

**TELLURIDE SKI AREA EXPANSION  
SNOW SAFETY PLAN DEVELOPMENT AND IMPLEMENTATION  
1993-2001**

Craig Sterbenz \*  
Telluride Ski & Golf Company, Telluride, Colorado

Proposed expansion of the Telluride Ski Area onto previously permitted, but undeveloped, National Forest lands required an Environmental Impact Statement (EIS) and subsequent Avalanche Technical Report. The initial portion of the study during 1993-1994 focused on producing an avalanche atlas and map to identify and catalog all avalanche terrain within the proposed expansion area. Secondly, this atlas became the basis of the Avalanche Technical Report, which identified potential avalanche hazards and proposed possible mitigation options.

Three to five years of continual observations were needed to fully evaluate the potential hazards and develop the basis of a snow safety plan. These observations required the installation and operation of a computerized weather station network, installation of two new avalanchers and increased staffing to conduct semi-routine control routes and record snowpack and avalanche observations. In order to effectively manage all of the data, templates were created for a relational database, which permitted cross-referencing of all weather, terrain and avalanche observations. This database provided for a 'nearest- neighbor' 'expert' forecasting system as well as for reporting of daily observations to local avalanche centers and the Westwide Avalanche Network (WWAN). Daily evaluations of all possible mitigation options were maintained to determine the most effective control methods.

A large storm cycle in 1995 yielded several very large "design" avalanches which resulted in several design changes to proposed lifts and the development of new innovative tools for more effective hazard management.

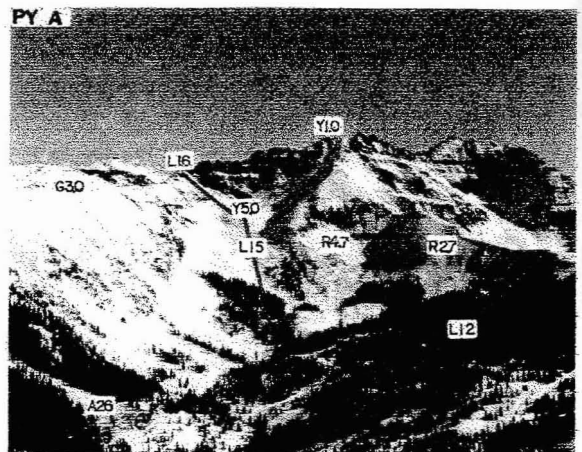
Finally, the resulting snow safety plan is to be "proofed" for one entire season (2000-2001) prior to public use in order to insure adequate public safety.

**KEYWORDS: SKI AREA, PLANNING, HAZARD MAPPING, HAZARD IDENTIFICATION & MITIGATION, EXPERT FORECASTING**

## 1. INTRODUCTION

Nearly three decades ago, in 1971, the Telluride Company received a Special Use Permit from the United States Forest Service (USFS) to operate a ski area on 1,367.8 hectares (3,380 acres) of Uncompahgre National Forest land and 246 hectares (608 acres) of private land. Telluride is located high in the rugged San Juan Mountains of southwestern Colorado and is "blessed" with a predominantly faceted continental-radiational snowpack. Initial development and operation of the ski area focused on the western and northern portions of the permit area adjacent to company owned real estate and the town of Telluride. An updated Master Plan in 1980 and subsequent "First-Phase Mid-Capacity Development Plan" in 1983 proposed numerous facilities in the yet

undeveloped southern portion of the permit area. In order to comply with the National Environmental Policy Act (NEPA) an Environmental Impact Statement (EIS) was required to provide the USFS with information necessary to make a Record of Decision (ROD) regarding the proposed development. Since a major portion of the development area is located above timberline in avalanche prone terrain an extensive Avalanche Technical Report was required for the EIS and subsequent ROD.



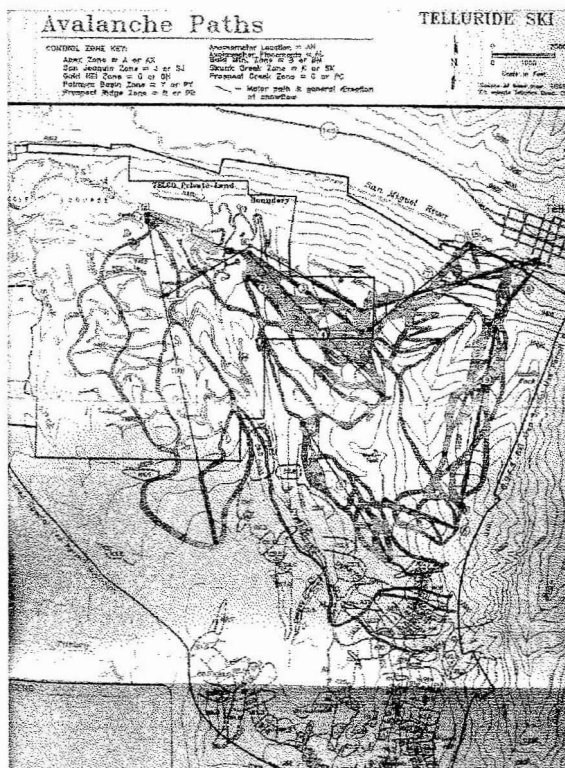
---

\*Craig Sterbenz, Snow Safety Director, Telluride Ski & Golf Company, Telluride, CO 81435  
work tel: 970-728-7587, email: sterbie@rmi.net

## 2. AVALANCHE TECHNICAL REPORT

The purpose of the Avalanche Technical Report was to identify potential avalanche hazard within the development area and propose possible mitigation options for the perceived hazard. Preparation of the report would fall on those most familiar with the terrain and it's potential hazards, the ski patrol. At the recommendation of Jim Hackett, then USFS Snow Ranger, Craig Sterbenz, the Snow Safety Director from the Telluride Ski Patrol, was chosen to prepare the report for Pioneer Environmental Services. In order to insure validity and avoid potential conflict of interest issues, Liam Fitzgerald of Snowbird was chosen as an outside consultant to the author.

The first phase of this site-specific study required identifying and quantifying all of the individual avalanche paths within the study area. An Avalanche Atlas was created with maps, photographs and summaries of relevant information about each path. Pertinent information included physical data such as size, shape, aspect, elevation, inclination, snow depths and ground cover as well as historical data on frequency, magnitude and run-out distances.



Methodology of the study initially required daily ski tours into the terrain to collect physical

data (Feb.-April 1993). Snow depths were probed, pits were dug, slope angles and aspects were taken, explosives were thrown, slopes were skied, avalanches were recorded, old satellite photos were studied, trim lines were documented and new photographs were taken...

Paths were mapped on a 1:7200 (1"=600ft) contour map with 3 meter (10 ft) intervals. In order to more effectively manage all of the information, templates for recording field observations were created using a cross platform relational database (Filemaker Pro). Nearly 150 avalanche path summaries were entered into the avalanche atlas database.

The second phase of this study utilized the information logged in the atlas and map overlays to identify hazards to proposed facilities. Facilities included lifts, buildings, trails and the skiers on them. Other facilities included infrastructure like bridges, snowmaking systems and utilities as well as some cultural & natural resources.

The third and final portion of the study offered possible mitigation or "control" options for the hazards recognized during phase two. These mitigation options relied upon traditional passive and active techniques of protective structures, control skiing and explosives use.

Conclusions and recommendations in the published report (March 1994) called for "Three to five years of continual observations...the expeditious placement of weather instrumentation...and the development and testing of an operational control plan."

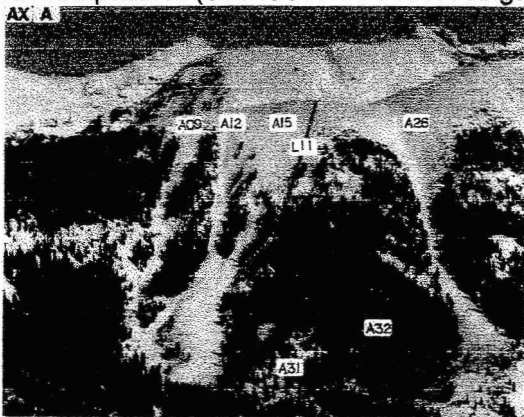
## 3. SNOW SAFETY PLAN DEVELOPMENT

Observations continued the following season ('94-'95) with the installation of an integrated weather recording system. Four Campbell Scientific weather stations were installed and linked through a dedicated CPU accessible via modem. New snow amounts, total snow, temps, winds and humidity could now be checked in the early morning from the home office. Additional "tab & type" templates were created in the Filemaker Pro database for recording daily weather and avalanche observations. Daily weather and avalanche observations entered into the templates could be faxed out daily to local avalanche centers, weather service offices and company offices or uploaded monthly to the Westwide Avalanche Network (WWAN) website database.

Staffing levels were increased to provide 'semi-routine' daily control operations. A portion of the expansion area terrain on lower Gold Hill was operated for "hike to get to" limited access 'expert

only' skiing. A crude 2x6 and polypropylene rope 'bomb-tram' was built on the Dynamo and an old fixed-mount avalauncher was mounted on a snowcat to upgrade the expansion area control capabilities.

Ski compaction of early season snow on Gold Hill was undertaken in October. Substantial early season snowfall permitted an early December opening and continued limited access skier compaction. However, as prophesied in the avalanche technical report, "... skier compaction may allow for more snow to accumulate above 'weak' layers, the result of which could be a larger avalanche." Following a large storm cycle (3 meters in week) during March of 1995, the entire snowpack failed on the ski-compacted October snow layer. (Ed said, "Never trust a faceted layer!") The resulting HSAL5 "design avalanche" allowed the ski company to gracefully realign its' proposed Gold Hill lift to a safer location. It also allowed for replacing the crude "Hooty-Pole?" bomb tram with a more sophisticated gear driven 300-meter stainless steel span and for the development of the "Winch Roller" for early season compaction. (See ISSW '98 Proceedings)



The winch roller and the two new explosives tramways on Gold Hill proved their worth. Two new McCracken avalaunchers were added to aid in reaching the numerous starting zones in Palmyra and Prospect Basins as well as those remaining paths on upper Gold Hill. However, the steep northeast facing starting zones high on Palmyra Peak remained inaccessible, obscure target angles and long range excluded the avalauncher. Several medium size natural avalanche releases from this area were observed to run full track across proposed intermediate ski trails low in Prospect Basin. In order to propose mitigation for this hazard every possible control method, including helicopters and Gaz-ex, was considered. For two seasons, '96-'97 and '97-'98, daily evaluations were made to determine which

combination of control options would provide for the fewest closures of the threatened ski trails. These evaluations indicated that with only hand charges and avalaunchers half of the Prospect Basin trails could be closed as much as 44% of the time and that with a military weapons program 100% could be open as much as 98% of the time. Military weapons and other new technology like Doppelmayer's "Avalanche Blaster" are being pursued as viable mitigation options for this inaccessible terrain.

Observations continued during subsequent seasons of the "3-5 year" study period. Snowpro replaced older computer templates for entering snowpit profiles. Path summaries in the Avalanche Atlas were updated. Daily weather and avalanche observations were added to the Filemaker Pro database. It was now possible to cross-reference all of these observations over several seasons and develop an 'expert forecasting system' using the 'nearest -neighbor' approach. (i.e., Given 200cm old snow and 30 cm of new snow with strong SW winds above 3,000 m... what avalanche activity occurred in the past w/ similar conditions or what NE facing paths above 3,000 m might be suspect?)

#### 4. PROOFING THE SNOW SAFETY PLAN

Several draft snow safety plans for the new terrain have been put to paper, but no final copy yet exists. The snow safety plan for the Gold Hill portion of the expansion has been put to use and has shown itself to be very successful in providing quality expert skiing in challenging avalanche terrain with minimal threat to public safety.

In the wake of numerous 'environmental' and legal battles the USFS eventually issued it's final Record of Decision. The ROD ultimately approved most of the proposed development with specific restrictions and requirements. Concerns over public safety as well as concerns over The Ski Area's financial commitment to adequately fund the enormous snow safety program prompted the USFS to require that the Snow Safety Plan for the expansion area be fully implemented for one entire season prior to public use. The Ski Area has recently acquired a new principal owner with sufficient capital and interest to insure adequate funding for a large snow safety program. With lift construction scheduled for the upcoming summer of 2001, the Snow Safety / Operational Control plan will have to be finalized and fully tested this 2000-2001 season. Let 's hope the "proof is in the pudding"... or powder skiing.