

December 4, 2000

Mr. Kevin Stewart  
Urban Drainage and Flood Control District  
2480 W. 26<sup>th</sup> Avenue, Suite 156B  
Denver, Colorado 80211

Dear Kevin:

Maintenance activities on the ALERT Gauging Network for 2000 have been completed under Agreement 00-01.17. During the 2000 operating season, DIAD generated 699 maintenance reports for the combined UDFCD/Boulder County network. Of these, 38 (5.4%) were unscheduled service calls; the remainder documented standard maintenance activities.

The combined UDFCD/Boulder County network received its normal dose of damage via both vandalism and heavy equipment malpractice during the 2000 season. The Mission Viejo site was taken out in June by an out-of-control truck boom that sheared the standpipe off 36" above grade (Figure 1). Aside from cabling, all the equipment was salvaged. At last inspection, heavy equipment was still all over the place. The site will be reinstalled when construction is complete. Expo Park was taken out of service early in 2000 in order to accommodate the reconstruction of the detention pond there. Construction is nearing completion and the site shall be brought back to life for the 2001 season. Harvard Gulch received destructive influences from either vandals or Denver maintenance crews. The PT conduit had been bent and breached at 2 different locations, leaving the pressure transducer cable fully exposed. We suspect the real culprit was a park maintenance snowplow that got a bit carried away. Polypipe that runs from the standpipe to the culvert headwall was near ground level on the culvert end, and was not buried deep enough to survive a wayward plow blade. The breaches were repaired and the conduit is buried deeper and extends farther out from the wall before it mates to the polypipe, making it more secure than before.

Utah Park stopped reporting around October 11<sup>th</sup> due to devious vandals. The pressure transducer had been ripped off of its cable (Figure 2) at the housing end, and the cable was reinserted into the water inside the PT housing. (The cap was reinstalled on the riser to make it appear that all was well.) The resulting short caused damage to the splice box and fried the 5050 logic board. In addition, the antenna was missing. All components (with the exception of the tipping bucket) at the site will require replacement. In more minor incidents, the solar panel was shot to bits (again) at Big Elk Park (along with the antenna base and the mast). Two ground planes were MIA at Red



**Figure 1. Negligent destruction of Mission Viejo standpipe**



**Figure 2. Utah Park vandalism**

Garden, as well as the antenna at Jewel Detention. The antenna and ground planes were bent at SPR @19<sup>th</sup>, and ground planes were found bent at the Broomfield site.

Discharge related damage was believed to have caused problems with the horizontal intake at Cherry Creek @ Steele. The intake (used to) extend at least 15' from the west bank to near the center of the channel. It historically gets loaded with debris and gets plugged with sediment. Sometime after August 11<sup>th</sup>, the intake was bent downstream, disconnecting from the T-post anchor in midstream. The end of the intake had deteriorated to the point that it had broken off from the anchor clamp, leaving the intake free to move. Debris that hung up on the intake during the next high discharge apparently produced sufficient moment to bend the pipe. Upon replacement, we would like to install a shorter intake to decrease (or possibly entirely eliminate) the propensity for debris to hang up on the intake. The sediment regime is comprised of mostly coarse sand, resulting in an unstable, dynamic bed level. Hydraulic contact should not be compromised even if the end of the intake is buried in sediment. If the new configuration fails to produce necessary results, the intake can easily be extended farther into the channel; the braided channel depth is quite uniform from bank to bank. Farther upstream at Castle Oaks, the unstable bed has resulted in significant scour, such that the intake is no longer immersed in the water during normal discharge. We recommend lowering the intake 9" if capturing low flow data is a priority here.

Several new Druck PDCR 1830 pressure transducers were installed in the system during the 2000 season. The bulk of the dead or dying transducers were Foxboro's. At the beginning of the season, replacements were installed at Montview Park, Harvard Gulch Park, Croke Pump Station, Temple Pond and two at Confluence Pond. The PT's at Evergreen Lake, 6<sup>th</sup> and Lena and Sports Complex died during the field season and were replaced. (The 6<sup>th</sup> and Lena transducer was replaced with the PT rescued from the Expo Park reconstruction.) Late in the season, PT's died at Kelly Dam, Grandby Ditch and Maple Grove Reservoir (as well as the unit vandalized at Utah Park). The Maple Grove and Grandby Ditch PT's have been replaced with system spares. If possible, the Kelly Dam PT will be replaced prior to 2001 startup activities. The new Expo Park site will be configured with just one PT when it is reinstalled. For 2001, we strongly recommend replacing the Foxboro pressure transducers at Carr Street and Harvard/Jackson, which have required several signal conditioning adjustments for sensor drift.

Although DIAD Inc. is pleased overall with the performance of Druck PT's, it is clear that there is room for improvement on Druck's part, especially with regard to PDCR 1830's. In the past 2 years, new PDCR 1830's at Harvard Gulch Park (1998), Grandby Ditch (1998), and Croke Pump Station (2000) all exhibited drift since they were installed. Havana Park (1998) and Englewood Dam (1999) have been a bit shaky as well. So far, the drift has not been caused by signal conditioning problems, which was a common occurrence with Foxboro configurations. In lieu of a superior product on the market, we continue to recommend upgrading stage sites with Druck pressure transducers as needed, but also continue to cast an eye on potential alternatives.

A Handar weather suite was installed at the 20' level on the State of Colorado telecommunications tower at Squaw Mountain in early June (Figure 3). After resolving initial RF issues, the site performed reliably through the summer and early fall. However, concurrent with colder temperatures, wind data has become somewhat less



**Figure 3. Squaw Mountain weather suite. Omni antenna is now mounted on opposite plane of tower facing SE.**

reliable. A gap in wind data correlated with the passage of a cold, wet front on September 20, 2000. Wind speeds of 181 mph were reported for several hours. We hypothesize that the sonic wind device was subject to ice buildup, effectively inhibiting its functionality until warmer conditions eliminated the ice. Similar wind data were noted at Elbert as well, again correlating with probable ice buildup. It seems likely that in order to eliminate these gaps in wind data, the sonic devices will require heating during those periods where ice buildup will otherwise occur. Handar offers a heated version of the 425, called the 425AH. The transducer heads are internally heated when a temperature sensor in the 425AH senses some predetermined value. The Handar 425-7006 power supply provides the recommended 36V required by the sensor. Depending on importance of wind data, the District may want to consider acquiring the 425AH, at least for Squaw Mountain. Eliminating ice buildup at Elbert would be less cost effective since the problem is very likely less frequent there. The cost of one heated sonic wind sensor/power supply combo plus cable is close to \$3,000 (ouch!). If replaced, the original 425 could either serve as a spare unit for Elbert, or could replace the conventional vane/anemometer configuration at Hiwan.

The Squaw Mountain installation is by far subject to the most extreme environmental conditions in the UDFCD network. Unfortunately, it is also by far the most difficult site to maintain in the entire system as well, even in optimum weather. Maintenance/service activity can become hazardous in just a matter of minutes with rapidly changing weather conditions. This stems partly from its location on the tower, which requires full extension of a 24' ladder to reach. Even after tying the ladder to the tower, the person providing maintenance still must use great care ascending to and descending from the NEMA enclosure and sensors. High wind and precipitation make the situation increasingly risky. Once the road to the site has drifted in with snow later in the year, winter and early spring access to the site is impossible with a 4WD vehicle. We are entirely dependent on "hitching a ride" with the State of Colorado snowcat, which takes occasional trips to Squaw to maintain and service their own equipment. The State will not provide trips on the snowcat until they are required to go there for their own work. Thus, after requesting a "trip" with the State, it could conceivably be weeks before we could get to the site. And, upon arrival, poor weather could possibly preclude effective service. We know this sounds like serious whining, but we simply want to stress that both "scheduled" and "unscheduled" maintenance for Squaw Mountain involves a unique set of logistics and working conditions, thus the District cannot expect the usual response time to service requests for this weather station during the winter and early spring.

One more comment regarding Squaw Mountain. We are not enthusiastic about installing a fuel moisture/temperature sensor there, as informally suggested by the Evergreen Fire District. The ideal sensor location should be in an open, undisturbed "natural" area. No such area exists in the small plat that is controlled by the State, where the tower and building are located. The entire area surrounding the State's bounds of ownership belongs to the U.S. Forest Service. In these areas, there might be a few places where sensor location would be appropriate, but the cable runs would be well in excess of 100 feet. Cable from the sensors would need to be buried from wherever they would be located to the base of the tower. "Burial" in a granite outcropping would be a very time-consuming, labor-intensive (i.e., expensive) chore. Based on past history, obtaining permission from the USFS to disturb the Forest Service land would be very onerous and runs the risk of not ever being approved. We understand the usefulness and need of these data, but the bottom line cost of first gaining permission, and finally installing these sensors at Squaw Mountain would likely be at least as expensive as including FM/FT sensors *with a brand new weather suite* somewhere else in the Evergreen Fire District.

In July, the Temple Pond precipitation and stage site was successfully relocated from the north side of Union Street to the south side, about 15 feet from the pressure transducer housing (Figure 4). The relocate transformed this site from one of the most difficult to maintain in the system to one of the simplest. The PT cable run was reduced from 330+ feet to less than 40 feet. Contamination from irrigation at the new location occurs at about the same degree as that of the old location.

A good start was made during 2000 with regard to upgrading the network to narrow-banding compliance by 2005. Particular strides were made in Boulder County, where the oldest equipment in the system resides. Combined District and Boulder County monies in 2000 resulted in the purchase of 21 High Sierra Electronics 3206 binary transmitters, many with power amplifiers. All but one of these was deployed in the Boulder County network prior to end-of-season maintenance. The only site in the



**Figure 4. Result of Temple Pond relocation.**

shared portion of the UDFCD/Boulder County network that does not currently have a 3206 transmitter is Magnolia, site 4090. Six sites in the “unshared” portion of the network remain ASCII sites: Johnny Park (4310), Big Elk Park (4300), Red Hill (4290), Cannon Mountain (4270), Taylor Mountain (4260) and Golden Age (4230). With one more 3206 available for an ASCII replacement in the spring, five more 3206 transmitters will be needed in the north portion of the network, and one 3206 in the south portion in order to complete the Boulder County narrowband upgrade. If this cannot be accomplished during 2001, the replacement of the remainder of the ASCII transmitters could still be accomplished by installing spare Sierra-Misco 5050 binary transmitters there in the interim. The risk involved with such a strategy would be that the transmit power of the replacement transmitters would be less than the transmit power of those removed from these sites, and reliability could well suffer as a result.

One of the consequences of removing the ancient ASCII transmitters in Boulder County is that the power requirements associated with the new units are different. HSE transmitters universally use 12 volt, 12 amp-hour rechargeable batteries, while some of the older transmitters in sites with poor access traditionally utilized 12 volt, 26-amp-hour batteries. The beefier batteries were especially useful in the winter, so that the sites would have a better chance of staying alive for the long interval between visits in October and spring startup (usually May). To facilitate their survival, several of these

same sites were also configured with solar panels appropriate for the power budget associated with the large batteries and greater power consumption of the old transmitters. These higher capacity batteries cannot be used with the 3206's because the cylindrical housings are too small in diameter to accommodate larger batteries. Because the new transmitters draw significantly less quiescent and transmit current, the smaller batteries are not a liability in relative terms. However, the old solar panels should be replaced with smaller units that better fit the power budget requirements associated with the new site configurations. We have identified a dozen sites that should undergo solar retrofitting to avoid battery overcharge, ensuring that battery life is maximized.

A total of 19 District stage sites are still using Sierra-Misco 5050 transmitters. After Boulder County, these sites should take the highest priority in terms of continuing narrowband upgrades. Fifteen more S-M 5050's are still employed at rain only sites, leaving a total of 34 S-M 5050's that will require replacement with 3206's.

As part of the effort to maximize RF reliability in the network, we have identified about 10 sites that are currently operating with marginal voltage standing wave ratios (our liberal definition of "marginal" means a forward-to-reflected power ratio smaller than 10:1). Although most of these sites are "reliable" in the sense that they still report consistently, such high impedance mismatches between transmission line and load indicate a deteriorating antenna, antenna cable, or connector. They are therefore ripe for failure, perhaps at a critical time. Such sites can easily be made considerably more reliable by replacing the antenna suite with new components. We intend to replace these components as part of startup activity next spring.

In addition, we recommend installing new YAGI directional antennas for both El Rancho and for Highlands Ranch, replacing omnidirectionals. El Rancho was one of the least reliable sites in the system during the 2000 field season. We installed a spare transmitter, then later installed a new 5/8 wave omnidirectional antenna and cable there, but performance still dragged. Highlands Ranch has performed marginally since being installed in 1998, regardless of whether it was transmitted through Blue Mountain or Smoky Hill. Given the apparent success of the YAGI install at Pine Cliff this year (which had a similar history of marginal performance), we are cautiously optimistic that a YAGI install will yield significant improvement in reliability at Highlands Ranch.

After considerable time and effort, we believe that we have found an appropriate location for the East Plum Creek site in Douglas County open space, about 5 miles south of Castle Rock. The proposal requires a series of agencies to review and approve the installation because it is located in endangered species (Preble Mouse) habitat. The proposed precipitation and stage installation is currently under review by the U.S. Fish and Wildlife Service. According to DOCO open space staff, the Colorado Division of Wildlife has already given their stamp of approval. Open space personnel have advised us that habitat disturbance can only occur from the month of November through the month of May. Therefore, unless one of the agencies really drags their feet, we should know well before the end of May whether or not we have permission to install East Plum Creek at the proposed site.

## **Miscellaneous ruminations and equipment failures**

--The strategy of replacing Handar batteries during midseason inspections to try and curtail September dead battery fallout was successful. This activity will therefore become a permanent part of regular maintenance.

--The RHAT sensor at Lafayette was replaced in September with a new Hydrolynx 2046 sensor. The old sensor required a calibration offset in the 5096 program when it was installed in 1998. Its performance since then indicated that it was not as stable as it should have been. The replacement sensor appears to be working fine.

--The rusting steel transmitter enclosure at Evergreen Lake was replaced with a custom built stainless steel enclosure, which will be far more durable. The PT housings at Holly Dam, Croke Pump Station, and Montview Park were re-anchored to their respective concrete walls to improve stability.

--The Handar RHAT sensor at Quincy should be replaced, as there appears to be consensus that 1) dew point readings are consistently high at this site, and 2) there is no local environmental influence that would account for this behavior.

--Attempts at "upgrading" the Quincy weather station (replacing the 585 transmitter with a programmable 555) were not completely successful. There is a problem getting the 555 to generate solar radiation reports. The sensor is working with the 585, indicating a problem either with the 555 program or the adaptor cable. However, troubleshooting has so far proved futile, as the cable is fine and the program parameters are correctly defined. The 555 recognizes all the other sensors comprising the weather suite at Quincy. As it stands now, the 555 install would result in the loss of solar radiation data, at least temporarily until the problem can be defined and fixed. In the meantime, the 585 continues to faithfully report all sensor parameters.

--The 555 at Hiwan stopped generating wind speed reports and was replaced with a spare. A blown fuse was replaced and the 555 program was reloaded, but the problem persisted on site. Back at the bench, we were able to generate wind speed data with the transmitter and a spare anemometer. We intend to swap the 555 back into Hiwan next spring to determine if the problem is of an intermittent nature.

--The mast box assembly at Flings had cracked just above the box-to-mast weld and was replaced with a spare unit.

--A broken TB cable was repaired at Nott Creek.

--The FM/FT sensor at Blue Mountain died and was returned to Handar for repair. The sensor was returned, reinstalled, and has been working fine since.

--At Hiwan, the anemometer failed to rotate in light wind due to bad bearings. The anemometer was sent back to Handar and was refurbished and returned to DIAD, where it is now available as a spare.

--New antennas, cables and connectors were installed at Magnolia and at the Filter Plant to fix poor RF performance.

--Equipment is currently on order for the Urban Farm project. As you are aware, the equipment configuration will be rather unique, both in terms of equipment type and in terms of the physical installation. As soon as we have received the sensors, we can begin designing the interior of the NEMA-type enclosure that will house the CR10X datalogger, synchronous serial transmitter and sensor cabling, as well as complete development of the datalogger programming. We intend to have the site installed prior to 2001 startup activity.

Kevin, DIAD would like to extend our thanks for your professionalism, and we hope to be able to support the UDFCD during the next flood season.

Sincerely,

Robert Cress  
DIAD Inc.