



# UDFCD ALERT Gauging System Maintenance 2015 Annual Report

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## Executive Summary

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### Introduction

The purpose of this report is to summarize the ALERT system maintenance activities completed by OneRain in 2015 on behalf of the Urban Drainage and Flood Control District (UDFCD) under our current contract.

We believe that maintenance for the 2015 season was successful. We are excited about the continued implementation of the ALERT2™ protocol and the positive impact it will have on more reliable data collection.

Beginning in the 2008 maintenance season, OneRain and the District modified the maintenance schedule slightly from previous years by including an interim trip to all rain gauge sites. Table 1 below summarizes the maintenance activity over the course of the last eleven years. The "Service Rate" column is the ratio (%) of service calls to sites in the combined UDFCD/Boulder System.

**Table 1: Recent Maintenance Activity Statistics for UDFCD & Boulder Co.**

Year	Total # of Visits	Service Calls OneRain/District	Number of Sites <sup>1</sup>	Service Rate
2001	701	66 (30/36)	152	43%
2002	723	59 (45/14)	161	37%
2003	794	110 (86/24)	171	64%
2004	790	78 (51/27)	173	45%
2005	810	97 (76/21)	174	56%
2006	696	97 (78/19)	182	53%
2007	653	58 (49/9)	183	32%
2008	715	94 (62/32)	194	48%
2009	715	107 (93/14)	179	60%
2010	744	82 (81/1)	180	45%
2011	680	78 (69/9) <sup>2</sup>	180	43%
2012	692	67 (53/14) <sup>2</sup>	176	38%
2013	635	97(87/10)	177	55%
2014	624	64(64/0)	178	36%
2015	598	73(63/10)	175	42%

<sup>1</sup>This total number of sites includes repeaters and base stations.

<sup>2</sup>Count does not include 'administrative' maintenance records which document battery disposal

## System Performance

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We had a total of 598 maintenance records; there were 63 service calls initiated by OneRain and 10 initiated by another source. These records were gathered between January 1, 2015 and December 14, 2015.

### Service Calls

The 73 total service calls are broken down as follows:

- 26 Stage issues
- 18 Power related issues
- 16 Tipping Bucket issues
- 8 Transmitter/RF issues
- 4 Other site issues
- 1 Infrastructure issue

Key factors of the unscheduled visits can be attributed to the following:

- **Transmitter/RF issues** – Transmitter-related issues encompass a wide array of on site issues from dead radios and program corruptions to transmitter failures.
- **Power issues** – Due to a continuing aging battery fleet, a number of batteries did not survive the interval between standard preventative maintenance visits. Batteries go through a dynamic discharge at our office. If the battery under performs the unit is scrapped.
- **Stage issues** – Out of the 26 stage service calls, 13 were due to PT failures/replacements. Seven service calls were for signal conditioning and calibration. The other calls were for miscellaneous repairs such as flushing the PT riser.
- **Tipping Bucket issues** – Typically most issues for tipping buckets arise from being clogged whether it is by vegetation or animal activity.
- **Infrastructure issues** – Most problems are from breakages in PT conduit.

### Pressure Transducer Failures and Replacements

There were less PT failures compared to last year. Over the past few years PT replacements have been high as the aging fleet is upgraded. This year 54 pressure transducer calibrations were performed. This number falls in line with standard maintenance years. For the past two years we have been transitioning to the Keller Accuview unit. Specific pressure transducer replacements are listed below.

- Maple Grove Res (10013) – Replaced 5/14/2015
- Horseshoe Park (710) – Replaced 7/10/2015
- ETG @ Hampden (10011) – Replaced 4/06/2015
- L'Ville DWI (1100) – Replaced 7/13/2015
- Sanderson Gulch (1340) – Replaced 7/13/2015
- Little Narrows (4470) – Replaced 4/07/2015
- Pinney Creek at Liverpool (950) – Replaced 4/29/2015
- Niver Detention (1900) – Replaced 3/11/2015
- Broomfield (1200) – Replaced 7/10/2015
- Leyden Reservoir (200) – Replaced 3/31/2015
- Van Bibber (330) – Replaced 8/13/2015
- Marston (1520) – Replaced 8/11/2015
- Havana Pond (10023) – Replaced 9/10/2015

## Damaged Equipment/Other Replacements

### **Leyden Reservoir (200)**

The Pressure transducer was replaced on March 31, 2015. In recent years this site is prone to sediment deposition. On May 11<sup>th</sup> it was noticed that the PT was not reporting accurately; the riser was flushed with a gasoline engine pump. A noticeable amount of sediment was removed. A review of install pictures revealed that the PT resides close to the floor of the reservoir channel. Over the years we assume that this location has filled with silt resulting in erroneous PT readings. The site will need to be continually monitored and flushed of sediment.



### **Van Bibber (330)**

On August 13<sup>th</sup> it was noted that the stage was not functional. A site visit determined that a 4-20 mA pressure transducer was installed along with a mA to 0-5 Volt signal conditioner. It was determined that the signal conditioning had failed. UDFCD no longer keeps 4-20 mA PTs as spares. The unit was replaced with a 0-5 Volt PT.

Furthermore, the channel has shifted over the last few years. The site should be relocated and will be discussed in the sections below.

### **Aurora Regional Pond (940)**

During May the tipping bucket under reported during an event. During a site visit on May 15, it was determined that the tipping bucket was functional and the issue was the input on the transmitter. The transmitter was replaced making the site operational.

### **DIA at 3<sup>rd</sup> Creek (1480)**

The tipping bucket did not respond to a rain event. A site visit was performed on April 20<sup>th</sup>. It was determined that mice had chewed through the tipping bucket cable. The wire was replaced and secured. This site has a history of heavy mouse infestation. This site should be re-located. Last year discussions were initiated with DIA regarding installing a standpipe. Due to the stringent permitting of the airport, the discussions were dropped.

### **Marston (1520)**

The PT failed and was replaced on August 11<sup>th</sup>. Due to the short run of the PT, a spare 4-20 mA unit was installed. The program was modified to handle a current PT output. A 100 Ohm precision resistor was added to the data logger.

### **Brighton ETO (1570)**

It was noticed that Brighton ETO was under reporting rain. It was determined that the WST520 had failed. The sensor was sent back for replacement and paid for by the City of Aurora.

### **Cub Creek Below Blue (2270)**

The antenna mast is bent preventing easy access to the top section. Attempts to re-align the antenna mast have failed. OneRain currently has an old mast from a removed stand pipe. The mast will be replaced during spring start up.

### **Lakeshore (4060)**

Over the years a large tree has grown in the vicinity of the rain gauge. It is obscuring the rain catch and solar panel. This site is on private property and we cannot trim or remove the tree.

### **Lee Hill Repeater (4210)**

Lee Hill Repeater failed on October 13<sup>th</sup>. Gold Hill Repeater was placed to pass all during the outage. This outage affected only ALERT. On October 14<sup>th</sup> the repeater was replaced with a spare unit. The serial output cable was replaced to the ALERT2 repeater. It was also determined that the AC power unit had an intermittent connection to the ALERT2 repeater. Connections were verified and a second battery was added to the ALERT2 unit.

### **Justice Center (4360)**

The standpipe door lock has seized and will no longer open. Currently access is gained through the top of the standpipe. The door will need to be replaced.

### **Eldorado Springs (4380)**

In May the stage quit reporting. This site uses a SDI-12 sniffer which reads DWR data. A site visit determined that the DWR had replaced the radar sensor with a new sensor address. The sniffer was reconfigured for the proper address. The site is functional.



**Broadway (4580)**

The pressure transducer is starting to develop a diurnal affect. We are currently awaiting funding from the City of Boulder to upgrade the site to ALERT2 and install a freeze resistant pressure transducer.

**Gold Hill Repeater (8015)**

On December 9<sup>th</sup>, the Gold Hill Repeater stopped functioning due to battery failure. All three batteries were replaced and solar was verified for proper output.

**Maple Grove Reservoir (10013)**

The PT failed on May 14 during a rain event. OneRain performed an emergency maintenance trip during the event to replace the PT and bring the site back online.

**Murphy Creek (10019)**

On May 12, 2015, the signal conditioning unit on site failed. Once the unit was replaced, the span and zero were adjusted. The PT was also re-calibrated.

## New Site Installations

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### Coal Creek at McCaslin (10030)

<i>Latitude</i>	<i>Longitude</i>	<i>Site ID</i>
39.9531830°	-105.1651920°	10030



Installation was completed on 12/08/2015. Coal Creek at McCaslin utilizes ALERT2 technology and is powered with a Campbell Scientific ALERT2 transmitter. It is currently configured for rain and stage. The stage sensor is a non contact radar.

<i>Sensor</i>	<i>Time Transmission</i>	<i>Delta Transmission</i>
Stage	1 Hour	0.01 Feet
Precip Accumulation	1 Hour	0.04 inches
Battery	1 Hour	N/A
GPS Lock	1 Hour	N/A

## 2015 Site Reconstructions, Relocations, and Upgrades

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### **Croke Pump Station (120)**

The pressure transducer was pulled at Croke Pump Station on November 4<sup>th</sup>. The unit was removed after being contacted by the City of Arvada. They are currently doing work at this location. As of this report the sensor has not been replaced and there is no word on excavation work.

### **Montview (400)**

Montview was removed on January 23<sup>rd</sup> for construction in the area. All electronics, solar panel, and pressure transducer were removed. The site is still currently out of service and awaiting new install.

### **Kelly Dam (410)**

During high water events the pressure transducer elevation differs from on site readings. This was due to the stage sensor being located inside the outlet structure. The structure has a tendency to clog with debris, resulting in different elevations from inside and out. On July 14<sup>th</sup>, the water level subsided enough to re-locate the conduit to the outside of the structure.



### **Ferril Lake (1380)**

The bubbler at Ferril Lake failed last year. The site was put out of service on May 12<sup>th</sup> until funding for a new sensor could be provided. On October 20<sup>th</sup>, the bubbler was replaced with a freeze-resistant pressure transducer. The conduit was extended to allow ease of access and maintenance. The site is now transmitting both stage and water temperature.



### **Diamond Hill Wx (1420)**

The Diamond Hill Weather Station was moved from the corner of the roof to an existing satellite antenna mast in the center. During the move the electronics were upgraded to ALERT2. The existing standpipe was scrapped and the site is now contained in a NEMA enclosure.



### **SPR at Dartmouth (1630)**

The site quit reporting on August 9<sup>th</sup>. A site visit determined that the USGS had removed all sensors and electronics from the enclosure without our notification. A USGS field tech had removed the equipment believing that the electronics were obsolete. The shaft encoder and solar panel were scrapped without our permission. OneRain currently possesses the transmitter.

## **Boulder County Activity**

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There were no major issues in Boulder County this year. A separate report will be delivered to the county with additional recommendations and upgrades.

### **Eagle Ridge Repeater (4520)**

Eagle Ridge repeater quit reporting on October 12<sup>th</sup>. A site visit determined that the RF cable had become disconnected. The cable was repaired bringing the site back online.

### **Lyons Diversion (4560)**

The enclosure accumulates excessive moisture. All access ports to the enclosure have been sealed. Additional desiccant has been added. This site will be continually monitored for moisture buildup. Furthermore, this site is on the edge of the receive capability for the Eagle Ridge Repeater. Currently Eagle Ridge is not upgraded to ALERT2. If there are no plans of upgrading Eagle Ridge, Apple Valley could be upgraded to a 3306 ALERT transmitter which would repeat the Lyons Diversion signal. Apple Valley has a clear view of Lyons Diversion and would make an excellent hop.



## Miscellaneous Activity

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### FCC Licensing

OneRain is currently in the process of updating and renewing all applicable licenses.

### Diamond Hill Base Station Issues

ALERT2 latency at Diamond Hill continues to be an issue. On March 19<sup>th</sup>, all ALERT and ALERT2 equipment was re-located from the roof to the UDFCD server room. During this re-location the antenna was moved to a new location at the corner of the roof. A single RF feed line runs from the antenna to their server room, where it is split to all equipment.



After the move, OneRain installed a CR6 data logger on the same network as the B2010. This data logger transmits its voltage every minute to OneRain. With the data logger on the same network as the B2010, we have a better understanding if future outages are network related or B2010 related.

Since the install of the data logger there has only been one major outage. This outage occurred on July 31<sup>st</sup> and was the result of a power outage at Diamond Hill. All of the ALERT/ALERT2 equipment is on UPS and an additional battery backup. However, a component "up stream" was not functional without back up power. Once power was restored, the data logger came back online immediately. The B2010 did come back; however, it took a few additional minutes.

Currently OneRain is alarming if no data is received from the B2010 for 5 minutes. If an alarm is received, we can verify if we still have network connectivity by checking the status of the data logger.

## **Alarming**

Rainfall alarms were added to all sites in Contrail. Alarming is triggered by the following events:

- 0.5 Inches in 10 Minutes
- 1.0 inches in 1 hour
- 3.0 inches in 2 hours
- 5.0 Inches in 5 hours

Deliveries are set up for e-mail and/or text message. When a site is in alarm state the icon will change on the user interface.

## Future Areas of Interest

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The sections below outline areas that the District and OneRain have been tracking through our monthly meetings, or areas of future concern that we want to make you aware of.

### **ALERT2™ Upgrade**

Below is a complete list of sites that have been upgraded to ALERT2:

- Carr Street
- Maple Grove Reservoir
- East Toll Gate at Hampden
- Blackstone
- Havana Pond
- James Creek at Jamestown
- Lower Lefthand
- Murphy Creek
- Nolte Pond
- South St. Vrain at Berry
- Sand Creek at Colfax
- Westerly Creek Dam
- Coal Creek at McCaslin
- Diamond Hill Wx

### **Secondary ALERT2 Base Station at Westminster**

To ensure reliable data reception, a redundant ALERT2 data receive location will be installed at the City of Westminster Public Safety building. Data will be collected using a DB224 antenna and Blue Water Design's B2010 Base Station Receiver/Demodulator. The serial output will then be transmitted to OneRain's secure data storage center via TCP/IP for display in Contrail. With the ongoing latency issue, it is critical to have the secondary base station operational by April 1, 2016.

### **Metadata Consistency**

OneRain will continue to work with WET and other agencies to integrate database metadata ensuring accuracy and consistency.



## Spare Equipment Recommendations for Upcoming Season

**Table 2: Spare Equipment Recommendations**

<b>Manufacturer</b>	<b>Model</b>	<b>Cost</b>	<b>Quantity</b>	<b>Total</b>	<b>Notes</b>
Hydrolynx*	Repair	\$500	1	\$500	Hydrolynx Repeater Repair
High Sierra*	Repair	\$170	3	\$510	HSE Transmitter Repair
High Sierra	2400-03	\$260	3	\$780	Tipping Bucket
High Sierra	3306-02	\$680	1	\$680	Upgrade HSE to ALERT2
High Sierra	3306-02	\$1,530	2	\$3,060	Upgrade Boards on 3306-02
Keller	Acculevel	\$620	2	\$1,240	120 ft PT
Keller	Acculevel	\$668	2	\$1,336	160 ft PT
Keller	Acculevel	\$716	2	\$1,432	200 ft PT
Talley	MBS150	\$125	1	\$125	Spare Antenna
-			<b>Total</b>	<b>\$9,663</b>	

\*These repair costs are estimated and will be determined by the manufacturer.

## **Additional Site Recommendations**

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The following are additional site recommendations not associated with spares. A detailed proposal can be provided upon request.

### **Stand Pipe Door Implementation**

High Sierra has released a new product that allows the installation of a door in sites previously lacking one. Currently there are many sites that lack a door option and are therefore difficult to access the electronics inside. We propose purchasing at least 5 Retrofit Kits for install this spring. The installation of doors will improve safety and maintenance efficiency. The cost of **\$495** per retrofit includes hardware and labor. The list below contains sites that would benefit most greatly from the upgrade.

- Lena Gulch at HWY 6
- Powers Park
- Grandy Ditch
- Englewood Dam
- Kelly Dam

### **Van Bibber Re-Work**

Since the flooding of 2013 we have struggled maintaining hydraulic contact at the current PT riser location at Van Bibber. The channel has shifted greatly and deposited sediment over the PT. Furthermore, the standpipe top section is in disrepair and poses poor access in its current location. We recommend replacing the stage sensor with a non-contact radar mounted to the bridge. During this upgrade the site would also be transitioned to ALERT2. The standpipe would be replaced and relocated to a site more conducive to maintenance. Similar to Coal Creek at McCaslin, the radar sensor would be donated free of charge. Pricing for this project is listed below:

- \$14,170

### **Sanderson Gulch Standpipe**

The standpipe located at Sanderson Gulch has been repeatedly vandalized over the years. The infrastructure has deteriorated resulting in difficult access to the transmitter and tipping bucket. The stage sensor is still in good working order and location. We recommend replacing the standpipe with a new unit. While completing this work the site would be upgraded to ALERT2 from spare equipment.

- \$7,154

### **ALERT2 Site Upgrades**

Currently sites are only upgraded to ALERT2 when the previous transmitter fails or a new site is installed. We would like to implement an ALERT2 upgrade plan, in which a specific number of sites are upgraded each year. By upgrading, we increase the quality of data and preemptively reduce the chances of transmitter failure. The price to upgrade a site to ALERT2 includes hardware and labor. Also included in the price is configuration of Conrail.

- \$3,427 per location

### **Holly Dam Riser**

The riser conduit at Holly Dam has been damaged by the city during excavating and needs repaired. Currently the pressure transducer is exposed and the conduit needs replaced. Price to complete these activities is:

- \$1,040

### **ALERT2 SDI-12 Sniffer**

High Sierra Electronics has combined an SDI-12 sniffer feature with their new ALERT2 transmitters. We currently have 2 ALERT sites where SDI-12 sniffers are in place. We can easily upgrade these locations to ALERT2 while eliminating the SDI-12 sniffer hardware.

- \$4,652 New 3306-02 Transmitter
- \$2,332 Upgrading old 3306-00 Transmitter

### **Lee Hill Repeater**

The AC float charger and cabling at Lee Hill should be replaced. While replacing this equipment the serial cable will also be reconfigured to pass through the enclosure and not the door.

- \$833

### **Justice Center**

The door lock has failed at this location. The old door needs cut out and replaced with a new door.

- \$495

## **Appendix A: Spares on Hand**

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**Per separate PDF accompanying this document**

## **Appendix B: Maintenance Records**

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**Per separate PDF accompanying this document**

## **Appendix C: PT Calibration Log**

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**Per separate PDF accompanying this document**