

# 1996 Annual Maintenance Report

## by Bob Benedict, DIAD Incorporated

The following was excerpted from a December 27, 1996 letter from Bob Benedict to Kevin Stewart, UDFCD.

The maintenance work on the ALERT Gaging Network under Agreement 96-02.02 is drawing to a close. During this operating season, DIAD has submitted 609 maintenance reports for the combined UDFCD/Boulder County network, 489 of which documented field activities. Of the 609 reports, 46, or 7.6%, were unscheduled service calls.

PT failures at 3 sites occurred over the 95/96 winter. As a result a PT was replaced at Rosedale. A PT was replaced and a new PT housing installed at Granby Ditch. An attempt was made to salvage the PT at Expo Park (423) through the 1996 season but the degree of instability has been unacceptable and we recommend replacement. The RH/AT sensor at Quincy Reservoir also failed this year and had to be replaced.

RF problems at Shop Creek were resolved by replacing the antenna and installing a power amplifier to boost the output signal. I recommend testing the RF performance without the PA next season.

The calibration drift at the Morrison shaft encoder was finally tamed. It required grounding between the transmitter, standpipe, stilling well and shaft encoder. At the end of the season the Morrison stilling well was replaced and the shaft encoder and grounding scheme had to be reinstalled. Some modifications to grounding may still be required.

This season, there were at least five occasions on which caps were removed from PT housings and the sensors disturbed. Metal caps have replaced plastic caps at some of the more vandal prone sites however we should continue to review how PT's are secured. The damaged standpipe at Jeffco Fairgrounds survived the season with temporary repairs. It should be replaced since this is a standpipe with a riveted bottom. The standpipe at Carr Street also requires repairs.

Changes in maintenance procedures were an overall success this year. PT calibrations are more accurate. We now determine calibration coefficients of the instrument instead of attempting to adjust the PT output to a predetermined level with signal conditioning. A linear least squares fit is applied to a sample of five test points to determine the calibration coefficients and signal conditioning adjustments are only made to keep the instrument close to the desired standard calibration. Temperature dependencies in PT's, especially Foxboro PT's, are a source of calibration error. Calibration procedures were modified part way through the season to reduce this error. All rain gages were physically inspected and tested during the start up, mid season and end of season inspection cycles. Informal analysis of data accompanied these inspections. Historical knowledge and rain gage data analysis directed physical inspections during the alternate May and August inspections. Analysis revealed 11 rain gages with low counts, 3 double tipping rain gages, and 1 dead battery - all requiring site visits. Four sites with weak RF in Boulder County were also confirmed. The August analysis of rain gage performance was hampered by a lack of synoptic storms during the period. Analysis is still a fairly manual process but efforts are underway to increase its automation and improve the analysis algorithms. We recommend continuing the 1996 maintenance schedule for the 1997 season. On site servicing of rain gages every 90 days with data analysis directing site visits during the alternate 45 day cycles while continuing to service all stage and weather sites every 45 days.

This was the second year to use the ALERT gaging network for low-flow monitoring in the City of Aurora. The results have been mixed. There are two sites using Design Analysis SDI-12 PT's, Shop Creek and Utah Park. Shop Creek utilizes a Handar 555 transmitter to interface with the SDI-12 PT. There were early season problems with both the PT and the transmitter believed to be the result of a near-by lightning hit. After the problems were corrected the data obtained were of good quality. Utah Park has a High Sierra Electronics transmitter that uses an intermediate SDI-12 interface board. The interface emulates a shaft encoder for input into the transmitter. The data contained significant deviations and offsets from base level readings periodically through out the monitoring season. Discussions with High Sierra indicated there are flaws in the SDI-12 interface prom program. HSE is attempting to correct the flawed code and will deliver a new prom when ready. Until the HSE SDI-12 interface board can prove itself reliable we recommend using the Handar 555 for future SDI-12 PT's. The Design Analysis SDI-12 PT's are more susceptible to damage from moisture, shock and freezing than the analog PT's used elsewhere in the district due to the onboard electronics. Bruce Rindahl from the City of Aurora has indicated that, when working, the data from Shop Creek is acceptable for their low-flow monitoring efforts. I recommend discontinuing the averaged data, ID 1703, the increased reporting frequency of event data contains the same information, ID 1704.

Work was completed on the contract items from 1995 that were carried over to 1996. We replaced the standpipe at 1600 - Englewood Dam. The Evergreen Metro District completed construction this year making way for reinstallation of the

Evergreen site below the confluence of Cub and Bear Creeks. The Kelly Dam PT that was out of service at the end of last season due to lack of a replacement pressure transducer has been replaced including the addition of a new PT housing. A New PT and PT housing were installed at the Upper Sloan Detention Pond. Analysis at Denver Waste Water indicated RF noise and not antenna location is the primary cause of receive problems. We will install a crystal filter here.

There are now only 4 EG&G gages left in the UDFCD system. DIAD recommends that these transmitters be replaced with new transmitters, all brands of which now support full binary ALERT encoding. These EG&G transmitters could be used for a few more years in the Boulder Creek system, where they would replace obsolete units.

The addition of Boulder County's ALERT Network into the maintenance schedule for UDFCD greatly increased the amount of field activity this past year. Establishing data and RF path integrity as well as physical site and equipment rehabilitation were the main thrust of effort aimed at Boulder County.

The RF backbone of the system was strengthened. Lee Hill became the centerpiece of the RF backbone. The voice repeater was disabled and replaced with a digital dual frequency repeater. All data are funneled through Lee Hill for ID translation to provide a smooth transition from analog to digital transmitters. The Lyons voice repeater was discontinued and replaced by a digital store and forward repeater on Eagle Ridge greatly improving data integrity in the north end of the system. The Louisville voice repeater was also replaced with a digital store and forward repeater. The new configuration allowed us to discontinue the Jail and Riverside repeaters. By the end of the season only 2070 had path problems. We have reduced the number of frequencies used from three to two by the use of digital repeaters and pass lists. All but two transmitters have been converted from 169.475 MHz to 159.500 MHz. Louisville, Eagle ridge and Lee Hill repeaters now receive at 169.500 MHz.

Nearly all of Boulder Counties Sierra Misco tipping bucket rain gages were refurbished this year. Leaky buckets made of soldered sheet metal were replaced with buckets made from welded aluminum stock. The new buckets will better withstand the thermal stresses associated with over-winter operation. Seventeen transmitters were retrofitted with MS solar connectors. GE radios were replaced with Repco radios in two transmitters. With the coming availability of Repco radios to be salvaged from discontinued Ronalco stream gages the remaining GE radios can be replaced during the 1997 season.

It is our belief that the reliability and performance of the UDFCD system remains high, and that consistent improvements are being made in the accuracy of hydromet measurements. In 1997, DIAD will be reviewing its maintenance equipment and procedures to continue to improve measurement accuracy while increasing maintenance efficiency. DIAD thanks you for an excellent and professional working relationship, and we hope we have the opportunity to work again with the UDFCD.

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