Improvements in Snow Sensor Installation Techniques

by

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INTRODUCTION

The California Cooperative Snow Surveys Program (CCSS) has the primary responsibility for collection of data for the generation of water supply forecasts. Under its auspices some 80 cooperating agencies perform manual snow survey measurements and participate in the installation and maintenance of automated snow sensors. California has 311 active snow courses and 86 automated sensor sites.

The sensor sites are a combination of wilderness installations and shelter sites. The wilderness installations present unique problems owing to the requirements for minimum impact on the site and adverse weather conditions. The wilderness design developed by the CCSS has proven to be reliable for most sites except for those areas subject to inundation during the spring thaw and those areas having significant black bear populations. The Paradise Meadow sensor site #167 in the Tuolumne River watershed has both problems and served as the development site for these improvements.

Paradise Meadow is located in the north half of Yosemite National Park at an altitude of 2,332 m(7,650 feet). The average April 1 water content is 104.9 cm (41.3 inches). The site initially was a standard wilderness installation located approximately 15.2m (50 feet) from Jack Main Creek. The sensor was first operational in September, 1980. The sensor did not prove reliable due to leakage of the instrument box. This sensor failed annually during its first 3 years of operation and was inoperative during the entire 1984 season. Bear damage was first observed on one of the 4 tanks in the fall of 1984. At this site the bears bent up the corners of the stainless steel tanks resulting in leakage from ruptured seams. Tanks were replaced and the sensor was operational for the 1985 season. The sensor developed electronic problems during the 1986 season due to leakage of the instrument housing. During the summer of 1986 all four tanks were destroyed by bears and the sensor was off the air during the 1987 season. Alternative sites were considered but rejected by the Park. Either a sensor at this site would be made operational or the site would be abandoned.

BEAR DAMAGE

Solution to the bear damage problem at first appeared to be the most difficult. Three sets of pillows were destroyed over three seasons. Park bear specialists suggested the offending bear might be a resident sow, with a cub being tutored in pillow play by mama. Such a disturbance was not judged to be likely to decline over time. The pillows could not be covered by anything which would interfere with either the deposition or ablation of the snowpack. The goal was to prevent access by the bear to the edges or corners of the tanks. Three alternatives were considered; construction of a low concrete foundation surrounding the tanks with a .304m (1 foot) lip constructed of reinforcing steel extending over the edges of the tanks, fencing of the tank area or some sort of a flexible covering over the tanks.

The concrete foundation presented significant logistic and construction difficulties and could result in major difficulties should the tanks fail and require replacement. Fencing sufficient to prevent access by the bear would be obtrusive and would affect the snowpack accumulation. A flexible covering over the tanks offered the most attractive solution.

Chainlink fencing was first considered because of availability and low initial cost. This material, while relatively flexible in one direction is relatively rigid perpendicular. Flexible steel cable woven into a rectangular net offered an ideal solution but initial investigation at local vendors indicated major construction difficulties with an awkward connection at each crossing of the warp and woof of the net. Ultimately, a source was located for a net constructed of 7.94 mm (5/16 inch) stainless steel cable on 101.6 mm (4 inch) center. This is an optimal opening size considering the snow deposition and the size most likely to prevent access by the bear. The connections at the intersections of the net were a proprietary swaged fitting. Recognizing that the anchoring of the net to the ground might present a point of weakness, a net 3.05 m (10 feet) by 3.66m(12 feet) was ordered. A net of this size would allow a .61m(2

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feet) overlap beyond the edge of the 4 stainless steel pillows. With such an overlap, the bear would be standing on the net while trying to pull it up, hopefully precluding access to the tanks.

The anchoring of the net around the perimeter of the tanks was accomplished using deadmen constructed of 19.05mm(3/4 inch), .61m(2 feet) long rod welded perpendicular to an 15.24cm (6 inch) x 45.72 (18 inch) 6.35mm (1/4 inch) steel plate. Deadmen were buried at each corner of the net and in the middle of each side for a total of 8 anchors. Steel cable was woven through the periphery of the net and through the eye at the top of each deadman and secured with cable clamps. This type of installation facilitates removal of the net should work on the tanks be required.

The net was installed in October of 1987 and after three full seasons the net has proven satisfactory in preventing damage by bears at the Paradise Meadow location. Bears have been observed examining the installation and no damage has been experienced. As a result of this work, similar nets have been installed at Shimmey Lake #12, Red Rock Mountain #10, Lower Kibie Ridge #856, Mumbo Basin #15 and Middle Boulder 3 #311. Each site has shown some efforts by bears to damage the tanks following installation of the nets but so far the nets have held.

Nets installed later at the sites listed above have been constructed by local wire cable vendors utilizing spliced connections at the intersections of the crossings. Galvanized 6.35mm (1/4 inch) cable is being used instead of the stainless cable that was obtained for the first net. Costs for a net of the first type increased significantly resulting in the attractiveness of the locally produced version. Vendors for these products are common in the Yellow Pages under wire rigging or wire rope headings.

WATER DAMAGE

The second problem developed by the sensor at Paradise was water damage to the electronics of the data collection platform. Repeated efforts to waterproof the partially buried instrument box proved unsuccessful. Permission was requested and granted to mount the instruments in a metal box above the observed highwater line in this area of Jack Main Canyon.

The wilderness type installation has a data collection platform (DCP) consisting of a GOES satellite radio transmitter, interface electronics and an analog to digital converter board, and a storage battery powered by a solar panel. The basic sensing device consists of a pressure transducer connected to the snow pillows by tubing. The pressure transducer generates a change in voltage dependent upon the hydraulic pressure. The transducer must be mounted such that a definitive positive head differential exists between the tanks and transducer, precluding mounting of the transducer within the main instrument housing. Additionally, the pressure transducers have been very susceptible to moisture damage, requiring the development of a waterproof capsule for the transducer.

The first design installed at Paradise consisted of a 30.48cm (12 inch) section of 15.24cm (6 inch) PVC pipe with end caps. The housing was drilled and tapped to provide connections for the pressure line from the tanks and cable from the transducer to the DCP through 2.54cm (1 inch) PVC conduit up to the instrument housing mounted on a tree. While the housing was waterproof, replacement of the transducer required sawing off the end cap of the housing. Within two weeks of the initial installation, replacement of the transducer was necessary due to damage from the PVC glue fumes. The site was placed back on the air with the existing capsule but the damage dictated improvements to the design.The site failed again in the spring of 1989 and a new transducer capsule was installed.

The new design is similar to an oil filter cartridge housing. A 20.32cm (8 inch) diameter, 15.24 (6 inch) deep aluminum cap with an O-ring sealed bolt in the center secures the cap to an aluminum plate drilled and tapped for the pressure line and wiring conduit. The plate has a groove milled to accept an O-ring which provides a water tight seal for the cap. This design permits installation and bleeding of the transducer with complete accessibility. Following the bleeding, the cap is secured to the plate. Should further work be required on the transducer, the cap can be readily removed without destroying the housing.

Development of these two enhancements has resulted in the preservation of the site at Paradise and the techniques have proved invaluable at avoiding similar sorts of damage at other sites throughout the California network.

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