EVENT REPORTING ON MOUNT SAINT HELENS

SNOTEL, FLEXIBILITY FOR THE FUTURE

By

J. K. Marron 1/ and R. T. Davis 2/

INTRODUCTION

The first recorded eruption of Mount Saint Helens was in 1857, over one hundred and twenty years ago. The damage done to man was negligible but the damage to the environment was catastrophic. Since then, man has encroached into the Mount Saint Helens area with dams for water and power, cities, small communities, and vacation spots. With these improvements, measurements of the climate were initiated.

Water stage measurements began in 1909. Weather stations for precipitation and temperature were started about 1905-06. These measurements were taken near centers of population and at lower elevations. To better manage resources, snow measurements were begun in 1943. The Soil Conservation Service established three snow courses to the south and east of the mountain; Surprise Lakes, Cultus Creek, and on the eastern flank, Plains of Abraham. Additional sites were installed from 1955 to 1963 until there were eighteen snow courses and aerial markers on or adjacent to the mountain.

The Soil Conservation Service then established automated hydrometeorological data stations at two of the original snow courses and two of the newer snow courses. Surprise Lakes and Lone Pine Shelter's radio equipment was installed in 1979. Plains of Abraham and Spencer Meadows were constructed in 1979 with the electronics scheduled to be installed in the summer of 1980.

On March 27, 1980, Mount Saint Helens started to smoke and spew ash. A volcano watch team of Federal-State-County and private entities was formed immediately to assess hazards. This volcano watch team is still in existence and their mission has not changed.

Snow course measurements, which had been made by the U. S. Geological Survey since approximately 1955, had been discontinued in 1978. Since no current snow survey measurements were taken around the mountain in 1980, a record of the snowpack was not available until the Soil Conservation Service began taking the measurements again in April, 1980. These special measurements were taken to assess the impacts of ash on snow melt. These surveys were discontinued after May 18, 1980, and have been thoroughly discussed in previous presentations (Crook, et al., 1981).

The May 18, 1980 eruption brought the real destructive capability of this sleeping beauty to the attention of the watching scientists and demonstrated the need for an expanded automated snow measurement system for the Mount Saint Helens area. In the fall of 1980, three new SNOTEL sites; an acronym for SNow TELemetry, the Soil Conservation Services' automated system, were added to the existing three site network. In addition, the Plains of Abraham site that had been completely destroyed on May 18 was re-established. This brought the SNOTEL network on Mount Saint Helens to seven sites.

Table 1 shows all SNOTEL sites with their locations and elevations.

Presented at the Western Snow Conference, April 19-23, 1982, Reno, Nevada

1/ Soil Conservation Service, Reno, Nevada

2/ Soil Conservation Service, Spokane, Washington

Table 1

Sites, Elevations, and Locations

Site Name	Elevation	Location
Plains of Abraham	1341 m	Sec. 35, T. 9N, R. 5E L. 46 13 Long. 122 09
Sheep Canyon	1280 m	Sec. 12, T. 8N, R. 4E L. 46 11 Long. 122 15
Strawberry Landing	1000 m	Sec. 9, T. 10N, R. 6E L. 46 22 Long. 122 05
June Lake	975 m	Sec. 25, T. 8N, R. 5E L. 46 12 Long. 122 08
Lone Pine	1170 m	Sec. 8, T. 9N, R. 7E L. 46 16 Long. 121 58
Spencer Meadow	1036 m	Sec. 15, T. 8N, R. 7E L. 46 11 Long. 121 56
Surprise Lakes	1295 m	Sec. 14, T. 7N, R. 8E L. 46 06 Long. 121 45

EVENT MONITORING

The SNOTEL system was originally designed to obtain near real time information on snowpack and temperature for water supply forecasting on at least a daily basis. (Barton et al., 1977).

When Mount Saint Helens began her current activities and exhibited her capability of turning a quiet mountainside, covered with snow, into a raging flood the equipment for event actuated response from SNOTEL was obvious. The event system was born from the need for the sites on the mountain to respond when significant increases or decreases occurred in the snowpack. Installation of event reporting equipment took place on September 29-30, 1981, but due to programming problems the equipment had to be removed and was reinstalled by January 6, 1982. Significant hydrologic events on Mount Saint Helens are described as any occurrence which causes 25.4 mm increase in up to an hour either in snow water content or precipitation; or a 38.1 mm decrease in water content in eight hours or less. The significant event of most concern is melt occurring at greater than 38.1 mm per eight hours. Melt rates usually exceed this threshold only near the end of spring or when external influences such as rain or chinook winds increase the rate.

The standard SNOTEL operation involves broadcasting a probe from the central master station to a particular remote site or groups of sites at predetermined times. This probe triggers the remote site to respond with its data (Barton et al., 1977). To operate the event system, the remote site has to sense when a significant event has occurred and notify master stations. This requires special equipment which contains programmable micro chips. After receiving the event alert, the master station probes the remote site for the data from that site. Due to the similarity in weather, two or more sites may simultaneously notify the master station that an event has occurred. Therefore, the master station listens for the report of events from all sites on Mount Saint Helens. When an event signal was received, the system probes for all seven sites so that all significant data are retrieved. In addition, the master station can be directed to reprobe at given time intervals for extended periods to determine storm duration and intensity.

EVENT ANALYSIS

The event system has operated in two time periods from October 1, 1981 until it was removed and continuously since January 6, 1982. In the early period, equipment used had incomplete programming and many difficulties were encountered with event identification. Originally, if a momentary fluctuation in voltage occurred, the system could identify that fluctuation as an event. This was corrected by programming which specified that if a reading exceeded 5.1 mm, another reading would be taken one minute later. If that reading was not the same or higher, then no event was recorded and the system would return to its original sequence. The efficiency at any individual site is dependent on the random occurrence at usable meteor trails, plus the state of health of its electronic components. Therefore, in a discrete time period, individual sites in any group would be expected to occasionally fail to respond to a probe.

Responses can be broken down into three types: responses to event probes from the master station, responses to the 5 A.M. nominal poll, and unrelated responses. Table 2 shows this breakdown for each event site during the period from January 6, 1982 through March 15, 1982.

Table 2

Responses and Data Availability

		Triggered by		
Site Name	Total Responses	Event Probes	Nominal Poll	Unrelated Probes
Sheep Canyon	63	21	28	14
June Lakes	135	38	45	52
Strawberry Landing	75	22	31	22
Lone Pine	103	29	43	31
Surprise Lakes	122	35	53	34

An analysis of these responses during the period shows the system responded to ninety-two percent (92%) of all significant occurrences. Only seven events out of a possible ninety-one were missed. None of the missed events were more than 51 mm and were probably not 25.4 mm/hr. as required by the system.

Currently, event reporting in the Mount Saint Helens area may be the most important function of the SNOTEL system in Washington State, but nominal poll data must still be obtained to satisfy streamflow forecasting needs. The event reporting sequence affects the nominal poll response in the following manner. In the nominal poll sequence, if data has been received from a given site within thirty minutes of the beginning of a nominal poll its data are forwarded and nominal pole requirements are satisfied. Thus event sites, in many cases, had current data which preceded the nominal poll and the site was not pursued during the remainder of the nominal poll. If an event occurs during a nominal poll, the event is recognized and event data are retrieved even though the system wide nominal poll is in progress.

Table 3 summarizes the nominal poll efficiency during the January-March period.

Table 3

Nominal Poll Response
January 6-March 15, 1982

Site Name	Possible Nominal Polls	Nominal Data Received	Percent Response to Nominal Poll
Sheep Canyon	50	45	90
June Lake	67	53	79
Strawberry Landing	74	59	80
Lone Pine	74	65	88
Surprise Lakes	74	71	96

During this time period, Sheep Canyon and June Lake did not function for short periods due to power supply failures, thus possible nominal polls and possible event responses were less then from other sites.

The Plains of Abraham SNOTEL site had numerous mechanical problems caused mainly by its location. The original site was completely destroyed on May 18 and then was re-established on the new pumice plain which now covers the old Plains of Abraham. Both precipitation and water content sensors malfunctioned causing thirty-five (35) erroneous events triggering responses from the other event sites. Spencer Meadows was not analyzed because data were not available through February 25.

A major storm event occurred from February 12 to February 18 and the following summary illustrates the responsiveness of the system. The complexity of the events that were occurring during this time period are best shown by a review of site responses. June Lake began reporting significant events at 2:08 P.M. on February 12. It answered twenty-nine (29) probes during the storm period and showed a final precipitation total of 558.8 mm. June Lake had severe melt reducing the snowpack from a peak of 965.2 mm water content to 655.3 mm at 4:57 A.M. on February 18, 1982. The combination of 558.8 mm precipitation plus 309.9 mm of snow melt produced a total of 868.7 mm of water available to runoff. Lone Pine began on February 13 at 10:44 A.M. answering an event probe caused by Surprise Lakes which had registered 127 mm causing the 10:44 A.M. event sequence. Lone Pine answered sixteen times during the storm period and showed a final precipitation total of 515.6 mm. During this same period, Lone Pine melted 88.9 mm of snow producing a total of 604.5 mm of water available to runoff.

Installation of the June Lake SNOTEL site in 1980, filled in a rather large gap in meteorological information for Mount Saint Helens. The first full year's operation, water year 1982, showed that June Lake received 4678.7 mm of precipitation which raised some concern as to the accuracy of the sensor. On inspection the site was found to be operating correctly, and comparison to gages at Cougar, Washington and Swift Reservoir, showed the value to be reliable. From October 1, 1981 to April 16, 1982, June Lake received 4749.8 mm and will probably exceed 5080 mm prior to the end of the water year on September 30, 1982.

As a positive side effect of event reporting, the retrieval of new types of data was possible. The first new data available due to the use of the new programmable equipment are maximum, minimum, and true mean temperature from midnight to midnight. These data will be very positive assets when streamflow simulation models are adapted to use SNOTEL data.

Implications for SNOTEL expansion were also a positive side effect.

The microprocessor also allows for more sophisticated remote site operations. This has implications in the use of improved addressing and polling, as well as onsite self diagnosis of the remote stations health.

REFERENCES

Barton, M. and M. Burke, 1977: SNOTEL: An Operational Data Aquisition System Using Meteor Burst Technology, Proceedings of the 45th Annual Western Snow Conference, Albuquerque, New Mexico, pp. 82-84.

Barton, M. and A. G. Crook, 1980: Operational Experience with the SNOTEL System, American Society of Civil Engineers 1980 Annual Convention, Hollywood-by-the-Sea, Florida October 30.

Crook, A. G., R. T. Davis, and R. E. Moreland, 1981: The Impact of Mount Saint Helens Ash Deposition on Snowmelt, Proceedings of the 49th Annual Western Snow Conference, St. George, Utah, pp. 77-84.

Farnes, Phillip E., 1978: Future Snow Survey Operations with SNOTEL, Proceedings of the 46th Annual Western Snow Conference, Otter Crest, Oregon, pp. 15-20.

Harris, S. L., 1976: Fire and Ice, The Cascade Volcano's, The Mountaineers, Seattle, Washington, 320 pp.