [2]	13:00	0.30	56.4	10.20	54.40	0.002	0.971	**0.973**	**0.200**	0.042	**0.75**	0.01	3.11	0
091020	15:00	0.11	54.1	0.75	0.80	0.002	0.120	0.122	**0.025**	0.002	**0.53**	**0.06**	1.3	0.5
091116	13:10	0.13	54.8	0.32	0.80	0.003	0.055	0.058	**0.027**	0.007	-	-	1.3	0
091201	no samples taken in December 2009; low flow or no flow													
Second Quarter WY 2009-2010														
100101	no samples taken in Janurary 2010; low flow or no flow													
100225	16:00	0.09	66.8	1.30	5.20	0.012	0.155	0.167	**0.029**	0.005	**0.26**	**0.12**	-2.78	0.5
100316	15:48	0.14	65.70	0.87	1.60	0.011	0.105	0.116	**0.025**	0.010	-	-	3.61	0
Third Quarter WY 2009-2010														
100427	12:50	0.09	53.0	4.0	4.80	0.025	0.233	**0.258**	**0.036**	0.012	**0.30**	**0.38**	5.28	0
100505	14:15	0.14	53.1	4.25	5.60	0.018	0.186	**0.204**	**0.031**	0.009	-	-	4.78	0
100513	16:30	0.35	46.40	2.50	4.40	0.003	0.160	0.163	**0.026**	0.005	-	-	2.16	0
100520	13:55	0.55	41.40	1.80	2.80	0.011	0.171	0.182	**0.030**	0.011	-	-	4.22	0
100525	13:30	0.36	40.20	1.75	3.60	0.008	0.163	0.171	**0.027**	0.010	-	-	-1.00	0
100603	14:15	1.04	28.30	4.75	26.00	0.014	0.524	**0.538**	**0.069**	0.005	-	-	7.50	0.1
100609	15:30	5.31	18.35	6.25	26.80	0.006	0.301	**0.307**	**0.062**	0.008	-	-	9.72	0
100621	15:45	2.34	21.70	0.95	5.00	0.001	0.145	0.146	**0.018**	0.006	-	-	7.00	0
Fourth Quarter WY 2009-2010														
100720	15:20	0.39	33.0	0.6	1.20	0.002	0.054	0.056	**0.019**	0.009	**0.16**	**0.10**	14.6	0
100816	15:30	0.75	37.5	0.42	2.00	0.006	0.010	0.016	**0.027**	0.008	**-**	**-**	12.1	0
100927	9:04	0.38	54.60	0.63	2.00	0.007	0.058	0.065	**0.029**	0.007	**-**	**-**	13.6	0
Annual Summary	**Minimum**	0.09	18.35	0.32	0.80	0.001	0.010	0.016	0.018	0.002	0.16	0.01	-	-
	Maximum	5.31	66.80	10.20	54.40	0.025	0.971	0.973	0.200	0.042	0.75	0.38	-	-
	Average	**0.78**	**45.33**	**2.58**	**9.19**	**0.008**	**0.213**	**0.221**	**0.043**	**0.010**	**0.40**	**0.13**	**-**	**-**
	Std Error	1.33	14.61	2.71	14.52	0.007	0.235	0.236	0.044	0.009	0.24	0.14	**-**	**-**
	90th Percentile				26.40								**-**	**-**

[1]Standards are annual averages for the receiving waters of Trout Creek. For Suspended Sediment, standards are for streams tributaries to Lake Tahoe. Suspended Sediment concentrations shall not exceed a 90th percentile value of 60 mg/L.

[2]Storm Event

Table A-5:		Heavenly Mountain Resort water year 2009/2010 water quality monitoring data from station HV-E1, Edgewood Creek above Boulder Parking Lot. This station is located in Edgewood Bowl above the learn-to-ski center, at an elevation of 7,280 feet.											
Date	**Time**	**Discharge (cfs)**	**Specific Conductivity (mmhos)**	**Turbidity (ntu)**	**Suspended Sediment (mg/L)**	**Total Nitrite/Nitrate (mg/L)**	**Total Kjeldahl N (mg/L)**	**Total Nitrogen (mg/L)**	**Total Phosphorus (mg/L)**	**Soluble Reactive P (mg/L)**	**Dissolved P(mg/L)**	**Average Temperature (Deg C)**	**Precipitation (in)**
NDEP Standards[1]		N/A	N/A	**10**	**25.00**	N/A	N/A	**0.6** [2]	**0.1**	N/A	N/A	N/A	N/A
First Quarter WY 2009-2010													
no samples taken; low flow or no flow													
Second Quarter WY 2009-2010													
no samples taken; low flow or no flow													
Third Quarter WY 2009-2010													
100427	14:40	0.1	83.4	1.50	2.80	0.002	0.270	0.272	0.031	0.005	0.012	5.28	0
100505	11:40	0.18	70.5	1.50	3.20	0.002	0.140	0.142	0.025	0.003	0.009	4.78	0
100513	12:00	0.07	70.90	1.10	1.60	0.002	0.126	0.128	0.020	0.003	0.011	2.16	0
100520	10:00	0.12	61.50	1.00	0.80	0.002	0.097	0.099	0.022	0.009	0.021	4.22	0
100525	10:00	0.06	63.10	1.00	0.86	0.001	0.094	0.095	0.016	0.003	0.011	-1.00	0
100603	10:00	0.06	58.20	1.80	1.25	0.001	0.113	0.114	0.018	0.003	0.015	7.50	0.1
100609	12:15	0.05	68.40	4.75	12.40	0.002	0.081	0.083	0.025	0.004	0.016	9.72	0
100621	12:10	0.01	75.60	5.50	20.80	0.001	0.279	0.280	0.083	0.003	0.017	7.00	0
Fourth Quarter WY 2009-2010													
no samples taken; low flow or no flow													
Annual Summary	**Minimum**	0.01	58.2	1	0.8	0.001	0.081	0.083	0.016	0.003	0.009	-	-
	Maximum	0.18	83.4	5.5	20.8	0.002	0.279	0.280	0.083	0.009	0.021	-	-
	Average	0.081	68.950	2.27	5.46	0.002	0.150	0.152	0.030	0.004	0.014	-	-
	Std Error	0.052	8.149	1.80	7.28	0.001	0.079	0.079	0.022	0.002	0.004	-	-

[1]NDEP Standards are from the Nevada Administrative Code (NAC) Chapter 445A.1915. All listed numbers are standards for single values no greater than a given parameter unless otherwise noted.

[2]Annual Average

[3]Storm Sample

Table A-6:		Heavenly Mountain Resort water year 2009/2010 water quality monitoring data from station HV-E2, Edgewood Creek below Boulder Parking Lot. . This station is located 1/4 mile below the parking lot, underneath the power lines at an elevation of 7,120 feet.											
Date	**Time**	**Discharge (cfs)**	**Specific Conductivity (mmhos)**	**Turbidity (ntu)**	**Suspended Sediment (mg/L)**	**Total Nitrite/Nitrate (mg/L)**	**Total Kjeldahl N (mg/L)**	**Total Nitrogen (mg/L)**	**Total Phosphorus (mg/L)**	**Soluble Reactive P (mg/L)**	**Dissolved P (mg/L)**	**Average Temperature (Deg C)**	**Precipitation (in)**
NDEP Standards[1]		N/A	N/A	**10.0**	**25.0**	N/A	N/A	**0.6** [2]	**0.1**	N/A	N/A	N/A	N/A
First Quarter WY 2009-2010													
no samples taken; low flow or no flow													
Second Quarter WY 2009-2010													
no samples taken; low flow or no flow													
Third Quarter WY 2009-2010													
100427	14:50	0.19	134.6	**14.0**	23.33	0.036	0.390	0.426	0.090	0.009	0.018	5.28	0
100504	11:55	0.18	107.2	7.00	11.90	0.022	0.203	0.225	0.042	0.004	0.011	4.78	0
100513	12:15	0.08	115.60	4.0	4.00	0.030	0.184	0.214	0.025	0.006	0.012	2.16	0
100520	10:15	0.2	92.50	3.00	2.00	0.018	0.118	0.136	0.025	0.010	0.021	4.22	0
100525	10:15	0.06	106.7	2.25	2.00	0.025	0.118	0.143	0.022	0.004	0.011	-1.00	0
100603	10:30	0.07	97.00	9.95	**32.80**	0.018	0.141	0.159	0.025	0.003	0.017	7.50	0.1
100609	12:30	0.08	119.5	9.96	**30.80**	0.035	0.146	0.181	0.031	0.003	0.015	9.72	0
100621	12:30	0.06	133	0.98	5.60	0.038	0.159	0.197	0.023	0.002	0.014	7.00	0
Fourth Quarter WY 2009-2010													
no samples taken; low flow or no flow													
Annual Summary	**Minimum**	0.06	92.50	0.98	2.00	0.018	0.118	0.136	0.022	0.002	0.011	-	-
	Maximum	0.20	134.60	14.00	32.80	0.038	0.390	0.426	0.090	0.010	0.021	-	-
	Average	0.12	113.31	6.39	14.05	0.028	0.182	0.210	0.035	0.005	0.015	-	-
	Std Error	0.06	15.49	4.59	13.01	0.008	0.089	0.093	0.023	0.003	0.004	-	-

[1]NDEP Standards are from the Nevada Administrative Code (NAC) Chapter 445A.1915. All listed numbers are standards for single values no greater than a given parameter unless otherwise noted.

[2]Annual Average

[3]Storm Sample

Appendix B

BMP Effectiveness Monitoring

(See Appendix I)

Appendix C

Annual Work List (See Appendix VI)

Appendix D

Summary of Deicer Application and Recovery in Water Year 2010

Appendix D
Summary of Deicer Application and Recovery
for Water Year 2010

Monthly Breakdown for WY 2010		
Month/Year	**Total Amount of Deicers and Abrasives Applied (lbs)**	**Total Amount of Deicers and Abrasives Recovered (lbs)**
Oct-09	0	0
Nov-09	2,412	13,360
Dec-09	15,320	0
Jan-10	38,534	7,040
Feb-10	18,001	12,880
Mar-10	51,070	13,760
Apr-10	5,172	0
May-10	4,787	20,680
Jun-10	0	95,260
Jul-10	0	0
Aug-10	0	0
Sep-10	0	0

Summary for WY 2010	
Deicers and Abrasives Applied (lbs)	**135,296**
Deicers and Abrasives Recovered (lbs)	**162,980**
Percent Recovered [1]	**120%**

[1] This value is above and beyond 100%, because sweeping accounts for all particles collected off of the roadway. Vehicular traffic adds additional material that is collected.

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Appendix E

Effective Soil Cover Workplan

Appendix E

Effective Soil Cover Workplan

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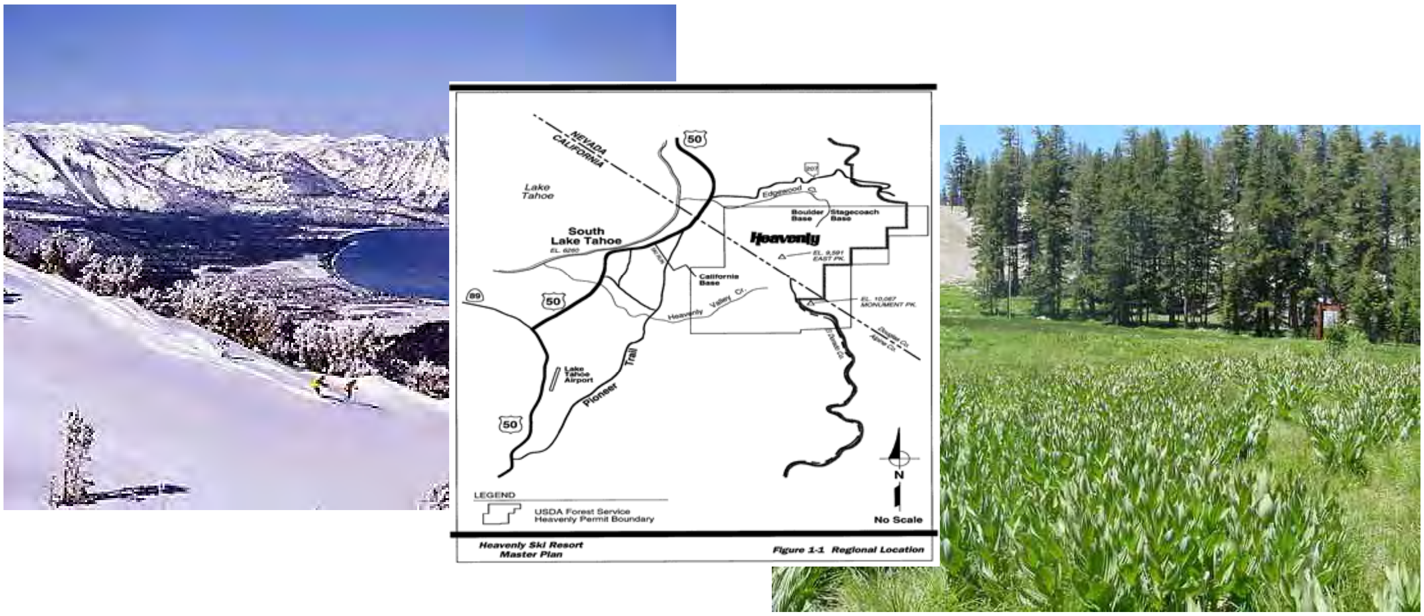
Heavenly Mountain Resort
Effective Soil Cover Workplan
2008



ENTRIX
ENVIRONMENTAL CONSULTANTS

Prepared by:

Entrix, Inc.
1048 Ski Run Boulevard
South Lake Tahoe, CA 96150

June 30, 2008

Resource Interest:

Soil Cover, Soil Conditions, Fine Sediment (<20 micron), Slope Stability, Sediment Influx to Lake Tahoe

Management Goals and Objectives:

1. Maintain and restore soils with favorable infiltration characteristics and diverse vegetative cover to absorb and filter precipitation and to sustain favorable conditions of stream flows.

Monitoring Objective(s):

1. Determine if changes in cover result in changes in runoff and sediment volume from ski runs and other project infrastructure.

2. Evaluate utilization of soil amendments/treatments to increase infiltration capacity for those areas resistant to revegetation efforts, or where revegetation is ineffective.

Project Nexus:

According to the results of the Bailey Land Capability Classification (1974), most of Heavenly Mountain Resort's land is classified as High Hazard for erosion (Class 1A). Construction, operation, and maintenance of ski runs, roads, and other infrastructure can therefore lead to excessive erosion. Operations on volcanic soils can lead to erosion of fine (<20 micron) soils that are of particular concern to water clarity in Lake Tahoe.

Monitoring Methods:

These methods are derived from the Vegetation Rapid Assessment Protocol (VRAP) Developed by the CNPS (CNPS 2004). The VRAP is a semi-quantitative method of vegetation and habitat sampling. Quantitative vegetation and site data recorded include, but are not limited to: topography, soil, rock and litter (size and percent cover), vegetation association and alliance (following Sawyer and Keeler-Wolf 1995), and vegetation cover (by percent cover, stratum and species). These data are not based on established test plots, but on a broader scale unit that is appropriate for the vegetation type found on the landscape. This judgment is made by the experienced practitioner conducting the measurements. This method allows enough flexibility to respond to site-specific attributes of the areas, combined with enough quantitative observation to allow comparison between years. The method is augmented with the establishment of permanent photo points to better track variability over time. The measurements will be conducted over time, and the trends will be analyzed to meet the ESC study objectives.

1. In 2008, approximately twenty-five sites will be selected on Heavenly Mountain Resort. Sites will be selected to include a representative sample of ski run slopes,

aspects, and soil types, as well as the erosion control treatment methods applied up to the present. See Appendix A for preliminary list of selected sites.

2. A permanent photo point or points will be selected and established at each site and its coordinates will be recorded using a GPS unit. Surveyors will visit the established photo points annually to reassess the effective soil cover (ESC) as described in step 3 below, and to take an updated photo.

3. A survey team, which must include at least one biologist with experience in botany and soil cover estimation, will visit each established photo point and perform the ESC field analysis on one landscape unit (between ¼ acre and 1 acre in size). Initially, the size of the landscape unit will be estimated as an area that received a certain type of treatment to abate erosion. The field crew will finalize the boundaries of each selected site in the field using visual boundaries of soil cover types and practical boundaries of the photo point.

4. The survey crew will assess the site's soil cover using the field form, Appendix B. They will also take a photo from the established photo point, recording the bearing of the camera towards the slope. The area of the photograph will be recorded using a long tape measure for length and camera zoom information for width.

5. The data will be recorded into a Microsoft Excel database. The sites will be revisited, reassessed, and photographed annually for the duration of the 5-year Mitigation and Monitoring Plan. Percentages of effective soil cover and eroded areas for each site will be recorded and reported annually along with qualitative observations made by the field crew.

6. Using the physical characteristics of the ski run and the applied treatment types, the results for the twenty-five selected sites can be extrapolated to other areas on Heavenly. A comparative analysis will be conducted, with a focus on explaining areas resistant to establishing effective soil cover.

Reporting

The ESC Report will be included in the Annual Report of the year it is completed. The contents of the report will include a description of methods, results, and discussion. The discussion will focus on observed trends and their significance with respect to project related effects. The report will identify areas resistant to vegetation efforts and propose additional efforts that could improve revegetation. The report will also include recommendations for future monitoring and management.

Schedule

ESC and photo point monitoring will occur in July 2008.

The results of the ESC and photo point monitoring will be summarized in the annual report in February 2009.
Subsequent ESC and photo point monitoring will occur either annually during the summers of 2009, 2010, 2011, and 2012 or once, at the culmination of the five-year Mitigation and Monitoring Plan.

Literature Cited

California Native Plants Society (CNPS). 2004. California Native Plant Society - Vegetation Rapid Assessment Protocol CNPS Vegetation Committee. Revised September 20, 2004. Available at: http://www.cnps.org/cnps/vegetation/pdf/rapid_assessment_protocol.pdf

Sawyer, J.O., and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society. Sacramento, California.

State Water Resources Control Board, 2001. Stream Photo Documentation Procedure. Standard Operating Procedure 4.2.1.4.

APPENDIX A

Sites Selected for Analysis

Landscape Unit	Ski Run Name
1	First Ride
2	World Cup
3	Gunbarrel
4	Pistol
5	Powderbowl
6	Groove
7	Pioneer Poma
8	Waterfall
9	Upper Mombo
10	Lower Ridge
11	Ellie's Swing
12	Liz's
13	Ellie's
14	Edgewood Meadow
15	North Bowl or Bohemain Grove
16	Boulder Chute
17	Lower Olympic
18	Cloud Nine
19	The Pines
20	Gondola Line
21	Cascade
22	Easy Street
23	Rope Tow Area near Big Easy and Gondola
24	Double Down/ Lower High Roller
25	Lower Cal Trail
26	Sky Canyon*

*Sky Canyon will be substituted if construction is occuring on any site or if the vegetation specialist deems it necessary

APPENDIX B

Field Form

HEAVENLY MOUNTIAN RESORT - VEGETATION RAPID ASSESSMENT FIELD FORM

Landscape Unit:	Ski Run Name:	Map Number:	Date:	Time:	Surveyors Names:

Description of photo point location:	Photo Point Marker (rebar?, nail, cap color?)

Camera Zoom:	Sample Area Width (ft):	Sample Area Length (ft):	Total Sample Area (sq ft)
GPS waypoint #:	GPS name:	GPS datum:	GPS Error: (± ft/m)
Elevation (ft):	Photograph #'s:		

Topography: convex____ flat____ concave____ undulating____	Slope Exposure (circle or enter actual exposure): NE____ NW____ SE____ SW____ Flat__ Variable__

Slope Steepness (circle or enter actual exposure):
0º__ 1-5º _____ 5-25º_____ > 25º_____ Upland or Wetland/Riparian (circle one)

Geology:	Soil Texture:	TRPA Land Capability	TRPA Soil Type (see map)

Site history, disturbance, and comments:

Existing manmade erosion features (circle or list):
Water bars Downed Timber Drain Rock Rock Lined Channel Grass Lined Swale
Revegetation EC Blanket Coir logs/Wattles Gabions Mulch Other ____________________
Comments:

Existing signs of erosion (gullies or rills)	Approximate Area (sq ft)

Rock (% cover):
Bedrock ____ >12" diameter ____ 6"-12" diameter ____ 3"-5" diameter ____ 3/4"-3" diameter ____

Duff Cover (%)	Litter Cover (%)	Large Downed Wood (%)	Total Organic Matter (%)

Tree (Circle Avg. dbh): T1 (<1" dbh), T2 (1-6" dbh), T3 (6-11" dbh), T4 (11-24" dbh), T5 (>24" dbh), T6 multi-layered
If Tree, list 1-3 dominant overstory spp.:

Shrub: S1 seedling (<3 yr. old), S2 young (<1% dead), S3 mature (1-25% dead), S4 decadent (>25% dead)

Herbaceous: H1 (<12" plant ht.), H2 (>12" ht.)

Conifer Cover (% overstory)	Shrub Cover (%)	Herbaceous Cover (%)	Mosses/ Lichens (%)
Overstory Conifer height:	Tall Shrub height	Low Shrub height	Herbaceous height

Height classes: 01=<1/2m 02=1/2-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m

Species (List up to 12), Stratum, and Approximate % cover: (Jepson Manual nomenclature please)
Stratum category: T=tall, M=med, L=low; *% cover intervals for reference:* <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%

Strata	Species	% cover	Strata	Species	% cover

Major non-native species and % cover:

Unusual species:

Sum of Percentages of Rock, Organic Matter, and Vegetation Cover:

Confidence in identification: (L, M, H)	Explain:

Other identification problems (describe):

Appendix F

Effective Soil Cover 2009-2010 Cover Photo Comparisons

Gunbarrel Ski Run - looking west from top of slope (2009)

Gunbarrel Ski Run - looking west from top of slope (2010)

Edgewood Ski Run - looking upslope (2009)

Edgewood Ski Run - looking upslope (2010)

Lower Olympic Ski Run - looking upslope (2009)

Lower Olympic Ski Run - looking upslope (2010)

Boulder Chute - looking upslope to the southwest (2009)

Boulder Chute - looking upslope to the southwest (2010)

Groove Ski Run - looking upslope towards the northwest (2009)

Groove Ski Run - looking upslope towards the northwest (2010)

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Appendix G

Lower Edgewood Riparian Cross Sectional Data

Table 5.2 Results from 2006, 2008, 2009, and 2010 SCI – Lower Edgewood Reach.																	
Reach Name	Year	Reach No.	Dominant Pebble Class (secondary axis in mm)	Total Wood	Mean Bankfull Width (m)	Mean Width to Depth Ratio	Mean Entrenchment Ratio	Mean Water Surface Gradient (%)	Mean Pool Length (m)	Mean Residual Pool Depth (cm)	Percent Fines	Percent Stable Banks	Percent Vulnerable Banks	Mean Shading (%)	Mean Bank Angle (deg)	Mean Shore Depth (cm)
Lower Edgewood	2006	EC-2	N/A	N/A	1.6	4.6	15.2	3.9	N/A	N/A	N/A	60	40	92.13	111	2.97
Lower Edgewood	2008	EC-2	N/A	N/A	1.4	3.5	15.1	4.5	N/A	N/A	N/A	67	33	92.64	108	1.84
Lower Edgewood	2009	EC-2	N/A	N/A	1.1	5.2	15.2	4.3	N/A	N/A	N/A	100	0	95	113	1.7
Lower Edgewood	2010	EC-2	N/A	N/A	1.38	7.83	16.13	5.1	N/A	N/A	N/A	50	50	89	102	1.7

Table 5.3 2006, 2008, 2009, and 2010 Cross Section Bankfull Widths, Width-to-Depth Ratios and Entrenchment Ratios – Lower Edgewood Reach.

Bankfull Widths (m)			
Year	XS-1	XS-2	XS-3
2006	3.35	0.91	1.77
2008	3.63	0.73	1.71
2009	3.96	0.70	1.92
2010	3.96	0.73	1.92

Width-to-Depth Ratio			
Year	XS-1	XS-2	XS-3
2006	17.5	0.83	8.95
2008	16.1	0.60	5.46
2009	15.7	1.44	5.92
2009	17.3	1.28	9.73

Entrenchment Ratio			
Year	XS-1	XS-2	XS-3
2006	3.14	29.17	4.22
2008	2.90	36.46	4.38
2009	2.65	38.04	3.89
2009	2.65	36.46	3.89

Table 5.4 (Appendix G) outlines the positive and negative changes that have occurred in the Lower Edgewood channel (EC-2) since 2008.

Table 5.4 Degree of Channel Changes at Lower Edgewood since 2008.

Reach Name	Measurement	Degree of Channel Change
Lower Edgewood	Dominant Pebble Class	NA
Lower Edgewood	Total Wood	NA
Lower Edgewood	Mean Bankfull Width	NC
Lower Edgewood	Mean Width to Depth Ratio	MC
Lower Edgewood	Mean Entrenchment Ratio	MC
Lower Edgewood	Mean Surface Water Gradient	MC
Lower Edgewood	Mean Pool Length	NA
Lower Edgewood	Mean Residual Pool Depth	NA
Lower Edgewood	Mean Percent Fines	NA
Lower Edgewood	Percent Stable Banks	MC
Lower Edgewood	Percent Vulnerable Banks	MC
Lower Edgewood	Mean Shading	NC
Lower Edgewood	Mean Bank Angle	NC
Lower Edgewood	Mean Shore Depth	NC

+: Positive Channel Change, -: Negative Channel Change, MC: Minimal Channel Change, NC: Little to No Change, ND: Not Applicable

Appendix H

Facilities and Watershed Awareness

June 8, 2010

Mr. Bud Amorfini

Environmental Scientist

State of California Regional Water Control Board Lahontan Region

2501 Lake Tahoe Blvd

South Lake Tahoe, CA 96150

Dear Mr. Amorfini:

HEAVENLY SKI RESORT UPDATED WASTE DISCHARGE REQUIREMENTS BOARD ORDER NO. R6T-2003, WDID NO. 6A090033000-VERIFICATION OF FACILITIES AND WATERSHED AWARENESS TRAINING

This letter verifies the 2010 Facilities and Watershed Awareness training that was held at Heavenly Mountain Resort on June 8, 2010. A copy of the agenda and attendance list is attached.

Thanks you for attending the meeting and speaking on behalf of your organization. Please contact me at 775.586.2313 if you have any further questions or comments.

Sincerely,

Andrew Strain

Vice President of Planning and Governmental Affairs

/bt

Enclosures

cc: Mike Guarino, USDA Forest Service Lake Tahoe Basin Management Unit

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Appendix V

2009-2010 Daggett Creek Monitoring

ENGINEERING • SURVEYING • RESOURCES & ENVIRONMENTAL SERVICES

RESOURCE CONCEPTS, INC.

May 2, 2011

Sent Via E-mail

Mr. Andrew Strain
HEAVENLY MOUNTAIN RESORT
P.O. Box 2180
Stateline, Nevada 89449

Re: Daggett Flow for the 2010 Water Year

Dear Mr. Strain:

The gauge on Daggett Creek installed below East Peak Lake in 2004 consists of a pressure transducer mounted in a perforated pipe at a confined natural section of Daggett Creek. Resource Concepts, Inc. periodically downloads the data and maintains the gauge. Pressure data is collected continuously at 15-minute intervals. Data was downloaded from the gauge three times during the water year (on October 14, 2009, June 18, 2010 and September 10, 2010). Due to problems with the field laptop and connectors for the pressure transducer, there are two gaps in the 2010 water year data: June 18th through June 22nd, and September 9th through October 1st. We anticipate being able to retrieve the data from September 9th 2010 to the present once the gauge is accessible this spring (typically late May), and we can bring the equipment into the office to download the data. The attached Figure 1 graphs the pressure data collected.

RCI staff also makes stream discharge measurements when checking the gauge, in order to develop a relationship between pressure depth and stream discharge. Lower base flow is typically too shallow for a propeller type discharge meter, so a portable 60 degree v-notch weir is used to measure flow. For higher flows, we use a Swoffer (propeller type) flow meter to measure discharge. A rating curve has been developed from the in-stream measurements collected to estimate discharge from the pressure transducer/depth readings recorded by the gauge. This curve was adjusted in 2010 to take into account the most recent measurements collected in coordination with the Nevada Division of Water Resources. Figure 2 graphs the estimated discharge.

In 2010, Heavenly Mountain Resort worked with the Nevada Division of Water Resources to revise water rights permits and the related monitoring requirements, to incorporate the new well drilled near East Peak Lodge in 2008. RCI and Heavenly accompanied representatives from the Division for a site visit to review metering and monitoring equipment on July 23, 2010. Current metering of flows into and out of East Peak Lake demonstrate adequate monitoring of annual

2011-05-02 ltr Strain 03-255.10 Heavenly jls-kh L5-5.doc water usage and compliance with water rights permits. However, RCI is continuing to coordinate with the Division regarding methods to better estimate natural runoff and releases from East Peak Lake.

The stream gauge below East Peak Lake has been used to support compliance monitoring for Heavenly's water rights. While the pressure transducer gauge provides a relative indication of water depth in Daggett Creek below East Peak Lake, the correlation to discharge is not very accurate particularly in the range of 0 to 0.4 cfs. This is primarily due to the minimal flow depth and irregular cross section of the natural stream channel. In addition, the pressure transducer equipment has been difficult to maintain, due to both access limitations and because the equipment is no longer manufactured.

If the Nevada Division of Water Resources concurs, RCI will recommend removal of the gauge. Alternative methods can be used to demonstrate compliance with water rights permits, thereby making the gauge unnecessary. If this is not acceptable to the State, the gauge may be able to be used for supplementary monitoring. If in-stream discharge measurements must be continued, a permanent cross section (flume or V-notch weir) and new pressure transducer may be required.

Please feel free to contact me with any comments or questions.

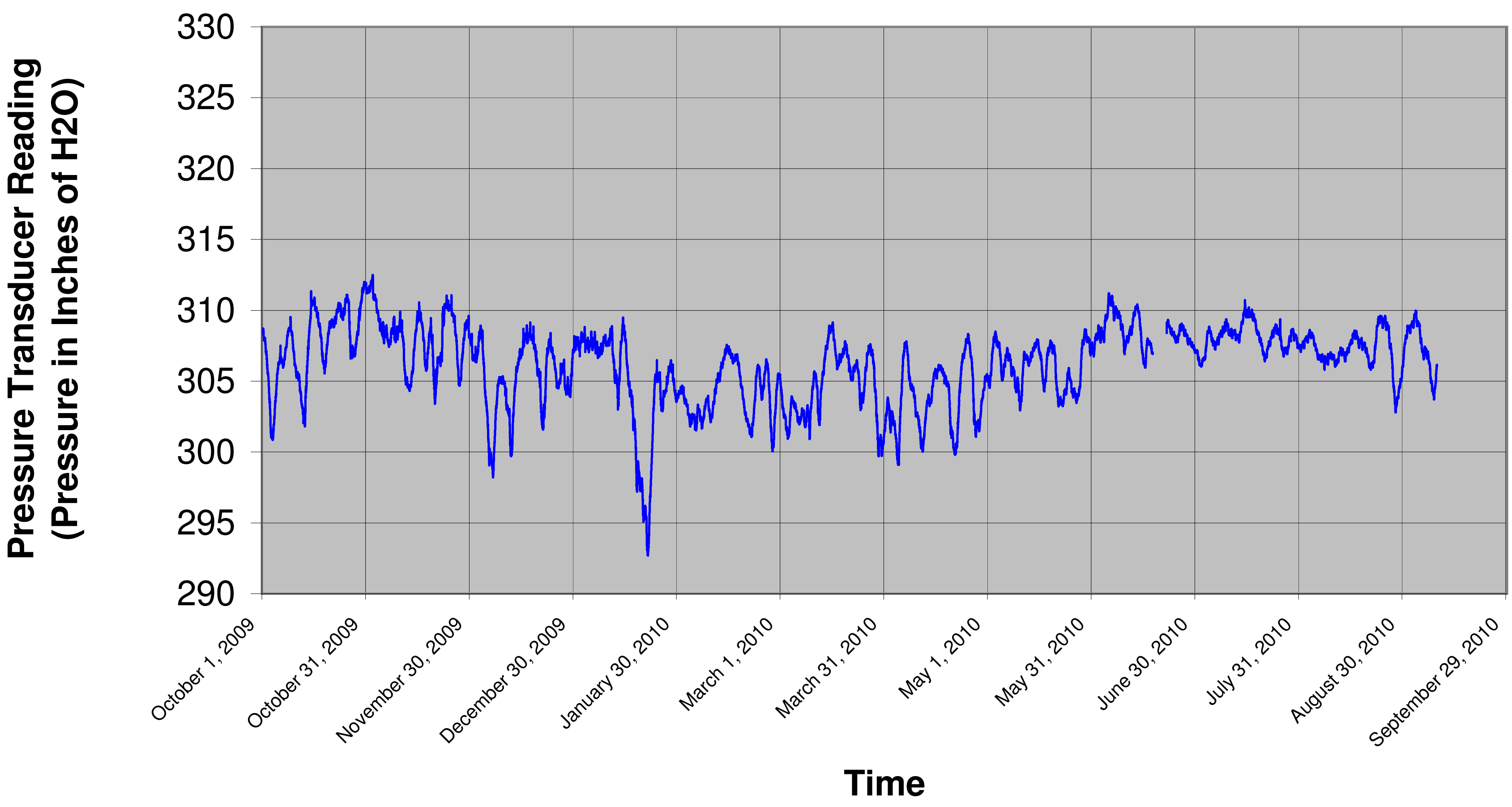
Sincerely,

Jill Sutherland

Jill Sutherland, P.E.
Project Manager

JS:kh
Attachments

Figure 1. Daggett Creek Transducer Readings 2010



05/02/2011

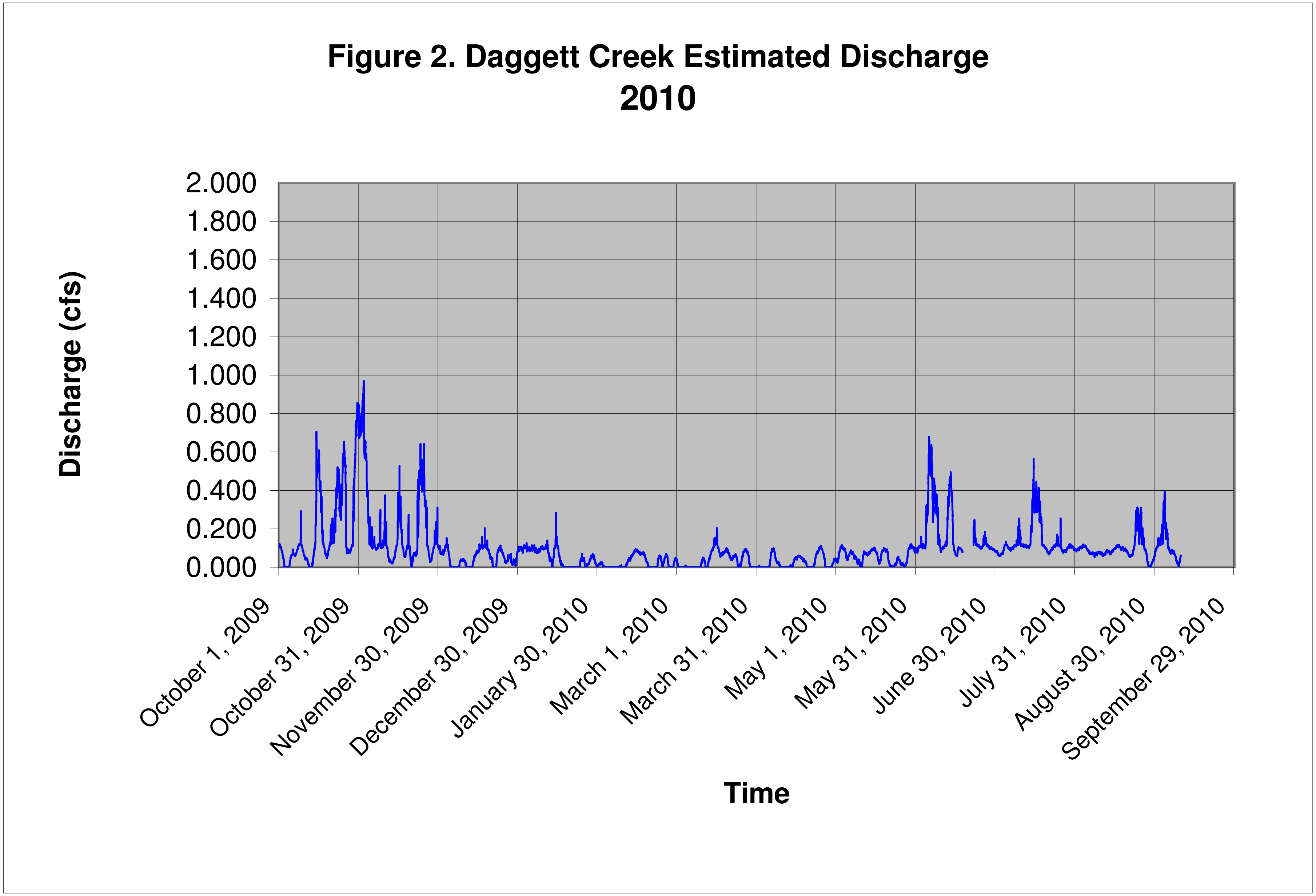


Figure 2. Daggett Creek Estimated Discharge
2010
Discharge (cfs)
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
October 1, 2009
October 31, 2009
November 30, 2009
December 30, 2009
January 30, 2010
March 1, 2010
March 31, 2010
May 1, 2010
May 31, 2010
June 30, 2010
July 31, 2010
August 30, 2010
September 29, 2010
Time

05/02/2011

Appendix VI
2011 CWE Work List

HEAVENLY MOUNTAIN RESORT
2011 ANNUAL WORK LIST
February 8, 2011

Project #	Source*	Location	Treatment
Watershed: CA-1 Heavenly Valley Creek			
1	P	J Lift	Install new detachable ski lift.
2	P	Run Widening	Remove trees over snow and relocate boulders outside edges of run: Ridge Promenade, Liz's, and Ellie's trails and High Roller terrain park.
3	P	Adventure Peak Children's Ski School Facility	Construct new building and access spur road for children's ski school. Remove existing yurt and sprung structure and restore sites.
4	P	Relocate Umbrella Bar	Relocate existing Umbrella Bar facility from Adventure Peak to site adjacent to Snow Beach, and restore Adventure Peak site.
5	P	Heavenly Flyer Zipline	Modify Heavenly Flyer zip line to add tensioned trolley retrieval system.
6	RM	Powderbowl Sewer Line Relocation	Relocate section of sewer line near Powderbowl Express lift.
7	RM	Ridge Run Snowmaking Lateral Lines	Addition of three snowmaking laterals on Ridge Run
8	M	Tubing Lift Maintenance Road	Realign top of tubing access road, stabilize fill bank at top of lift.
9	M	Gondola Top Station	Refurbish existing infiltration basin and improve drainage to maintain effectiveness.
10	M	Groove Upper Terminal	Improve soil cover to stabilize steep slope and redirect runoff to channel and infiltration area.
11	P	Lakeview Water System	Remove old tank. Decommission old tank site and road to tank.
12	M	Upper Vehicle Maintenance Shop	Stabilization work on gully above SEZ restoration, embankment between road and SEZ, and road intersection and base of SEZ..
13	B	Top of Gondola Magic Carpet	Verify drip line protection/infiltration.
14	M	Mid Station Road	Maintain water bars and energy dissipation at outlets
15	M	Hellwinkel's Trail	Maintain road BMPs from Sky Deck to Sky Water Tank
16	M	Blue Angel Chutes	Improve effective cover
Watershed: NV-3 Edgewood Creek			
17	M	Edgewood SEZ at Boulder	Maintain road BMPs, road grading, and redirect road runoff near corner

Watershed: NV-2 + 5 Daggett Creek			
18	RM	Perimeter Run	Lower entrance to perimeter run by removing soil, place in existing area near base of Dipper Express lift.
19	RM	Orion’s Run Snowmaking Lateral Lines	Addition of three snowmaking laterals on Orion’s Run
20	P	Ski Trails 14, 15 U3 and U4	Implement ski trails using over the snow logging and hazard reduction treatment.
21	B	East Peak Lodge	Stabilize drip lines and drainage swales near foundation of building.
22	M	Base of Comet Express lift	Improve effective cover and refurbish infiltration BMP
23	M	East Peak Lodge Sanitary Sewer Lift Holding Tank	Improve effective cover and delineate vehicle turn around.
Resort Wide			
24	M	Resort-Wide	Install and maintain closure signs on Ellie’s Swing Trail, Betty’s Return Trail, Powderbowl tower road, Lower Cal Trail below Hellwinkle’s trail, East Peak Dam Road and West Round-a-bout
25	M	Resort-Wide	Develop a process to treat priority areas with long-term soil cover needs on ski runs and to identify and perform road maintenance needs. Note: This replaces the treatment listed in previous Annual CWE Work Lists as “Reseed and fertilize degenerating grassy areas on +/- 1/5th of ski runs (all runs are reviewed/reseeded over 5 years)”
26	M	Resort-Wide	Inspect and restore all areas damaged affected by winter resort operations, including hydrants & pipe failures, and areas affected by snowcat operations; document areas treated.
27	M	Resort-Wide	Erect and maintain vehicles barriers and/or fences to prevent unauthorized vehicle access off of designated summer roads and facility parking areas.
28	M	Resort-Wide	Inspect and maintain all drainage structures.
29	M	Base Areas	Erect and maintain vehicle barriers and/or fences to prevent unauthorized vehicle access from base areas.
***Source Codes**			
	M B	BMP Maintenance Needed Project need determined from BMP Effectiveness Monitoring	

	P RM MMP	Master Plan Implementation Project Resort Maintenance Project Master Plan Monitoring & Mitigation Plan Requirement	

Appendix VII
2009-2010 Biological Survey Results Summary

HAUGE BRUECK
ASSOCIATES

www.haugebrueck.com

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P 916-283-5800
F 916-313-3445
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Sacramento, CA 95825

NEVADA
P 775-588-4700
F 775-588-4704
P.O. Box 10291
310 Dorla Court, Suite 209
Zephyr Cove, NV 89448

19 October 2010

Mr. Andrew Strain
Heavenly Mountain Resort
P.O. Box 2180
Stateline, NV 89449

SUBJECT: HEAVENLY MOUNTAIN RESORT 2010 BIOLOGICAL SURVEY RESULTS SUMMARY

Dear Mr. Strain,

In order to comply with US Forest Service LTBMU requirements and to allow for preparation of environmental documentation for future construction and implementation of projects, Hauge Brueck Associates LLC has performed wildlife surveys in suitable habitat within the Special Use Permit Boundary in 2010. Surveys for both northern goshawk and California spotted owl were completed to protocol. A summary of each species surveys is provided below:

California Spotted Owl

Methods: Surveys were conducted and completed in potentially suitable habitat within and surrounding the project area. Surveys were conducted according to the United States Forest Service "Protocol for Surveying for Spotted Owls in Proposed Management Activity Areas and Habitat Conservation Areas" (March 12, 1991, Revised February 1993). The survey points used since the 2007 field season were utilized again in 2010 to provide continuity of data collected. Data sheets for 2010 surveys are attached to this letter.

Results: No auditory or visual detections of California spotted owls were documented within the survey area during 2010.

Northern Goshawk

Methods: Surveys were conducted and completed in suitable habitat within and adjacent to the project area for northern goshawk based on the updated habitat map generated by the US Forest Service for the environmental analysis of the Master Plan Amendment. In 2010, both dawn acoustical and broadcast survey methods were utilized and were completed to protocol. All surveys were conducted according to "Survey Methodology for Northern Goshawks in the Pacific Southwest Region, U.S. Forest Service" (14 May 2002). Data sheets for 2010 dawn acoustical and broadcast surveys are submitted with this letter.

Results: No auditory or visual detections of northern goshawk were documented within the survey area in 2010.

The completion of the 2010 field surveys for northern goshawk and California spotted owl results in meeting the two-year protocol for these species. Based on Appendix A of the California spotted owl survey protocol, since no detections were documented, and the two year protocol was met, "the negative results may be considered accurate for two additional years without conducting additional surveys." The two-year timeline starts on the last day of the last survey, which would be 23 June 2010. Therefore, if implementation of projects would commence prior to 23 June 2012, no further surveys for California spotted owl would be necessary. However, if construction does not commence prior to this date, two-year protocol surveys must be conducted. The northern goshawk protocol does not include any discussion as to validity of surveys for any duration of time after protocol has been met. However, since northern goshawks have been detected in previous years, it is recommended surveys for northern goshawks are continued to determine if goshawks are nesting within the special use permit boundary.

If you should have any questions regarding the surveys performed for the 2010 season, please do not hesitate to contact me at (775) 588-4700.

Regards,

Garth Alling
Senior Planner/Biologist

Enclosures

CC: Shay Zanetti , USFS LTBMU
Patrick Stone, TRPA
Chris Donneley, Entrix

Appendix VIII
Boundary Management

BOUNDARY MANAGEMENT

A. In perimeter areas, where it is likely for the skiing public to ski out of the patrolled area, Heavenly shall utilize a gated boundary system consisting of the following elements:

1. Gates are located in areas people have traditionally gone through in order to reach an area out-of-bounds.

2. Appropriate signage will be placed at the gates, informing users this is true backcountry access. Heavenly will place signs indicating that no patrolling of the area will occur, no hazards will be marked, no avalanche control work will be done and searches may or may not be conducted due to hazardous conditions. Skiers who enter the Backcountry areas will do so knowingly and will accept full responsibility for property loss, injury, and/or death. They may also be cited by local authorities and charged for the cost of their rescue.

3. Gated entries will have two vertical steel posts through which a skier must pass. A steel bar will hang horizontally from one post and be held against the other by a steel spring. For someone to enter the area they must pull the bar in front of them and as they pass through, the bar will automatically close behind them. The bar will be height adjustable to allow it to remain waist-high for a normal adult. The intent in doing this is to require a physical action beyond merely going through the posts to enter the area.

4. Due to the fact that this experience would be the same as any other backcountry experience, Heavenly will rarely “close” access into the terrain. The only time that these gates would be closed is when Heavenly staff is actively performing avalanche control with explosives in the adjacent permit area. Other than this special situation, the gate itself would never be locked or signed “closed”. Heavenly has no way of ascertaining the hazards that exist on a day-to-day basis in that terrain.

5. “Closed Ski Area Boundary, Exit Through Gates Only” signage will be placed along perimeter ropes. These signs are placed at appropriate intervals so that individuals would have the opportunity to read the warning and not cross under the ropes. The signage will indicate that some routes may access private property.

6. Heavenly will position signs in populated areas of the resort warning of skiing outside of the defined (roped) boundary. These signs clearly state that skiing under a rope boundary carries the potential of a citation by the appropriate law enforcement, cost of search (if any), removal of their pass and the forfeiture of any future opportunity to possess a Heavenly pass.

7. Heavenly will provide and maintain counters at each of the gates for the entire ski season. Gate use will be monitored weekly and reported to Forest Service monthly.

8. Heavenly will continue to assist county search and rescue efforts when requested.

B. Heavenly will install and maintain three gates. These gates will be monitored on a daily basis throughout the winter season to ensure signage is in place, the gates are functioning properly and that they are at the appropriate height. The gates are installed at the following locations:

1. Fire Break
   This gate is located to the north of the top of Olympic Chair. It accesses terrain locally termed “The Palisades”.

2. Raley’s Gulch
   This gate is located off of California Trail at the start of Maggie’s Canyon.

3. Fulstone Canyon
   This gate is located above the existing Gate “A” of Killebrew Canyon.

It controls access to the area directly to the south and east of Killebrew Canyon.

Appendix IX
2009-2010 Water Use Balance Report

Heavenly Mountain Resort

Water Use Report, 2009-10 Season

Heavenly Mountain Resort is furnishing this report on water usage during the 2009-10 season as per the terms of the existing master plan agreement.

Snowmaking Water Usage

The Heavenly Mountain Resort snowmaking system consumed a total of 149.6 million gallons of water during the 2009-10 season to cover a total of 317 acres of terrain. The distribution of water sources and water consumption is described below:

Total Snowmaking Water Use--California	85.14	million gallons
Total Snowmaking Water Use--Nevada	64.43	million gallons
Net Total Snowmaking Water Use	149.57	million gallons
Water Supplied in California	96.61	million gallons
Water Used in California	85.14	million gallons
Net Surplus (flow out of California)	11.47	million gallons
Water Supplied in Nevada	52.96	million gallons
Water Used in Nevada	64.43	million gallons
Net Deficit (Flow into Nevada)	-11.47	million gallons
Water Supplied In Basin	96.61	million gallons
Water Used in Basin	99.35	million gallons
Net Surplus (flow out of Basin)	-2.74	million gallons
Water Supplied Out of Basin	52.96	million gallons
Water Used Out of Basin	50.22	million gallons
Net Deficit (flow into Out of Basin)	2.74	million gallons
Water Purchased--STPUD	94.76	million gallons
Water Purchased--KGID	25.51	million gallons
TOTAL WATER PURCHASED	120.26	million gallons

Table 1 provides a breakdown of water usage between California and Nevada, along with the net transfer of water between the States.

Table 1...2009-2010 Water Usage Summary--Inter State Transfers					
Pumping Region	**MG used**	**In California**		**In Nevada**	
		% of acre-ft	**Water (MG)**	**% of acre-ft**	**Water (MG)**
Cal Base	29.8	100%	29.8	0%	0.0
Cal Dam	50.5	100%	50.5	0.0%	0.0
E. Peak	69.2	7.0%	4.8	93.0%	64.4
Total	**149.6**		**85.1**		**64.4**
Water Supply- (Purchased + Recharge)			**96.6**		**53.0**
InterState Water Transfer			**-11.5**		**11.5**

Table 2 provides a breakdown of water usage between in-basin and out of basin regions, along with the net inter-basin transfer of water. This table also provides a breakdown of Nevada water use within 4 water right quadrants as listed below (see Attachment 6 for graphical representation):

A - Within Tahoe Basin and south of the southern boundary of section 25, 26, 27 T. 13 N. R 18 E. and section 30 T. 13. N., R. 19 E.

B - Outside of Tahoe Basin and south of the southern boundary of section 25, 26, 27 T. 13 N. R 18 E. and section 30 T. 13. N., R. 19 E.

C - Outside of Tahoe Basin and North of the southern boundary of section 25, 26, 27 T. 13 N. R 18 E. and section 30 T. 13. N., R. 19 E.

D - Within Tahoe Basin and North of the southern boundary of section 25, 26, 27 T. 13 N. R 18 E. and section 30 T. 13. N., R. 19 E.

Table 2...2009-2010 Water Usage Summary--Inter Basin					
Pumping Region	**MG used**	**In Basin**		**Out of Basin**	
		% of acre-ft	**Water (MG)**	**% of acre-ft**	**Water (MG)**
Cal Base	29.8	100%	29.8	0%	0.0
Cal Dam	50.5	100.0%	50.5	0.0%	0.0
E. Peak--CA	4.8	0%	0.0	100%	4.8
Total California	**85.1**		**80.3**		**4.8**
E. Peak--NV	64.4	29.5%	19.0	70.5%	45.4
Total Nevada	**64.4**		**19.0**		**45.4**
TOTAL SNOWMAKING	**149.6**		**99.4**		**50.2**
Water Supply			**96.6**		**53.0**
Inter Basin Water Transfer			**2.7**		**-2.7**

The following attachments provide documentation and calculations procedures used in determining these values:

Attachment 1....Map of Existing Meter Locations

Attachment 2….Meter Readings
Attachment 3….Schematic of Water Transfers
Attachment 4….California Snowmaking Trails
Attachment 5….Nevada Snowmaking Trails and Water Right Quadrants

Calculation Procedures

Water allocation calculations for Heavenly Mountain Resort are complicated by the fact that snowmaking occurs in both Nevada and California, as well as inside and outside the TRPA boundary. While the snowmaking piping distribution system for the entire resort is interlinked, there are 3 basic sub-regions:

1. Cal Base — This region consists of the acreage on the California side falling below Cal Dam. This entire region falls within the State of California and within the Tahoe Basin.

2. Cal Dam — This region consists of acreage on the California side that is above Cal Dam. This entire region falls within the State of California and within the Tahoe Basin.

3. East Peak — This region consists of acreage above and below East Peak Lake. The region is predominantly in Nevada, though some trails serviced at the top fall inside California. A majority of this terrain is out of the Tahoe Basin, but 25% lies inside the Basin.

Attachment 3 provides a schematic of pumping operations, meter readings, and the calculation procedure for interstate water transfers. These calculations consist of performing a water balance between the STPUD and KGID supplies, water entering and exiting reservoirs, and a flowmeter installed on the existing transfer line between the Cal Dam and East Peak systems.

The methodology used this analysis to track inter-basin water usage involves calculating the total water usage within the 3 major sub-regions (Lower Cal, Cal Dam, and East Peak) and then allocating water proportionally based on snowmaking terrain within that region that falls inside and outside the Tahoe basin. Since different trails require different design depths of snow, the allocation is based on the trail acreage x design depth for each trail, as detailed in Attachments 4 and 5. The same methodology is used to allocate East Peak water between California and Nevada. No changes have been made in the metering locations, configuration, or calculation procedure from the previous year. However, the 2009-10 annual report includes flow data through 9/30/10 as opposed to the end of the snowmaking season for previous years. This change will allow Heavenly to better balance the water transfers over the summer by filling reservoirs from the preferred water source.

The trail data provided in Attachment 5 indicates that 7% of the East Peak design acre-ft of snow coverage occurs in California. Therefore, 7% of the total 69.2 MG used for snowmaking in the East Peak sub-region is calculated to fall in California (4.8 MG) while 93% is calculated to fall in Nevada (64.4 MG)[1]. Of this 64.4 MG of East Peak water that is used in Nevada, 29.5% of the design acre-ft of snow production occurs within the Tahoe Basin. Therefore 29.5% of the 64.4 million gallons of water used in this sub-region are calculated to be used within the Basin (19.0 MG) while 70.5% are calculated to be used outside the basin (45.4 MG)[2].

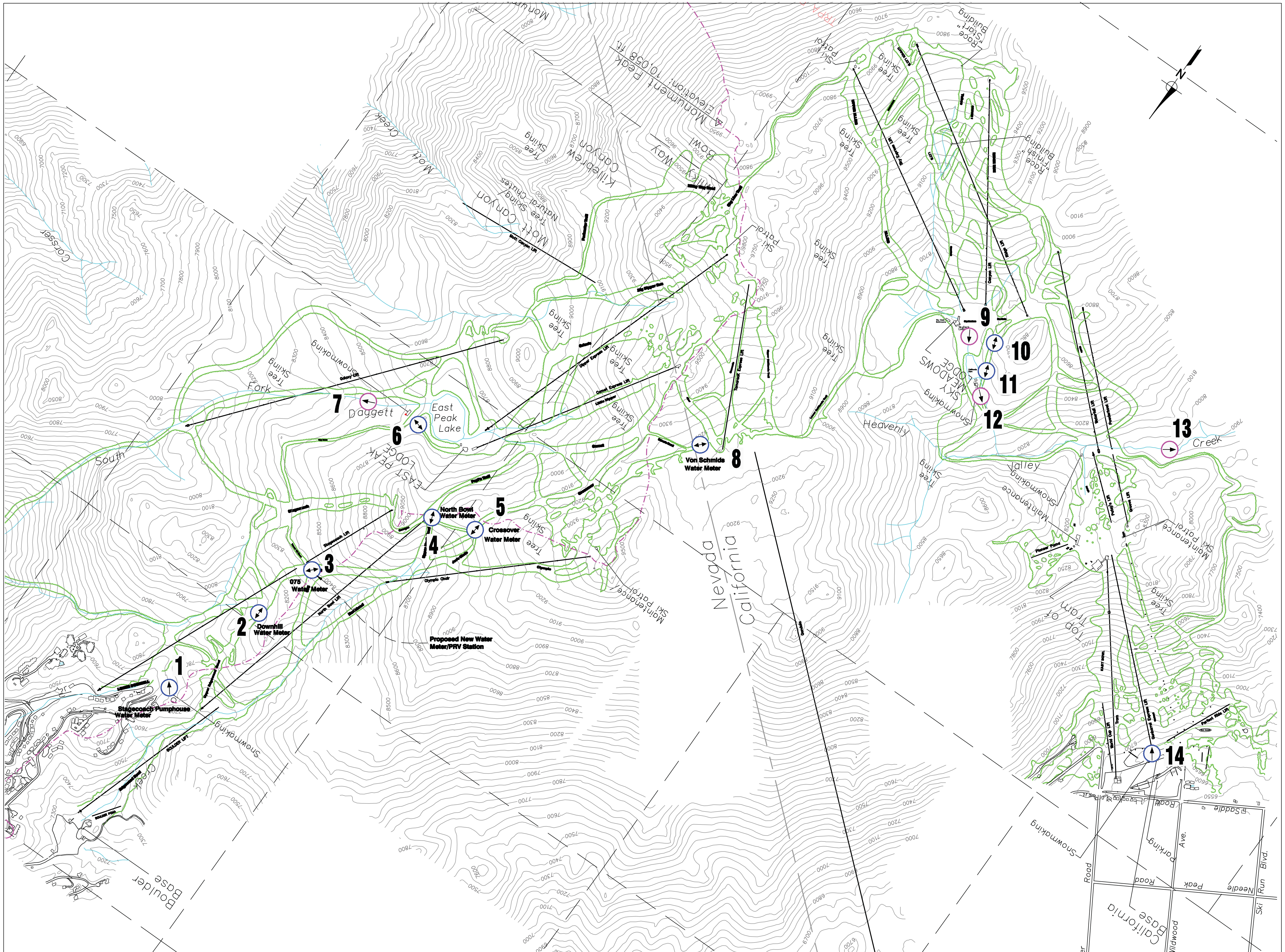
[1] Refer to Table 1 for calculation
[2] Refer to Table 2 for calculation

Revised Operating Procedures

The calculations indicate that a net of 2.7 million gallons of in-basin water was transferred out of basin during the 2009-2010 snowmaking season. This represents only 1.8% of the total water pumped during the season. In the future, this transfer balance will be minimized further through monitoring the net water transfer balances during the winter and adjusting snowmaking withdrawals accordingly. In addition, the transfer rates can be further balanced during summer operations when filling the reservoirs and supporting slope irrigation.

Respectfully Submitted,

Scott Barthold, PE
Sno.matic Controls and Engineering, Inc.



REVISIONS

No.	DATE	DESCRIPTION	DRAWN BY	APP'D BY

NOTES / LEGEND

- Water Meter Single Direction Measurement
- Water Meter Bi Direction Measurement
- Pipe Meter
- Stream Water

DRAFT

FOR REVIEW ONLY, NOT FOR CONSTRUCTION

Heavenly
Lake Tahoe

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CLIENT

HEAVENLY SKI RESORT

PROJECT TITLE

HEAVENLY SNOWMAKING SYSTEM

DRAWING TITLE

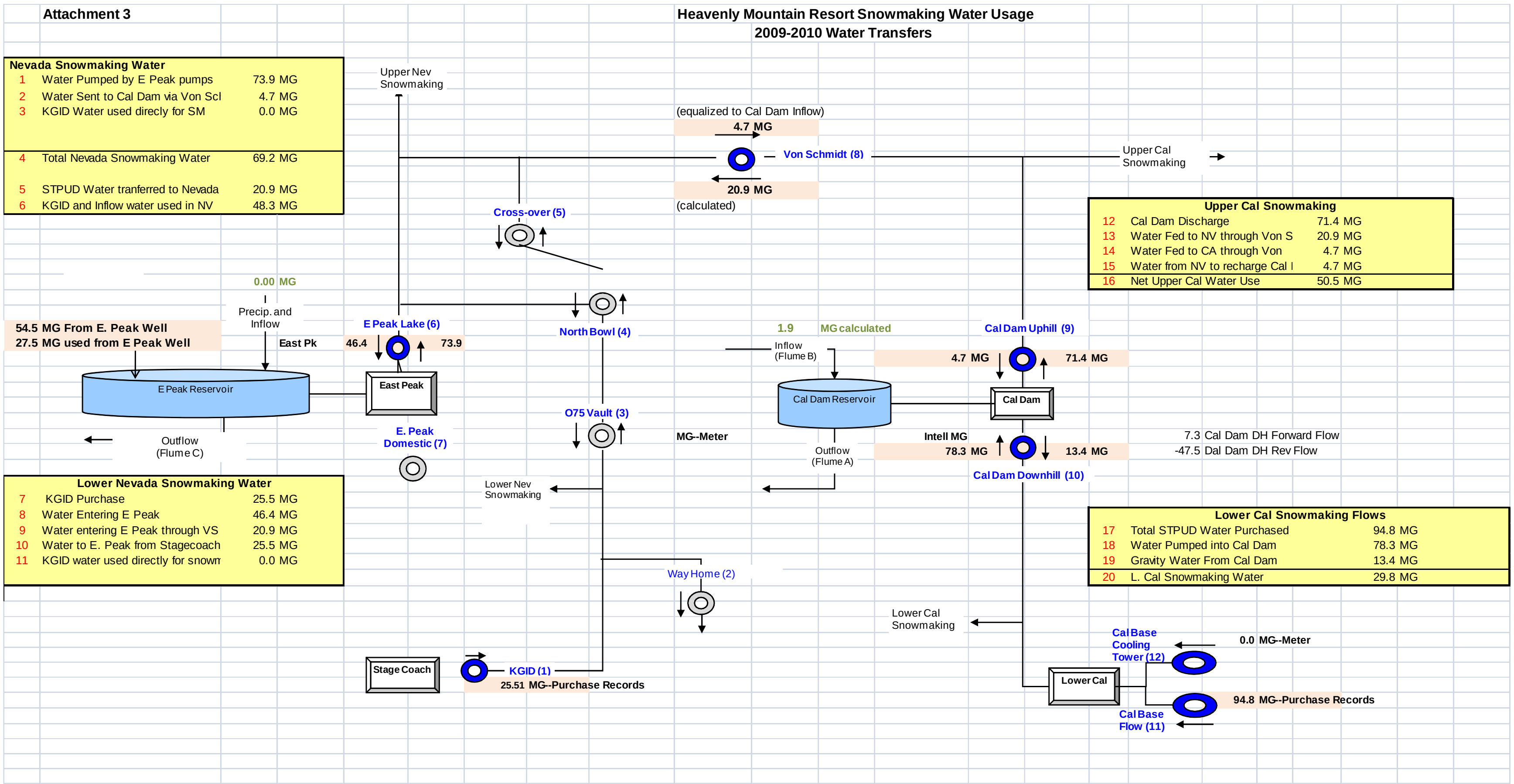
Master Plan Map
Metering Stations
-

Designed by: S. Barthold	Approved by: –
Project no.: 149.1	Drawn by: J. Wilkinson
Date: 5/19/03	Scale: 1" = 800'-0" D SIZE
Drawing no.: Heavenly updated map1.dwg	Sheet no.: __ - __

Attachment 2…Meter Readings

2009-2010 Snowmaking Water Meter Readings										
	Ca Base	**Ca Base**	**Ca Dam New Meter by road**		**Ca Dam Old Meter Down**		**Cal Dam Uphill**		**Von Schmidt's**	
	Back Flow	**Water Cooler**	**Reverse**	**Forward**	**Rev**	**Forward**	**Forward**	**Reverse**	**Rev**	**Fwd**
			missing meter data		new meter	new meter	new meter	new meter		
Total	**94,755,892**	**0**			**13,867,659**	**880,200**	**68,000,000**	**5,000,000**	**1,972,651**	**3,113,236**
	through 6/30/10		-47.5	12.6	as of 3/8/2010	as of 3/8/2010	as of 3/8/2010	as if 3/8/2010	as if 3/8/2010	as if 3/8/2010
	from Paul Pfot	Water from STPUD	To Dam	Out of dam dn hill	To Dam	Out of dam dn hill	System	To Dam	To California	To Nevada
			(in MG)	(in MG)	Via World Cup/Face	snowmaking-low	snowmaking high	via Round-a-bout		
						from Intellution	plus water to E Pk			
		data from 3/1 to 9/30	15.3	0.0	1.7	-0.1	3.4	-0.3		
		Total through 9/30 in MG	**62.7**	**12.6**	**15.6**	**0.8**	**71.4**	**4.7**	**2.0**	**3.1**
		East Peak		**Crossover**		**075**		**Way Home**		**KGID**
		Fwd	**Rev**	**Fwd**	**Rev**	**Fwd**	**Rev**	**Fwd**	**Rev**	**Stagecoach**
		Into System	Into Pond		disabled	disabled		disabled		
		70,000,000	**46,000,000**							**25,505,000**
		as of 3/8/2010								(purchase records)
										through 6/30/10??
	data from 3/1 to 9/30	3.9	-0.4							
	Total through 9/30 in MG	**73.9**	**46.4**							**25.5**
Water Pumped from E Peak Well		**54,458,651**								
		from Paul Pfot								

Attachment 3---Schematic



Calculation Notes

1	From E Peak Meter. Uphill	12	Read from Cal Dam uphill meter
2	Based on Von Shmidt meter reading, but meter issues so this is equalized to what flows into Cal Dam Uphill meter.	13	same equation as (5)
3	Calculated by Equation 11	14	Same equation as (2)
4	Total Nevada water = E Peak Pumping -Water sent to Cal Dam	15	Cal Dam Uphill meter reading (reverse flow)
5	Meter issues with Von Schmidt, so water flowing into E Peak through meter - water supplied by KGID	16	(Water Pumped from Cal Dam - water transferred to NV) + (Water pumped from E Peak into CA - water entering Cal Dam)
		17	From Purchase records
7	Provided by Purchase Records from KGID	18	From Cal Dam downhill meters (addition of 2 channel meter)
8	Based on E. Peak Meter Reading	19	From Cal Dam Downhill Meter (addition of 2 meters)
9	Same equation as (5)	20	Water Pumped from L Cal - Water delivered to Cal Dam + gravity water running back down to lower Cal
10	From flowmeter and KGID purchase records		
11	Water purchased from KGID - water transferred from KGID to E. Peak = KGID water used directly for snowmaking; assume all is transferred		

ATTACHMENT 4---CALIFORNIA SNOWMAKING ACREAGE

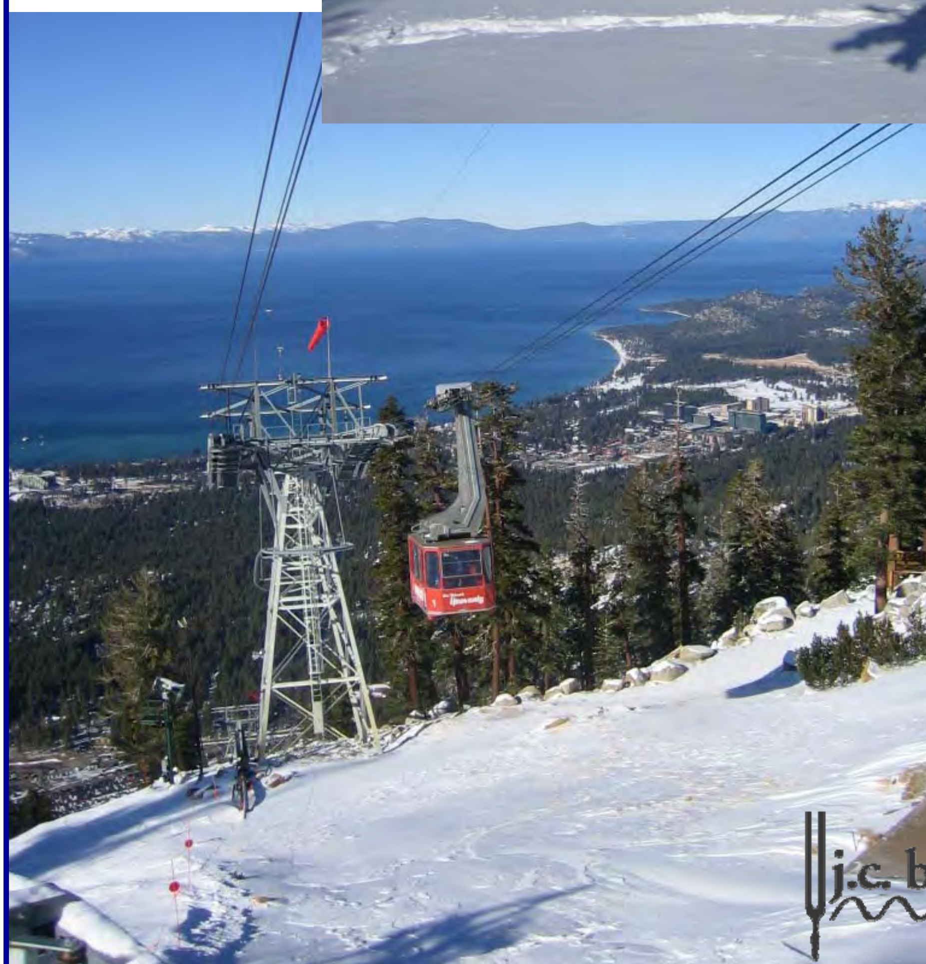
2007 Master Plan Amendment Trail #	1996 Master Plan Trail #	Trail Name	2007 Master Plan Amendment Snowmaking Action (1)	Length (feet)	Width (feet)	Acreage (acres)	Acre ft. (3)	Sub Region
California In Basin.... 'pod' trails								
B1	1	EAST BOWL -THE FACE	EXISTING	3,220	220	16.3	81.3	Cal Base
B2	2	GUNBARREL	EXISTING	2,030	175	8.2	40.8	Cal Base
D1	5	WORLD CUP	EXISTING	1,000	260	6.0	16.1	Cal Base
E1	7	PATSY'S	EXISTING	1,730	200	7.9	21.4	Cal Dam
G1	9	MAGGIES	EXISTING	5,210	80	8.4	22.7	Cal Dam
G2	10	CAT TRACK	EXISTING	1,070	40	1.0	2.7	Cal Dam
G5	13	MOMBO MEADOWS	EXISTING	1,190	170	4.1	11.1	Cal Dam
G6	14	MOMBO	EXISTING	1,700	25	1.0	2.6	Cal Dam
G7	14	LOWER MOMBO	EXISTING	1,200	90	2.5	6.7	Cal Dam
H9	23	CANYON - SKY CANYON	EXISTING	2,400	128	6.1	16.5	Cal Dam
H10	24	JACKPOT (RUSUTSU)	EXISTING	1,860	125	4.3	11.6	Cal Dam
H11	26	HIGH ROLLER (STEAMBOAT)	EXISTING	1,430	130	3.3	8.9	Cal Dam
I1	25	LIZ'S	EXISTING	4,630	100	9.6	25.9	Cal Dam
I3	27	UPPER ELLIE'S / ELLIE'S	EXISTING	4,490	130	12.4	49.6	Cal Dam
K1	30	PERFECT RIDE (WEST BOWL)	EXISTING	1,260	300	8.7	23.4	Cal Base
*L1	31	LOWER SKI SCHOOL	EXISTING	500	200	2.3	6.2	Cal Base
M1	32	CHILDRENS SKI CENTER	EXISTING	390	100	0.9	2.4	Cal Base
N1	33	PIONEER PLATTER PULL	EXISTING	700	150	2.4	6.5	Cal Dam
O1	34	LEARN TO SKI CENTER	EXISTING	400	150	1.4	3.7	Cal Dam
*GG1	29	(UPR.) CALIFORNIA TRAIL	EXISTING	2,900	145	7.4	20.0	E. Peak
**GG2	29A	SAM'S DREAM	EXISTING - UNBUILT	1,430	130	4.3	17.1	E. Peak
*GG3	29B	TAMARACK RETURN	EXISTING	650	50	0.7	2.0	E. Peak
*GG6	82	CASCADE	EXISTING	2,800	125	8.0	32.1	E. Peak
*HH1	81	EASY STREET (1/2)	EXISTING	740	200	3.4	9.2	E. Peak
HH2	81	EASY STREET II (1/2)	RETAIN	300	300	2.1	5.6	
B3	3	PISTOL	REMOVE	1,220	130	0.0	0.0	
B4	4	WEST BOWL	REMOVE	2,040	100	0.0	0.0	
E2	8	GROOVE	EXISTING	1,640	100	3.8	10.2	Cal Dam
G3	11	SWING TRAIL	NO ACTION	1,190	30	0.0	0.0	
G4	12	WATERFALL	RETAIN	760	200	3.5	17.4	
G8	15	POWDERBOWL	RETAIN	1,540	100	3.5	14.1	
G9	NC	NEW - POWDERBOWL 2 (Gladed)	NEW	1,640	50	1.9	5.1	
H1	17	WOODS TRAIL	NO ACTION	2,960	25	0.0	0.0	
H2	18	BETTY'S SWING	NO ACTION	1,080	30	0.0	0.0	
H3	19	RIDGE BOWL	NO ACTION	1,400	100	0.0	0.0	
H4	19	RIDGE CHUTE	NO ACTION	860	50	0.0	0.0	
H5	20	HIGH ROLLER (BETTY'S RUN)	RETAIN	3,680	150	12.7	63.4	
H6	20	DOUBLE DOWN (BETTY'S BOWL)	RETAIN	400	180	0.0	0.0	
H7	21	LOWER BETTY'S	RETAIN	710	50	0.0	0.0	
H8	22	BETTY'S CUTOFF	NO ACTION	570	130	0.0	0.0	
H12	NC	NEW - BETTY'S CUTOFF	NO ACTION	600	150	0.0	0.0	
H13	NC	NEW - BETTY'S ESCAPE	NO ACTION	250	60	0.0	0.0	
I2	27	ELLIE'S SWING - EXTENSION	RETAIN	2,740	70	3.4	9.2	
I4	NC	NEW - SKIWAYS 1 (GLADED)	NO ACTION	3,089	50	0.0	0.0	
I5	NC	NEW - SKIWAYS 2 (GLADED)	NO ACTION	2,982	50	0.0	0.0	
GG5	64	49ER	RETAIN	1,710	40	1.6	6.3	
California In-Basin..non 'pod' transport trails								
1	6	ROUND-A-BOUT	EXISTING	17,000	40	15.6	42.1	Cal Base
2	16	RIDGE RUN	EXISTING	1,200	60	1.7	4.5	Cal Dam
3	16	LOWER RIDGE RUN	EXISTING	4,610	155	15.9	42.9	Cal Dam
5	29	CALIFORNIA TRAIL	EXISTING	6,010	50	5.5	14.9	Cal Dam
5A	NC	NEW- CAL. TRAIL ALTERNATIVE	NEW	1,800	40	1.7	4.5	
10	67	VON SCHMIDT'S (1/4)	RETAIN	1,050	50	1.2	3.3	
**11	83	VON SCHMIDT'S - MEADOW	RETAIN	600	300	4.1	11.1	
1	6	ROUND-A-BOUT - REALIGNMENT	NEW	1,691	40	1.6	4.2	
4	28	SKYLINE TRAIL	RETAIN	3,100	54	2.8	7.6	
12	NC	NEW - MAGGIES CANYON (GLADED)	NO ACTION	1,890	150	0.0	0.0	
In Basin Total--Master Plan						**212.8**	**706.7**	
In Basin Total--Cal Base Existing						**57.9**	**212.4**	
In Basin Total--Cal Dam Existing						**91.2**	**262.3**	
In Basin Total--E. Peak Existing						**0.0**	**0.0**	
California Out of Basin 'pod' trails								
V4	54	BIG DIPPER (1/5)	EXISTING	1,080	150	3.7	10.0	E Peak
V8	58	ORION'S (1/2)	EXISTING	1,820	200	8.4	22.6	E Peak
*V10	72	METEOR (1/2) - (GLADED)	EXISTING - UNBUILT	970	130	2.9	7.8	
**V11	75	METEOR II (1/3) - (GLADED)	REMOVE	500	100	0.0	0.0	
V7	57	DIPPER BOWL (1/2)	NO ACTION	680	450	0.0	0.0	
GG4	61	SAND DUNES	RETAIN	1,610	80	3.0	8.0	
V1	51	MILKY WAY BOWL (2/3)	NO ACTION	1,800	900	0.0	0.0	
V3	53	DIPPER KNOB	RETAIN	1,730	30	1.2	3.2	
Out of Basin Total--Master Plan						**17.9**	**48.4**	
Out of Basin Total--Cal Base Existing						**0.0**	**0.0**	
Out of Basin Total--Cal Dam Existing						**0.0**	**0.0**	
Out of Basin Total--E. Peak Existing						**12.1**	**32.6**	
California Total--Master Plan						**230.8**	**755.1**	
California Total--Existing						**161.1**	**507.3**	
Cal Base Total Existing						**57.9**	**212.4**	
Cal DamTotal Existing						**91.2**	**262.3**	
E Peak Total Existing						**12.1**	**32.6**	
Cal Base Existing---% In Basin						**100%**	**100%**	
Cal Dam Existing---% In of Basin						**100%**	**0%**	
E Peak Existing---% In Basin						**0%**	**0%**	

ATTACHMENT 5---NEVADA SNOWMAKING ACREAGE

	2007 Master Plan Amended Facilities - Snowmaking at Buildout											
2007 Master Plan Amendment Trail #	**Trail Name**	**2007 Master Plan Amendment Snowmaking Action (1)**	**Acreage (acres)**	**Acre ft. (3)**	**Acreage by Quandrant A**	**B**	**C**	**D**	**Acre-ft by Quadrant A**	**B**	**C**	**D**
Nevada In Basin 'pod' trails												
Q1	BOULDER (EDGEWOOD) BOWL	EXISTING	17.2	68.9				17.2				68.9
S1	OLYMPIC DOWNHILL (3/5)	EXISTING	15.5	41.8	15.5				41.8			
X1	BOULDER SKI SCHOOL	EXISTING	2.8	7.6				2.8				7.6
*HH1	EASY STREET (1/2)	EXISTING	3.4	9.2	3.4				9.2			
S2	BOULDER CHUTE (O75)	RETAIN	2.7	11.0								
S3	NORTH BOWL	RETAIN	7.8	38.9								
S4	UPPER NORTH BOWL	RETAIN	4.2	21.0								
S8	NEW - NORTH BOWL 2	NEW	5.1	13.8								
S9	NEW - NORTH BOWL 3 (Gladed)	NEW	8.1	22.0								
S10	NEW - NORTH BOWL 4 (Gladed)	NEW	7.8	21.2								
HH2	EASY STREET II (1/2)	NO ACTION	2.1	5.6								
	(wasn't on snowmaking plan)											
Nevada In Basin non 'pod' transport trails												
9	STEVE'S	EXISTING	0.5	1.4	0.5				1.4			
10	VON SCHMIDT'S (1/4)	RETAIN	1.2	3.3								
NV In Basin Total--Master Plan			**78.5**	**265.5**								
NV In Basin Existing Total (all E. Peak)			**39.4**	**128.8**								
Nevada Out of Basin 'pod' trails												
R2	(UPPER) STAGECOACH	EXISTING	4.2	16.6			4.2				16.6	
S1	OLYMPIC DOWNHILL (2/5)	EXISTING	10.3	27.9		3.8	6.5			10.4	17.5	
S5	CROSSOVER	EXISTING	6.7	18.1		6.7				18.1		
V4	BIG DIPPER (4/5)	EXISTING	14.8	40.0		14.8				40.0		
V6	ORION'S BELT	EXISTING	1.1	2.9		1.1				2.9		
V8	ORION'S (1/2)	EXISTING	8.4	22.6		8.4				22.6		
V9	LOWER ORION'S	EXISTING	2.9	7.8		2.9				7.8		
*V10	METEOR (1/2) - (GLADED)	EXISTING - UNBUILT	2.9	7.8								
W3	LITTLE DIPPER	EXISTING	10.4	52.2		10.4				52.2		
W4	COMET	EXISTING	14.2	38.3		14.2				38.3		
Z1	NEW - WELLS FARGO 1	NEW	5.4	14.5								
Z2	NEW - WELLS FARGO 2	RETAIN	8.3	22.4								
Z3	NEW - WELLS FARGO 3	NEW	11.4	30.7								
Z4	NEW - WELLS FARGO 4	RETAIN	12.8	34.6								
Z5	NEW - WELLS FARGO 5	NEW	2.8	7.5								
Z7	NEW - WELLS FARGO 7	NEW	6.9	18.7								
R1	STAGECOACH	EXISTING	12.4	49.6		10.8	1.6			43.2	6.3	
R3	NEW - STAGECOACH 2	NO ACTION	7.1	35.6								
R4	NEW - STAGECOACH 3	NO ACTION	0.0	0.0								
R5												
S6	PONDEROSA (BONANZA BOWL)	RETAIN	4.0	15.9								
S7	EAST PEAK	RETAIN	3.9	15.8								
U1	PERIMETER	RETAIN	13.5	36.4								
U2	GALAXY	RETAIN	10.1	27.3								
U3	NEW - GALAXY 1	NEW	8.7	23.4								
U4	NEW - GALAXY 2	NEW	2.7	7.3								
V5	LOWER BIG DIPPER	RETAIN	3.7	9.9								
V12	NEW - ORION'S II	NEW	3.4	9.3								
W1	ARIES	RETAIN	1.3	3.4								
W2	JACK'S	NEW	3.0	8.0								
*HH3	SILVER SPUR	NO ACTION	0.5	1.4								
Necada Out of Basin Non 'pod' transport trails												
7	LOWER WAY HOME	EXISTING	5.2	14.1			5.2				14.1	
8	PEPI'S	EXISTING	4.0	10.8		4.0				10.8		
10	VON SCHMIDT'S (1/2)	EXISTING	2.4	6.5		2.4				6.5		
14	NEW - GALAXY ACCESS	NEW	6.4	17.3								
15	NEW - SCORPION	NEW	6.3	17.1								
6	NEW - NEVADA TRAIL (WAY HOME)	NEW	5.9	16.0								
16	NEW - FARGO TO GALAXY	NEW	1.1	2.9								
NV-Out of Basin Total MP			**229.1**	**690.8**								
NV Out of Basin Existing Total (all E. Peak)			**97.0**	**307.5**								
					Acreage by Quandrant				**Acre-ft by Quadrant**			
		Acreage total by Quandrant			**19.4**	**79.5**	**17.5**	**20.0**	**52.4**	**252.8**	**54.6**	**76.5**
		% of Total Acreage			**14.2%**	**58.3%**	**12.8%**	**14.7%**	**12.0%**	**58.0%**	**12.5%**	**17.5%**
							TOTAL	**136.4**			**TOTAL**	**436.3**
Nevada Total--Master Plan			**307.6**	**956.3**								
Nevada Total--Existing			**136.4**	**436.3**								
% In Basin--Existing			**29%**	**30%**								
% Out of Basin			**71%**	**70%**								
Grand Total--2007 Master Plan			**538**	**1711**								
		Cal Base Total	**58**	**212**								
		% in CA	**100%**	**100%**								
		% In Basin	**100%**	**100%**								
		Cal DamTotal	**91**	**262**								
		% in CA	**100%**	**100%**								
		% in Basin	**100%**	**100%**								
		E. Peak Total	**148.5**	**468.9**								
		% in CA	**8%**	**7%**								
		E. Peak in CA	**12.1**	**32.6**								
		% of E. Peak in CA-in Basin	**0.0%**	**0.0%**								
		E. Peak in NV	**136.4**	**436.3**								
		% of E. Peak in NV-in Basin	**28.9%**	**29.5%**								

Appendix X
2009-2010 Master Plan Noise Monitoring Report

Heavenly Ski Resort
Master Plan Noise Monitoring Survey
2009-2010 Ski Season



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I INTRODUCTION

j.c. brennan & associates, Inc. is providing a final report on the noise monitoring and analysis of noise measurement data collected during the 2009/2010 snowmaking operations at Heavenly. The noise measurements and analysis of data are required as a condition of approval for the Heavenly Master Plan EIS/EIR. This is the thirteenth annual analysis of snowmaking noise.

The previous noise analyses for the 2008/2009, 2007/2008, 2006/2007, 2005/2006 and 2004/2005 ski seasons were prepared by j.c. brennan & associates, Inc. The five noise analyses for the 1999/2000, 2000/2001, 2001/2002, 2002/2003, 2003/2004 ski seasons were prepared by Bollard & Brennan, Inc. The three noise analyses for the 1996/97, 1997/98, and 1998/99 ski seasons were prepared by Brown-Buntin Associates, Inc (BBA).

The conditions of approval for the Heavenly Master Plan EIS/EIR are aggressive, and include instituting a comprehensive noise monitoring program, the replacement of older and louder air/water nozzles with quiet model snowmaking equipment, sound control devices for snowmaking equipment, and participation with the snowmaking industry in the research and development of quiet snowmaking equipment and sound control devices for snowmaking equipment. The current technology considers quiet snowmaking equipment to be fan guns, and based upon noise measurement data collected for the various types of snowmaking equipment, fan guns are generally 15 dBA quieter than traditional air/water nozzles.

Since the 1996/1997 ski season, Heavenly committed to the installation of a permanent noise monitoring site at the base of the ski area near the California lodge, and to establishing the existing snowmaking noise levels at the Boulder Base and Stagecoach Base. Refer to Figure 1 for locations of noise monitoring sites.

According to the previous snowmaking noise reports, during the 1996/1997 ski season some quiet snowmaking equipment was installed and used at the California Base facilities. However, the use of quiet equipment was limited. During the 1997/1998 ski season, additional quiet snowmaking equipment was introduced into the fleet of snowmaking operations. During the 1998/1999 snowmaking operations, no additional quiet snowmaking equipment was implemented. Based upon review of the log of snowmaking activities provided by Heavenly, fan guns were used in both the lower and upper locations of the California Base during the 1999/2000 - 2003/2004 ski seasons. During the 2008/2009 ski season, fan guns were used extensively on the lower portion of the California Base area. Based upon the snowmaking logs, there was limited use of air/water nozzles on the lower portion of the California side as an effort to reduce overall snowmaking noise levels. Currently, air/water nozzles are only used on the Round About trail of the lower portion of the California face.

Figure 1
Heavenly at Tahoe Ski Resort
Project Site and Noise Measurement Locations

: Short Term Noise Measurement Location

: Continuous Noise Measurement Location 1

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II PURPOSE AND NEED

The purpose and need for the Annual Noise Monitoring Report, is to address the attainment of performance standards contained within the Heavenly Master Plan and to address progress toward attainment of the TRPA noise level criteria.

TRPA Criteria

The Tahoe Regional Planning Agency (TRPA) has adopted Environmental Thresholds for the Lake Tahoe Region. The noise standards, or Thresholds as they are commonly referred to, are numerical Community Noise Equivalent Level (CNEL)[1] values for various land use categories and transportation corridors.

As a form of zoning, the TRPA has divided the Lake Tahoe Region into more than 175 separate Plan Areas. Boundaries for each of the Plan Areas have been established based upon similar land uses and the unique character of each geographic area. For each Plan Area, a Statement is made as to how that particular area should be regulated to achieve regional environmental and land use objectives. As a part of each Statement an outdoor CNEL standard is established based upon the Thresholds. Table 1 shows the existing CNEL standards for the Heavenly Plan Areas and adjacent Plan Areas.

Table 1
Plan Area Statement (PAS) CNEL Criteria

PAS	Description	CNEL Criterion
087	Heavenly Valley California	55 dBA
085	Lakeview Heights (Location of California Base noise monitoring location)	55 dBA
094	Glenwood	50 dBA
095	Trout/Cold Creek	50 dBA
086	Heavenly Valley Nevada	55 dBA
082	Upper Kingsbury	55 dBA
080	Kingsbury Drainage	50 dBA
088	Tahoe Village	55 dBA

[1] For an explanation of these terms, see Appendix A: "Acoustical Terminology"

III COMPLIANCE REPORTING

III.1 Snow Grooming Noise

III.1a Master Plan Mitigation Methods

The Master Plan mitigation methods for snow grooming operations are to maintain an 85 foot setback from Plan Area boundaries that are adjacent to Heavenly. Operations of snow grooming equipment would not exceed Plan Area noise standards with a minimum of 85 feet of separation.

III.1.b Master Plan Milestone/Product

Snow grooming machines are not operated within 85 feet of PAS boundaries. Portions of the fleet are replaced continually with newer technology equipment

III.1c Responsible Party

Heavenly is responsible for educating snow groomers to maintain the 85 foot setback.

III.1d PAS Criteria

PAS 080 – 50 dB CNEL
PAS 082, 085, 086, 087, 088 – 55 dB CNEL
PAS 095, PAS 121 – 45 dB CNEL

III.1.e Results of Reporting and Determination of Compliance

To be included in ENTRIX compliance report.

III.2 Snowmobile Noise

III.2.a Master Plan Mitigation Methods

Replace all snowmobiles with 4-stroke technology. This would ensure that snowmobiles would comply with the 82 dBA single event noise level standard.

III.2.b Master Plan Milestone/Product

Snowmobile equipment is maintained and operated within 85 feet of PAS boundaries. Portions of the fleet are replaced with new equipment.

III.2.c Responsible Party

Heavenly is responsible for replacing the fleet of snowmobiles with 4-stroke technology machines.

III.2.d Criteria

The TRPA single event noise level standard for snowmobiles is 82 dBA Lmax, at a distance of 50 feet.

III.2.e Results of Reporting and Determination of Compliance

Heavenly staff reported in 2008 that all snowmobiles in the fleet are 4-stroke engine technology. Therefore, this is in compliance with the TRPA thresholds.

III.3 Snow Removal Noise

III.3.a Master Plan Mitigation Methods

Mitigation methods for snow removal noise impacts are to minimize nighttime snow removal operations, and by constructing noise barriers along the perimeters of the parking lots. At the California Base area, the upper parking lot should be cleared first, and clearing of the lower parking lot should be conducted during the daytime and evening hours.

III.3.b Master Plan Milestone/Product

Snow removal equipment is operated consistent with the measures listed above.

III.3.c Responsible Party

Heavenly is responsible for operating snow removal equipment consistent with the measures listed above.

III.3.d Criteria

PAS 080 – 50 dB CNEL
PAS 082, 085, 086, 087, 088 – 55 dB CNEL
PAS 095, PAS 121 – 45 dB CNEL

Results of Reporting and Determination of Compliance

To be provided in ENTRIX compliance report.

III.4 Snowmaking California Base Area Noise

III.4.a Master Plan Mitigation Methods

1. Use of fans in place of air/water nozzles or air/water guns which are low noise;
2. Re-direction of nozzles and fans to minimize noise exposures at PAS boundaries;
3. Reduction in the numbers of nozzles and/or fans;
4. Use of setbacks to reduce noise exposures at PAS boundaries;
5. Use of noise reduction housings for air/water nozzles;
6. Use of barriers at low-mounted air/water nozzles;
7. Reduction in snowmaking activities at nighttime;
8. Sponsor research into reducing noise produced by snowmaking. This may include support of industry-wide research activities, specific studies concerning nozzle design sponsored directly by Heavenly, and the study of alternatives in placement of guns and fans at Heavenly.

III.4.b Master Plan Milestone/Product

Heavenly has installed the long-tem noise monitoring station at the California Base area. The annual noise monitoring occurs from November 1, and generally through March 31st, depending on the snowmaking activities. Heavenly has completely replaced the air-water snowmaking nozzles at the base of California with fan guns. Heavenly has not implemented items 4 through 8 listed above.

III.4.c Responsible Party

Heavenly is responsible for implementing the mitigation measures.

III.4.d PAS Criteria

PAS 080 – 50 dB CNEL
PAS 082, 085, 086, 087, 088 – 55 dB CNEL
PAS 095, PAS 121 – 45 dB CNEL

III.4.e Results of Reporting and Determination of Compliance

1996/1997 - 2008/2009 Snowmaking Noise Levels Summary:

Please see previous j.c brennan & associates, inc., and Bollard & Brennan, Inc. reports for details on the analysis of past snowmaking seasons. The results of previous noise monitoring surveys are provided in Tables 2 and 3.

2009/2010 Snowmaking Noise Levels Summary:

The ski season during the 2009/2010 spanned a total of 150 days. Continuous snowmaking noise level measurements were conducted between November 1, 2009 and March 31, 2010 at the permanent noise monitoring site, located on the USFS property located directly east of Heavenly Ski

Area, and across Keller Road (PAS 085). The monitoring site is located on the southeast corner of the intersection of Keller Road and Saddle Road, with a direct line of sight to the California Base snowmaking operations. As mentioned in previous reports, the location of the noise monitor was at the northeast corner of Keller Road and Saddle Road, and adjacent to the Tahoe Seasons Resort. That monitoring location was reaching the limitations of its usefulness. Traffic noise from the intersection of Keller Road and Saddle Road was influencing the overall measured noise levels. The current location has sufficient setback to reduce the amount of noise associated with the traffic as it affected the overall measured noise levels and the noise levels associated with the snowmaking operations.

The equipment used for the noise level measurements was a Larson Davis Laboratories (LDL) Model 820 precision integrating sound level meter which was calibrated with an LDL Model CAL 200 acoustical calibrator.

During the 2008/2009 ski season the Heavenly continued the log of snowmaking operations, also noting the use and location of snowmaking equipment, during the hours of operation when snowmaking activity occurred. Upon review of the snowmaking activities log provided by Heavenly snowmaking personnel, the measured CNEL values during snowmaking activities was determined at the noise monitoring location. Noise associated with snowmaking activities was a function of the number and location of snowmaking nozzles and/or fans guns in operation. Table 2 summarizes the previous twelve years of snowmaking levels at the Tahoe Seasons Resort (PAS 085), as well as the 2009/2010 season.

Table 2
Summary of Measured Noise Levels at the Heavenly Base Area
(Average Measured CNEL Values)

Noise Monitoring Site GPS Coordinates (38° 56' 17.43" N - 119° 56' 18.43" W)

Year	CNEL on Days with Snowmaking	CNEL on Days without Snowmaking	CNEL During Measurement Period	Total # of Monitoring Days	Total # of Snowmaking Days
1996/1997	74.1 dBA	61.7 dBA	71.6 dBA	--	--
1997/1998	73.5 dBA	61.8 dBA	70.2 dBA	--	--
1998/1999	73.0 dBA	62.0 dBA	69.5 dBA	--	--
1999/2000	74.3 dBA	62.0 dBA	73.0 dBA	141	101
*2000/2001	74.1 dBA	60.0 dBA	72.2 dBA	140	89
*2001/2002	73.9 dBA	60.3 dBA	72.1 dBA	145	93
*2002/2003	72.0 dBA	63.1 dBA	68.3 dBA	150	61
*2003/2004	67.4 dBA	62.3 dBA	65.7 dBA	104	56
*2004/2005	65.3 dBA	61.5 dBA	63.1 dBA	149	51
*2005/2006	61.0 dBA	60.9 dBA	61.4 dBA	151	41
*2006/2007	63.7 dBA	58.1 dBA	62.6 dBA	149	75
*2007/2008	62.4 dBA	58.2 dBA	61.6 dBA	140	62
*2008/2009	62.4 dBA	59.7 dBA	61.2 dBA	119	75
****2009/2010**	**59.8 dBA**	**55.5 dBA**	**58.1 dBA**	**150**	**72**

*The 2000/2001 - 2007/2008 measurement site was moved to the ground level of the Tahoe Seasons Resort. Previously this site was located at the roof-top of the Tahoe Seasons Resort.
** Noise measurement site moved to USFS property @ northeast corner of Keller and Saddle.

Year 2003-2004 Heavenly began Fan Gun Technology

The average measured CNEL value at the 2009/2010 monitoring site was 59.8 dBA when snowmaking operations occurred. This was 2.5 dBA less than the 2008/2009 season, and the first time it was below 60 dBA CNEL. This level exceeds the 55 dBA CNEL standards for PAS 085 and PAS 087. In addition, the measured CNEL values on days without snowmaking operations (55.5 dBA) also exceeded the 085 and 087 Plan Area CNEL standards. It was still noted that when snowmaking did not occur there was influence from roadway traffic and individuals recreating on the USFS property.

Figures 2 through 6 graphically show the results of the noise monitoring, as they compare to the

TRPA CNEL criterion of 55 dBA for PAS 085 and 087.

Based upon revisions to the methods for tracking daily snowmaking operations over the past eight ski seasons, a more detailed analysis of snowmaking noise levels can be conducted. Specifically, the snowmaking database has incorporated specific information on the type of snowmaking equipment which is operating (air/water nozzles or fan guns), number of each type of snowmaking gun, and the geographic array of snowmaking equipment on the mountain.

Snowmaking can occur over a significant portion of the California side of the mountain. In addition, the array of snowmaking at the California Base can include air/water nozzle and fan-gun type snowmaking equipment. The fan-guns have been found to produce noise levels which are a minimum of 10 dBA less than the traditional air-water nozzle guns, such as Ratnik and Omicron brand snowmaking nozzles. Table 3 summarizes the last nine years of CNEL values for varying types of snowmaking operations.

Table 3
Summary of Measured Noise Levels at the Tahoe Seasons Resort
Based upon Varying Arrays of Snowmaking Operations at the California Base

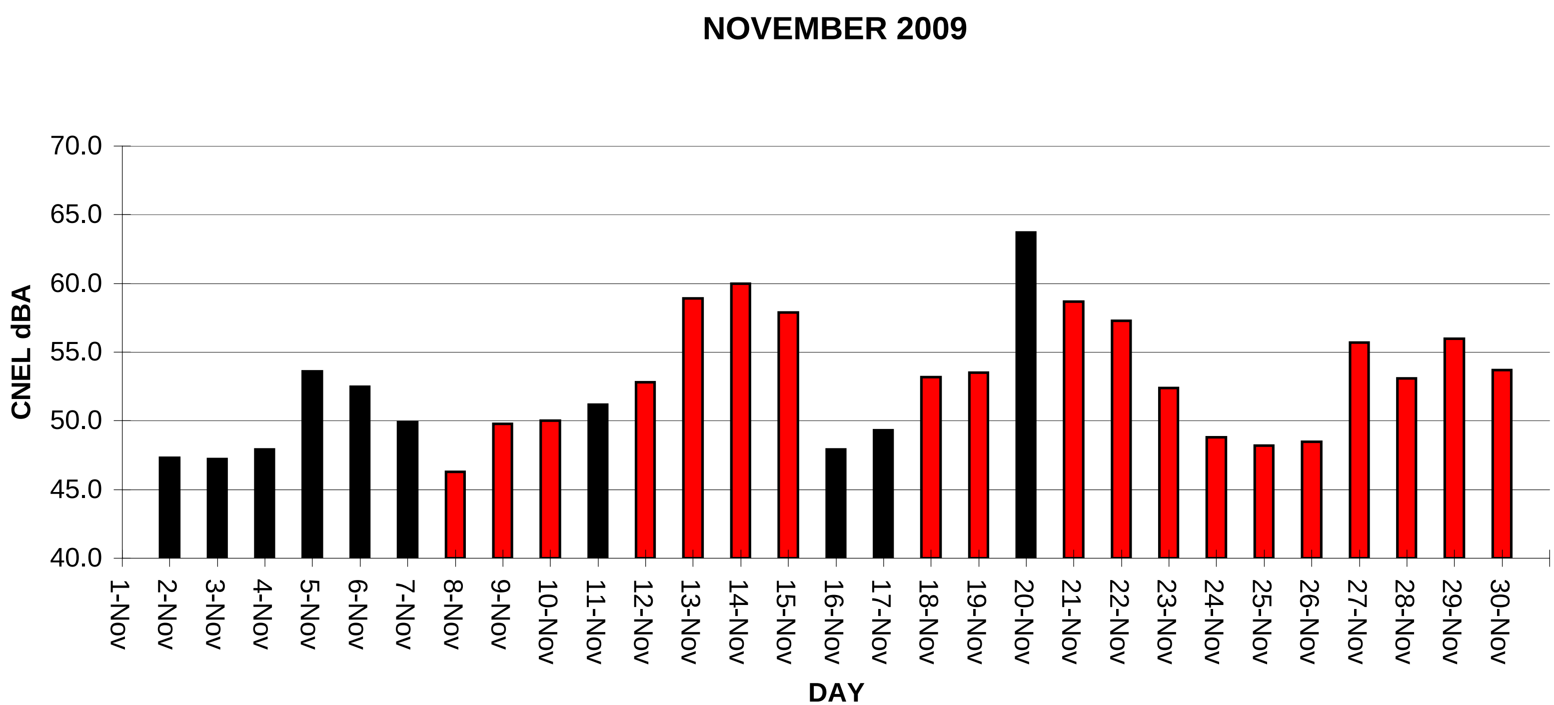
Year	Days with Lower Snowmaking Only	Days with Upper Snowmaking Only	Days with Lower Air/Water Nozzles Only	Days with Upper Air/Water Nozzles Only	Days with Lower Fan-Guns Only
	Logarithmic CNEL				
2001-2002	74.7 dBA	63.7 dBA	72.2 dBA	63.7 dBA	NA[2]
2002-2003	73.0 dBA	63.0 dBA	NA[3]	62.8 dBA	NA[2]
2003-2004	61.7 dBA	60.9 dBA	NA[3]	60.3 dBA	61.1 dBA
2004-2005	64.1 dBA	60.3 dBA	66.1 dBA	NA[1]	NA[2]
2005-2006	63.4 dBA	57.6 dBA	NA[3]	NA[1]	63.4 dBA
2006-2007	65.4 dBA	60.2 dBA	NA[3]	59.3 dBA	65.2 dBA
2007-2008	60.6 dBA	61.2 dBA	NA[3]	62.0 dBA	60.1 dBA
2008-2009	64.3 dBA	58.1 dBA	NA[3]	63.3 dBA	63.4 dBA
2009-2010	57.9 dBA	55.7 dBA	NA[3]	58.4 dBA	57.9 dBA

[1]NA - No snowmaking occurred with strictly Upper Air-Water Nozzles operating.
[2]NA - No snowmaking occurred with strictly Fan Guns operating.
[3]NA - No snowmaking occurred with strictly Lower Air-Water Nozzles Only

Figure 2

Heavenly California Base Area Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
November-09



NO SNOWMAKING

SNOWMAKING

CNEL Criterion 55 dBA

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Figure 3
2009-103
California Base Area Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
December-09

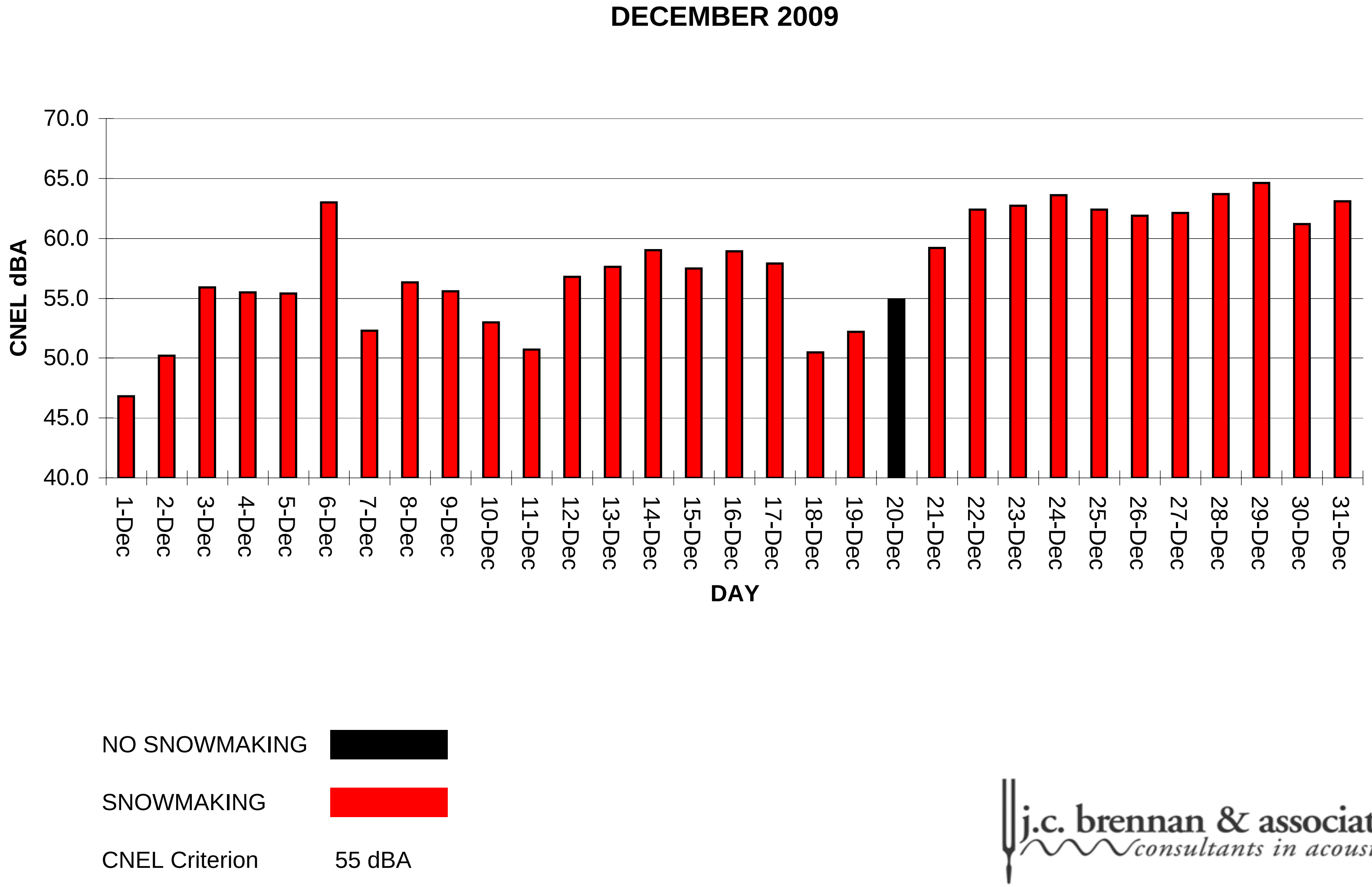

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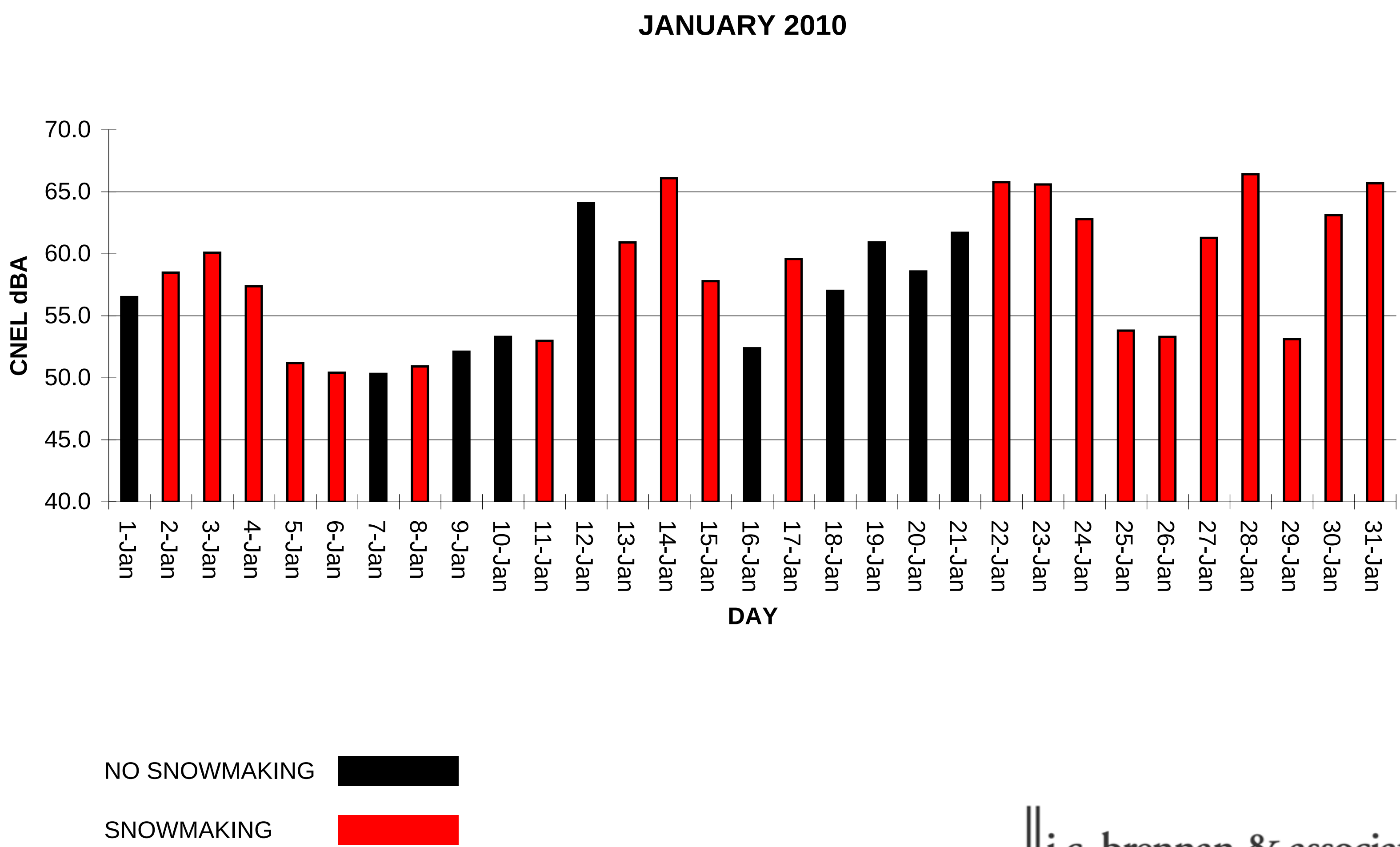
Figure 4
2009-103
California Base Area Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
January-10



CNEL Criterion 55 dBA

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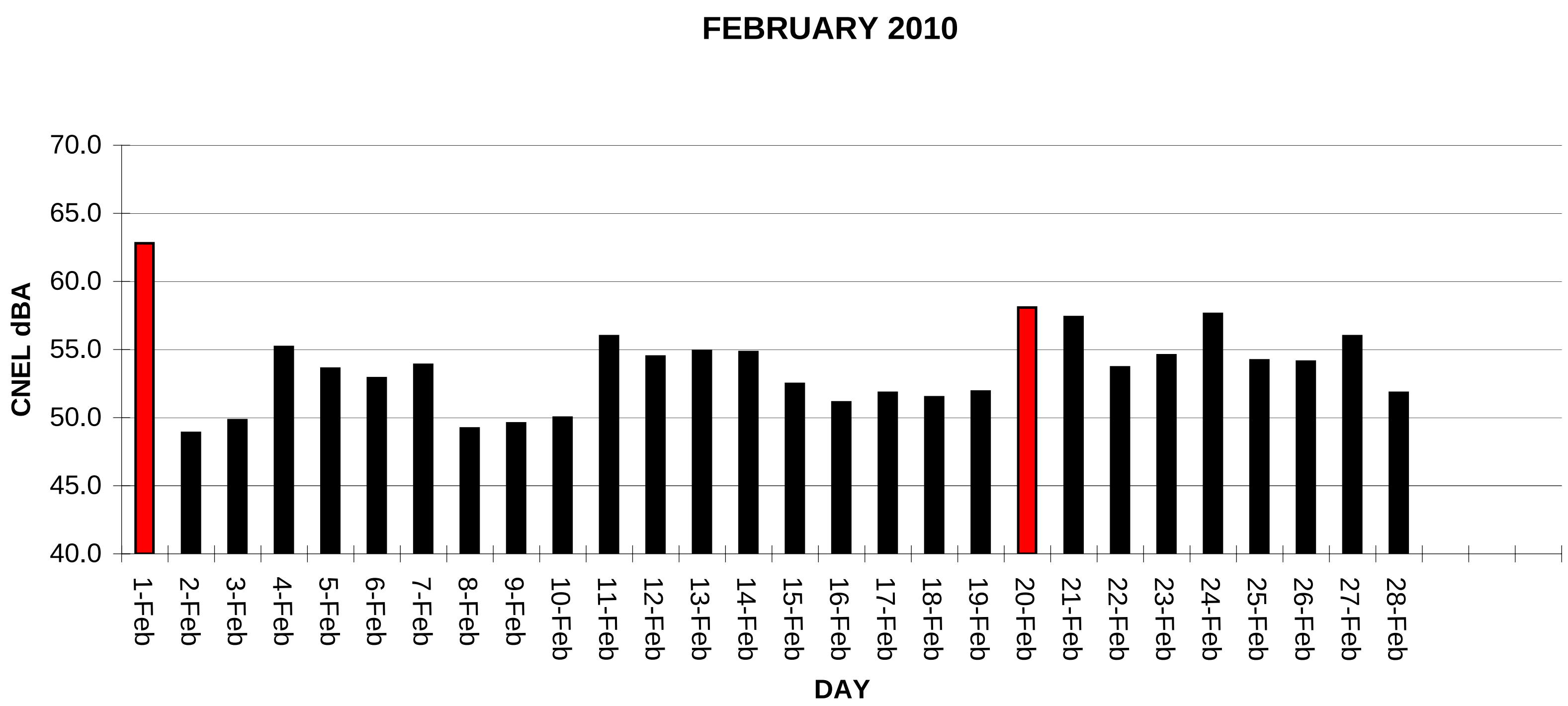
Figure 5
2009-103
California Base Area Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
February-10



NO SNOWMAKING

SNOWMAKING

CNEL Criterion 55 dBA

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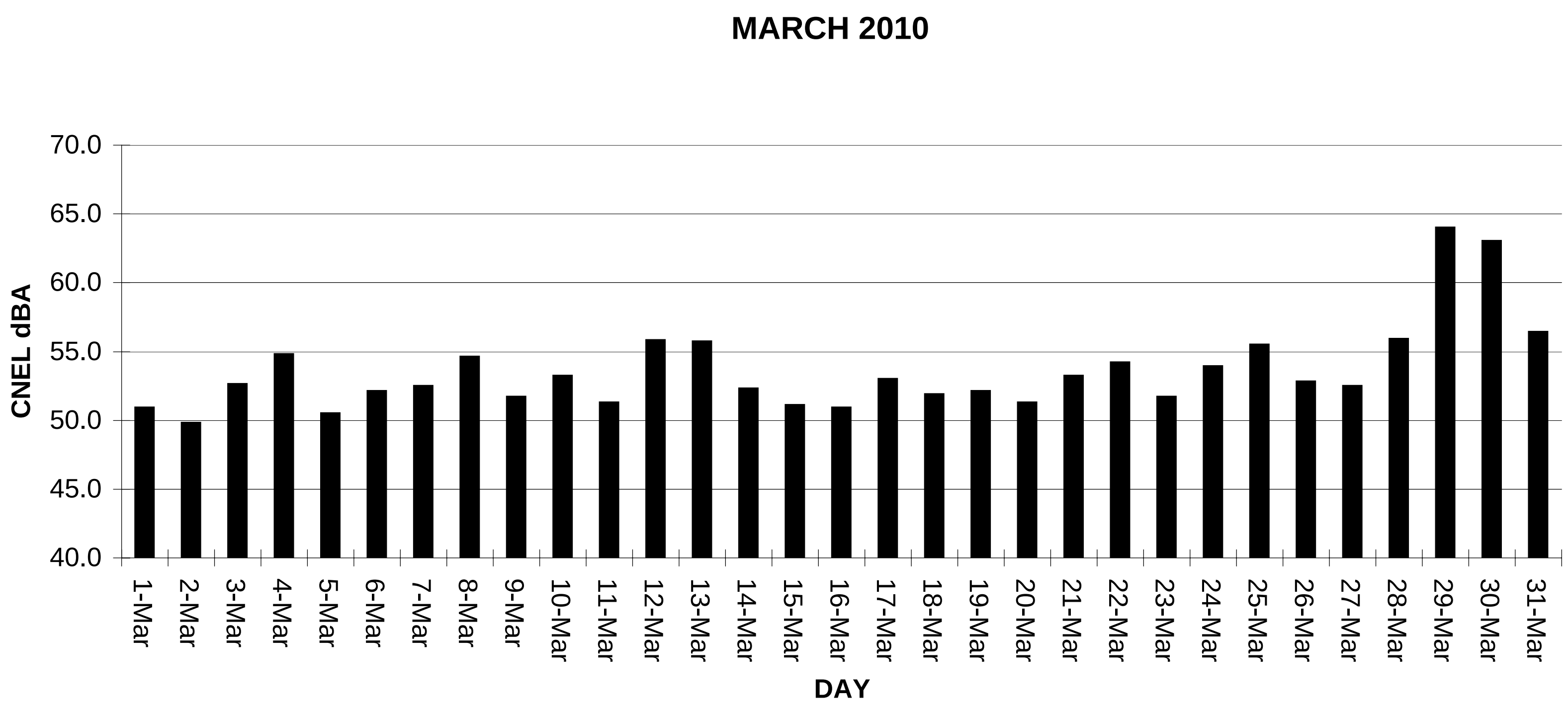
Figure 6
2009-103
California Base Area Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
March-10



NO SNOWMAKING

SNOWMAKING

CNEL Criterion 55 dBA

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The CNEL values shown in Table 3 for the 2009/2010 ski season indicate a fairly substantial decrease in noise levels associated with only lower snowmaking operations. However, in review of the data, there were only 2 days, when only the lower snowmaking operations occurred. During both of those days, only Fan Guns were in operation. The data indicates that the new base location does separate out a significant contribution of the background traffic noise from the snowmaking noise.

Fan Gun Noise Levels

Heavenly has completed the process of converting the California Base snowmaking operations to the use of fan-guns. However, portions of the lower mountain which include the ski runs named Round About and lower Gun Barrel continue to utilize air/water nozzles. The types of fan guns which Heavenly is currently using include SMI Super Polecat. Noise level measurements were conducted on three of the air/water nozzle snowmaking guns on March 24, 2003. The results indicate that noise levels associated with the fan guns are approximately 22 dBA to 25 dBA less than a typical Omicron Whisper Gun or Ratnik Single air/water snowmaking nozzle.

Assuming that the lower California snowmaking fleet could be converted completely to fan gun technology or other low noise technology air/water nozzles, it is expected that a minimum noise level reduction of 3 dBA to 5 dBA can be achieved for all snowmaking operations. During the 2009/2010 ski season, Heavenly reported consistent use of air/water nozzles for snowmaking at the lower portion of the California side along the Round About and Lower Gun Barrel trails. As the upper mountain converts to fan guns, it is not expected that a significant reduction in snowmaking noise levels can be realized at the base areas. However, the upper mountain boundaries will experience significant reductions in overall snowmaking noise levels.

The determining factors on overall noise from the snowmaking system include the types of snowmaking equipment, the number of air/water nozzles or fans operating at any time, and the total hours of operations. If fan gun technology is not capable of producing the amount of snow that the air/water nozzles produce, then snowmaking operations may require an increase in the number of fan guns operating at any one time and/or an increase in hours of operation.

III.5 Snowmaking at Boulder Base Area Noise

III.5.a Master Plan Mitigation Methods

1. Use of fans in place of air/water nozzles or using air/water nozzles which are low noise;
2. Re-direction of nozzles and fans to minimize noise exposures at PAS boundaries;
3. Reduction in the numbers of nozzles and/or fans;
4. Use of setbacks to reduce noise exposures at PAS boundaries;
5. Use of noise reduction housings for air/water nozzles;
6. Use of barriers at low-mounted air/water nozzles;
7. Reduction in snowmaking activities at nighttime;

8. Sponsor research into reducing noise produced by snowmaking. This may include support of industry-wide research activities, specific studies concerning nozzle design sponsored directly by Heavenly, and the study of alternatives in placement of guns and fans at Heavenly.
9. At the Stagecoach and Boulder Bases, Heavenly will strive to replace all air/water nozzles with fans.

III.5.b Master Plan Milestone/Product

During the 2009/2010 ski season, Heavenly has conducted short-term noise monitoring at the Boulder Base area. The noise monitoring occurs for short periods of time since the snowmaking only occurs for between 2 and 4 days per year. Heavenly anticipates replacing the air/water nozzles after complete replacement of nozzles with fan guns on the entire California face. Heavenly is investing in low noise technology fan gun and air/water nozzles and anticipates this is the next area for replacement of noisy air/water nozzles. Heavenly has not implemented any of the other mitigation measures listed above.

III.5.c Responsible Party

Heavenly is responsible for implementing the mitigation measures.

III.5.d PAS Criteria

PAS 080 – 50 dB CNEL
PAS 082, 085, 086, 087, 088 – 55 dB CNEL
PAS 095, PAS 121 – 45 dB CNEL

III.5.e Results of Reporting and Determination of Compliance

Short-term noise level measurements of snowmaking operations were conducted during the 2009/2010 ski season at the Boulder Base on December 15, 2009. Measured noise levels at this location were approximately 68 dBA Leq during snowmaking operations. Measurements were also conducted at the corner of Jack Circle and Bonnie Court. The measured noise levels were approximately 62 dBA Leq. The results of the ambient noise measurements for the 2009/2010 ski season and previous ski seasons are shown in Table 4. The predicted CNEL value at the Boulder Base is 75dBA. The predicted CNEL value at the Jacks Circle location is 69dBA.

Table 4 **Ambient Noise Level Measurements for the Boulder Base Area**				
Year	Date	Measured Sound Level, Leq		
		Boulder Base Site 1	Corner of Jack Cir. & Bonnie Ct. - Site 2	
			Measured	Measured for Master Plan
1999-2000	December 14, 1999	70 dBA	63 dBA	65 dBA
2000-2001	December 14, 2000	73 dBA	65 dBA	
2001-2002	NA[1]	NA[1]	NA	
2002-2003	February 4, 2003	71 dBA	53 dBA	
2003-2004	December 8, 2003	60 dBA	NA[1]	
2004-2005	December 3, 2004	66 dBA	58 dBA	
2005-2006	December 13, 2005	71 dBA	64 dBA	
2006-2007	December 28, 2006	68 dBA	63 dBA	
2007-2008	December 31, 2007	67 dBA	65 dBA	
2008-2009	December 24, 2008	67 dBA	65 dBA	
2009-2010	December 15, 2009	68 dBA	62 dBA	

[1]Snowmaking operations did not occur at this location during this season.
Boulder Base GPS Coordinates (38° 58.3’ 3.98” N - 119° 53’ 25.81”W)
Jack Circle/Bonnie Ct. GPS Coordinates (38° 58’ 5.14” N – 119° 53’ 34.76” W)

Currently, the snowmaking operations are out of compliance with the TRPA criteria.

III.6 Snowmaking at Stagecoach Base Area Noise

III.6.a Master Plan Mitigation Methods

1. Use of fans in place of air/water nozzles or air/water guns which are low noise;
2. Re-direction of nozzles and fans to minimize noise exposures at PAS boundaries;
3. Reduction in the numbers of nozzles and/or fans;
4. Use of setbacks to reduce noise exposures at PAS boundaries;
5. Use of noise reduction housings for air/water nozzles;
6. Use of barriers at low-mounted air/water nozzles;
7. Reduction in snowmaking activities at nighttime;
8. Sponsor research into reducing noise produced by snowmaking. This may include support of industry-wide research activities, specific studies concerning nozzle design sponsored directly by Heavenly, and the study of alternatives in placement of guns and fans at Heavenly.
9. At the Stagecoach and Boulder Bases, Heavenly will strive to replace all air/water nozzles with fans.

III.6.b Master Plan Milestone/Product

During the 2009/2010 ski season, Heavenly has conducted short-term noise monitoring at the Stagecoach Base area. The noise monitoring occurs for short periods of time since the snowmaking only occurs for between 2 and 4 days per year. Heavenly anticipates replacing the air/water nozzles after complete replacement of nozzles with fan guns on the entire California face. Heavenly has not implemented any of the mitigation measures listed above.

III.6.c Responsible Party

Heavenly is responsible for implementing the mitigation measures.

III.6.d PAS Criteria

This area is located outside of the TRPA area of influence.

III.6.e Results of Reporting and Determination of Compliance

Short-term noise level measurements of snowmaking operations were conducted during the 2009/2010 ski season at three locations of the Stagecoach Base, on December 8, 2009. The noise levels during snowmaking operations were 78 dBA Leq at 460 Quaking Aspen, 62 dBA Leq at the entrance to the Eagle Nest, and 56 dBA Leq at the entrance to the Ridge. The average hourly noise levels at the Quaking Aspen location conducted for the development of the Master Plan were between 82 dBA and 92 dBA Leq in 1996. The results of the ambient noise measurements for the 2009/2010 ski season and previous ski seasons are shown in Table 5.

Table 5 Ambient Noise Level Measurements Stage Coach Base Area					
Year	Date	Measured Sound Level, L_{eq}			
		460 Quaking Aspen Rd. Site 3		Entrance to The Ridge Site 4	Eagles Nest Site 5
		Measured	Measured for Master Plan		
1999-2000	December 4, 1999	87 dBA	82-92 dBA	62 dBA	78 dBA
2000-2001	December 11, 2000	86 dBA		56 dBA	72 dBA
2001-2002	November 30, 2001	57 dBA		55 dBA	59 dBA
2002-2003	February 2, 2003	83 dBA		--	70 dBA
2003-2004	December 8, 2003	87 dBA		58 dBA	74 dBA
2004-2005	November 30, 2004	81 dBA		58 dBA	68 dBA
2005-2006	December 5, 2005	81 dBA		63 dBA	73 dBA
2006-2007	December 18, 2006	88 dBA		62 dBA	72 dBA
2007-2008	December 20, 2007	82 dBA		60 dBA	68 dBA
2008-2009	December 17, 2008	78 dBA		55 dBA	65 dBA
2009-2010	December 8, 2009	78 dBA		56 dBA	62 dBA
Quaking Aspen GPS Coordinates (38° 57' 37.52" - 119° 53' 16.57" W) **Entrance to Ridge GPS Coordinates (38°57' 46.68" N - 119° 56' 3.68" W)** **Eagles Nest GPS Coordinates (38° 57' 35.04" N - 119° 53' 23.63" W)**					

Using the data collected on December 8, 2009 shown in Table 5, a 24 hour CNEL was calculated for each of the three locations at the Stage Coach Base Area. With continuous snowmaking operations, 24 hour operations at Eagle Nest resulted in a 69 dBA CNEL. The 24 hour operations at 460 Quaking Aspen resulted in a CNEL of 85 dBA. The 24 hour operations at the entrance to The Ridge resulted in a 63 dBA CNEL.

III.7 Snowmaking Upper Mountain Noise

III.7.a Master Plan Mitigation Methods

In order to reduce overall snowmaking noise the levels, Heavenly shall use fan guns or other similar noise reduction measures for all new snowmaking areas. In addition, where new snowmaking is placed adjacent to existing ski trails with snowmaking, Heavenly shall convert the existing air/water snowmaking nozzles with fan guns or use other similar noise reduction measures to maintain or reduce existing noise levels in that area.

III.7.b Master Plan Milestone/Product

Snowmaking noise from the upper mountain areas is monitored and evaluated from the California

Base Area permanent noise monitor, and through Remote Plan Area monitoring. The analysis to date indicates that upper mountain snowmaking does not exceed the ambient noise when snowmaking is not occurring. New snowmaking installations are fan guns.

III.7.c Responsible Party

Heavenly is the responsible party.

III.7.d PAS Criteria

PAS 080 – 50 dB CNEL
PAS 082, 085, 086, 087, 088 – 55 dB CNEL
PAS 095, PAS 121 – 45 dB CNEL

III.7.e Results of Reporting and Determination of Compliance

See the reporting for the California Base Area. The following provides results of the Remote Plan Area Noise Measurements

j.c. brennan & associates, Inc., conducted noise level measurements of snowmaking operations at two remote Plan Area locations January 2, 2010. The noise measurement locations included "Party Rock" (Noise Measurement Site 7) located within Plan Area 080, and the second noise measurement location was in Plan Area 095 adjacent to the ski area boundary, and southeast of Liz's and Canyon Runs (Noise Measurement Site 6). The noise level measurements were conducted to determine if snowmaking operations would exceed the applicable standards.

The noise measurements for Plan Area 080 were conducted during a full array of snowmaking operations at Upper Ellie's, High Roller, Sky Chute and Lakeview Lodge. The results of the noise measurements and field observations were that the snowmaking operations were not audible. The noise measurements for Plan Area 095 were conducted during the same time frame. The snowmaking report indicates that there were 40 air/water nozzles and 2 fan guns operating during this time period. The snowmaking operations resulted in a noise level of 70 dBA Leq.

GPS coordinates for the Remote Plan Area measurements sites are as follows:

Party Rock (38° 56' 27.63" N - 119° 56' 1.35" W);
Liz's / Canyon Run (38° 54' 47.5" N - 119° 54' 43" W).

Currently, the noise levels exceed the noise level criteria at the top of Sky Chair area (PAS 095). Noise levels do not exceed the Plan Area 080 criteria.

III.8 Rock Busting Noise

III.8.a Master Plan Mitigation Methods

Rock busting generally occurs through the use of explosives and blasting. Control the number, size and location of Rock Busting blasts.

III.8.b Master Plan Milestone/Product

None

III.8.c Responsible Party

Heavenly is the responsible party.

III.8.d PAS Criteria

PAS 080 – 50 dB CNEL
PAS 082, 085, 086, 087, 088 – 55 dB CNEL
PAS 095, PAS 121 – 45 dB CNEL

III.8.e Results of Reporting and Determination of Compliance

Heavenly has not contacted j.c. brennan & associates, Inc. to conduct noise measurements of blasting or rock busting. It is assumed that this activity has not occurred.

III.9 Amphitheater Operations Noise

III.9.a Master Plan Mitigation Methods

Restrict hours of concert noise to the daytime and early evening hours. This is consistent with the hours of operations assumed for the amphitheater noise study. In addition, concerts should not extend more than 6 hours in duration.

III.9.b Master Plan Milestone/Product

Heavenly has conducted a concert simulation and amphitheater noise study.

III.9.c Responsible Party

Heavenly is the responsible party

III.9.d PAS Criteria.

PAS 080 – 50 dB CNEL

PAS 082, 085, 086, 087, 088 – 55 dB CNEL
PAS 095, PAS 121 – 45 dB CNEL

III.9.e Results of Reporting and Determination of Compliance

No concerts have occurred to date.

Appendix A

Acoustical Terminology

Acoustics	The science of sound.
Ambient Noise	The distinctive acoustical characteristics of a given space consisting of all noise sources audible at that location. In many cases, the term ambient is used to describe an existing or pre-project condition such as the setting in an environmental noise study.
Attenuation	The reduction of an acoustic signal.
A-Weighting	A frequency-response adjustment of a sound level meter that conditions the output signal to approximate human response.
Decibel or dB	Fundamental unit of sound, A Bell is defined as the logarithm of the ratio of the sound pressure squared over the reference pressure squared. A Decibel is one-tenth of a Bell.
CNEL	Community Noise Equivalent Level. Defined as the 24-hour average noise level with noise occurring during evening hours (7 - 10 p.m.) weighted by a factor of three (+5 dB for TRPA calculations) and nighttime hours weighted by a factor of 10 (or +10 dB) prior to averaging.
Frequency	The measure of the rapidity of alterations of a periodic signal, expressed in cycles per second or hertz.
Ldn	Day/Night Average Sound Level. Similar to CNEL but with no evening weighting.
Leq	Equivalent or energy-averaged sound level.
Lmax	The highest root-mean-square (RMS) sound level measured over a given period of time.
L(n)	The sound level exceeded a described percentile over a measurement period. For instance, an hourly L50 is the sound level exceeded 50% of the time during the one hour period.
Loudness	A subjective term for the sensation of the magnitude of sound.
Noise	Unwanted sound.
Peak Noise	The level corresponding to the highest (not RMS) sound pressure measured over a given period of time. This term is often confused with the "Maximum" level, which is the highest RMS level.
RT_{60}	The time it takes reverberant sound to decay by 60 dB once the source has been removed.
Sabin	The unit of sound absorption. One square foot of material absorbing 100% of incident sound has an absorption of 1 sabin.
Threshold of Hearing	The lowest sound that can be perceived by the human auditory system, generally considered to be 0 dB for persons with perfect hearing.
Threshold of Pain	Approximately 120 dB above the threshold of hearing.
Impulsive	Sound of short duration, usually less than one second, with an abrupt onset and rapid decay.
Simple Tone	Any sound which can be judged as audible as a single pitch or set of single pitches.

Appendix B
2009-103
Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
November-09

			Nevada				California					
Day	CNEL dB	Snow	Upper		Lower		Upper		Lower		Base	York
			A	F	A	F	A	F	A	F	F	
1-Nov												
2-Nov	47.3	n										
3-Nov	47.2	n										
4-Nov	47.9	n										
5-Nov	53.6	n										
6-Nov	52.5	n										
7-Nov	49.9	n										
8-Nov	46.3	y	78	12								
9-Nov	49.8	y	78	12								
10-Nov	50.0	y	72	12								
11-Nov	51.2	n										
12-Nov	52.8	y	82	12								
13-Nov	58.9	y	90	12				1			7	
14-Nov	60.0	y	108	12				1			11	
15-Nov	57.9	y	104	12				1			11	
16-Nov	47.9	n										
17-Nov	49.3	n										
18-Nov	53.2	y	86	12				1				
19-Nov	53.5	y	80	12				1			4	
20-Nov	63.7	n										
21-Nov	58.7	y	84	9				3			7	
22-Nov	57.3	y	76	8				3				
23-Nov	52.4	y	88	10				3				
24-Nov	48.8	y	82	10				3				
25-Nov	48.2	y	70	10								
26-Nov	48.5	y	40	6				2				
27-Nov	55.7	y	64	10				3				
28-Nov	53.1	y	78	10			10	3				
29-Nov	56.0	y	30	13			52	3			7	
30-Nov	53.7	y	20	10			48	3			7	

CNEL Average	
No Snowmaking	55.1
Snowmaking	55.1
Total	55.1

# of No Snowmaking Days	10
# of Snowmaking Days	19
Total Days of Monitoring	29

* A- Air Nozzles
F- Fan Guns
No Snowmaking Log Available
Snowmaking
Meter Setup

j.c. brennan & associates
consultants in acoustics

Appendix B
2009-103
Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
December-09

			Nevada				California					
Day	CNEL dB	Snow	Upper		Lower		Upper		Lower		Base	York
			A	F	A	F	A	F	A	F	F	
1-Dec	46.8	y	10	10			58	3				
2-Dec	50.2	y	16	10			58	3				
3-Dec	55.9	y	22	12			62	4			5	
4-Dec	55.5	y	20	12			50	4			5	
5-Dec	55.4	y	20	12			60	4		5		
6-Dec	63.0	y	32	12			60	4			8	
7-Dec	52.3	y	20	12			50	4			8	
8-Dec	56.3	y	16	5			40	4			7	
9-Dec	55.6	y	12	4	28		60	4			6	
10-Dec	53.0	y	36	3	8		36	1			5	
11-Dec	50.7	y	40	3			14		30			
12-Dec	56.8	y	36	3			10		24			
13-Dec	57.6	y									6	
14-Dec	59.0	y	2	4	36		12		18		7	
15-Dec	57.5	y	2	3	44		20		8		7	
16-Dec	58.9	y	2	3	46		26					
17-Dec	57.9	y	30	5			38	2				
18-Dec	50.5	y	22	5			42	2				
19-Dec	52.2	y	18	2			50	2				
20-Dec	54.9	n										
21-Dec	59.2	y	16	2			54					
22-Dec	62.4	y	32	13			38	2	24		25	
23-Dec	62.7	y	12	7	26		40	2	22		13	
24-Dec	63.6	y	12	10	26		46		10		20	
25-Dec	62.4	y	16	10			54		8		28	
26-Dec	61.9	y	16	10			64				14	
27-Dec	62.1	y	16	10			68				12	
28-Dec	63.7	y	16	8			58				19	
29-Dec	64.6	y	14	11			36		24		8	
30-Dec	61.2	y	16	12			40		16			
31-Dec	63.1	y	27	13			42	1	16		9	

CNEL Average	
No Snowmaking	54.9
Snowmaking	59.8
Total	59.7

# of No Snowmaking Days	1
# of Snowmaking Days	30
Total Days of Monitoring	31

* A- Air Nozzles
F- Fan Guns
No Snowmaking Log Available
Snowmaking

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Appendix B
2009-103
Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
January-10

			Nevada				California					
		Snow	Upper		Lower		Upper		Lower		Base	York
Day	CNEL dB		A	F	A	F	A	F	A	F	F	
1-Jan	56.5	n										
2-Jan	58.5	y	16	11			42	2	6		4	
3-Jan	60.1	y	16	11			40	2	6		4	
4-Jan	57.4	y	20	3			46	2	12			
5-Jan	51.2	y	20	2			38	2				
6-Jan	50.4	y					28		4			
7-Jan	50.3	n										
8-Jan	50.9	y					46		16			
9-Jan	52.1	n										
10-Jan	53.3	n										
11-Jan	53.0	y					50					
12-Jan	64.1	n										
13-Jan	60.9	y					24					
14-Jan	66.1	y					18		40		28	
15-Jan	57.8	y					6		40			
16-Jan	52.4	n										
17-Jan	59.6	y					44		30			
18-Jan	57.0	n										
19-Jan	60.9	n										
20-Jan	58.6	n										
21-Jan	61.7	n										
22-Jan	65.8	y					46		30		14	
23-Jan	65.6	y					60		32		15	
24-Jan	62.8	y					46		30		14	
25-Jan	53.8	y					46		20			
26-Jan	53.3	y					42					
27-Jan	61.3	y					50					
28-Jan	66.4	y					56		28		40	
29-Jan	53.1	y					10					
30-Jan	63.1	y					50		20			
31-Jan	65.7	y					32		38		14	

CNEL Average	
No Snowmaking	58.7
Snowmaking	61.7
Total	61.0

# of No Snowmaking Days	10
# of Snowmaking Days	21
Total Days of Monitoring	31

* A- Air Nozzles
F- Fan Guns

Snowmaking

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Appendix B
2009-103
Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
February-10

			Nevada				California					
		Snow	Upper		Lower		Upper		Lower		Base	York
Day	CNEL dB		A	F	A	F	A	F	A	F	F	
1-Feb	62.8	y					30		38		14	
2-Feb	48.9	n										
3-Feb	49.8	n										
4-Feb	55.2	n										
5-Feb	53.6	n										
6-Feb	52.9	n										
7-Feb	53.9	n										
8-Feb	49.2	n										
9-Feb	49.6	n										
10-Feb	50.0	n										
11-Feb	56.0	n										
12-Feb	54.5	n										
13-Feb	54.9	n										
14-Feb	54.8	n										
15-Feb	52.5	n										
16-Feb	51.1	n										
17-Feb	51.8	n										
18-Feb	51.5	n										
19-Feb	51.9	n										
20-Feb	58.1	y									19	
21-Feb	57.4	n										
22-Feb	53.7	n										
23-Feb	54.6	n										
24-Feb	57.6	n										
25-Feb	54.2	n										
26-Feb	54.1	n										
27-Feb	56.0	n										
28-Feb	51.8	n										

CNEL Average	
No Snowmaking	53.8
Snowmaking	61.1
Total	55.0
# of No Snowmaking Days	26
# of Snowmaking Days	2
Total Days of Monitoring	28

* A- Air Nozzles
F- Fan Guns
No Snowmaking Log Available
Snowmaking

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Appendix B
2009-103
Heavenly Snowmaking Monitoring

Annual Snowmaking Report
Summary of CNEL
March-10

			Nevada				California					
		Snow	Upper		Lower		Upper		Lower		Base	York
Day	CNEL dB		A	F	A	F	A	F	A	F	F	
1-Mar	50.9	N										
2-Mar	49.8	N										
3-Mar	52.6	N										
4-Mar	54.8	N										
5-Mar	50.5	N										
6-Mar	52.1	N										
7-Mar	52.5	N										
8-Mar	54.6	N										
9-Mar	51.7	N										
10-Mar	53.2	N										
11-Mar	51.3	N										
12-Mar	55.8	N										
13-Mar	55.7	N										
14-Mar	52.3	N										
15-Mar	51.1	N										
16-Mar	50.9	N										
17-Mar	53.0	N										
18-Mar	51.9	N										
19-Mar	52.1	N										
20-Mar	51.3	N										
21-Mar	53.2	N										
22-Mar	54.2	N										
23-Mar	51.7	N										
24-Mar	53.9	N										
25-Mar	55.5	N										
26-Mar	52.8	N										
27-Mar	52.5	N										
28-Mar	55.9	N										
29-Mar	64.0	N										
30-Mar	63.0	N										
31-Mar	56.4	N										

CNEL Average	
No Snowmaking	55.4
Snowmaking	#DIV/0!
Total	55.4
# of No Snowmaking Days	31
# of Snowmaking Days	0
Total Days of Monitoring	31

* A- Air Nozzles
F- Fan Guns

No Snowmaking in March 2010

Meter Downloaded During 3:00 Hour

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2009-103

Heavenly Snowmaking Monitoring

CNEL Summary

CNEL Averages						
	November	December	January	February	March	Average for Measurment Period
Total	55.1	59.7	61.0	55.0	55.4	58.1
Snowmaking	55.1	59.8	61.7	61.1	0.0	59.8
No Snowmaking	55.1	54.9	58.7	53.8	55.4	55.5

	November	December	January	February	March	Total
# of Snowmaking Days	19	30	21	2	0	72
Total Days of Monitoring	29	31	31	28	31	150

Annual Snowmaking CNEL (dB)	**52.7**

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Appendix XI

2009-2010 Ski Shuttle and Route Schedule

Schedules are in effect between 8:00 a.m. and 2:00 p.m. After 2:00 p.m. buses only discharge from lodges or Stateline Transit Center to lodging facilities until approximately 6:00 p.m.

RED ROUTE 10

	MINUTES PAST THE HOUR		
1	Stateline Transit Center	:00	:30
2	Bellamy Court/Forest Suites Resort	:01	:31
3	Heavenly Village Way/Shops at Heavenly Village	:01	:31
4	US Highway 50/Applebee's	:02	:32
5	US Highway 50/Holiday Inn Express	:02	:32
6	Ski Run Boulevard/Lake Tahoe Vacation Resort	:04	:34
7	US Highway 50/Tahoe Beach & Ski (Ski Run Blvd)	:06	:36
8	US Highway 50/Lakeland Village	:06	:36
9	Bal Bijou Road/Lakeshore Lodge & Spa	:08	:38
10	US Highway 50/Best Western Timber Cove Lodge	:10	:40
11	Fremont Avenue/Inn By The Lake (Arrive)	:12	:42
11	Fremont Avenue/Inn By The Lake (Depart)	:12	:42
12	US Highway 50/Johnson Boulevard (Safeway)	:14	:44
13	US Highway 50/Super 8 Motel (Herbert Avenue)	:16	:46
15	US Highway 50/Ski Run Boulevard (Fantasy Inn)	:17	:47
16	US Highway 50/Quality Inn	:17	:47
27	Park Avenue/Cedar Avenue (Park Tahoe Inn)	:19	:49
28	Park Avenue/Manzanita Ave (Big Pines Mountain House)	:20	:50
29	Park Avenue/Pine Boulevard (Heavenly Inn/Best Western)	:20	:50
30	Lakeshore Boulevard/Royal Valhalla	:21	:51
31	Stateline Avenue/Pine Boulevard (Rodeway Inn)	:22	:52
32	Harveys Lake Tahoe Bus Center	:24	:54
33	Friday Avenue/US Highway 50 (Stardust Lodge)	:26	:56
1	Stateline Transit Center	:28	:58

ORANGE ROUTE 11

	MINUTES PAST THE HOUR		
1	Stateline Transit Center	:00	:20
2	Bellamy Court/Forest Suites Resort	:02	:22
3	Heavenly Village Way/Shops at Heavenly Village	:02	:22
17	Pioneer Trail/7-Eleven	:05	:25
46	Pioneer Trail/Americana Village	:07	:27
47	Pioneer Trail/Wildwood Avenue	:08	:28
39	Ski Run Boulevard/Pioneer Trail	:09	:29
40	Heavenly California Lodge (Arrive)	:15	:35
40	Heavenly California Lodge (Depart)	:20	:40
41	Ski Run Boulevard/Inn at Heavenly	:30	:50
43	Pioneer Trail/Aspenwald Road	:32	:52
44	Pioneer Trail/Glen Road (Across from Americana Village)	:35	:55
45	Pioneer Trail/Moss Road (Across from 7-Eleven)	:35	:55
1	Stateline Transit Center	:38	:58

GREEN ROUTE 12

	MINUTES PAST THE HOUR		
1	Stateline Transit Center	:05	:35
2	Bellamy Court/Forest Suites Resort	:06	:36
3	Heavenly Village Way/Shops at Heavenly Village	:06	:36
19	Embassy Suites Hotel	:08	:38
20	Harrah's Lake Tahoe Retail East Entrance	:11	:41
21	MontBleu Resort Casino & Spa Side Entrance	:15	:45
22	US Highway 50/Kingsbury Transit Center	:17	:47
23	Kingsbury Transit Center	:17	:47
24	Lakeside Inn & Casino Side Entrance	:18	:48
26	Horizon Casino Resort Side Entrance	:22	:52
32	Harveys Lake Tahoe Bus Center	:25	:55
33	Friday Avenue/US Highway 50 (Stardust Lodge)	:27	:57
1	Stateline Transit Center	:28	:58

Important Information

These times are approximate and may vary due to road conditions, weather, traffic conditions and other unforeseen circumstances. BlueGO assumes no responsibility for acts or omissions of others, or for lost or stolen or damaged baggage or other personal articles, or for personal items left behind.
Time tables shown are approximate and not guaranteed. Passengers should allow extra time for delays.

GOLD ROUTE 13

	MINUTES PAST THE HOUR		
11	Fremont Avenue/Inn By The Lake	:25	:55
12	US Highway 50/Johnson Boulevard (Safeway)	:27	:57
34	Bavarian Village/Herbert Avenue	Service upon request	
13	US Highway 50/Super 8 Motel (Herbert Avenue)	:29	:59
6	Ski Run Boulevard/Lake Tahoe Vacation Resort	:31	:01
14	Ski Run Boulevard/US Highway 50	:32	:02
35	Ski Run Boulevard/Alder Inn	:33	:03
36	Ski Run Boulevard/Discount Ski	:33	:03
37	Ski Run Boulevard/Across from Rainbow Mountain	:34	:04
38	Ski Run Blvd/Deerfield Lodge & Black Bear Inn (Willow Ave)	:34	:04
39	Ski Run Boulevard/Pioneer Trail	:35	:05
40	Heavenly California Lodge (Arrival)	:38	:08
40	Heavenly California Lodge (Departure)	:40	:10
41	Ski Run Boulevard/Inn at Heavenly	:43	:13
42	Ski Run Boulevard/Terry Lane	:44	:14
7	US Highway 50/Tahoe Beach & Ski (Ski Run Blvd)	:47	:17
8	US Highway 50/Lakeland Village	:47	:17
9	Bal Bijou Road/Lakeshore Lodge & Spa	:48	:18
10	US Highway 50/Best Western Timber Cove Lodge	:50	:20
11	Fremont Avenue/Inn By The Lake	:53	:23

PURPLE ROUTE 14

	MINUTES PAST THE HOUR			
49	Heavenly Boulder Lodge	:03	:23	:43
50	Heavenly Stagecoach Lodge	:10	:30	:50
51	The Ridge Resorts Clubhouse*	:13	:33	:53
50	Heavenly Stagecoach Lodge	Service upon request		
52	Galaxy Lane	Service upon request		
49	Heavenly Boulder Lodge	:20	:40	:00

**Service to The Ridge Resorts begins at 8:33 a.m.*

BLUE ROUTE 15

	MINUTES PAST THE HOUR		
1	Stateline Transit Center	:05	:35
2	Bellamy Court/Forest Suites Resort	:06	:36
3	Heavenly Village Way/Shops at Heavenly Village	:06	:36
48	State Route 207/Market Street (Mott Canyon Tavern)	:12	:42
49	Heavenly Boulder Lodge (Arrival)	:25	:55
49	Heavenly Boulder Lodge (Departure)	:30	:00
50	Heavenly Stagecoach Lodge (Arrival)	:35	:05
50	Heavenly Stagecoach Lodge (Departure)	:40	:10
53	State Route 207/Market Street (Scotty's Hardware)	:53	:23
23	Kingsbury Transit Center	:55	:25
25	US Highway 50/Lakeside Inn & Casino	:57	:27
1	Stateline Transit Center	:00	:30

VIOLET ROUTE 18X

		A.M.						P.M.					
51	The Ridge Resorts Clubhouse	8:30	8:50	9:10	9:30	9:50	10:10	3:00	3:20	3:40	4:00	4:20	4:40
50	Heavenly Stagecoach Lodge	8:40	9:00	9:20	9:40	10:00	10:20	3:10	3:30	3:50	4:10	4:30	4:50
51	The Ridge Resorts Clubhouse	8:48	9:08	9:28	9:48	10:08	10:28	3:18	3:38	3:58	4:18	4:38	4:58

THE RIDGE RESORTS

This route only operates between 8:00 a.m. to 10:00 a.m. and again from 3:30 p.m. to 5:30 p.m.
Between 11:00 am and 2:00 pm utilize Purple Route 14 for service to Heavenly Stagecoach Lodge.

Times listed are departure times.
Buses only stop at designated bus stops.
No flag stops or deviations allowed.

If you have any questions about BlueGO Heavenly Ski Shuttles, please call:

(530) 541-7149 • www.bluego.org

Heavenly is proud to be among the family of

VAIL RESORTS
EXPERIENCE OF A LIFETIME

premier mountain resorts.

Vail. Beaver Creek. Breckenridge Ski Resort. Keystone. Heavenly Lake Tahoe. RockResorts.

CLEAN FUEL VEHICLE

Heavenly is a proud partner with the Tahoe Regional Planning Agency, Tahoe Transportation District and South Tahoe Area Transit Authority known as BlueGO. Together we are working to replace the bus fleet with new clean-fuel technology vehicles. The new vehicles will not only improve air quality and reduce congestion in South Lake Tahoe, but it will directly improve the water quality and clarity of Lake Tahoe.

Heavenly is pleased to be associated with a select group of corporate

American Express — The Official Card of Heavenly
SoBe Life Water — The Official Sports Beverage of Heavenly
Sprint — The Official Communications Provider to Heavenly
Starbucks Coffee — The Official Coffee of Heavenly
Smartwool — The Official Sock of Heavenly
Nature Valley Granola Bars — The Official Natural Energy Source of Heavenly
Hertz — The Official Car Rental Company of Heavenly
Forest Service, U.S. Department of Agriculture — Partners in Outdoor Recreation

Heavenly LAKE TAHOE

BLUE GO

2009 - 2010
SKI SHUTTLE RIDER'S GUIDE

BLUEGO HEAVENLY SKI SHUTTLE

The BlueGO Heavenly Ski Shuttle service is comprised of seven routes (red, green, gold and orange for California and blue, purple, and violet for Nevada). The shuttles pick up at each of the shuttle stops according to the shuttle timetables listed for each route color.

The time tables are in service from 8:00 a.m. - 2:00 p.m. After 2:00 p.m. the shuttles make continuous loops from the Gondola and California / Nevada base lodges to expedite guest return to their lodging properties until approximately 6:00 p.m.

Please allow extra time when riding shuttles during holidays and Saturdays, as the shuttles are in peak demand during these high-use periods. Shuttles also need extra time during inclement weather, as visibility and slippery road conditions require extra caution and slower speeds.

Look for the white BlueGO Heavenly Ski Shuttle stop signs to board the shuttles.

GONDOLA SHUTTLE OPERATION

In the event the gondola is not operating (due to mechanical or weather issues), the green and red routes will go to the California Lodge.

At the end of the day, be sure to board a shuttle with the correct colored sign. Shuttles display colored signs near their entry doors or displayed overhead on the designation sign.

If you have any questions about BlueGO Heavenly Ski Shuttles, please call:

(530) 541-7149 • www.bluego.org

For comments, concerns, or questions or suggestions regarding BlueGO transit services please contact John Andoh, BlueGO Transit Administrator by calling: (775) 589-5284, writing to: South Tahoe Area Transit Authority, 128 Market Street, Stateline, NV 89449, fax to: (775) 588-4527 or emailing: jandoh@bluego.org.

Transit services are provided by MV Transportation, Inc under contract to the South Tahoe Area Transit Authority.

FOR ADDITIONAL MOUNTAIN RESORT INFORMATION CONTACT:

Heavenly Mountain Resort

(775) 586-7000 skiheavenly.com

Information updated as ski or weather conditions change.

Heavenly LAKE TAHOE

Lake Tahoe

Route Key

- **Red Route 10** - Gondola Base and Stateline Transit Center via U.S. Hwy 50
- **Orange Route 11** - Express service between Gondola Base, Stateline Transit Center and California Lodge via Pioneer Trail
- **Green Route 12** - Casino area to Gondola Base and Stateline Transit Center
- **Gold Route 13** - California Lodge to Ski Run Blvd. and U.S. Hwy 50
- **Purple Route 14** - The Ridge Resorts to Boulder Lodge and Stagecoach Lodges, Nevada
- **Blue Route 15** - Express service from Gondola Base and Stateline Transit Center to Boulder and Stagecoach Lodges, Nevada
- **Violet Route 18X** - The Ridge Resorts to Stagecoach Lodge, Nevada

Please call (530) 541-7149 prior to using Shuttle during inclement weather as road conditions may limit operations.

Ski Shuttle Stop Locations

The shuttles display colored signs. Please board appropriate shuttle when returning to your lodge.

P Parking

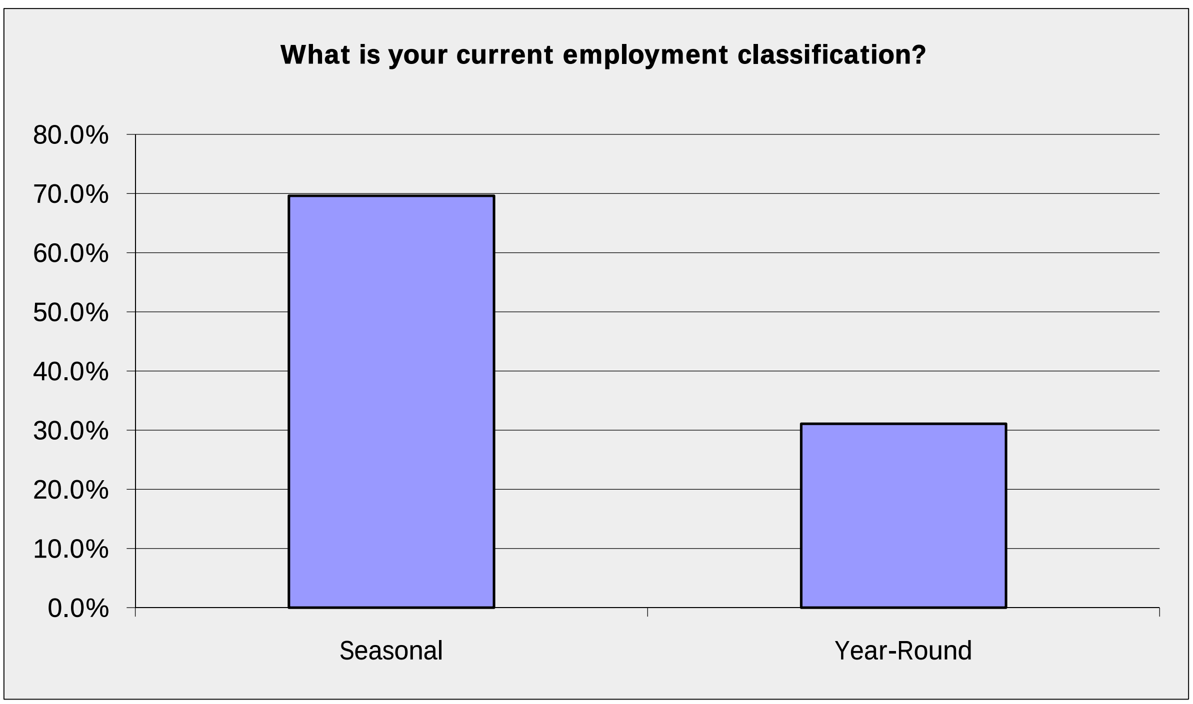
1. Stateline Transit Center
2. Bellamy Court/Forest Suites Resort
3. Heavenly Village Way/Shops at Heavenly Village
4. US Highway 50/Applebee's
5. US Highway 50/Holiday Inn Express
6. Ski Run Boulevard/Lake Tahoe Vacation Resort
7. US Highway 50/Tahoe Beach & Ski (Ski Run Blvd)
8. US Highway 50/Lakeland Village
9. Bal Bijou Road/Lakeshore Lodge & Spa
10. US Highway 50/Best Western Timber Cove Lodge
11. Fremont Avenue/Inn By The Lake
12. US Highway 50/Johnson Boulevard (Safeway)
13. US Highway 50/Super 8 Motel (Herbert Avenue)
14. Ski Run Boulevard/US Highway 50
15. US Highway 50/Ski Run Boulevard (Fantasy Inn)
16. US Highway 50/Quality Inn
17. Pioneer Trail/7-Eleven
18. US Hwy 50/Heavenly Gondola (Special Request Only)
19. Embassy Suites Hotel
20. Harrah's Lake Tahoe Retail East Entrance
21. MontBleu Resort Casino & Spa Side Entrance
22. US Highway 50/Kingsbury Transit Center
23. Kingsbury Transit Center
24. Lakeside Inn & Casino Side Entrance
25. US Highway 50/Lakeside Inn & Casino
26. Horizon Casino Resort Side Entrance
27. Park Avenue/Cedar Avenue (Park Tahoe Inn)
28. Park Avenue/Manzanita Ave (Big Pines Mountain House)
29. Park Avenue/Pine Bouelvard (Heavenly Inn/Best Western)
30. Lakeshore Boulevard/Royal Valhalla
31. Stateline Avenue/Pine Boulevard (Rodeway Inn)
32. Harveys Lake Tahoe Bus Center
33. Friday Avenue/US Highway 50 (Stardust Lodge)
34. Bavarian Village/Herbert Avenue
35. Ski Run Boulevard/Alder Inn
36. Ski Run Boulevard/Discount Ski
37. Ski Run Boulevard/Across from Rainbow Mountain
38. Ski Run Blvd/Deerfield Lodge & Black Bear Inn (Willow Ave)
39. Ski Run Boulevard/Pioneer Trail
40. Heavenly California Lodge
41. Ski Run Boulevard/Inn at Heavenly
42. Ski Run Boulevard/Terry Lane
43. Pioneer Trail/Aspenwald Road
44. Pioneer Trail/Glen Road (Across from Americana Village)
45. Pioneer Trail/Moss Road (Across from 7-Eleven)
46. Pioneer Trail/Americana Village
47. Pioneer Trail/Wildwood Avenue
48. State Route 207/Market Street (Mott Canyon Tavern)
49. Heavenly Boulder Lodge
50. Heavenly Stagecoach Lodge
51. The Ridge Resorts Clubhouse
52. Galaxy Lane
53. State Route 207/Market Street (Scotty's Hardware)

Heavenly is operated under permit of the USDA Forest Service Lake Tahoe Basin Management Unit. The USDA prohibits discrimination in its programs on the basis of race, color, national origin sex, religion, age disability, political beliefs and marital status. (Not all prohibited bases apply to all programs.) To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washington, DC 20250, or call 1-866-632-9992. Persons with disabilities who require alternative means for communication of program information (Braille, large print, audio-tape, etc.) should contact USDA's TARGET center at 202-720-2600 (voice and TDD.)

Appendix XII
2009-2010 Employee Transportation and Housing Survey Results

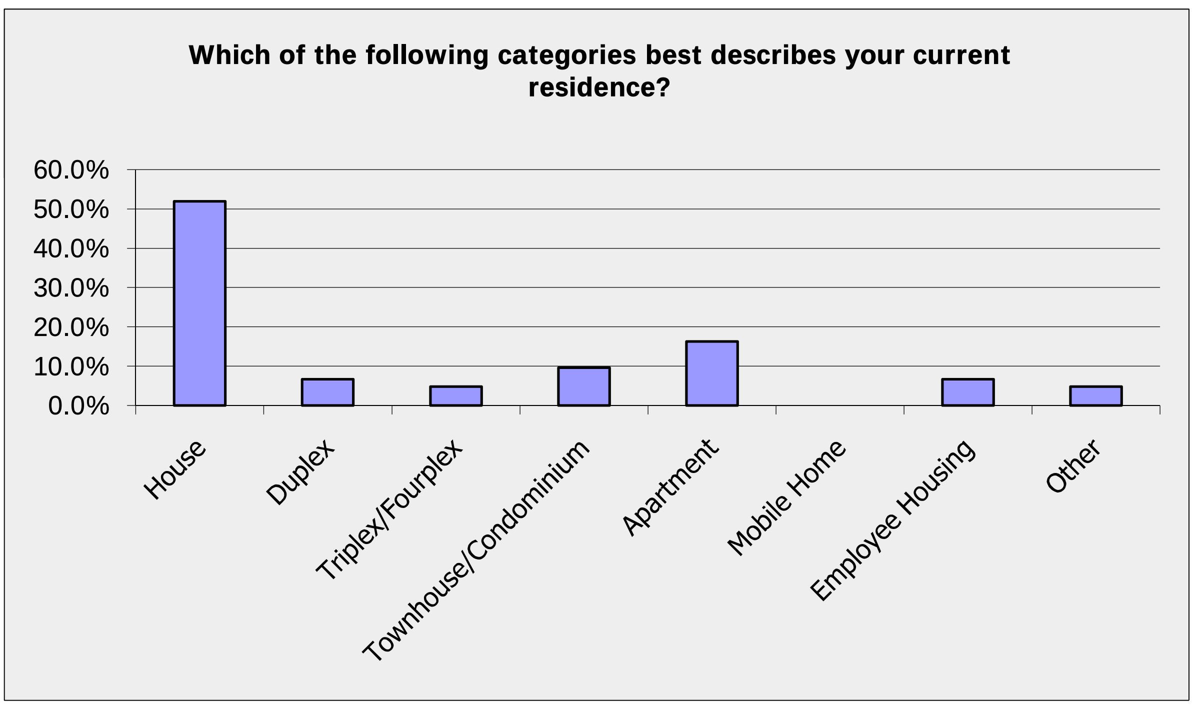
09-10 Employee Housing Survey

What is your current employment classification?		
Answer Options	**Response Percent**	**Response Count**
Seasonal	69.6%	188
Year-Round	31.1%	84
	answered question	**270**
	skipped question	**0**



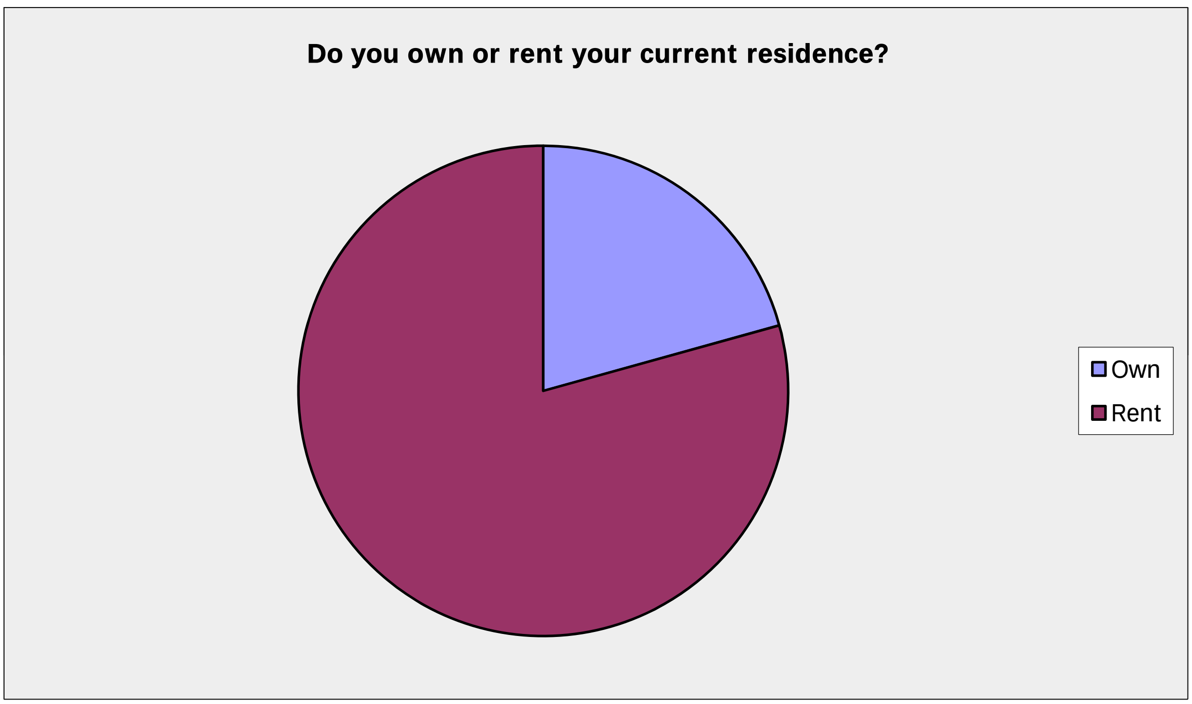
09-10 Employee Housing Survey

Which of the following categories best describes your current residence?		
Answer Options	**Response Percent**	**Response Count**
House	51.9%	140
Duplex	6.7%	18
Triplex/Fourplex	4.8%	13
Townhouse/Condominium	9.6%	26
Apartment	16.3%	44
Mobile Home	0.0%	0
Employee Housing	6.7%	18
Other	4.8%	13
Other (please specify)		10
	answered question	**270**
	skipped question	**0**



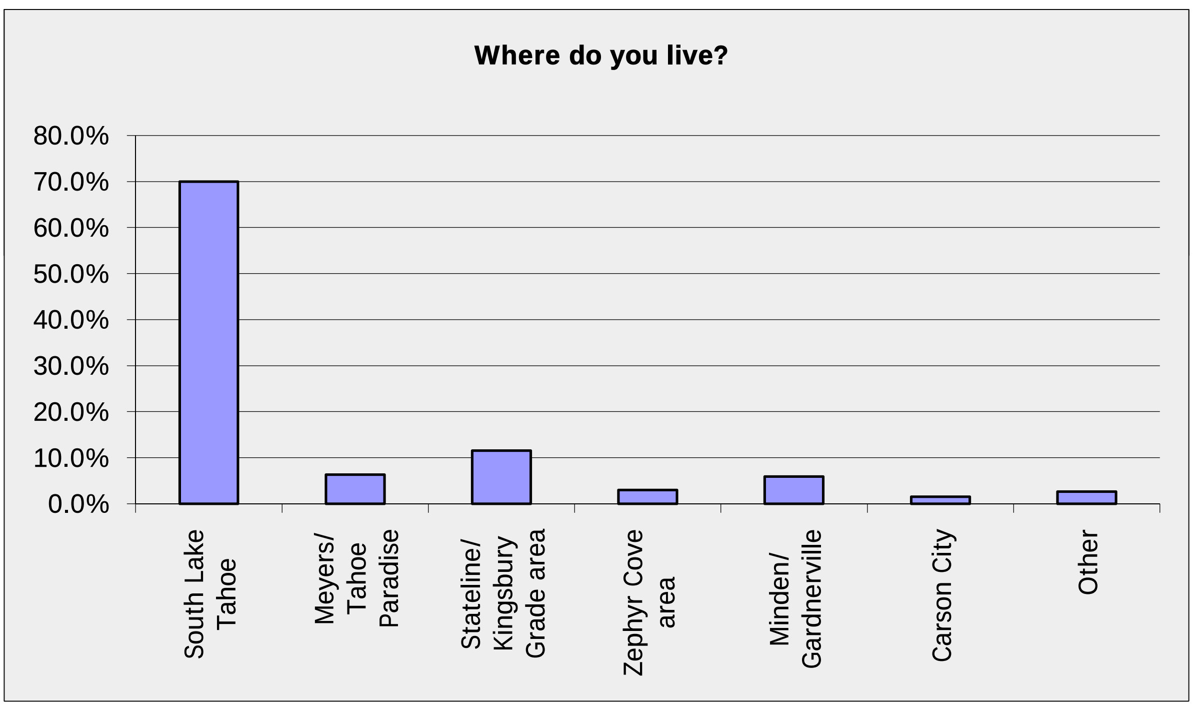
09-10 Employee Housing Survey

Do you own or rent your current residence?		
Answer Options	**Response Percent**	**Response Count**
Own	20.7%	56
Rent	79.3%	214
	answered question	**270**
	skipped question	**0**



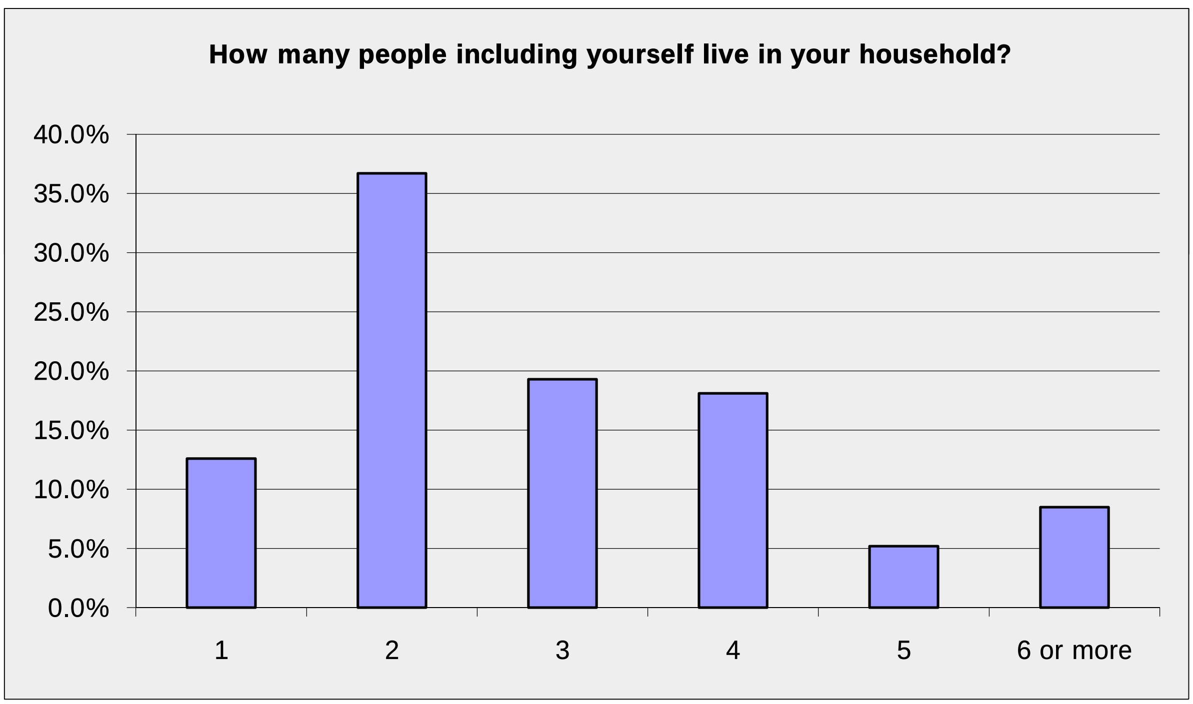
09-10 Employee Housing Survey

Where do you live?		
Answer Options	**Response Percent**	**Response Count**
South Lake Tahoe	70.0%	189
Meyers/ Tahoe Paradise	6.3%	17
Stateline/ Kingsbury Grade area	11.5%	31
Zephyr Cove area	3.0%	8
Minden/ Gardnerville	5.9%	16
Carson City	1.5%	4
Other	2.6%	7
Other (please specify)		5
	answered question	**270**
	skipped question	**0**



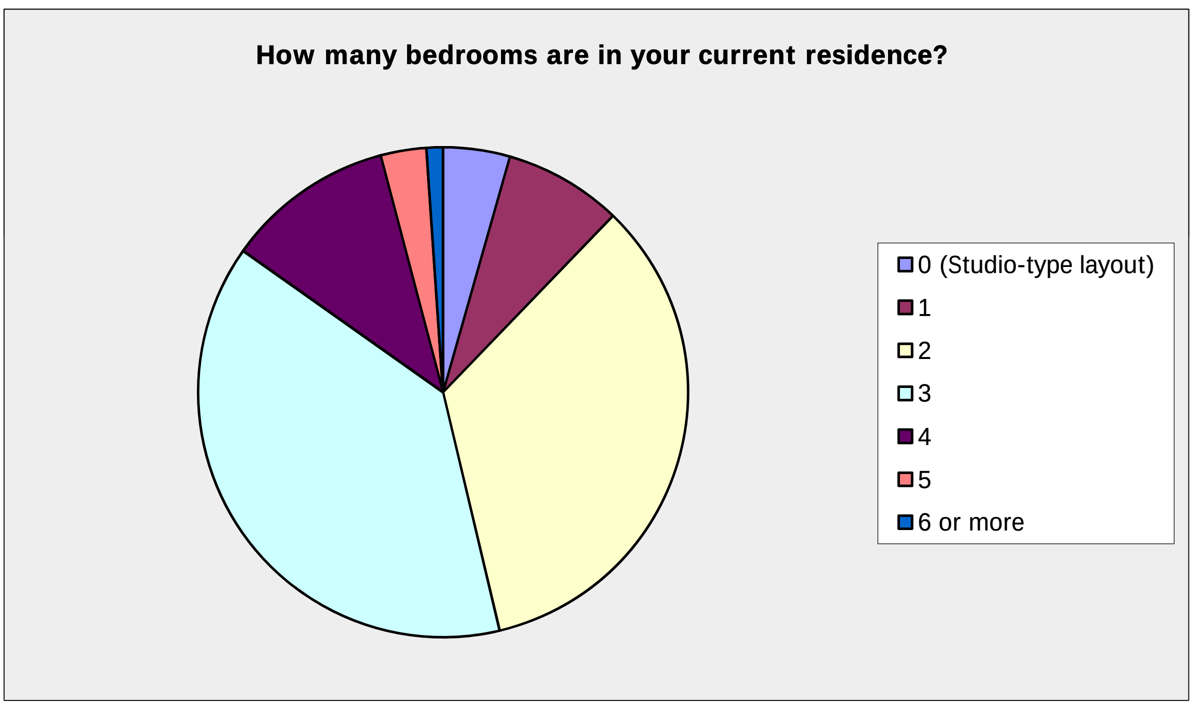
09-10 Employee Housing Survey

How many people including yourself live in your household?		
Answer Options	**Response Percent**	**Response Count**
1	12.6%	34
2	36.7%	99
3	19.3%	52
4	18.1%	49
5	5.2%	14
6 or more	8.5%	23
	answered question	**270**
	skipped question	**0**



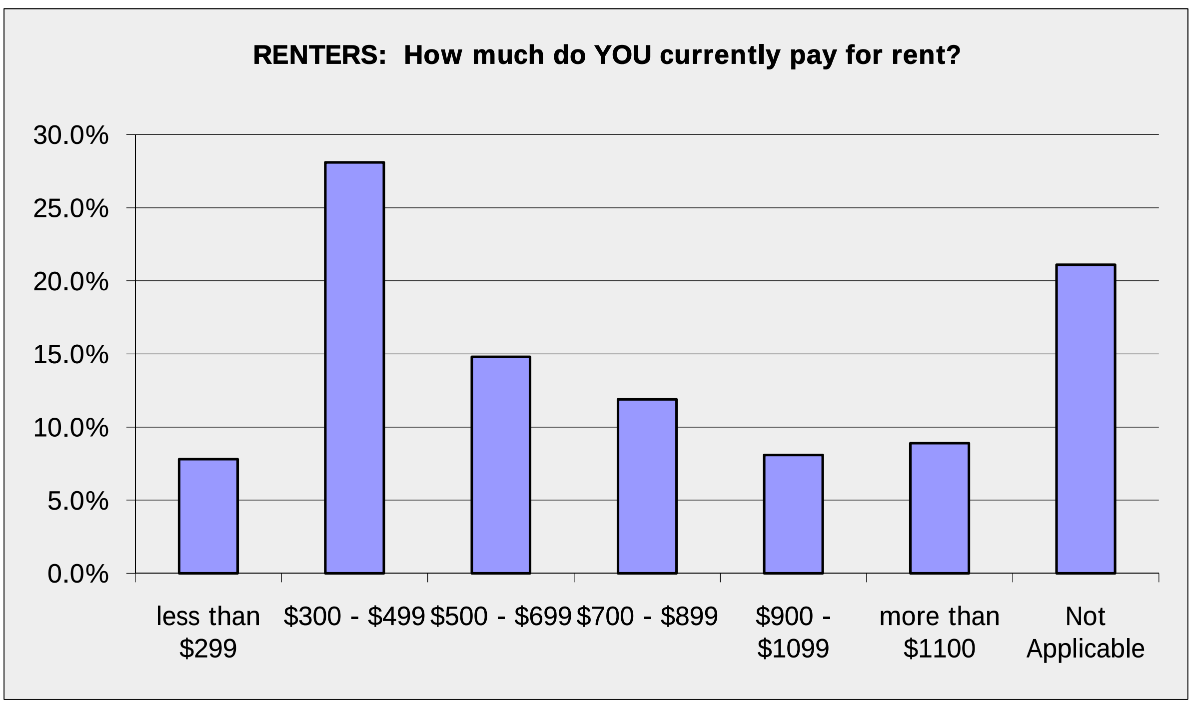
09-10 Employee Housing Survey

How many bedrooms are in your current residence?		
Answer Options	**Response Percent**	**Response Count**
0 (Studio-type layout)	4.4%	12
1	7.8%	21
2	34.1%	92
3	38.5%	104
4	11.1%	30
5	3.0%	8
6 or more	1.1%	3
	answered question	**270**
	skipped question	**0**



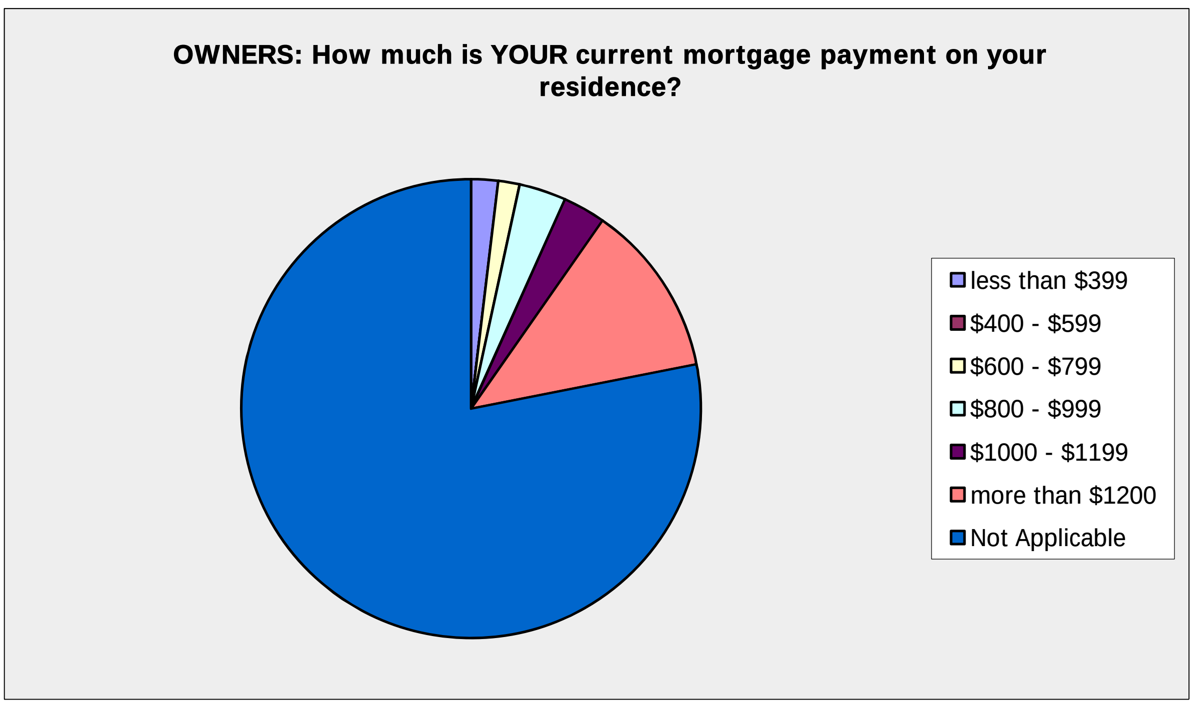
09-10 Employee Housing Survey

RENTERS: How much do YOU currently pay for rent?		
Answer Options	**Response Percent**	**Response Count**
less than $299	7.8%	21
$300 - $499	28.1%	76
$500 - $699	14.8%	40
$700 - $899	11.9%	32
$900 - $1099	8.1%	22
more than $1100	8.9%	24
Not Applicable	21.1%	57
	answered question	**270**
	skipped question	**0**



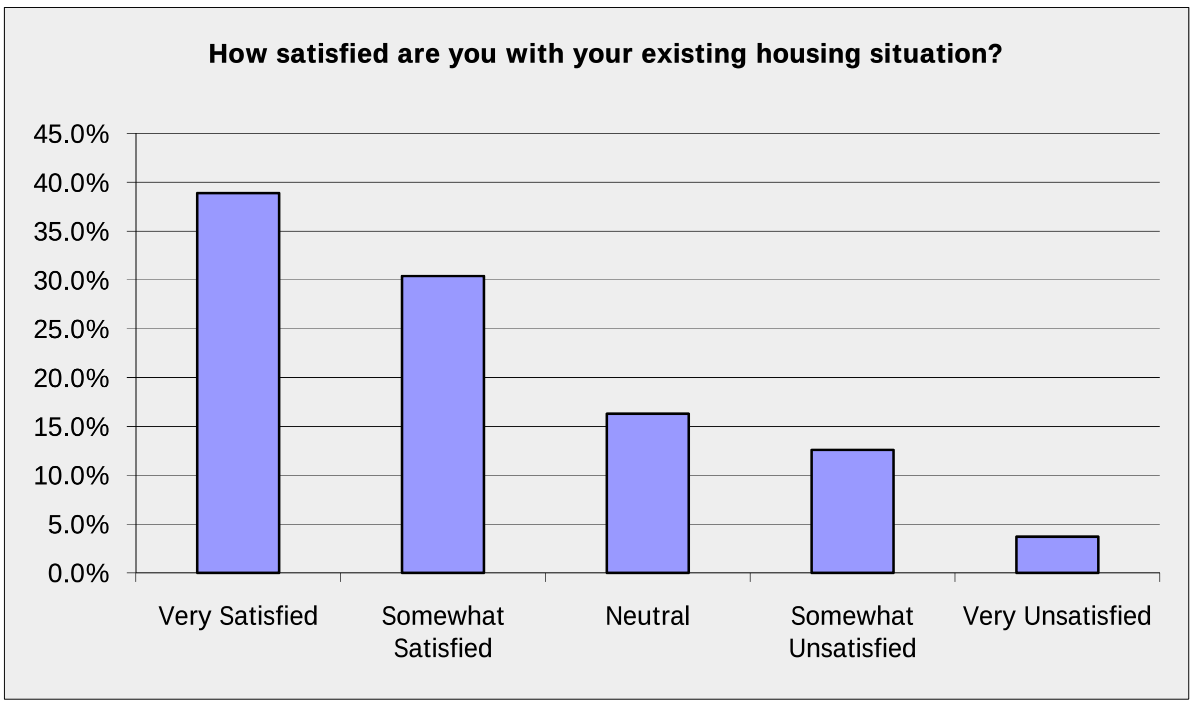
09-10 Employee Housing Survey

OWNERS: How much is YOUR current mortgage payment on your residence?		
Answer Options	**Response Percent**	**Response Count**
less than $399	1.9%	5
$400 - $599	0.0%	0
$600 - $799	1.5%	4
$800 - $999	3.3%	9
$1000 - $1199	3.0%	8
more than $1200	12.2%	33
Not Applicable	78.1%	211
	answered question	**270**
	skipped question	**0**



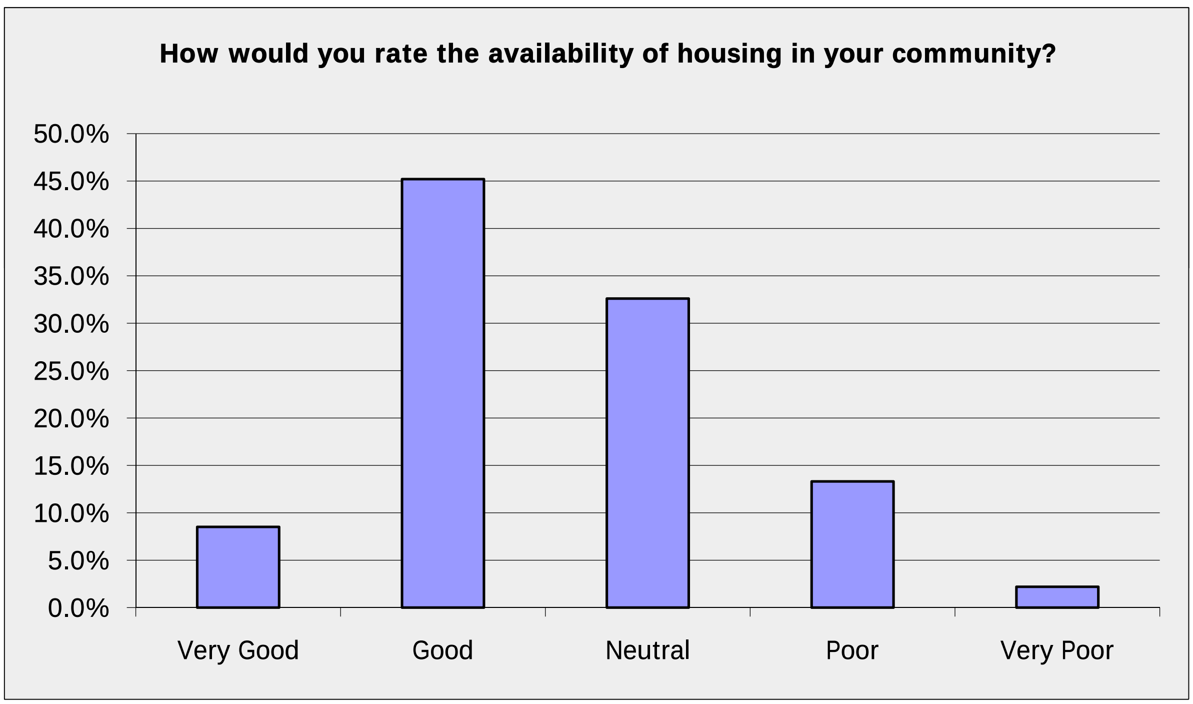
09-10 Employee Housing Survey

How satisfied are you with your existing housing situation?		
Answer Options	**Response Percent**	**Response Count**
Very Satisfied	38.9%	105
Somewhat Satisfied	30.4%	82
Neutral	16.3%	44
Somewhat Unsatisfied	12.6%	34
Very Unsatisfied	3.7%	10
	answered question	**270**
	skipped question	**0**



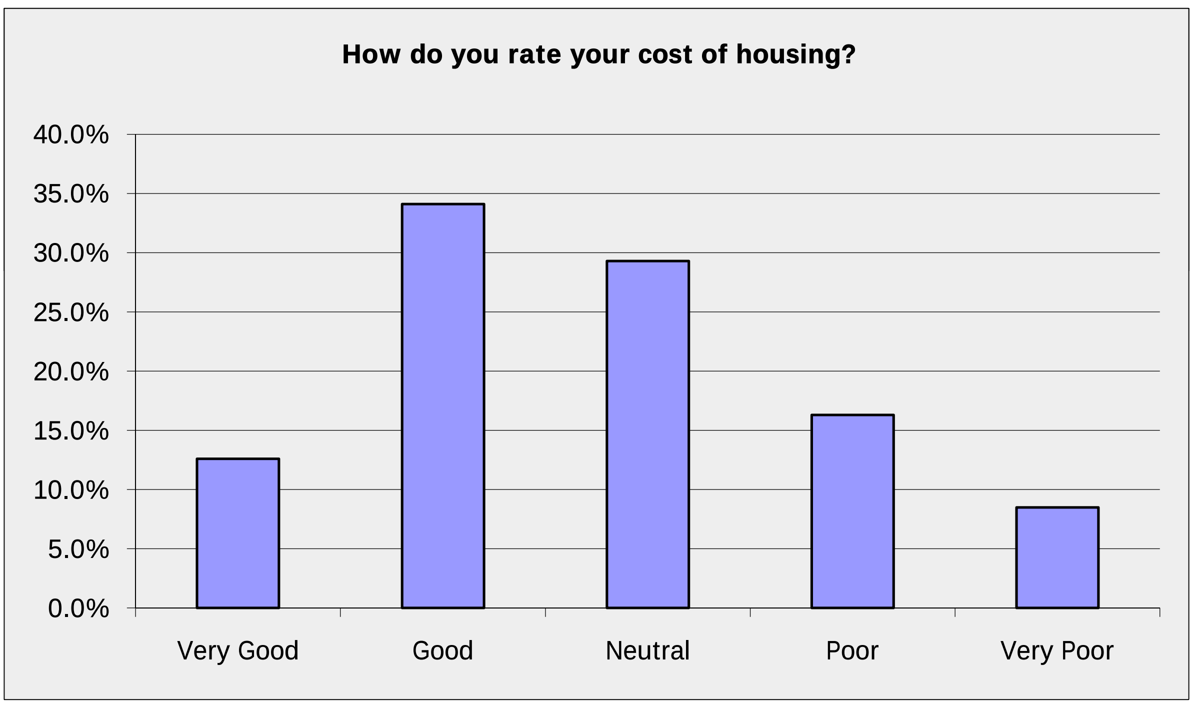
09-10 Employee Housing Survey

How would you rate the availability of housing in your community?		
Answer Options	**Response Percent**	**Response Count**
Very Good	8.5%	23
Good	45.2%	122
Neutral	32.6%	88
Poor	13.3%	36
Very Poor	2.2%	6
	answered question	**270**
	skipped question	**0**



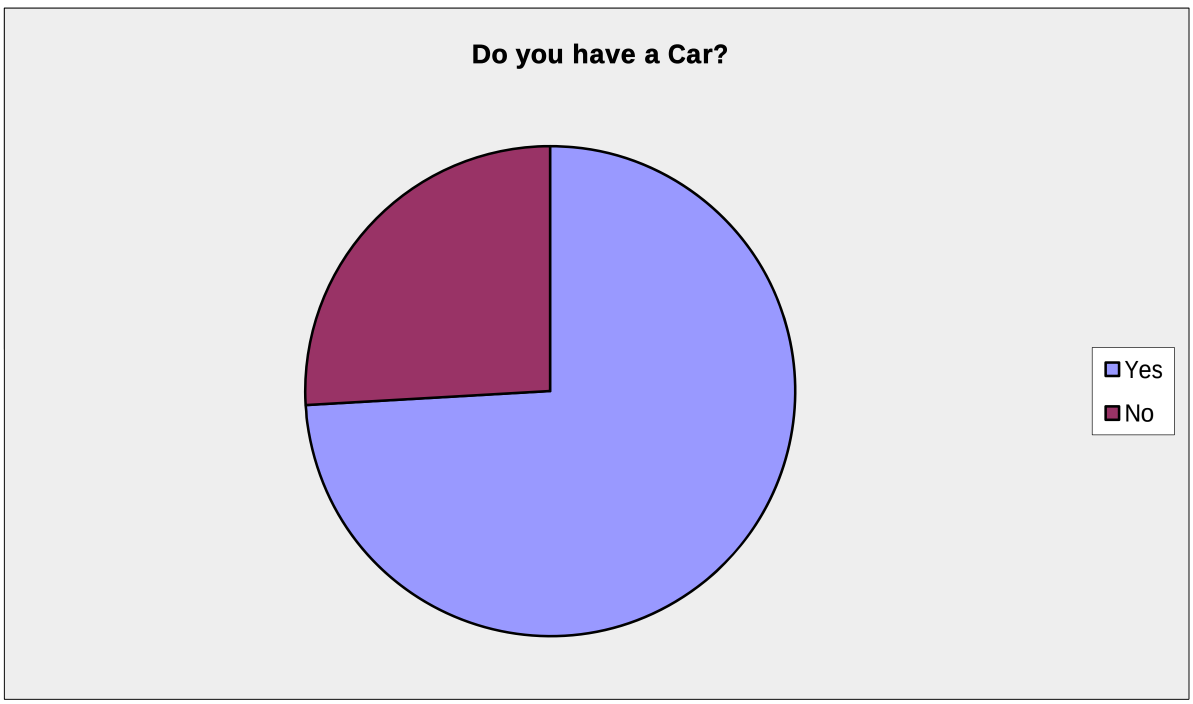
09-10 Employee Housing Survey

How do you rate your cost of housing?		
Answer Options	**Response Percent**	**Response Count**
Very Good	12.6%	34
Good	34.1%	92
Neutral	29.3%	79
Poor	16.3%	44
Very Poor	8.5%	23
	answered question	**270**
	skipped question	**0**



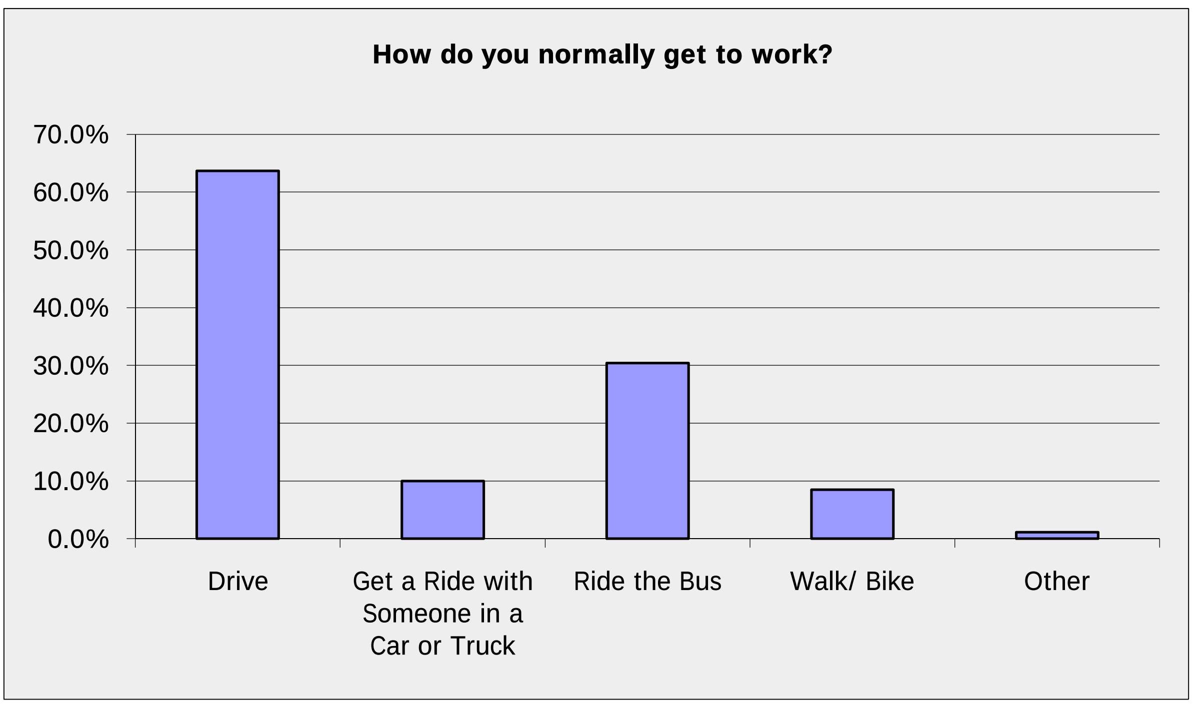
09-10 Employee Housing Survey

Do you have a Car?		
Answer Options	**Response Percent**	**Response Count**
Yes	74.1%	200
No	25.9%	70
	answered question	**270**
	skipped question	**0**



09-10 Employee Housing Survey

How do you normally get to work?		
Answer Options	**Response Percent**	**Response Count**
Drive	63.7%	172
Get a Ride with Someone in a Car or Truck	10.0%	27
Ride the Bus	30.4%	82
Walk/ Bike	8.5%	23
Other	1.1%	3
Other (please specify)		8
	answered question	**270**
	skipped question	**0**



Appendix XIII
Forest Service Letter of Completion for Old Growth Forest Mitigation

United States Department of Agriculture | Forest Service | Lake Tahoe Basin Management Unit | 35 College Drive South Lake Tahoe, CA 96150 530 543-2600

File Code:
Date: March 19, 2009

Andrew Strain
Heavenly Mountain Resort
PO Box 2180
Stateline, NV 89449

Dear Andrew,

The High Meadows stand identified for hand thinning to improve long-term habitat conditions for northern Goshawk per the Heavenly Master Plan Amendment was treated in the fall of 2007. All contract work was completed and accepted per the contract requirements on December 6 2007. I will fax you the signed copies of the Certificate of Final Inspection and the Contract Release for this project for your records. If you have questions, please give me a call at (530) 543-2687.

Sincerely,

SCOTT PARSONS
Contracting Officer's Representative

U.S DEPARTMENT OF AGRICULTURE FOREST SERVICE **CERTIFICATE OF FINAL INSPECTION** *(Reference FSH 6309.31)*	CONTRACT NUMBER **AG-9A63-C-08-0015** UNIT **LTBMU** PROJECT **South Shore hand Thin 2007**
TO: **Matthew Gagnon** **CONTRACTING OFFICER**	NAME AND ADDRESS OF CONTRACTOR **Central Valley Forestry** **18985C Road 256** **Exeter, CA 93221**

I hereby certify that the final inspection of the work under the above contract was made on **12-6-07**.

The last day on which work was performed was **12-6-07** after which no calendar days should be charged against time All materials have been furnished, all the work has been performed, and all the construction required by the contract in accordance with its terms has been completed.

A copy of the inspection report is enclosed.

Enclosure(s)

SIGNATURE	TITLE	DATE
Robert Guebard	**Contracting Officer's Representative**	**12-6-0'**

FS-6300-5 (11/79)

Matthew 12-10-07

FS-6300-16 (11/00)

USDA - Forest Service **CONTRACT RELEASE** *(Reference FSH 6309.11)*	CONTRACT NUMBER AG-9A63-C-06-0015 UNIT LTBMU PROJECT South Shore Hand Thin 2007
TO: Matthew Gagnon CONTRACTING OFFICER	NAME AND ADDRESS OF CONTRACTOR Central Valley Forestry 18985C Road 256 Exeter, CA 93221

In consideration of the receipt of final payment in the amount of $ 84,385.00 the undersigned hereby releases the United States of America from any and all obligations arising under this contract and any modifications thereof except as reserved below.

Reservations:

none

12/10/07
Date (mm/dd/yyyy)

Central Valley Forestry
Contractor

By [signature]

Title Owner

Microsoft Word 2000

Appendix XIV
2009-2010 Avalanche Rescue Plan

HEAVENLY

AVALANCHE

RESCUE

PLAN

2009-2010

GENERAL RESCUE PLAN

General Rules

1. Stay Calm
2. Your safety is the most important thing
3. Work as quickly as possible
4. Do not take undue risks
5. Discipline is essential – follow the rescue plan, stick to your training and job descriptions
6. Remember – you are the victim's best chance for a live recovery
7. Provide emergency care - ABC^{s}, stabilize, and transport
8. Keep accurate notes of the entire operation

General Action Plan – Four Stage Rescue

1. Accident Occurs
2. Accident Reported (rescue operations clock starts)
3. **Stage I initiated – Immediate action**
   - The alarm is sounded/ personnel is frozen at stations/ 10-19 all patrollers
   - Information is gathered from witness
   - Hasty search team is formed and dispatched (with witness if possible)
   - Rescue headquarters contacted
   - Rescue leader designated
   - Rescue recorder designated
   - Accident site commander designated
   - Arrangements made to get avalanche rescue dogs and handlers staged in appropriate safe area. **Only certified rescue dogs will be dispatched**.
   - Additional columns formed and dispatched
4. **Stage II initiated**
   - Additional columns formed and dispatched to accident site
   - Contact medical personnel (see attached appendix)
   - Make arrangements for other rescue dogs/handlers to be transported to accident site
5. **Stage III initiated – Prolonged search**
   - Arrange for additional manpower to relieve tired crews
   - Additional supplies for extended search
   - Arrange for transport of toboggans, blankets, additional first aid equipment, stoves, tents, and other equipment needed for an extended search
6. **Stage IV – clean up**

HEAVENLY AVALANCHE RESCUE PROCEDURES

Summary

The following are steps you should follow if you are the person who receives word of a possible avalanche.

Initial Steps

- Sound the alarm on your radio. Broadcast the report of a possible avalanche and the location of the accident on channels one and three. Notify Dispatch at 6900. Contact all patrol stations to freeze personnel and 10-19 all patrollers.
    1. CA First Aid 6250/6251
    2. Face Patrol 6943
    3. Sky Patrol 2349
    4. NV First Aid 2386
    5. Dipper Patrol 2347
    6. East Peak Patrol 2348
- Make sure the eyewitness is held at, or escorted to, the nearest mountain phone or Patrol Station. It is imperative that this key person makes it back to the avalanche site if possible. If this is not possible then steps need to taken to ensure the witness is held at a patrol station.
- Refer to the witness statement form for the necessary witness information
- Assist in forming and dispatching a hasty team to the reported avalanche site
- Contact the first person available on the attached list of qualified Avalanche **RESCUE LEADERS.** (See Appendix)
- **Public access must be immediately cut off from the accident site – a patroller must be dispatched to close these areas.**
- After a rescue leader has been appointed, notify the following people (use after hours phone numbers if necessary; page 14)
    1. Casey Blann 6268
    2. Les Marsh 6260
    3. Karen Foster 6254
    4. Brian Gannon 6250/6251
    5. Erik Birkholm 6250
    6. Duty Patrol Supervisor 6250
- With the help of the rescue leader, assist in determining a rescue recorder and an accident site commander.

Qualified Avalanche Site Commanders & Rescue Leaders

Name	Work Ext.	Home Phone
Birkholm, Erik Heavenly Snow Safety Director	6250	530-573-1928 805-350-2458
Terry, Colton Heavenly Snow Safety Asst.	6250	530-559-4357 530-541-1980
Blackman, Jeremy Heavenly Snow Safety	6250	530-545-9062
Mcpartland, Ryan Heavenly Snow Safety	6250	530-318-7779 530-544-8089
Gannon, Brian Heavenly Ski Patrol Director	6250	775-782-8783 530-545-3489
Allen, Lee Heavenly Ski Patrol	6250	530-542-4273
Brown, Adrian Heavenly Ski Patrol	6250	530-542-2343

Ultimately this is a senior patroller responsibility

The Rescue Leader and the accident site commander are ultimately responsible for the safety of all field personnel involved. They are also responsible for the on-scene coordination including management of resources, record-keeping, etc. Among these responsibilities is the need to follow protocol and rigid discipline. Certain actions must be taken in a relatively specific order, and it is the responsibility of the Rescue Leader to assure that this occurs. As mentioned, the Rescue Leader's first responsibility is the safety of all field members. S/he might find it necessary to keep all involved (rescuers, media, volunteers, etc.) out of the area before the rescue can even begin, in the case of additional avalanche hazard, worsening weather or darkness, for example. Still, in the absence of these issues, the decision to proceed with the rescue is a complex one that cannot be taken lightly. If the Rescue Leader determines that the risk to rescuers is anything more than minimal, something must be done to reduce the danger. If the danger of additional avalanche cannot be controlled, or if the weather is such that the risk to the rescuers is too great, the safest action is for rescuers to retreat. After the initial hazard assessment is made, the team's leadership/Rescue Leader may decide that further avalanche control work is necessary before rescuers can enter the field (or the accident site). At this point, if explosives are to be used in avalanche control, the Rescue Leader must assure that s/he has radio communications with the control team leader. Furthermore, all associated personnel must be made aware that control work is underway.

RESCUE LEADER INSTRUCTIONS

Summary

The rescue leader is the overall coordinator of the rescue operation, typically the ski patrol director, snow safety director, or a person with equal experience in all facets of the avalanche discipline. He or she should be thoroughly familiar with the rescue plan. The rescue leader should appoint a recorder to keep track of personnel and equipment and maintain a record of the rescue operation history. The rescue leader is also responsible for appointing an accident site commander who acts as his eyes and ears at the avalanche site.

- As the Rescue Leader you will determine whether or not a rescue is actually necessary if no eyewitness is present.
- Appoint and dispatch hasty search team and/or accident site commander
- Arrange for Dog teams to be staged at an appropriate location; prior to avalanche site being deemed safe for rescue operations.
- Appoint a scribe to keep detailed notes of the operation
- Obtain pertinent information from the witness
- Appoint dispatcher at nearest station to accident
- Organize subsequent Stage II columns and dispatch to accident site
- Organize Stage III
- Dispatch Second Stage Columns as needed:
- Arrange for long term search and rescue – additional equipment and or manpower may be necessary
- Contact the appropriate Heavenly managers and advise them of additional equipment you may need such as: snowcats, personnel, snowmobiles, trucks, radios, drivers, food, shelter, etc.
- Notify other Tahoe basin ski areas of the incident in order to receive additional rescue personal and rescue dogs.
- Notify the following agencies:
    1. El Dorado County Sheriffs' Office (530) 573-3300
    2. Douglas County Sheriffs' Dispatch (775) 782-9935 x7
    3. Alpine County Sheriff's Dispatch (916) 694-2231
    4. U.S. Forest Service (530) 573-2600
    5. Mike Guarino, USDA Forest Service
       Work (530) 573-2636
       Home (775) 265-6023
- Contact a skiing physician (see Appendix 3) and Barton Hospital (530) 541-3420
- Contact the Barton Heavenly Clinic – (530) 543-5575
- Maintain radio contact with hasty team leader and/or accident site commander
- Coordinate with other agencies and rescue groups
- Manage overall operation
- At completion:
    1. Verify all personnel accounted for and evacuated
    2. Verify all equipment accounted for
    3. Report to authorities with compiled report.

ACCIDENT SITE COMMANDER INSTRUCTIONS

Summary

An accident site commander is a highly experienced leader (the rescue leader's key person at the avalanche site) who is sent to the accident site as quickly as possible and relieves whoever is in charge (the Hasty team leader). The accident site commander evaluates the actions of those already on the scene and decides where to search, continuing or rearranging probe lines accordingly. A power-operated megaphone is helpful to call out instructions to column and/or probe line leaders. **It is this person's job to see the big picture and guide the rescuers in the most appropriate rescue methods.**

- Upon arrival at the accident site, assume command from the hasty team leader in charge
- Get complete briefing of the rescue operations.
- Arrange for dog team search if not already done.
- Get manpower lists and dog team lists.
- Continue direction of course probe lines.
- Establish and maintain radio contact with rescue leader as soon as possible. Report progress of search and needs of rescuers.
- Arrange to remove witness and exhausted rescuers from the area
- Arrange for the RECCO to be brought to the site and assign one person to do a RECCO search
- After whole debris area has been probed, reorganize probe lines at bottom and repeat coarse probe process. Resort to fine probe technique only when course probe attempts have been unsuccessful and you have determined that there is no chance of rescuing the buried person alive.
- If rescue operation appears to be a lengthy affair, arrange with base for organizing a Third Stage.
- Continue to arrange for the replacement of tired rescuers with fresh personnel.
- Dispatch tired personnel back to base in groups, under leader. Keep track of who is leaving.
- At conclusion of rescue operations, dispatch personnel and equipment back to base in groups with a leader. **MAKE SURE ALL MEMBERS** AND EQUIPMENT ARE ACCOUNTED FOR.

AVALANCHE RESCUE DOGS

Summary-Whenever possible, Heavenly avalanche rescue operations will utilize avalanche rescue dog teams and their handlers. It is very important to know what role the dogs and their handlers play in the rescue operation. Avalanche Rescue Dogs are the most powerful tool when recovering buried avalanche victims, if the use of beacons and experienced operators are not available. Although certified dogs and their handlers are the most powerful tools we have at our disposal, teams must remember the use of the dogs must come after the rescue leader has designated the avalanche rescue site **safe for rescue operations**. Individual rescuers must not just grab a dog and go. This is to ensure the safety of all rescuers / dogs involved. Individuals must avoid making a bad situation worse. Rely on the rescue leader to guide the dog teams to a safe staging location until the avalanche site is deemed safe for rescue operations by the rescue leader / accident site commander.

It is the rescue leader's / accident site commander's duty to delegate dog teams. This is to utilize multiple teams, and not to compromise the rescue operation and the teams' safety. All personnel must rely on the dog handlers to teach the group what to do when the dogs indicate, alert, and etc. Handlers must also advise personnel how to work around his/her dog. Rescue Leaders must notify arriving resources that avalanche dogs either are or may be on scene.

Special care must be taken to assure that individuals on scene do not compromise the effectiveness of dogs by any of the following actions: Individuals who must urinate or defecate must do so far away from the site at a designated place. Human feces can contaminate the area and compromise the effectiveness of dogs. Rescuers should not spit in the area. This is especially important if rescuers who use chewing tobacco are dispersed into the field. These individuals should refrain from this activity, since any human body fluids can compromise the effectiveness of avalanche rescue dogs.

Only certified avalanche rescue dogs will be used in Heavenly rescue operations. This ensures efficiency and increases the value of our most powerful rescue tools in Heavenly's avalanche rescue plan.

FIRST COLUMN LEADER (Hasty Search Party) INSTRUCTIONS

Summary-The hasty search team leader is temporarily is in charge at the accident site until the accident site commander relieves the individual. As the first leader person to arrive at the site, the hasty team leader immediately assesses the potential for further avalanches that could threaten the rescuers. If the hazard remains high, the leader must make the decision whether or not to continue the rescue operation. Any hazard that remains must be mitigated before the rescue operation can proceed. The first column leader must also establish emergency escape routes for the rescuers. The leader should also assign an avalanche guard, if possible, whose function is to watch for signs of other avalanches in or near the site. Based on clues, eyewitness accounts, and the avalanche debris, the hasty team personnel identify, prioritize, and spot probe the areas where the victim is most likely to be buried. The hasty team leader will also assign a beacon searcher to search the entire slide path. Eventually, if the first pass is not successful in recovering the victim, then a probe line will be formed at the toe of the slide, the location of which will be determined by the leader.

YOU ARE IN CHARGE OF THE HASTY SEARCH. WITH EMPHASIS ON SPEED AND SAFETY, PROCEED AS FOLLOWS :

- Screen out volunteers who seem unfit for the operation
- Equip each volunteer with a hasty pack and any additional equipment as assigned.
- Proceed to accident, according to the directions or the RESCUE LEADER. It may be necessary to have the witness accompany your column.
- If certified rescue dogs and dog handlers are present, dog teams will proceed to an appropriate staging area to wait to be dispatched by rescue leader.
- At avalanche site, evaluate the existing hazard and formulate the escape route. Each member of your column should know the escape route.
- Post an avalanche guard as necessary
- Designate an area outside the slide path to store and stage rescue team's personal equipment
- Begin rescue dog search if certified dogs and handlers are present.
- Assign one person to do a beacon search – all other rescuers and witness MUST switch their beacons to the lowest receive setting.
- All other rescuers should set up their probes.
- Make a through surface search of slide area, including outside perimeter.
- Mark the victim's last seen point if possible as well as any clothing or equipment found. **Blue flags** are used for clues, **yellow flags** for last seen point, and **red flags** are used for the deposition zone perimeter.
- Determine most likely burial regions and spot–probe all likely catchment areas in the path. Likely catchment areas include above and below trees and rocks, bends in the slide path, and at the toe of the deposition.
- If the first pass is unsuccessful, then the team must begin a course probe line with the available personnel.
- COURSE PROBE using the 'three – hole' method: Work uphill starting at the toe of the slide. Keep the holes approximately two feet apart. Move forward 2 feet and repeat.
- As additional columns arrive, integrate manpower into larger probe lines. Retain leadership until Accident Site Commander arrives. Brief the Accident Site Commander upon arrival. Give him/her manpower lists.

COLUMN LEADERS (Second, Third, etc) INSTRUCTIONS

Summary

Column (or probe line) leaders are personnel responsible for fast, continuous, and effective probing. This leader is also responsible for leading the column safely to the avalanche site. These individuals must be militaristic and precise in their leadership of the probing operation to increase the odds of finding the victim alive. The column leader needs to realign the probe line often to ensure maximum effectiveness and efficiency. The leader must allow individual probers to rest as they tire but make sure the overall probe line keeps moving as probers are replaced.

WITH EMPHASIS ON SPEED AND SAFETY, PROCEED AS FOLLOWS

- Screen out volunteers who seem unfit for the operation
- Equip each volunteer with a probe
- Pick up one shovel pack.
- Take additional equipment as assigned by RESCUE LEADER.
- Write down the names of members in your party and give to RESCUE LEADER.
- Follow established route to accident site. Improve trail markings as necessary.
- Upon arrival at accident site, follow directions of person in charge (either Hasty Team Leader or Accident Site Commander).
- Turn over manpower list to Accident Site Commander.

RESCUE RECORDER DUTIES

Summary
The Rescue Recorder works directly for the Rescue Leader, and should be at his side at all times in order to keep an accurate written account of everything that takes place, such as:

- Names, dates and times
- Manpower lists
- Equipment Lists
- Victims (names, ages, addresses, etc.)
- Rescue history
- Witness report

Also

- ***NO*** information should be given out until first cleared with the respective Sheriffs' Office.
- Collect all forms, notes and written information pertaining to the operation. Give them to the Sheriffs' Department Officer in charge for deposition. Make a complete copy of the avalanche rescue for Heavenly's records.

RECORDER INSTRUCTIONS AND CHECKLIST

- Keep an account log of rescue operation, including all names, times and equipment.
- Record the names, addresses and phone numbers of all outside personnel.
- Assist RESCUE LEADER with the remainder of all duties.
- Record the names, addresses and phone numbers of all outside suppliers and their equipment.
- Record obvious deficiencies and problems identified through closing of operation.
- Use inter-mountain phone line to sound general alarm for notification of all mountain personnel. Give location of rescue headquarters and instruct departments how to report for assignment.

STAGE IV – SECURING AVALANCHE RESCUE OPERATIONS

- **Accident Site Commander** must make sure that all members of the rescue teams are accounted for before leaving the rescue area.
- **Accident Site Commander** should be sure all equipment is picked up and returned to base camp before leaving rescue area. All trail markers should be picked up on return trip.
- **Rescue Leader** must make sure all rescuers have returned and have signed in at the end of the operation.
- **Rescue Leader** should notify the appropriate Sheriffs' Office and Forest Service that the rescue effort has ceased.
- Upon return to base camp, all equipment should be returned to a central location (designated by the Rescue Leader).
- All equipment borrowed from other areas will be place in separate piles and the **Rescue Leader** will make arrangement for its inspection and return.
- All forms and notes should be turned into the **Rescue Recorder** upon arrival of rescue teams to base camp. Anyone that has written information should turn this in before leaving the rescue area. (This information will be forwarded to the Sheriff's Office)
- **Ski Patrol** will check all equipment and restore, replace, or repair immediately. Remove all flashlight batteries and plan for immediate replacement.
- **Rescue Leader** should make out a final report as soon as it is possible.

List of available physicians

MD	Specialty	Office	Home
Barton Clinic Ca. Base	Emergency	530-543-5575	N/A
Brooks, Steve	Emergency Stateline medical	775-588-3561	775-588-5601
Marlowe, Paul	Emergency Stateline Medical	775-588-3561	775-588-5966
Martin, Brooks	General Practice	530-542-1900	530-577-8555
Muscat, Marissa	General Practice	530-543-5660	530-543-3239
Rupp, Robert	Orthopedics	775-588-3636	530-544-5457

When rescuers discover any victims, prompt medical attention must be given. Remember that it is a common belief among the emergency medical community that "a victim is not dead until warm and dead." This is especially true of young children, and is called the "Mammalian Diving Reflex." Seemingly miraculous recoveries have been documented where drowning victims have survived without oxygen for up to 45 minutes in ice-cold water. It must be noted, however, that the speed with which the body is cooled is directly proportional to the rate of survival. Unlike drowning accidents in cold water, where the body is cooled rapidly, the avalanche victim will not cool as quickly, therefore similar recoveries are unlikely. Still, every effort to revive the victims with aggressive CPR should be maintained until the rescuers either cannot, or should not continue. Rescue members generally do not declare any person to be dead. An emergency room physician or coroner often makes this decision. Rescuers should contact their local Trauma Center Emergency Room (ER) and describe to the physician the condition of the victim, the estimated length of burial, whether the victim had an air space and/or an open airway as well as the medical attention given to the victim. This can often be done over the radio, with the assistance of local dispatch that might contact the ER physician by landline and relay the required information. In the meantime, rescuers should continue aggressive life support, including CPR, until they cannot or should not continue.

Equipment List for an Extended Search

This is a list of the items that may be needed in the event of an extended search:

1. Extra Shovels (Heavy Duty)
2. Tents
3. Sleeping Bags
4. Headlamps for night operations
5. Floodlights (gas or propane)
6. Generator
7. Flares
8. Megaphone (battery powered)
9. Extra flagging
10. Toboggans
11. Rope
12. Food & Water
13. Stove

Heavenly Management Personnel

Emergency Call List
2008 - 2009

Management Personnel	After Hours Numbers
Casey Blann, VP Mountain Ops	530-577-8313 (Home)
Jim Laramore, Director Snow Surfaces	775-450-6896(Cell)
Les Marsh, VP Human Resources	530-577-4660 (Home)
	970-314-9523 (Cell)
Karen Foster, Risk Manager	775-450-9382 (Cell)
	775-588-5818 (Home)
Brian Gannon, Patrol Director	775-782-8783 (Home)
	530-545-3489(Cell)
Erik Birkholm, Snow Safety Coordinator	530-573-1928 (Home)
	805-350-2458 (Cell)
James Laws, Security Manager	530-577-8228 (Home)
Ed Sousek, Dir. Base Area Ops	530-577-0674 (Home)

Tram Personnel
3860 Saddle Rd. South lake Tahoe Ca. 96150

Steve McBride	530-573-8901 (Home)	Tram Outside Line 530-544-6021
Rich McAdon	530-541-1516 (Home)	Tram Extensions: 775-586-7000
Tim McFarland	775-265-4212 (Home)	Lower Station: 6958
	775-294-2137 (Cell)	Upper Station: 6001

Gondola Personnel
4080 Lake Tahoe Boulevard, South Lake Tahoe, Ca. 96150

James Grant – Gondola Lift Operations 757-572-5632 ext. 6066
Kevin Higgins – Gondola Maintenance Supervisor 530-573-0530 ext. 2308 / 6066
Base Station – 6066
Mid-Station – 6067
Top-Station - 6068

Lift Operations

James Grant - Director of lift operations ext. 6232
Steve Steele- Ca. Lift Supervisor ext. 6215 / 6216
Karyn Lacey - Nv. Lift Supervisor ext. 2370 / 2370
Audre Villaret- Ca. Lift Maintenance Supervisor 530-543-1713 ext. 6942
Criag Altringer -Nv. Lift Maintenance Supervisor 775-265-0058 ext.2323

<u>AVALANCHE WITNESS REPORT</u>

Date: ______________________ Time: ____________________

Exact Location of the Avalanche: ____________________Time of Avalanche________

Number of Persons Buried: ________________

Description of victim(s) ____

Avalanche Beacons: Yes / No

Skier or Snowboarder(s)? ____

Number and Condition of others at the site:

____

____

____

______

Size of the Avalanche: __________________________

Briefly Describe Accident and Action/Location of Survivors:

____

____

____

____

____

Witness Name____________________________________
Address ____
Phone ____________________
Signature ______________________________________
Employee Taking Report___________________________

<u>Avalanche Recorder Notes</u>

TIME ACCIDENT WAS REPORTED:______________________________________

TIME ACCIDENT OCCURRED:____

REPORTED BY:____

LOCATION OF ACCIDENT:____
NUMBER OF PEOPLE CAUGHT:____
____

NAMES:____
____
____

<u>HASTY TEAM DISPATCHED</u>:
PLACE AND TIME:____
TEAM LEADER:____
MEMBERS:____
____
____
EQUIPMENT:____
____
____

<u>RESCUE LEADER</u> _____________________

<u>ACCIDENT SITE COMMANDER</u> _________________________

<u>RESCUE RECORDER</u> ___________________________

<u>RESCUE DISPATCHER</u> ____________________________

<u>ADDITIONAL COLUMNS DISPATCHED</u>
<u>Column 2</u>
PLACE AND TIME:____
TEAM LEADER:____
MEMBERS:____
____
____
EQUIPMENT:____
____
____
<u>Column 3</u>
PLACE AND TIME:____
TEAM LEADER:____
MEMBERS:____
____
____
EQUIPMENT:____

Column 4
PLACE AND TIME:____
TEAM LEADER:____
MEMBERS:____
____
____
EQUIPMENT:____
Column 5
PLACE AND TIME:____
TEAM LEADER:____
MEMBERS:____
____
____
EQUIPMENT:____
Column 6
PLACE AND TIME:____
TEAM LEADER:____
MEMBERS:____
____
____
EQUIPMENT:____
Column 7
PLACE AND TIME:____
TEAM LEADER:____
MEMBERS:____
____
____
EQUIPMENT:____
Column 8
PLACE AND TIME:____
TEAM LEADER:____
MEMBERS:____
____
____
EQUIPMENT:____

Avalanche Recorder Notes (cont)

Additional Manpower List: ____

____

Other Notes:

AVALANCHE RESCUE LEADER- NOTES

ACCIDENT SITE COMMANDER - NOTES

ACCIDENT SITE COMMANDER – SKETCH OF AVALANCHE AREA

HASTY TEAM LEADER NOTES

Team Members

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________

Areas Probed

____

____

Exact Location of Avalanche

____

____

<u>Column Team Leader - Notes</u>

<u>Column Team Members</u>

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

Column Leader Notes:

AVALANCHE RESCUE EQUIPMENT INVENTORY

FACE PATROL (6943)

Two (2) Hasty Packs:

_____ shovels
_____ collapsible probes
_____ probe line markers
_____ instructions for Hasty Search Team Leader
_____ instructions for Accident Site Commander
_____ pencils
_____ extra paper

One (1) Industrial probes & Shovel Pack:

_____ Industrial heavy duty probes x 6
_____ shovels
_____ flagging
_____ probe line markers

Conduit Probes _____

SKY PATROL (2349)

Two (2) Hasty Packs:

_____ shovels
_____ collapsible probes
_____ rolls of flagging
_____ probe line markers
_____ instructions for Hasty Search Team
_____ instructions for Accident Site Commander
_____ instructions for First Column Leader
_____ pencils
_____ extra paper

One (1) Shovel Pack:

______ shovels
_____ instructions for First Column Leader
_____ flagging
_____ probe line markers

Conduit Probes _____

DIPPER PATROL (2347)

Two (2) Hasty Packs:

_____ shovels
_____ collapsible probes
_____ rolls of flagging
_____ probe line markers
_____ instructions for Hasty Search Team
_____ instructions for Accident Site Commander
_____ instructions for First Column Leader
_____ pencils
_____ extra paper

One (1) Industrial probe & Shovel Pack:

______Industrial heavy duty probes x 7
______shovels
_____ instructions for First Column Leader
_____ flagging
_____ probe line markers

i. Conduit Probes

______

EAST PEAK PATROL (2348)

Two (2) Hasty Packs:

_____ shovels
_____ collapsible probes
_____ rolls of flagging
_____ probe line markers
_____ instructions for Hasty Search Team
_____ instructions for Accident Site Commander
_____ instructions for First Column Leader
_____ pencils
_____ extra paper

One (1) Shovel Pack:

_____ shovels
_____ instructions for First Column Leader
_____ flagging
_____ probe line markers

Conduit Probes

____

SELF RESCUE

Summary

While no amount of training can prepare you for every possible situation, the following are tips to follow if you are caught in an avalanche.

1. While the avalanche is still moving
   - Yell. Let your partners know that you are caught!
   - Try to escape (hopefully you already had an escape route planned).
   - If you cannot escape off the slab then get rid of your equipment. Release your bindings by kicking them off and lose your poles.
   - Leave your pack on. It provides valuable protection for your back, contains things you will need if you survive, and may help you 'float' toward the surface of the avalanche while it is still moving.
   - Number one – fight for your life!
2. As the avalanche comes to a stop
   - Try to make a space around your face and mouth with your hands.
   - Extend a hand toward the surface
3. When the avalanche comes to a stop
   - Try to relax

WHAT TO DO IF YOUR PARTNER GETS CAUGHT

1. Shout out to your partner if he is not aware of the avalanche!
2. If he is caught it is imperative that you watch closely and get a last seen point
3. Memorize exactly where you saw them last with nearby landmarks (trees, rocks, etc)
4. If they are swallowed up by snow, watch the parcel of snow to see where it ends up
5. Immediately notify the nearest patrol duty station of the avalanche so the alarm can be sounded and an organized search can be mobilized
6. Stop, think, and plan – make a decision if it is safe to proceed to the debris zone.

METHODS OF LOCATING AVALANCHE VICTIMS

1. The victim must be found **– alive!**
2. General Procedures
   - From witness or clues determine last seen area
   - Perform a beacon search even if a witness states the victim was not wearing one (the witness may be wrong, and there is always a chance more than one person was caught)
   - Establish a probable victim trajectory in the avalanche
   - Make a rapid but systematic check of the debris surface
   - Mark all clues, last seen point, slide path perimeter.
   - Pick up each clue, probe around the clue, then mark it with a flag and leave in place
   - Make initial spot probes of most likely burial regions.
   - Coarse probe from the bottom of the slide path up
   - Resort to fine probing only when the probability of a live rescue has become slight
3. Decisions concerning the search procedures are in the hands of the accident site commander.

ESTABLISHING THE VICTIM'S MOST LIKELY LOCATION

1. Generalities
   - A moving avalanche resembles a fluid
   - The majority of buried victims are carried to the toe of the slide
   - If two points of the victim's trajectory can be established, the victim will probably be in the flow line below the two points.
   - Any terrain features that catch and hold avalanche debris are likely to catch victims.
   - In a wandering gully, all bends are likely burial points. Vegetation, rocks, and obstacles act as snares.
   - Maximum speed of the flowing snow occurs at the avalanche center.
   - Remember that it is possible the victim got thrown clear of the debris

PROBING

Summary

In the absence of transceivers and/or dogs, probing may give rescuers the best chance of finding the victim. Probing is a slow and tedious method of search when compared to transceivers or dogs, however, it is the only practical method if the victim is not wearing a transceiver and if a dog is unavailable. Initial spot probing will take place when the hasty team arrives on scene, but as more rescuers arrive on scene, the accident site commander will designate where these probe teams (columns) will search. Starting at the bottom of the toe of the avalanche the probe line advances uphill, working silently and steadily. Probe lines must be well disciplined and properly spaced in order to be effective. About fifteen to twenty probers per column is adequate, and if extra manpower is available a person can be place on either end of the column to ensure alignment. The boundaries of the probed area should be marked as the probe line advances. Probing does not stop when a strike is felt. The probe is left in place and given a new probe. The column proceeds while a shoveler investigates the strike.

Course Probe: When sufficient numbers of rescuers are available use the coarse probe method.
Dimensions: Probers stand approximately elbow-to-elbow with hands on hips probing once in between feet. On command the line advances one step or approximately .7 meters and probes once again in the same manner. This results in a probe pattern of approximately 30 inches between probes across the slope and 28 inches up or down slope.

Open Order Coarse Probe: This is an alternative to coarse probing and is useful where terrain is steep or there are only a few probers.
Dimensions: Probers stand farther apart – approximately palm-to-palm probing once to left and once to the right. Forward advance is the same as a coarse probe - this results in the same probe pattern as a coarse probe.

Three Probe Method: This is again a variation of the coarse probe and it is also useful when the number of probers is small and the terrain is steep. It will typically be the method employed by the hasty team once their initial spot probes and surface search are complete.
Dimensions: Once again the probers line up palm to palm and then probe three times – once to the left, once to the right, and once in the center, keeping the holes about 60 cm apart. This kind of coarse probing has about an 80 percent chance of finding a victim on the first pass.

Fine Probing: Fine probing is high density probing. It is time consuming when compared to coarse probing, therefore it is not done until all other methods have been exhausted and a live recovery is not expected.
Dimensions: Probers line up elbow-to-elbow, probing three times – once left, once right, and once center. Forward advance is only about 12 inches. The space between probes is ten inches across slope and twelve inches upslope.