

Memo

Date: January 9, 2017
To: Kevin Stewart
From: Markus Ritsch
Subject: December 2017 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 December 1 through December 31, 2017.

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	234,074	212,539	255,638	218,706	286,772	253,292	257,529	260,532	223,927	236,829	215,373	216,502	2,871,713
Concentrator	361,187	367,684	388,156	352,903	463,501	398,350	397,942	413,748	371,481	363,887	368,028	376,420	4,623,287
ALERT2	327,977	422,710	422,580	480,051	562,023	600,824	612,240	610,314	648,789	664,041	578,722	598,384	6,528,655
TOTAL	923,238	1,002,933	1,066,374	1,051,660	1,312,296	1,252,466	1,267,711	1,284,594	1,244,197	1,264,757	1,162,123	1,182,209	14,023,655
Conc/Leg	1.54	1.73	1.52	1.61	1.62	1.57	1.55	1.59	1.66	1.54	1.71	1.72	1.61
DataChron	668,091	637,926	741,413	693,903	830,649	793,158	800,743	812,069	769,715	700,732	690,700	706,795	8,845,894

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	234,074	212,539	255,638	218,706	286,772	253,292	257,529	260,532	223,927	236,829	215,373	216,502	2,871,713
Concentrator	361,187	367,684	388,156	352,903	463,501	398,350	397,942	413,748	371,481	363,887	368,028	376,420	4,623,287
ALERT2	327,977	422,710	422,580	480,051	562,023	600,824	612,240	610,314	648,789	664,041	578,722	598,384	6,528,655
NS5B (Greenhouse)													
Legacy	234,037	211,806	255,357	259,950	287,868	252,952	255,279	260,663	223,907	236,319	214,980	214,490	2,907,608
Concentrator	360,898	364,788	387,844	381,946	464,402	398,240	394,334	412,914	371,155	362,988	367,087	372,670	4,639,266
ALERT2	327,807	419,042	422,268	519,970	564,128	600,850	606,870	609,854	648,457	664,749	578,088	593,037	6,555,120
Diff (NS5a-NS5b)													
Legacy (Digi One)	37	733	281	-41244	-1096	340	2250	-131	20	510	393	2012	-35,895
Concentrator (B2010)	289	2,896	312	-29,043	-901	110	3608	834	326	899	941	3750	-15,979
ALERT2 (B2010)	170	3,668	312	-39,919	-2105	-26	5370	460	332	-708	634	5347	-26,465
Comments		GH network outage on Feb 8		DH network outage on Apr 8, 9, and 16			GH network outage on July 30						Network problems occurring the entire month

On July 30 at 6:15 AM the Greenhouse server went into failover. It seems the network was flaky between 6:00 AM and 6:45 AM and the network connection between Greenhouse and Diamond Hill was lost. The network connection was restored at approximately 10:00 AM on July 30th.

In December network issues were occurring during the entire month.

The daily ratio of concentrator to legacy reports is shown.

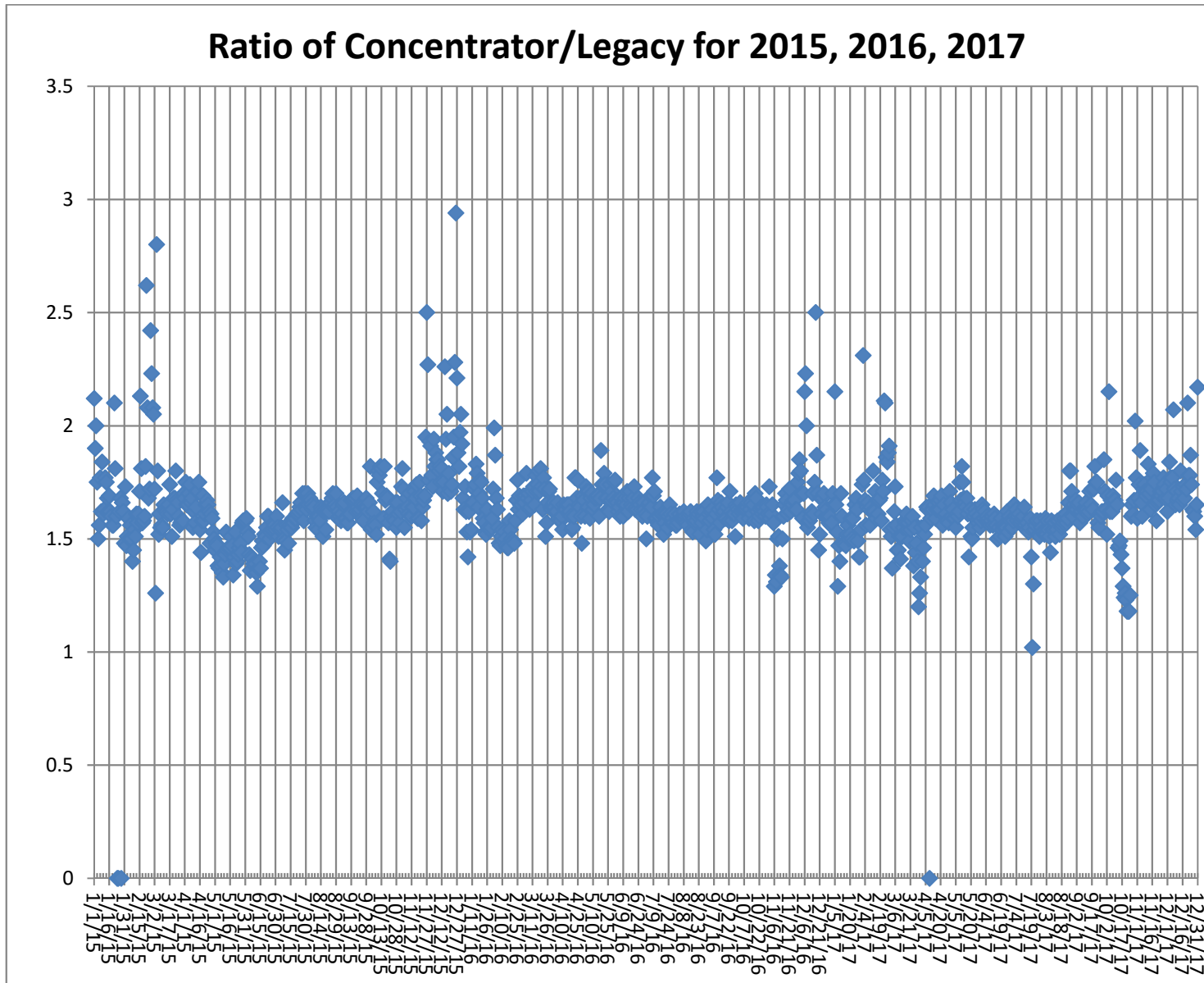


Figure 1. Daily Ratio of Concentrator Reports to Legacy Reports

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. Volatility in the ratio was experienced in March and early April as issues with the radio repeater network and the B2010 decoder are evident.

The West Creek repeater experienced an outage late in the evening of July 19th due to a large storm and associated lightning in the Hayman Burn scar. The ALERT2 encoder board was destroyed and it was replaced on July 21st. No data was collected through the West Creek repeater on July 20th. Interesting to note in the figure above that the ratio of legacy to ALERT2 traffic on July 20th was 1.0 which is expected.

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 a total of 744 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
2790	West Cherry Creek	Consistently poor timer performance
2980	Dakan Rd	Poor event performance
3020	West Creek WX	ALERT2 station with drifting clock (negative latency)
2101	Unknown	Unknown ID transmitted 2,435 reports on Concentrator
0, 1, 2	Unknown	Unknown IDS transmitted on legacy ALERT

C. 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 4). 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 4. 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 5). This helps to quantify repeater loading for the ALERT2 backbone.

Table 5. 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
Jun-15	11,987	72,449	65,742	82,998	69,570	302,746
Jul-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
Dec-2016	48,946	102,329	97,321	79,274	102,097	429,967
Jan-2017	47,286	50,748**	27,307**	97,947	104,689	327,977
Feb-2017	45,366	96,629	94,065	88,239	98,411	422,710
Mar-2017	53,021	87,160**	33,983**	121,578	126,722	422,464
Apr-2017	49,833	110,418	116,486	122,506	120,727	519,970
May-2017	54,375	128,362	128,310	118,908	134,173	564,128
Jun-2017	60,671	131,745	124,019	146,333	138,056	600,824
Jul-2017	58,442	137,750	130,136	146,134	139,778	612,240
Aug-2017	60,322	136,739	128,716	145,280	139,257	610,314
Sep-2017	58,388	146,759	135,632	157,248	150,762	648,789
Oct-2017	48,644	148,071	149,899	159,639	157,788	664,041
Nov-2017	39,868	123,026	134,197	141,153	140,478	578,722
Dec-2017	38,801	138,219	137,672	142,389	141,303	598,384

** - The number of reports coming through these repeaters declined significantly

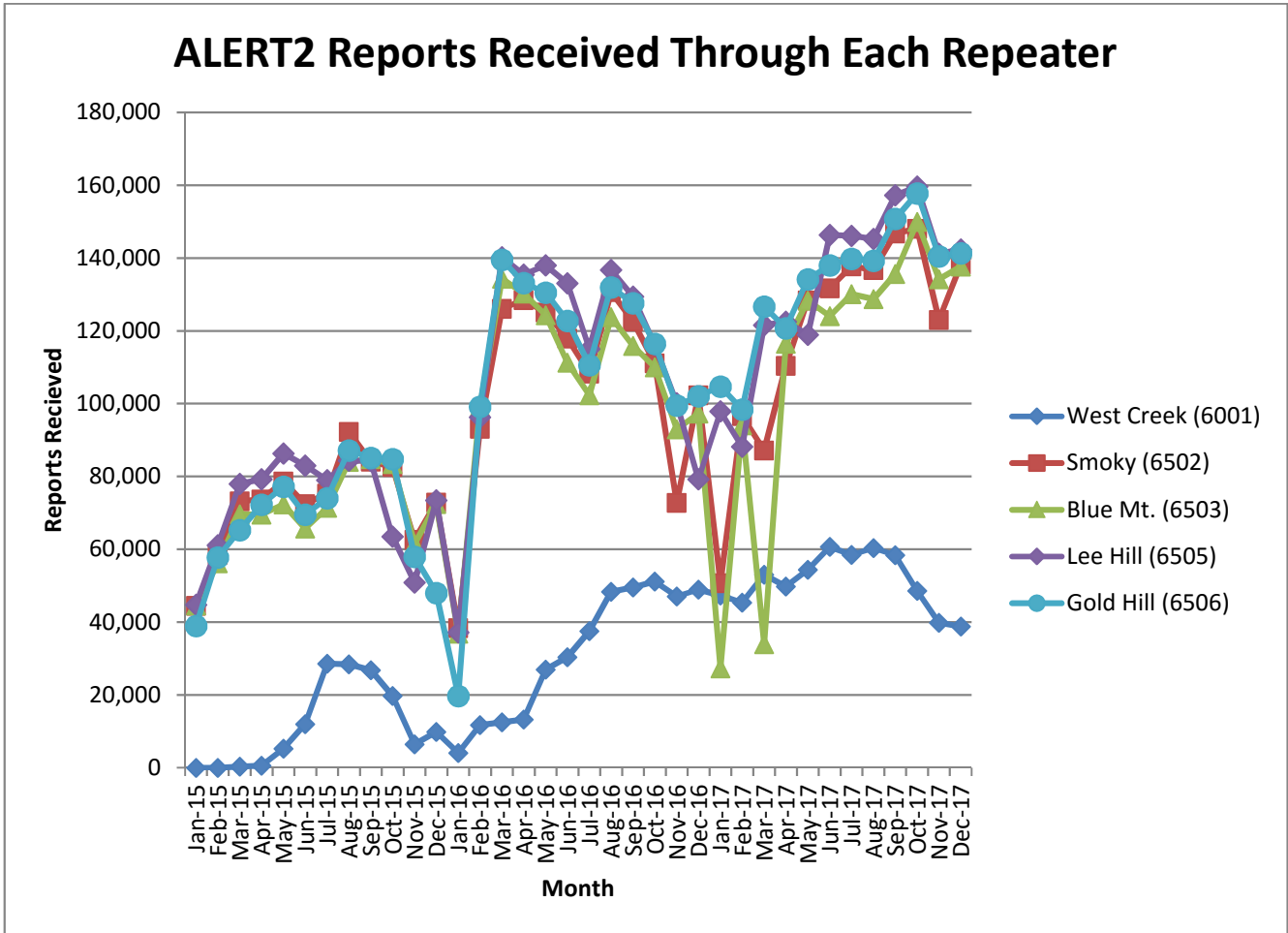


Figure 2. Reports received through each repeater (ALERT2 Only)

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.

In January of 2017 the ALERT2 reports received through Blue Mountain and through Smoky Hill showed a significant decrease. There may be a problem at these repeaters or it is possible that pass/block lists have been implemented.

In March of 2017 the ALERT2 reports received through Blue Mountain and through Smoky Hill showed a significant decrease. There may be a problem at these repeaters.

The West Creek repeater was down on July 20, 2017 which results in a reduced throughput for the month of July.

The following tables summarize the system-wide latency of ALERT2 self-reports (Table 6 and Table 7).

Table 6. System-Wide Latency of ALERT2 Self-Reports (seconds)

Statistical Parameter	Value (sec)	Comments
Mean	50.81	The average time it took a report from the field to reach the base
Minimum	-23	The minimum time it took for a report to go from the field to the base
Maximum	39,837	The maximum time it took for a report to go from the field to the base

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

Statistical Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	53.1	51.39	55.86	61.18	56.20	55.02	52.17	52.64	50.28	47.14	45.33	50.81
Minimum	-29	-23	-23	-4	-23	-23	-23	-23	-23	-23	-763	-23
Maximum	286	12,946	43,177	43,197	43,177	43,177	320	43,177	43,177	43,177	42,517	39,837
Station with Max Latency		West Creek WX	West Creek Wx	West Creek WX	West Creek WX	West Creek WX	Sellers Gulch at Haystack	West Creek WX	West Creek WX	West Creek WX	West Creek WX	West Creek WX

The negative latencies are observed only from the station West Creek WX. This is a HydroLynx transmitter. It is likely that the clock on this transmitter is drifting badly. A new GPS chip and EPROM are soon to be installed to help this station.

D. 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 8).

Table 8. Monthly Summary of Sensors with Poor Timer Performance (Sensor ID)

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
2790	2790	4470	2790	2790	2790	4100	3090	750	2790	3020	2790
5720	4100	100150	2800	3090	630	420	3010	1710	2880	4550	3020
4510	4330	2360	4100	5810	3090	2360	2330	4340	4470	4310	5940
100260	4040	2970	3050	1360	2330	3090	2360	2330	2360	5720	4550
4870	4270	2270	920	2330	5810	5810	100260	4550	2230	2330	1660
5940	4510	2350	1710	100270	4270	2330	4270	5720	2900	4870	2330

*- 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 9). 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 9. District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	5.35	Only the 1-mm rain sensors were included in the analysis
Median	5	Only the 1-mm rain sensors were included in the analysis
Standard deviation	3.30	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	15.26	Only the 1-mm rain sensors were included in the analysis
Mean minus two standard deviations	0	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	13 Stations
Maximum total count	14	Justice Center (4360)
Sensors showing NO rain for the month		
Sensors greater than 3 SD (over reporting)	0	

B. Monthly Average Tip/Count Summary

A monthly summary of the District-wide mean total tip/count is presented (Table 10).

Table 10. 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	8.74	23.23
2017	13.3	5.84	27.70	39.10	99.60	15.33	40.80	44.58	40.74	31.88	7.38	5.35	31.13
Ave	6.83	10.09	20.23	43.85	66.04	35.57	56.45	38.65	44.94	28.20	8.69	8.39	30.68

*- 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

Twenty-two sensors experienced a large jump in the sequential tip count (Table 11).

Table 11. Sensors with a Jump of 6 or More in Sequential Count

Sensor Description	Sensor ID	Comment
Dakan Rd	2980	All >6 reports were breaks in the data

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 419 incrementing reports were received and a total of 428 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 12).

Table 12. Monthly Summary of Sensors with the Worst Performance

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
2790	4330	2790	2790	2790	5810	2330	3010	1620	2980	150	2980
4870	750	1620	4270	4330	2790	2320	1340	4290	2360	1720	3010
1920	2790	2940	4100	5810	3090	4270	2330	4470	5720	530	4490
3010	100260	2750	2330	3090	4270	2970	4270	4270	2330	120	4870
4510	4270	2980	920	5900	5720	2880	100260	4490	940	310	4790
4330	4490	5900	1710	1500	630	2360	330	2230	2230	800	4510

*-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 13).

Table 13. Summary of Unknown IDs

Description	Concentrator	Legacy	A2
Total number of unknown IDs (IDs without a device definition)	257	214	0
Total reports from unknown IDs	3,282	759	0
Unknown IDs with only a single received report (potential noise)	140	130	0
Total reports from all IDs – RecData Log entire month	376,420	216,502	598,384
Unknown reports as a fraction of total reports	0.87%	0.35%	0.00%

The total number of reports from unknown sensors is very small relative to the total reports received for the month. Shown below (Table 14) are the total reports received from unknown sensor IDs for each month of the year.

Table 14. 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	879
2017	11,875	844	1,207	3,700	2,693	642	610	6,678	780	5,097	3,532	3,282

The fraction of reports from unknown sensors relative to the total number of reports is shown below (Table 15).

Table 15. 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%	0.22%
2017	3.29%	0.23%	0.31%	0.97%	0.58%	0.16%	0.16%	1.16%	0.21%	1.40%	0.96%	0.87%

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 16).

Table 16. Reports Received by Unknown IDs

Concentrator		Legacy ALERT		Comment
Unknown ID	Reports	Unknown ID	Reports	
		0,1,2	61,62,117	Legacy reports for IDs 0,1,2 only
2101	2,435			Unknown ID sending large amounts of data
3071	50			Newlin Gulch at Jordan Rd possibly sending invalid ID
3044	49			E Cherry Creek at Russellville possibly sending invalid ID
355	38			
1470	33	1470	33	Urban Farm possibly sending invalid ID

V. Sensors with Invalid Reports

The sensors below (Table 17 and Table 18) 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 17. Rain Sensors with the Most Invalid Reports

Sensor ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1530-Bear Cr. At Lowell	9	11	8	5	6	--	--	--	1	2	4	7
630-Temple Pond DTC	--	--	--	--	--	--	--	20**	--	--	--	--
1100-Louisville Rec Ctr	--	--	--	--	--	--	--	152*	--	--	--	--
2810-Pine Cliff Rd.	41	32	9	9	2	2	1	4	4	1	8	11
2880-Happy Canyon	--	--	--	--	--	--	4	--	--	1461***	--	--
3010-Wx-EPC @ 105	6	7	2	4	--	2	3	3	1	5	2	3
3050-E/W Trailhead	23	18	7	5	3	5	1	2	2	3	7	9
4030-Red Garden	--	10	5	--	4	2	2	3	2	1	3	--
4330-Hansen	--	--	--	--	--	--	4	2	2	2	--	--
4240-Sunset	--	9	5	2	--	--	--	5	1	1	1	--
4790-Wx-Button Rock	--	--	5	4	2	5	2	4	--	2	3	--

*-Louisville Rec Ctr (1100) was taken out of service on August 15 as it was not reporting correctly and placed back into service on August 16, 2017.

**-Temple Pond at DTC (630) was taken out of service at the beginning of August as it was not reporting correctly and placed back into service on August 4, 2017.

***-Happy Canyon (2880) was put into maintenance mode on October 3, 2017

Table 18. Level Sensors with the Most Invalid Reports

Sensor ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
413-Kelly Dam	--	--	43	3	10	2	1	4	--	1	1	--
403-Montview Park	--	--	--	--	--	--	--	833*	775*	788*	734*	903*
213-Leyden Confluence	--	--	17	--	--	4	--	4	--	--	--	--
723-WTG above Conf Pond	--	8	0	--	--	--	--	2	--	--	2	--
1483-Third Creek at DIA	--	8	4	204	2	--	--	--	--	--	--	--
1523-Marston Lake North	10	8	11	9	5	4	1	2	1	3	3	9
1649-SPR at 19 th Street	152	--	1	1	2	--	--	2	--	2	--	1
2223-Evergreen Lake	--	--	--	--	--	--	8	2	--	3	--	1
2273-Cub Cr below Blue	--	--	--	--	--	--	8	4	--	--	1	--
2803-Columbine Open Space								86**	--	--	--	--
2813-Pine Cliff Road	16	12	11	7	1	3	--	2	2	--	11	8
3013-EPC@Hwy 105	3	--	4	9	10	7	5	9	9	13	13	12
4383-Eldorado Springs	16	2	2	--	1	--	--	--	1	1	--	--
4593-Green Ditch	--	--	16	1	2	9	3	3	--	--	--	--

*-Montview Park (403) All data values are marked as questionable data values.

**--Columbine Open Space (2803) was out of service and was placed back into service on August 4, 2017.

VI. Rainfall Alarms and Intensity Analysis

No rainfall rate alarms from the Urban Drainage and Flood Control District NovaStar 5.0 Web Server were identified this month.

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\2017\12-2017\2017Dec.mdb

Summarize

First Date in Database	12/1/17 12:00 AM	Total Days	31.0
Last Date in Database	1/1/18 12:00 AM	Total Hours	744.0

Total Records Analyzed 1,191,306

Records by Group	Legacy	%	Concentrator	%	ALERT	%
Wind Data	88,037	41%	165,606	44%	255,695	43%
Temperature	33,398	15%	63,943	17%	91,272	15%
Relative Humidity	33,191	15%	57,004	15%	90,108	15%
Barometric Pressure	18,617	9%	28,986	8%	1,365	0%
Solar Radiation	7,881	4%	8,264	2%	36,835	6%
Battery Voltage	6,720	3%	19,131	5%	44,515	7%
Fuel Moisture	5,705	3%	6,059	2%	0	0%
Fuel Temperature	5,705	3%	5,987	2%	0	0%
Water Level	5,392	2%	6,088	2%	27,845	5%
Precipitation	4,360	2%	5,717	2%	20,502	3%
Soil Moisture	2,822	1%	2,991	1%	0	0%
Repeater Status Report	2,281	1%	1,974	1%	0	0%
Unknown	759	0%	3,282	1%	0	0%
ET-Hourly	734	0%	741	0%	0	0%
Repeater Pass List	554	0%	75	0%	0	0%
12Hr Status Report	119	0%	132	0%	0	0%
Water Temp	113	0%	126	0%	0	0%
Not Used	59	0%	60	0%	0	0%
ET-Daily	31	0%	31	0%	0	0%
Solar Power	20	0%	20	0%	0	0%
Handar 585 ALARM Status	3	0%	3	0%	0	0%
ALERT/A2 Testing	1	0%	2	0%	0	0%
GPS Lock	0	0%	198	0%	21,482	4%
Dew Point Temperature	0	0%	0	0	8,765	1%
Total	216,502		376,420		598,384	

Traffic Loading Summary	Legacy	Concentrator	ALERT
Alert Reports	216,502	376,420	598,384
Average Daily Traffic	6,984	11,763	19,303
Average Hourly Traffic	291	490	804
Median Hourly Traffic	296	hour beginning 502	781
Peak Hourly Traffic	419	Dec 29, 5:00 AM 856	941
2nd Max	406	Dec 29, 7:00 AM 703	938
3rd Max	406	Dec 29, 8:00 AM 692	932
4th Max	396	Dec 27, 8:00 AM 677	929
5th Max	395	Dec 28, 3:00 AM 661	927
		Dec 22, 4:00 AM	hour beginning 781
		Dec 4, 7:00 AM	Dec 15, 9:00 AM
		Dec 22, 4:00 PM	Dec 23, 11:00 AM
		Dec 4, 8:00 AM	Dec 24, 11:00 AM
		Dec 27, 8:00 AM	Dec 24, 12:00 PM
			Dec 1, 9:00 AM

Rain Timer Performance

Analyze Rain Sensors

0.51

0.922

Rain Sensors	Description	Rcv	Timer	Exp	Performance
2790	Wx-W. Cherry Creek	12	8:43	62	19%
3020	Wx-West Creek WX	188		744	25%
5940	Log Jumper	40	18:00	62	65%
4550	Boulder Jail	41	17:27	62	66%
1660	SPR at Henderson	42	17:04	62	68%
2330	Morrison	42	17:02	62	68%
2980	Dakan Rd	42	16:37	62	68%
5720	Four Mile Creek	45	15:20	62	73%
3010	WX-EPC at Hwy 105	49	14:36	62	79%
4870	SBC @ SB Road	51	13:49	62	82%
100260	Wx-A2-Trumbull (Hayman) - Precip	630		744	85%
4270	Cannon Mountain	53	13:41	62	85%
700	Toll Gate @ 6th	54	13:38	62	87%
4240	Sunset	55	12:40	62	89%
4490	Apple Valley	55	12:54	62	89%
4510	Pinewood Springs	55	12:54	62	89%
2320	Choke Cherry Resvr	56	12:56	62	90%
2750	Wx-Castle Rock	56	13:05	62	90%
4330	Hansen Rain	56	13:04	62	90%
5880	Hackett Mountain	56	12:53	62	90%
1700	Cherry Cr @ Champa	57	12:38	62	92%
3030	WX-Bingham Lake Park	57	12:53	62	92%
4050	Walker Ranch	57	12:49	62	92%
4060	Lakeshore	57	11:58	62	92%
4250	Geer Canyon	57	12:51	62	92%
4830	SBC @ San Souci	57	12:10	62	92%
4030	Red Garden	58	12:41	62	94%
4040	Martin Gulch	58	12:50	62	94%
4160	Sunshine	58	12:38	62	94%
4180	Gold Lake	58	12:35	62	94%
4220	Fling's	58	12:38	62	94%
4520	Eagle Ridge	58	12:26	62	94%
4770	Wx-Cal-Wood Ranch	58	12:27	62	94%
900	Wx-Aurora Reservoir	59	12:24	62	95%
1460	Wx-Urban Farm	59	12:25	62	95%
1640	SPR at Union Ave.	59	12:23	62	95%
1920	Wx-Brighton	59	12:24	62	95%
4020	Rio Grande	59	12:23	62	95%
4080	Twin Sisters	59	12:23	62	95%
4260	Taylor Mountain	59	12:25	62	95%
4300	Big Elk Park	59	12:23	62	95%
4310	Johnny Park	59	12:24	62	95%
4340	Riverside	59	12:24	62	95%
4350	Conifer Hill	59	12:09	62	95%
4360	Justice Center	59	11:57	62	95%
4570	St. Antons	59	12:25	62	95%
5860	Cedar Mountain	59	12:25	62	95%
1570	Wx-Brighton Ditch	60	12:12	62	97%
2730	Wx-Salisbury Park	60	12:12	62	97%
2990	Wx-Tomah Rd-DougCnty	60	12:15	62	97%
4010	Crescent	60	12:10	62	97%
4070	Bear Peak	60	12:09	62	97%
4130	Swiss Peaks	60	11:57	62	97%
4290	Red Hill	60	11:58	62	97%

4320	Lee Hill Rain 2012	60	12:10	62	97%
4710	Wx-Ward C-1	60	12:12	62	97%
4730	Wx-Sugarloaf	60	12:13	62	97%
4820	Doudy Draw	60	11:58	62	97%
5740	Trail Creek	60	12:12	62	97%
5810	Stump Bump	60	12:12	62	97%
100200	Wx-A2-OneRain Weather - Precipitation	60	12:13	62	97%
140	Wx-Blue Mountain	61	12:00	62	98%
200	Leyden Reservoir	61	11:58	62	98%
400	Montview Park	61	12:00	62	98%
750	Wx-Quincy Reservoir	61	12:00	62	98%
920	Wx-Aurora Town Hall	61	12:00	62	98%
970	Pump Sta 3	61	12:00	62	98%
1420	Wx-A2-Diamond Hill	61	12:00	62	98%
1440	Wx-Elbert	61	12:00	62	98%
1520	Wx-Marston Lake North	61	12:00	62	98%
2210	Wx-Hiwan G.C.	61	12:00	62	98%
2710	Wx-Highlands Ranch WTP	61	12:00	62	98%
2930	Wx-Spring Valley Rd-DougCnty	61	12:00	62	98%
4100	Filter Plant	61	12:00	62	98%
4110	Betasso	61	12:11	62	98%
4140	Logan Mill	61	11:57	62	98%
4150	Gold Hill	61	11:58	62	98%
4170	Pine Brook	61	11:57	62	98%
4190	Slaughterhouse	61	12:10	62	98%
4200	Lazy Acres	61	11:59	62	98%
4230	Golden Age	61	11:58	62	98%
4530	Winiger Ridge	61	12:10	62	98%
4750	Wx-Louisville Lake	61	12:00	62	98%
4790	Wx-Button Rock	61	12:00	62	98%
4810	Shanahan Ridge	61	12:11	62	98%
4840	SBC@S Boulder Ditch	61	11:57	62	98%
4860	Fairview Peak	61	12:00	62	98%
4880	Whispering Pines	61	11:57	62	98%
5730	West Creek	61	12:00	62	98%
100270	Wx-A2-WestCreek (Hayman) - Precip	733		744	99%
6601	Wx-A2-Magnolia WX-Precip	92	8:00	93	99%
100290	A2-PlumCr at Sedalia - Precip	738		744	99%
1000	A2-Maple Grove Resv.	741		744	100%
100420	A2-Thorncreek - Precip	741		744	100%
4850	Porphory Mtn	742		744	100%
100300	A2-CoalCreek at McCaslin - Precip	742		744	100%
100410	A2-Brantner Gulch - Precip	742		744	100%
4090	Magnolia	62	11:57	62	100%

Rain Event Performance																
	Reports Received	Reports Received	419	Analyze Rain Sensors						<<show stations with zero rain (1=yes, 0=no)						
	Systemwide Avg	Total Tips	428													
	98.32%	Data Loss	2.10%													
Description	Sensor	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcv	Exp	Miss	Hold	Bucket		
Dakan Rd	2980	71%	4	0	1	0	0	0	1	5	7	2	0	0.0393701		
WX-EPC at Hwy 105	3010	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701 Mean 5.35		
Apple Valley	4490	83%	4	1	0	0	0	0	0	5	6	1	0	0.0393701 Median 5		
SBC @ SB Road	4870	83%	4	1	0	0	0	0	0	5	6	1	0	0.0393701 St. Dev 3.304		
Wx-Button Rock	4790	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701 Mean plus 3 SD 15.26		
Pinewood Springs	4510	89%	7	1	0	0	0	0	0	8	9	1	0	0.0393701 Mean minus 2 SD 0		
Martin Gulch	4040	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701 Min 1		
SBC@S Boulder Ditch	4840	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701 Max 14		
Wx-Blue Mountain	140	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701		
Leyden Reservoir	200	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701		
Montview Park	400	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701		
Toll Gate @ 6th	700	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701		
Wx-Quincy Reservoir	750	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701		
Pump Sta 3	970	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701		
A2-Maple Grove Resv.	1000	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701		
Wx-A2-Diamond Hill	1420	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701		
Wx-Urban Farm	1460	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701		
Wx-Marston Lake North	1520	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701		
SPR at Union Ave.	1640	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701		
Cherry Cr @ Champa	1700	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701		
Wx-Hiwan G.C.	2210	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701		
Choke Cherry Resvr	2320	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701		
Morrison	2330	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701		
Wx-Spring Valley Rd-DougCnty	2930	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701		
Wx-Tomah Rd-DougCnty	2990	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701		
Wx-West Creek WX	3020	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701		
WX-Bingham Lake Park	3030	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701		
Cresent	4010	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701		
Rio Grande	4020	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701		
Red Garden	4030	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701		
Walker Ranch	4050	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701		
Lakeshore	4060	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701		
Bear Peak	4070	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701		
Twin Sisters	4080	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701		
Magnolia	4090	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701		
Filter Plant	4100	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701		
Betasso	4110	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701		
Swiss Peaks	4130	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701		
Logan Mill	4140	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701		
Gold Hill	4150	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701		
Sunshine	4160	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701		
Pine Brook	4170	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701		
Slaughterhouse	4190	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701		
Lazy Acres	4200	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701		
Fling's	4220	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701		
Golden Age	4230	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701		
Sunset	4240	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701		
Geer Canyon	4250	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701		
Taylor Mountain	4260	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701		
Cannon Mountain	4270	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701		
Red Hill	4290	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701		
Big Elk Park	4300	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701		
Johnny Park	4310	100%	9	0	0	0	0	0	1	9	9	0	0	0.0393701		
Lee Hill Rain 2012	4320	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701		
Hansen Rain	4330	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701		
Riverside	4340	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701		

Conifer Hill	4350	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
Justice Center	4360	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
Eagle Ridge	4520	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
Winiger Ridge	4530	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
Boulder Jail	4550	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
St. Antons	4570	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
Wx-Ward C-1	4710	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
Wx-Sugarloaf	4730	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
Wx-Louisville Lake	4750	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
Wx-Cal-Wood Ranch	4770	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
Shanahan Ridge	4810	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
Doudy Draw	4820	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
SBC @ San Souci	4830	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
Whispering Pines	4880	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
Four Mile Creek	5720	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
Trail Creek	5740	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
Stump Bump	5810	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
Cedar Mountain	5860	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
Hackett Mountain	5880	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
Log Jumper	5940	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
Wx-A2-Trumbull (Hayman) - Precip	100260	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
Wx-A2-WestCreek (Hayman) - Precip	100270	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
A2-PlumCr at Sedalia - Precip	100290	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
A2-CoalCreek at McCaslin - Precip	100300	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
	Total Tips		411	7	1	0	0	0						
Porphyry Mtn	4850	100%	9	0	0	0	0	0	0	9	9	0	0	0.01
Fairview Peak	4860	100%	9	0	0	0	0	0	0	9	9	0	0	0.01
Wx-A2-Magnolia WX-Precip	6601	100%	12	0	0	0	0	0	0	12	12	0	0	0.01
Wx-A2-OneRain Weather - Precipitation	100200	91%	19	0	1	0	0	0	0	20	22	2	0	0.01

2017 Monthly Peak Hour ALERT Radio Traffic Summary

