

Memo

Date: December 15, 2016
To: Kevin Stewart
From: Markus Ritsch
Subject: November 2016 ALERT Data Analysis

I. ALERT Data Source

Raw ALERT data records extracted from the Urban Drainage and Flood Control District's NovaStar 5 base station were analyzed for the period November 1 through November 30, 2016.

II. General System Analysis Summary

The District receives data through both the legacy ALERT channel and through the ALERT2 (concentrator plus A2 self-reports) channel. The following (Table 1) quantifies the data reports received by each channel.

Table 1. Reception of Data at Diamond Hill (Legacy, ALERT2 and Concentrator Reports from Recdatalog)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
Legacy	118,519	264,375	241,517	266,465	245,856	254,744	262,732	257,816	241,485	251,914	232,629		2,638,052
Concentrator	194,948	418,430	407,965	435,747	416,968	423,152	423,762	409,121	391,806	411,402	368,074		4,301,375
ALERT2	136,144	399,530	505,195	540,654	508,036	509,129	473,766	571,162	545,138	504,889	412,332		5,105,975
TOTAL	449,611	1,082,335	1,154,677	1,242,866	1,170,860	1,187,025	1,160,260	1,238,099	1,178,429	1,168,205	1,013,035	0	12,045,402
Conc/Leg	1.64	1.58	1.69	1.64	1.70	1.66	1.61	1.59	1.62	1.63	1.58	1.00	1.63
DataChron	645,913	662,847	674,426	742,749	732,116	776,223	757,956	775,073	743,446	723,613	666,837		7,901,199

The District operates two NovaStar5 base stations: the primary (ns5a) at Diamond Hill and a redundant base (ns5b) at Greenhouse Data. Additional analyses are conducted on the data received by these two base stations (Table 2). The data received by both base stations for the month are shown below.

Table 2. Comparison of Data Reception by ns5a and ns5b

NS5A (Diamond Hill)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
Legacy	118,519	264,375	241,517	266,465	245,856	254,744	262,732	257,816	241,485	251,914	232,629		2,638,052
Concentrator	194,948	418,430	407,965	435,747	416,968	423,152	423,762	409,121	391,806	411,402	368,074		4,301,375
ALERT2	136,144	399,530	505,195	540,654	508,036	509,129	473,766	571,162	545,138	504,889	412,332		5,105,975
NS5B (Greenhouse)													
Legacy	118,610	264,516	263,959	266,509	264,138	258,435	262,307	258,034	241,558	251,684	232,340		2,682,090
Concentrator	194,968	418,532	446,510	435,558	447,154	428,264	422,702	409,148	391,647	410,868	367,079		4,372,430
ALERT2	136,330	399,841	552,747	540,161	544,926	515,425	472,516	571,519	545,439	504,304	411,507		5,194,715
Diff (NS5a-NS5b)													
Legacy (Digi One)	-91	-141	-22,442	-44	-18,282	-3,691	425	-218	-73	230	289	0	-44,327
Concentrator (B2010)	-20	-102	-38,545	189	-30,186	-5,112	1,060	-27	159	534	995	0	-72,050
ALERT2 (B2010)	-186	-311	-47,552	493	-36,890	-6,296	1,250	-357	-301	585	825	0	-89,565
Comments	Recdatalog format changed... missing 1/3 of the month		DH base was down for a period		DH server was down at the end of May		First month that DH has better reception than GH						

The reception rates between Diamond Hill and Greenhouse are consistent. The trend during most of the year was that the Greenhouse server receives a few more reports than does Diamond Hill. During the last two months, the Diamond Hill server has received more reports than Greenhouse.

The daily ratio of concentrator to legacy reports is shown.

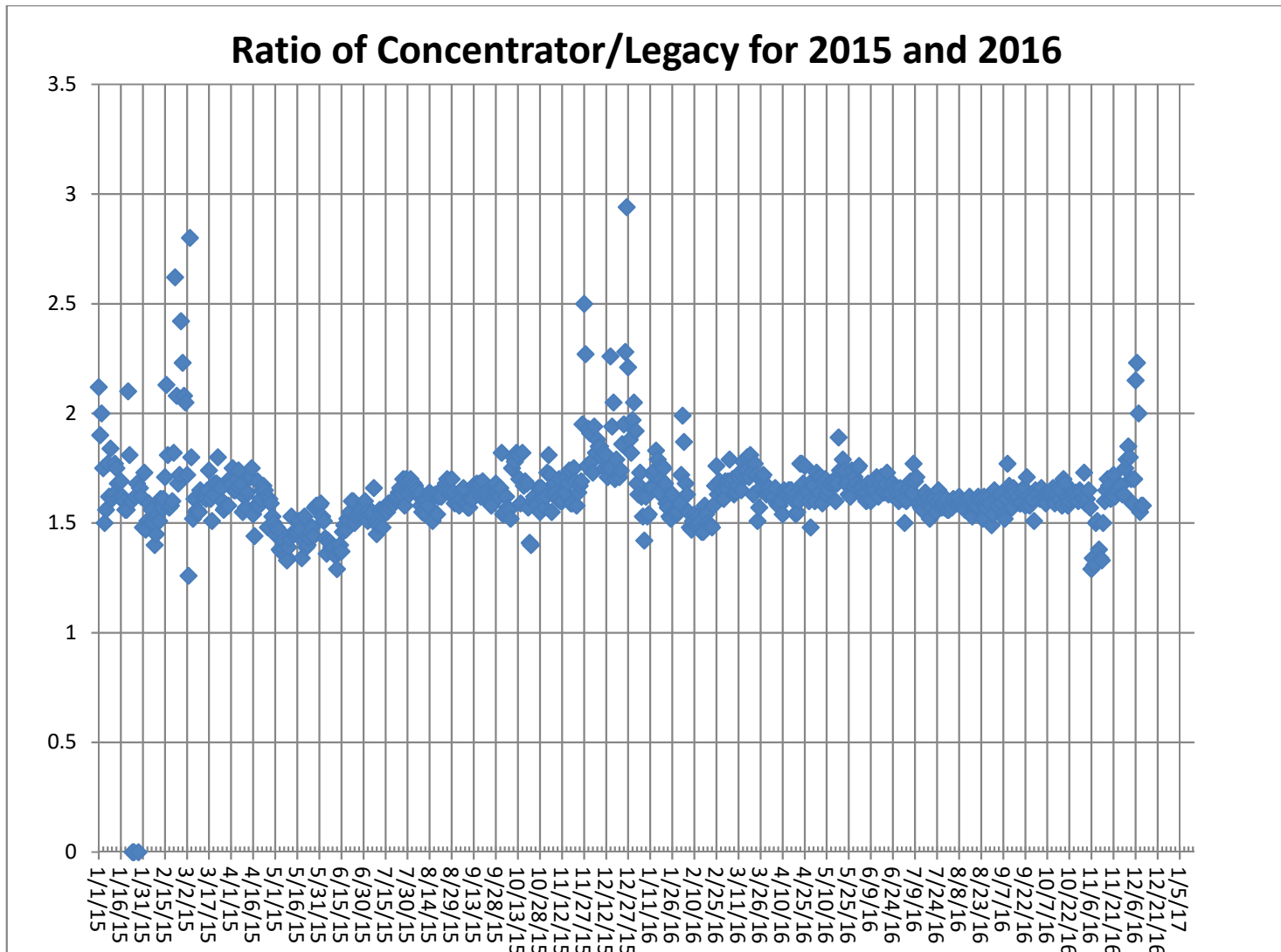


Figure 1. Daily Ratio of Concentrator Reports to Legacy Reports

The ratio becomes more volatile in the cold months as the Blue Mountain repeater has problems with legacy ALERT reporting when the temperature drops below zero. The ratio stays very consistent all the way through October in 2016 which may be due to the fact the air temperatures were relatively warm throughout the fall.

A. Continuous Operation of Base Receiver/Decoder

The base station was in continuous operation for the entire month. Data was collected on a continuous basis for every hour of every day for a total of 720 hours of operation. Outages of less than one hour are not identified.

B. Specific Issues Identified

Performance of the following sensors (Table 3) was questionable this month.

Table 3. Sensors with Poor Performance Characteristics

Sensor ID	Description	Comments
6502	Smoky Hill Repeater	Significant reduction in ALERT2 throughput relative to the other repeaters
6502	Smoky Hill Repeater	Relatively poor performance for all sensors going through Smoky
10021	OneRain Weather	Experienced a negative latency for temp/RH reports on Nov 6
3019	West Cr Weather	Experienced negative latencies for ALERT2 reports this month
1649	SPR at 19 th St.	Large number of invalid reports
4563	Lyons Diversion	Large number of invalid reports
4330	Hanson	Poor timer and event performance
ALERT2	Peak Hour Traffic	The peak hour of radio traffic for ALERT2 occurred on Nov, 6 at 1:00 AM. The peak traffic of 1,063 ALERT2 reports during this hour is very high. There may have been a problem with the ALERT2 reporting during this period.

C. Performance of New A2 Sites

This section of the report will look at specific reporting characteristics of the new A2 sites by analyzing their APDUID (Application PDU Identifier). The APDUID is a cyclical, incrementing counter from 0 to 6. Tracking skipped values and restarts of the application control byte counter provides useful insight into site performance and general network health. The performance of the cyclical counter is quantified for each A2 self-reporting site and repeater path (Table 4).

Table 4. APDUID Performance of A2 Sites by Source Address

Description	ID	W. Creek (6001)	Smoky Hill (6502)	Blue Mt. (6503)	Lee Hill (6505)	Gold Hill (6506)
Newlin Gulch	3070					
Heritage Regional Park	3090					
Magnolia	6601		0.66	0.77	0.80	0.81
Blackstone	10010					
ETG @ Hampden	10011					
Carr Street (100)	10012					
Maple Grove (1000)	10013		0.74	0.99	0.99	0.98
Upper Sellers	10014					
Haystack Road	10015					
Sand Cr at Colfax	10016					
James Creek	10017					
Lower Left Hand (4453)	10018					
Murphy Creek (870)	10019					
OneRain Weather	10020		0.50	0.84	0.75	0.83
S. St. Vrain at Berry Ridge	10021					
Arvada/Blunn Reservoir	10022		0.75	0.99	0.99	1.00
Havana Pond	10023					
Westerly Creek Dam	10024					
Lena @ Nolte Pond (1023)	10025					
Trumbull (Hayman)	10026	0.93				
West Creek (Hayman)	10027	0.93				
Diamond Hill (1420)	10028		0.67	0.88	0.86	0.85
Plum Creek at Sedalia	10029	0.98				
Coal Creek at McCaslin	10030		0.73	0.99	0.98	0.97
Boulder Cr. Broadway (4583)	10031		0.74	0.38	0.97	0.99
Weir Gulch	10032		0.07	0.96	0.96	0.01
Side Creek Park (830)	10033					
Not Used	10034					
Sanderson Gulch (1340)	10035					
Porphyry Mtn (4850)	10036		0.75	0.04	0.99	0.94
West Creek WX (3020)	10037	0.95				
Little Dry Creek at 64 th (1310)	10038					
Fire Station 47 (3060)	10039	0.96				

D. ALERT2 Repeater Loading

The District's ALERT2 architecture utilizes 5 repeaters with a single transmit frequency (170.300 MHz) to Diamond Hill. The repeaters utilize a 20 second frame where each repeater is allocated a slot of specific size and an offset within the frame. The slot allocated to each repeater is sized appropriately to accommodate the total number of existing and future remote sites routed through that repeater. Each repeater is shown along with its designated slot (Table 5). Currently there is no pass-listing for the ALERT2 repeaters. Any remote ALERT2 site can be received by all repeaters and re-broadcast to the base except for West Creek which has an input frequency unique to Douglas County.

Table 5. ALERT2 Repeater Architecture

Repeater	Slot Size (sec)	Slot Offset (sec)	Source Address	ALERT2 Input Frequency (MHz)	ALERT2 Output Frequency (MHz) – received at Diamond Hill
West Creek	2	0	6001	169.425	170.300
Smoky	3	2	6502	169.525	170.300
Blue Mt.	4	5	6503	169.525	170.300
Lee Hill	3	9	6505	169.525	170.300
Gold Hill	3	12	6506	169.525	170.300
Magnolia	5	15	6507		170.300
Frame Size	20				

The following tables summarize the total number of reports received through each repeater (Table 6). This helps to quantify repeater loading for the ALERT2 backbone.

Table 6. ALERT2 Reports Received through Each Repeater (Only A2 Self Reports)

Month-Yr	West Creek (6001)	Smoky (6502)	Blue Mt. (6503)	Lee Hill (6505)	Gold Hill (6506)	TOTAL
Jan-15	0	44,501	44,636	44,783	39,007	172,927
Feb-15	0	58,543	56,150	61,160	57,764	233,617
Mar-15	346	73,198	69,604	77,968	65,323	286,439
Apr-15	595	73,711	69,568	79,215	72,310	295,399
May-15	5,259	78,694	72,340	86,297	77,174	319,764
June-15	11,987	72,449	65,742	82,998	69,570	302,746
July-15	28,595	75,379	71,394	79,026	74,041	328,435
Aug-15	28,409	92,299	84,057	84,363	87,211	376,339
Sep-15	26,809	84,143	84,776	84,289	85,123	365,140
Oct-15	19,775	82,683	83,390	63,475**	84,825	334,148
Nov-15	6,438	62,615	61,477	50,888	58,004	239,422
Dec-15	9,835	72,886	72,465	73,431	47,996	276,613
Jan-16	4,034	38,348	36,826	37,168	19,768	138,160
Feb-16	11,732	93,120	99,206	96,284	99,188	399,530
Mar-16	12,533	126,123	134,329	140,226	139,536	552,747
Apr-16	13,262	128,473	130,223	135,499	133,197	540,654
May-16	27,002	125,098	124,280	138,033	130,513	544,926
Jun-16	30,405	117,877	111,309	133,036	122,798	515,425
Jul-16	37,492	108,334	102,335	115,028	110,577	473,766
Aug-16	48,323	130,666	123,827	136,746	131,957	571,519
Sep-16	49,555	122,625	115,898	129,454	127,606	545,138
Oct-16	51,170	111,105	110,038	116,087	116,489	504,889
Nov-2016	47,039	72,761	92,941	100,083	99,508	412,332

** - The number of reports coming through Lee Hill declined in October

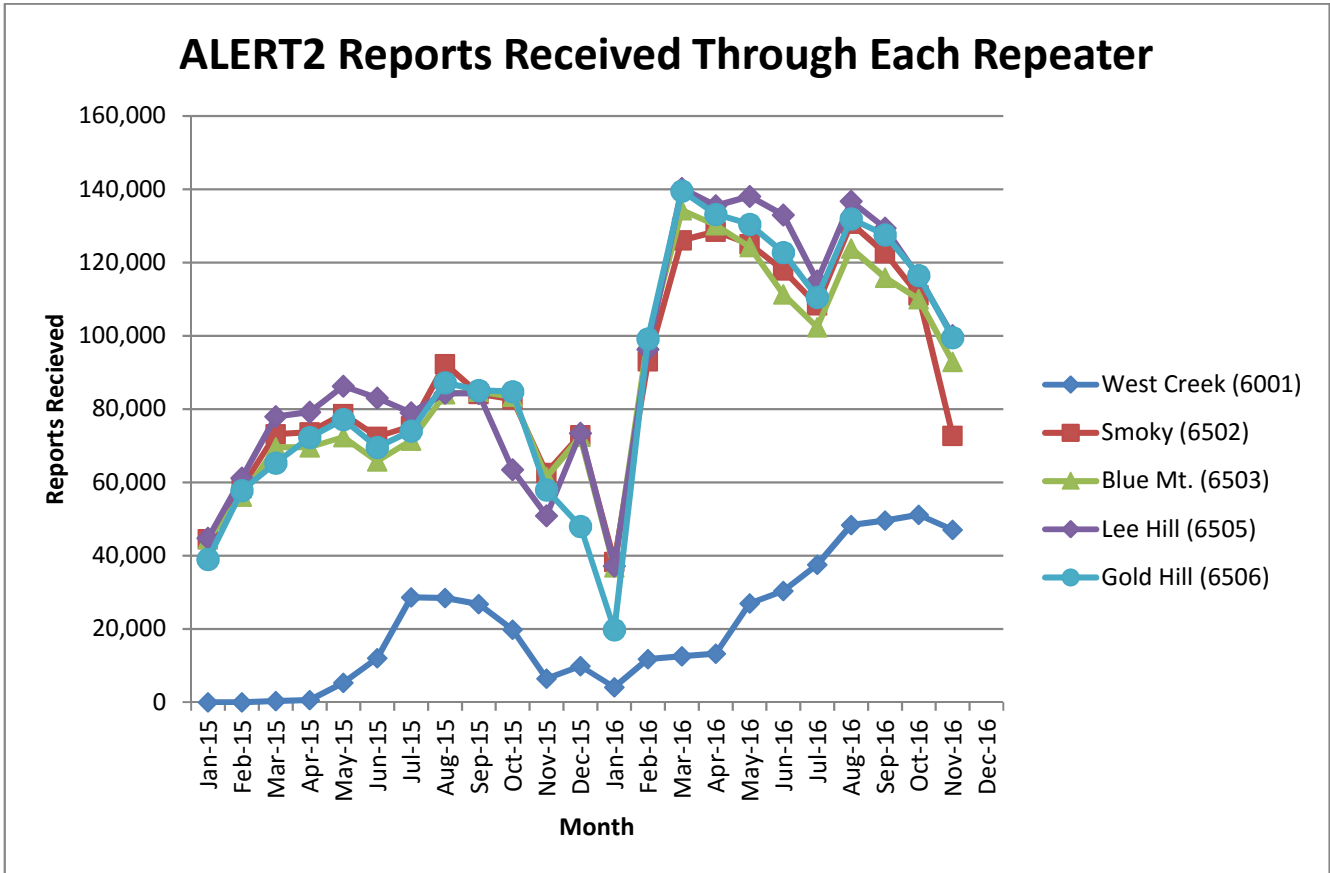


Figure 2. Reports received through each repeater (ALERT2 Only)

A convenient mechanism to track repeater performance throughout the year is to monitor total ALERT2 reports passed by each repeater. In general, each of the primary repeaters in the District process an equivalent number of ALERT2 reports because pass/block filtering is not being used. Several months are evident where the throughput of one repeater is not consistent with the other three.

The Magnolia Weather station was down from June 27 through July 12. This weather station reports on a frequency of 5 minutes and it reports up to ten total parameters. On a typical day it may send 2,500 total reports. It was not reporting for at least eleven days in July which resulted in a total loss of up to 25,000 reports. This likely explains the drop in total throughput for the months of June and July.

In November, the Smoky Hill repeater has a significant drop in ALERT2 throughput relative to the other repeaters. This is likely due to the fact that the majority of the District system is winterized except for the stations in Boulder County. The Smoky Hill repeater is not a primary repeater for the Boulder stations. Although, we did not see this large drop in November of 2015. There could possibly be a problem at Smoky.

The following tables summarize the system-wide latency of ALERT2 self-reports (Table 7 and Table 8).

Table 7. System-Wide Latency of ALERT2 Self-Reports (seconds)

Statistical Parameter	Value (sec)	Comments
Mean	49.90	The average time it took a report from the field to reach the base
Minimum	-3,512	The minimum time it took for a report to go from the field to the base
Maximum	43,177	The maximum time it took for a report to go from the field to the base

Table 8. Summary of ALERT2 System-Wide Latency (seconds)

Statistical Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	66.17	72.6	75.36	67.48	53.36	57.42	55.99	52.47	48.33	49.09	49.90	
Minimum	3	2	1	3	2	2	3	-20	-20	-23	-3512	
Maximum	300	261	521	745	262	226	280	288	43180	43180	43177	
Station with Max Latency	Magnolia WX (6602)	Magnolia WX (6607)	Sand Cr (10016)	Magnolia WX (6601)	Magnolia WX (6605)	Westerly Cr Dam (10024)	West Cr WX (3019)	West Cr WX (3019)	West Cr WX (3019)	West Cr WX (3019)	West Cr WX (3019)	

The large negative latency in November came from the OneRain weather station (10020) for the air temperature and relativity sensors. The large negative latency was observed only on November 6, 2016.

E. TDMA Time Slot Size

ALERT2 networks will have problems with missing timed station reports when they have transmit times at some stations that exceeded the TDMA slot size. For example, a test transmission from a site may be received when it's sent manually from the site but the timed transmissions are not received. This is a problem with the station preceding the missing station exceeding its slot size in the TDMA assignment.

A program is written for the UDFCD that checks the receive data log files looking for station reports that are too long. For example, the MANT TS=... the Length=# or the data packet size should not be more than 45 bytes. The only stations found to exceed the 45 byte limit were repeaters.....which is acceptable since their slot size is much larger than 0.5 seconds. No stations were found with a slot length exceeding 45 bytes.

F. Inefficient ALERT2 Packets

An inefficient ALERT2 packet contains multiple (MANT) data packets per air link packet. ALERT2 supports the composition of air link packets containing multiple data values in a single MANT packet. Using a single MANT packet for each data packet is an efficient use of the ALERT2 protocol and should be avoided. The following sites were identified as possibly being configured inefficiently:

-) Newlin Gulch (3070) – Campbell Scientific – this transmitter was updated with a new EPROM that allows for MSR reporting
-) OneRain Weather (10020) – Campbell Scientific
-) Diamond Hill (10028) – not sure what transmitter is being used here.
-) Plum Creek at Sedalia (10029) – Campbell Scientific

G. Rain Sensor Timer Reporting Summary

The following analysis assumes that each legacy rain sensor has a 12-hour timer-reporting interval and each A2 rain sensor has a 1-hour timer-reporting interval. The worst performing rain sensors for the month are summarized (Table 9).

Table 9. Monthly Summary of Sensors with Poor Timer Performance (Sensor ID)

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
10026	3020	4470	4850	2790	2790	2790	2790	2790	2790	10032	
4550	4520	2790	2790	1620	430	1530	2360	2360	4270	4270	
2330	2790	4850	2360	2750	4330	430	2330	1710	4330	5900	
4270	4850	5940	1420	2330	2330	4270	1530	2330	5720	3010	
1660	10026	10023	4270	5860	10026	1710	2230	2230	4490	5940	
4330	10020	10026	4520	2360	2360	4330	1620	4330	4870	4330	

*- Only sensors that operate year-round (weather stations and stations in Boulder County) are included for the analysis in these months.

Sensors identified as having poor timer performance in multiple months are shaded with unique colors. A developing trend can thus be identified from the color shading as the year progresses.

III. Rain Sensor Event Reporting Summary

A. District-Wide Total Tip/Count Statistics

The incrementing reports from all 1-mm rain sensors were analyzed to quantify the District-wide statistical total monthly tip summary (Table 10). For the months of January, February, March, October, November and December only the stations that operate year-round are included in the rain event analysis. These stations include all weather stations and the stations in Boulder County.

Table 10. District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	8.56	Only the 1-mm rain sensors were included in the analysis
Median	9	Only the 1-mm rain sensors were included in the analysis
Standard deviation	3.36	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	18.6	Only the 1-mm rain sensors were included in the analysis
Mean minus two standard deviations	1.84	Only the 1-mm rain sensors were included in the analysis
Minimum total count	0	Many sites
Maximum total count	16	Plum Creek at Sedalia (10029)
Sensors showing NO rain for the month		Many as this month was very dry
Sensors greater than 3 SD (over reporting)		None

B. Monthly Average Tip/Count Summary

A monthly summary of the District-wide mean total tip/count is presented (Table 11).

Table 11. Monthly Summary of District-Wide Mean Total 1-mm Tip/Count

Year	Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*	Ave
2006	4.62	5.92	18.39	20.47	19.44	13.75	74.03	46.89	24.17	41.13	5.04	16.45	24.19
2007	11.56	5.40	29.75	65.03	68.30	15.87	36.20	46.38	22.13	29.50	6.54	11.29	29.00
2008	4.05	7.38	12.26	20.57	54.82	26.06	16.43	90.20	37.54	19.59	2.82	9.24	25.08
2009	6.33	3.11	11.37	59.26	63.45	68.00	65.00	20.00	27.29	30.24	11.00	5.60	30.89
2010	5.97	11.90	32.54	70.57	39.63	56.04	50.23	31.01	4.18	18.31	8.30	3.31	27.67
2011	6.78	7.45	7.54	33.94	92.68	39.42	90.87	18.25	37.67	25.73	10.41	13.59	32.03
2012	4.89	13.57	2.35	30.17	38.97	19.35	73.03	11.31	48.81	22.32	2.98	4.18	22.66
2013	2.96	14.31	21.86	35.96	45.87	16.39	52.33	50.63	229.74	29.64	5.86	4.00	42.46
2014	6.88	11.86	25.91	29.30	77.30	29.16	99.73	43.59	50.96	29.26	13.36	8.11	35.45
2015	9.88	24.42	20.78	69.75	143.07	86.93	54.59	29.95	7.16	53.28	22.08	10.80	44.39
2016	4.68	9.91	32.30	52.10	49.40	40.50	24.20	31.00	8.86	7.51	8.56		
Ave	6.24	10.48	19.55	44.28	62.99	37.41	57.88	38.11	45.32	27.86	8.81	7.87	28.53

*- Only sensors that operate year-round (weather stations and stations in Boulder County) are included for the analysis in these months.

C. Sensors with a Jump of Six or More in the Sequential Count

Several sensors experienced a large jump in the sequential tip count (Table 12).

Table 12. Sensors with a Jump of 6 or More in Sequential Count

Sensor Description	Sensor ID	Comment
Filter Plant	4100	Several large jumps in count on Nov 30.....assumed to be maintenance related

D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 98 percent. A total of 589 incrementing reports were received and a total of 599 reports were expected. The total loss of incrementing reports for the month was approximately 2 percent. Those sensors with the worst event transmission performance are summarized (Table 13).

Table 13. Monthly Summary of Sensors with the Worst Performance

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
1530	4270	2790	2790	2790	2790	2790	2790	2790	5900	10026	
4550	10026	10026	5900	4330	4270	2360	4870	2310	3010	4490	
1640	2790	5940	4260	1620	1620	4470	2360	540	1440	4830	
4180	4240	4790	950	4470	4330	2970	1710	4490	4270	4340	
1660	5940	4510	2330	2230	2330	4330	4470	2350	2710	4240	
4840	4510	4870	1480	2980	10026	1620	1620	1370	4290	4330	

*-Only sensors that are operational year-round (weather stations and stations in Boulder County) are included for the analysis in these months.

Sensors identified as having poor event performance in multiple months are shaded with unique colors. A developing trend can thus be identified from the color shading as the year progresses.

IV. Unknown Device Analysis – Received Data Log

The ALERT IDs present in the audio signal received by the decoder are compared against a list of “active” device IDs that are defined within NovaStar. Those IDs received by the decoder that are not defined within NovaStar are considered to be “unknown” and may be the result of radio noise or problems with the telemetry system. The reception of “unknown” device reports for the month is summarized (Table 14).

Table 14. Summary of Unknown IDs

Description	Concentrator	Legacy	A2
Total number of unknown IDs (IDs without a device definition)	238	217	0
Total reports from unknown IDs	617	638	0
Unknown IDs with only a single received report (potential noise)	129	136	0
Total reports from all IDs – RecData Log entire month	368,074	232,629	412,332
Unknown reports as a fraction of total reports	0.17%	0.27%	0%

The total number of reports from unknown sensors is very small relative to the total reports received for the month. Shown below (Table 15) are the total reports received from unknown sensor IDs for each month of the year.

Table 15. Monthly Summary of Total Reports from Unknown IDs (Concentrator)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	1,220	1,474	1,276	1,174	721	5,707	610	1,738	442	533	2,857	6,396
2011	1,231	2,165	3,065	1,254	2,051	439	489	456	191	683	747	861
2012	692	750	1,575	977	5,469	11,016	453	683	774	2,657	3,854	5,466
2013	4,265	994	1,100	2,589	3,623	6,973	5,230	1,070	4,429	781	13,459	1,213
2014	870	4,284	2,399	2,104	25,746	1,832	3,983	268	369	448	470	1,099
2015	542	9,137	1,524	1,007	946	699	1,179	1,860	1,153	1,063	600	619
2016	323	1,241	3,085	3,586	1,268	945	1,408	2,029	1,413	753	617	

The fraction of reports from unknown sensors relative to the total number of reports is shown below (Table 16).

Table 16. Monthly Percent of Unknown Sensor Reports (Concentrator)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	0.42%	0.56%	0.38%	0.32%	0.20%	1.61%	0.17%	0.49%	0.13%	0.16%	0.93%	1.88%
2011	0.39%	0.73%	0.90%	0.37%	0.58%	0.12%	0.12%	0.05%	0.12%	0.18%	0.22%	0.26%
2012	0.30%	0.25%	0.43%	0.26%	1.37%	2.74%	0.11%	0.18%	0.20%	0.72%	1.15%	1.62%
2013	1.40%	0.31%	0.29%	0.60%	0.37%	0.61%	0.82%	0.21%	0.96%	0.31%	5.37%	0.23%
2014	0.14%	0.94%	0.40%	0.34%	3.95%	0.34%	0.66%	0.03%	0.03%	0.07%	0.11%	0.26%
2015	0.15%	2.25%	0.34%	0.22%	0.19%	0.14%	0.26%	0.42%	0.29%	0.24%	0.15%	0.15%
2016	0.10%	0.30%	0.69%	0.82%	0.28%	0.22%	0.33%	0.50%	0.36%	0.18%	0.17%	

Any month shaded in yellow has an excessive number of reports from unknown sensors.

A number of “unknown” sensors had multiple reports, which may indicate the existence of a transmitter that is sending information on an ID that is not currently defined within NovaStar. The unknown IDs with multiple reports including the number of reports received by each are shown (Table 17).

Table 17. Reports Received by Unknown IDs

Concentrator		Legacy ALERT		Comment
Unknown ID	Reports	Unknown ID	Reports	
--	--	2	112	
--	--	0,1	58, 58	
3047	31	2239	15	
3071	31	1950	12	
3044	28	4374	12	
1430	15	4377	11	

V. Sensors with Invalid Reports

The sensors below (Table 18 and Table 19) have the largest number of invalid decodes as determined by the validation process defined at the District NovaStar5 base station. These invalid reports may indicate poor radio paths (bit flip/contention errors/random decode) or validation criteria that do not match the physical installation at the site.

Table 18. Rain Sensors with the Most Invalid Reports

Sensor ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1310-LDC at 64th	--	--	--	--	--	49	264	0	0	0	--	
1530-Bear Cr. At Lowell	8	5	10	3	1	0	0	0	0	1	--	
2810-Pine Cliff Rd.	--	18	11	8	9	6	0	3	5	11	30	
2750-Wx-Castle Rock	10	24	0	0	1	3	1	2	0	2	1	
2790-Wx-W. Cherry Creek	--	--	--	--	8	4	0	1	0	4	3	
2980-Dakan Road	--	--	--	8	9	6	2	3	3	2	3	
2990-Tomah Rd.	--	12	2	2	2	2	1	0	0	1	3	
3010-Wx-EPC @ 105	--	--	8	10	11	11	6	2	1	0	3	
3020-Wx-West Creek	9	103	96	111	149	178	50	0	0	0	0	
3050-E/W Trailhead	--	--	8	7	7	8	1	4	3	7	21	
3070-Newlin Gulch	10	52	5	0	0	1	0	0	0	0	--	
3090-Heritage Reg.	--	--	--	--	--	38	0	1	0	0	--	
4030-Red Garden	23	41	3	4	2	2	0	3	3	4	--	
4330-Hansen Rain	--	--	--	--	5	2	4	2	1	0	2	
4770-Cal-Wood Ranch	--	--	--	--	--	--	--	10	0	0	1	
5730-West Creek	--	--	--	--	22	0	0	0	0	0	--	
10014-Upper Sellers	--	--	--	--	--	--	--	6	0	0	--	
10015-Sellers Haystack	--	--	--	--	--	--	--	10	0	0	--	

Table 19. Level Sensors with the Most Invalid Reports

Sensor ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
133-Simms Street	--	--	--	--	--	--	--	--	11	2	--	
203-Leyden Res	11	22	37	15	1	0	0	0	1	5	1	
323-Sports Complex	--	--	--	--	--	--	--	--	10	1	--	
633-Temple Pond at DTC	--	--	--	--	--	13	0	3	0	6	--	
653-GG at Iliff Pond	--	--	--	15	1	1	0	2	0	1	--	
713-Horseshoe Park Drop	--	--	--	12	0	0	0	0	0	2	--	
853-Flying J	--	36	57	58	58	59	61	0	0	0	--	
1203-Brmfld 3207/Pond6	--	--	--	--	--	--	--	10	0	0	--	
1323-SPR at 3 rd Ave	--	--	--	78	1	0	5	1	0	7	--	
1383-Ferril Lake	747	703	686	714	683	721	225	0	0	3	--	
1623-Slaughterhouse Gulch	--	--	--	--	13	10	4	5	0	2	--	
1649-SPR at 19 th Street	--	--	--	--	--	--	--	--	--	193	195	
1663-SPR at Henderson	--	--	--	--	9	8	5	7	6	3	2	
2253-Rosedale	--	--	--	--	--	--	--	--	17	0	--	
2813-Pine Cliff Road	--	--	--	--	1,172*	26	42	5	2	6	11	
2873-Cottonwood	--	--	85	2,807*	2,764*	0	0	0	0	0	--	
3013-EPC@Hwy 105	7	19	11	4	2	17	6	11	3	3	4	
3043-CC@Russelville	--	--	22	5	0	0	1	1	0	0	--	
3093-Heritage Reg. Park	--	--	--	--	--	54	1	0	0	0	--	
4433-Rowena	--	--	--	--	--	--	23	10	8	0	0	
4563-Lyons Diversion	--	13	13	10	3	3	4	4	9	8	20	
4593-Green Ditch	--	--	--	--	--	--	--	9	5	8	5	
10029-Plum Creek at Sedalia	--	--	--	--	--	--	--	8	12	3	2	

*These stations are out-of-service for the month

Ferril Lake and Flying J were placed back into service on the NovaStar base station on August 2, 2016.

Large number of invalid reports for SPR at 19th Street starting in October

VI. Rainfall Alarms and Intensity Analysis

The following rainfall rate alarms from the Urban Drainage and Flood Control District NovaStar 5.0 Web Server were identified this month.

There was one rainfall alarm this month from the Filter Plant (4100) which was caused by maintenance activity.

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\2016\11-2016\Novastar_extract_2016Nov-MLR.mdb

First Date in Database	10/31/16 11:59 PM	Total Days	30.0
Last Date in Database	11/30/16 11:59 PM	Total Hours	720.0

Summarize

Total Records Analyzed 368,074

Records by Group	Concentrator	Percent	Legacy	Percent	ALERT2	Percent
Wind Data	158,153	42.97%	89752	38.58%	164275	39.84%
Temperature	62,934	17.10%	35968	15.46%	78588	19.06%
Relative Humidity	55,582	15.10%	35313	15.18%	76166	18.47%
Barometric Pressure	30,723	8.35%	20896	8.98%	1337	0.32%
Battery Voltage	17,124	4.65%	9306	4.00%	32778	7.95%
Solar Radiation	9,026	2.45%	10407	4.47%	0	0.00%
Water Level	7,253	1.97%	6590	2.83%	16640	4.04%
Precipitation	5,808	1.58%	4478	1.92%	0	0.00%
Fuel Moisture	5,229	1.42%	5656	2.43%	12838	3.11%
Fuel Temperature	5,206	1.41%	5628	2.42%	0	0.00%
Repeater Status Report	3,179	0.86%	3643	1.57%	0	0.00%
Soil Moisture	2,873	0.78%	2777	1.19%	0	0.00%
Hayman Battery	2,350	0.64%	0	0.00%	0	0.00%
Wind Direction	902	0.25%	0	0.00%	13259	3.22%
Unknown	617	0.17%	638	0.27%	0	0.00%
ET-Hourly	572	0.16%	715	0.31%	0	0.00%
GPS Lock	153	0.04%	0	0.00%	16451	3.99%
12Hr Status Report	121	0.03%	129	0.06%	0	0.00%
Water Temp	119	0.03%	112	0.05%	0	0.00%
Repeater Pass List	61	0.02%	525	0.23%	0	0.00%
Not Used	51	0.01%	51	0.02%	0	0.00%
ET-Daily	23	0.01%	30	0.01%	0	0.00%
Solar Power	14	0.00%	14	0.01%	0	0.00%
ALERT/A2 Testing	1	0.00%	1	0.00%	0	0.00%
Total	368,074	100.00%	232,629	100.00%	412,332	100.00%

Traffic Loading Summary	Concentrator	Legacy	ALERT2
Alert Reports	368,074	232,629	412,332
Average Daily Traffic	11,873	7,754	13,301
Average Hourly Traffic	495	323	554
Median Hourly Traffic	509	hour beginning 319	hour beginning 595
Peak Hourly Traffic	801	Nov 6, 1:00 AM 577	Nov 6, 1:00 AM 1,063
2nd Max	746	Nov 27, 3:00 PM 435	Nov 27, 3:00 PM 692
3rd Max	738	433	650
4th Max	728	Nov 27, 2:00 PM 430	Nov 24, 8:00 AM 649
5th Max	723	Nov 16, 2:00 PM 427	Nov 29, 1:00 PM 647
			Nov 19, 11:00 AM
			Nov 20, 9:00 AM
			Nov 30, 10:00 AM

Rain Timer Performance

Analyze Rain Sensors

Rain Sensors	Description	Rcv	Timer	Exp	Performance
100320	A2-Weir Gulch - Precip	375		720	52%
4270	Cannon Mountain	42	15:55	62	68%
5900	Horse Creek-Satellite	492		720	68%
3010	WX-EPC at Hwy 105	46	15:26	62	74%
5940	Log Jumper	47	13:39	62	76%
4330	Hansen Rain	48	13:55	62	77%
5720	Four Mile Creek	50	14:06	62	81%
4510	Pinewood Springs	51	13:48	62	82%
2750	Wx-Castle Rock	54	13:08	62	87%
1520	Wx-Marston Lake North	55	12:42	62	89%
2710	Wx-Highlands Ranch WTP	55	12:54	62	89%
4790	Wx-Button Rock	55	12:54	62	89%
5740	Trail Creek	55	12:54	62	89%
4870	SBC @ SB Road	55	12:41	62	89%
4060	Lakeshore	55	12:38	62	89%
100260	Wx-A2-Trumbull (Hayman) - Precip	639		720	89%
3030	WX-Bingham Lake Park	56	12:27	62	90%
900	Wx-Aurora Reservoir	56	12:40	62	90%
4490	Apple Valley	56	12:38	62	90%
4310	Johnny Park	56	12:38	62	90%
4050	Walker Ranch	56	12:22	62	90%
4040	Martin Gulch	56	12:26	62	90%
4020	Rio Grande	56	12:25	62	90%
2990	Wx-Tomah Rd-DougCnty	57	12:27	62	92%
4770	Wx-Cal-Wood Ranch	57	12:24	62	92%
1570	Wx-Brighton Ditch	57	12:25	62	92%
4530	Winiger Ridge	57	12:24	62	92%
5880	Hackett Mountain	57	12:26	62	92%
5860	Cedar Mountain	57	12:26	62	92%
5810	Stump Bump	57	12:25	62	92%
4340	Riverside	57	12:24	62	92%
4300	Big Elk Park	57	12:09	62	92%
4200	Lazy Acres	57	12:12	62	92%
4190	Slaughterhouse	57	12:23	62	92%
4180	Gold Lake	57	12:24	62	92%
4070	Bear Peak	57	12:23	62	92%
4710	Wx-Ward C-1	58	12:12	62	94%
2930	Wx-Spring Valley Rd-DougCnty	58	12:12	62	94%
2730	Wx-Salisbury Park	58	12:12	62	94%
1440	Wx-Elbert	58	12:11	62	94%
140	Wx-Blue Mountain	58	12:12	62	94%
920	Wx-Aurora Town Hall	58	12:11	62	94%
5730	West Creek	58	12:12	62	94%
4350	Conifer Hill	58	12:09	62	94%
4320	Lee Hill Rain 2012	58	12:10	62	94%
4250	Geer Canyon	58	11:56	62	94%
4230	Golden Age	58	12:09	62	94%
4220	Fling's	58	12:10	62	94%
4100	Filter Plant	58	11:58	62	94%
4080	Twin Sisters	58	12:10	62	94%
1460	Wx-Urban Farm	59	11:58	62	95%
4730	Wx-Sugarloaf	59	11:58	62	95%
750	Wx-Quincy Reservoir	59	11:56	62	95%
4750	Wx-Louisville Lake	59	11:58	62	95%
2210	Wx-Hiwan G.C.	59	11:58	62	95%
1920	Wx-Brighton	59	11:58	62	95%
100200	Wx-A2-OneRain Weather - Precipitation	59	11:58	62	95%
1420	Wx-A2-Diamond Hill	59	11:58	62	95%
4880	Whispering Pines	59	11:56	62	95%
4830	SBC @ San Souci	59	11:56	62	95%
4820	Doudy Draw	59	11:56	62	95%
4810	Shanahan Ridge	59	11:56	62	95%
4570	St. Antons	59	11:58	62	95%
4550	Boulder Jail	59	12:09	62	95%
4360	Justice Center	59	11:56	62	95%
4290	Red Hill	59	11:56	62	95%

4260	Taylor Mountain	59	11:56	62	95%
4240	Sunset	59	11:56	62	95%
4160	Sunshine	59	11:56	62	95%
4140	Logan Mill	59	11:56	62	95%
4130	Swiss Peaks	59	11:56	62	95%
4110	Betasso	59	11:58	62	95%
4090	Magnolia	59	11:56	62	95%
4030	Red Garden	59	12:12	62	95%
4010	Crescent	59	11:57	62	95%
100270	Wx-A2-WestCreek (Hayman) - Precip	694		720	96%
4860	Fairview Peak	60	11:45	62	97%
4840	SBC@S Boulder Ditch	60	11:44	62	97%
4520	Eagle Ridge	60	11:58	62	97%
4170	Pine Brook	60	11:56	62	97%
4150	Gold Hill	60	11:44	62	97%
100290	A2-PlumCr at Sedalia - Precip	697		720	97%
6601	Wx-A2-Magnolia WX-Precip	89	7:59	90	99%
100300	A2-CoalCreek at McCaslin - Precip	717		720	100%
4850	Porphory Mtn	719		720	100%
3020	Wx-West Creek WX	741		720	103%
3060	Fire Sta 47	745		720	103%
2790	Wx-W. Cherry Creek	8	19:50	62	13%
2980	Dakan Rd	49	14:28	62	79%
2810	Pine Cliff Road	3		62	5%
2330	Morrison	44	15:34	62	71%
2320	Choke Cherry Resvr	52	13:30	62	84%
1700	Cherry Cr @ Champa	56	12:39	62	90%
1660	SPR at Henderson	40	17:01	62	65%
1640	SPR at Union Ave.	58	12:10	62	94%
1370	West Metro FS13	2	0:20	62	3%
1000	A2-Maple Grove Resv.	719		62	
970	Pump Sta 3	58	11:58	62	94%
840	Fire Station 12	2	0:05	62	3%
700	Toll Gate @ 6th	56	12:41	62	90%
200	Leyden Reservoir	15	14:26	62	24%
110	Ralston Reservoir	2		62	3%

Rain Event Performance															
	Reports Received	Reports Received	589		Analyze Rain Sensors					0	<<show stations with zero rain (1=yes, 0=no)				
	Systemwide Avg	Total Tips	599												
	98.33%	Data Loss	1.67%												
Description	Sensor	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcv	Exp	Miss	Hold	Bucket	
Wx-A2-Trumbull (Hayman) - Precip	100260	82%	8	0	1	0	0	0	0	9	11	2	0	0.03937	
Apple Valley	4490	83%	4	1	0	0	0	0	0	5	6	1	0	0.03937	Mean 8.56
SBC @ San Souci	4830	89%	7	1	0	0	0	0	0	8	9	1	0	0.03937	Median 9
Riverside	4340	89%	7	1	0	0	0	0	0	8	9	1	0	0.03937	St. Dev 3.36
Sunset	4240	89%	7	1	0	0	0	0	0	8	9	1	0	0.03937	Mean plus 3 SD 18.6
Hansen Rain	4330	90%	8	1	0	0	0	0	0	9	10	1	0	0.03937	Min 1
Gold Lake	4180	91%	9	1	0	0	0	0	0	10	11	1	0	0.03937	Max 16
SBC @ SB Road	4870	92%	11	1	0	0	0	0	0	12	13	1	0	0.03937	
Shanahan Ridge	4810	93%	13	1	0	0	0	0	0	14	15	1	0	0.03937	
A2-CoalCreek at McCaslin - Precip	100300	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
A2-PlumCr at Sedalia - Precip	100290	100%	16	0	0	0	0	0	0	16	16	0	0	0.03937	
Wx-A2-WestCreek (Hayman) - Precip	100270	100%	12	0	0	0	0	0	0	12	12	0	0	0.03937	
Whispering Pines	4880	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937	
SBC@S Boulder Ditch	4840	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
Wx-Button Rock	4790	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937	
Wx-Louisville Lake	4750	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937	
Wx-Sugarloaf	4730	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937	
Wx-Ward C-1	4710	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937	
St. Antons	4570	100%	13	0	0	0	0	0	0	13	13	0	0	0.03937	
Boulder Jail	4550	100%	8	0	0	0	0	0	0	8	8	0	0	0.03937	
Winiger Ridge	4530	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
Eagle Ridge	4520	100%	6	0	0	0	0	0	0	6	6	0	0	0.03937	
Pinewood Springs	4510	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937	
Justice Center	4360	100%	10	0	0	0	0	0	0	10	10	0	0	0.03937	
Conifer Hill	4350	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937	
Lee Hill Rain 2012	4320	100%	8	0	0	0	0	0	0	8	8	0	0	0.03937	
Johnny Park	4310	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
Big Elk Park	4300	100%	12	0	0	0	0	0	0	12	12	0	0	0.03937	
Cannon Mountain	4270	100%	8	0	0	0	0	0	0	8	8	0	0	0.03937	
Taylor Mountain	4260	100%	12	0	0	0	0	0	0	12	12	0	0	0.03937	
Geer Canyon	4250	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937	
Golden Age	4230	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937	
Fling's	4220	100%	14	0	0	0	0	0	0	14	14	0	0	0.03937	
Lazy Acres	4200	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937	
Slaughterhouse	4190	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
Pine Brook	4170	100%	6	0	0	0	0	0	0	6	6	0	0	0.03937	
Sunshine	4160	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937	
Gold Hill	4150	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937	
Logan Mill	4140	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937	
Swiss Peaks	4130	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
Betasso	4110	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
Filter Plant	4100	100%	8	0	0	0	0	0	0	8	8	0	0	0.03937	
Magnolia	4090	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937	
Twin Sisters	4080	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937	
Bear Peak	4070	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937	
Lakeshore	4060	100%	6	0	0	0	0	0	0	6	6	0	0	0.03937	
Walker Ranch	4050	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937	
Martin Gulch	4040	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
Red Garden	4030	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937	
Rio Grande	4020	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937	

Crescent	4010	100%	5	0	0	0	0	0	0	0	5	5	0	0	0.03937
Fire Sta 47	3060	100%	10	0	0	0	0	0	0	0	10	10	0	0	0.03937
WX-Bingham Lake Park	3030	100%	13	0	0	0	0	0	0	0	13	13	0	0	0.03937
Wx-West Creek WX	3020	100%	9	0	0	0	0	0	0	0	9	9	0	0	0.03937
Wx-Tomah Rd-DougCnty	2990	100%	14	0	0	0	0	0	0	0	14	14	0	0	0.03937
Wx-Spring Valley Rd-DougCnty	2930	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.03937
Wx-Castle Rock	2750	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.03937
Wx-Salisbury Park	2730	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.03937
Wx-Highlands Ranch WTP	2710	100%	9	0	0	0	0	0	0	0	9	9	0	0	0.03937
Wx-Hiwan G.C.	2210	100%	6	0	0	0	0	0	0	0	6	6	0	0	0.03937
Wx-Brighton	1920	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.03937
Wx-Brighton Ditch	1570	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.03937
Wx-Marston Lake North	1520	100%	12	0	0	0	0	0	0	0	12	12	0	0	0.03937
Wx-Urban Farm	1460	100%	11	0	0	0	0	0	0	0	11	11	0	0	0.03937
Wx-Elbert	1440	100%	5	0	0	0	0	0	0	0	5	5	0	0	0.03937
Wx-A2-Diamond Hill	1420	100%	12	0	0	0	0	0	0	0	12	12	0	0	0.03937
Wx-Aurora Town Hall	920	100%	1	0	0	0	0	0	0	0	1	1	0	0	0.03937
Wx-Aurora Reservoir	900	100%	8	0	0	0	0	0	0	0	8	8	0	0	0.03937
Wx-Quincy Reservoir	750	100%	8	0	0	0	0	0	0	0	8	8	0	0	0.03937
Wx-Blue Mountain	140	100%	5	0	0	0	0	0	0	0	5	5	0	0	0.03937
		Total Tips	580	8	1	0	0	0	0	0	589	599	10	0	
Porphory Mtn	4850	88%	12	2	0	0	0	0	0	0	14	16	2	0	0.01
Fairview Peak	4860	100%	21	0	0	0	0	0	0	0	21	21	0	0	0.01
Wx-A2-Magnolia WX-Precip	6601	100%	39	0	0	0	0	0	0	0	39	39	0	0	0.01
Wx-A2-OneRain Weather - Precipitation	100200	93%	24	2	0	0	0	0	0	0	26	28	2	0	0.01
East/West Trailhead	3050	25%	0	0	0	1	0	0	0	2	1	4	3	0	0.03937
Pine Cliff Road	2810	55%	2	3	1	0	0	0	0	2	6	11	5	0	0.03937
Morrison	2330	78%	5	2	0	0	0	0	0	0	7	9	2	0	0.03937
Choke Cherry Resvr	2320	89%	7	1	0	0	0	0	0	0	8	9	1	0	0.03937
Cherry Cr @ Champa	1700	100%	5	0	0	0	0	0	0	0	5	5	0	0	0.03937
SPR at Henderson	1660	100%	3	0	0	0	0	0	0	0	3	3	0	0	0.03937
SPR at Union Ave.	1640	100%	11	0	0	0	0	0	0	0	11	11	0	0	0.03937
A2-Maple Grove Resv.	1000	100%	10	0	0	0	0	0	0	0	10	10	0	0	0.03937
Pump Sta 3	970	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.03937
Toll Gate @ 6th	700	100%	10	0	0	0	0	0	0	0	10	10	0	0	0.03937
Van Bibber @ Hwy 93	330	71%	3	2	0	0	0	0	0	0	5	7	2	0	0.03937
Ralston Reservoir	110	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.03937
Log Jumper	5940	83%	4	1	0	0	0	0	0	0	5	6	1	0	0.03937
Horse Creek-Satellite	5900	27%	1	0	0	1	0	1	0	3	11	8	0	0	0.03937
Hackett Mountain	5880	100%	7	0	0	0	0	0	0	0	7	7	0	0	0.03937
Cedar Mountain	5860	89%	7	1	0	0	0	0	0	0	8	9	1	0	0.03937
Stump Bump	5810	100%	10	0	0	0	0	0	0	0	10	10	0	0	0.03937
Trail Creek	5740	100%	8	0	0	0	0	0	0	0	8	8	0	0	0.03937
West Creek	5730	100%	8	0	0	0	0	0	0	0	8	8	0	0	0.03937
Four Mile Creek	5720	100%	9	0	0	0	0	0	0	0	9	9	0	0	0.03937
Wx-W. Cherry Creek	2790	40%	1	0	0	1	0	0	0	0	2	5	3	0	0.03937

2016 Monthly Peak Hour ALERT Radio Traffic Summary

