

Memo

Date: March 5, 2012
To: Kevin Stewart
From: Markus Ritsch
Subject: February 2012 ALERT Data Analysis

I. ALERT Data Source

Raw ALERT data records extracted from the Urban Drainage and Flood Control District's NovaStar 5.0 base station were analyzed for the period February 1 through February 29, 2012. On February 24, the NovaStar 5.0 base station was relocated within the Diamond Hill office complex. The base station was not collecting data for several hours during this move. In addition, the A2 feed was down for approximately 2 hours longer than the legacy ALERT feed on February 24, 2012. An interruption in the A2 data feed was also identified on March 4th, beginning at approximately 9:30 AM that lasted to March 5 at approximately noon.

II. General System Analysis Summary

A total of 298,809 legacy ALERT data reports were analyzed. Meteorological sensors account for 86 percent, water level sensors 3 percent, and rain sensors 2 percent of the total monthly records.

The system-wide radio traffic loading was 10,304 reports per day with an average hourly loading of 429 reports. The peak hour of radio traffic loading was 704 reports, which occurred on February 29th, between 1:00 PM and 2:00 PM. A plot of monthly average and peak hourly traffic loading is provided.

A. Specific Issues Identified this Month

Performance of the following sensors (Table 1) was questionable this month.

Table 1. Rain Sensors with Poor Performance Characteristics

Rain ID	Description	Timer Performance	Event Performance
4550	Boulder Jail	36%	80%
4470	Little Narrows	45%	95%
1460	Wx-Urban Farm	43%	100%
2980	Dakan Road	86%	38%
3030	Wx-Bingham Lake Park	88%	53%
4240	Sunset	79%	63%
1520	Wx-Marston Lake North	50%	63%
4490	Apple Valley	84%	64%
1420	Wx-Diamond Hill	98%	68%
300	Van Bibber Park (Px)	Sensors with a large number of invalid reports	
4240	Sunset (Px)	Sensors with a large number of invalid reports	
1523	Marston Lake North (level)	Sensors with a large number of invalid reports	
1530	Bear Creek at Lowell (Px)	Sensors with a large number of invalid reports	
1643	SPR at Union Ave. (level)	Sensors with a large number of invalid reports	
2750	Quincy Res (battery)	Sensors with a large number of invalid reports	
1470	Unknown sensor IDs with excessive reports		
1423			
1454			
2811			

B. Continuous Operation of Base Receiver/Decoder

The ALERT and ALERT2 data feeds on the NS5 base computer were not operational for the entire month. Both were down for several hours on Friday, February 24 as the NS5 base station was being moved. Both feeds were up and fully functional by approximately 4:00 PM on February 24, 2012.

III. Rain Sensor Timer Reporting Summary

The following analysis assumes that each rain sensor has a 12-hour timer-reporting interval. The worst performing rain sensors for the month are summarized (Table 2).

Table 2. Monthly Summary of Sensors with Poor Timer Performance (Sensor ID)

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
2320	4550										
1460	1460										
1520	4470										
1440	1520										
1000	1440										
4520	140										

*- 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.

IV. 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 3). 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 3. District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	13.57	Only the 1-mm rain sensors were included in the analysis
Median	14	Only the 1-mm rain sensors were included in the analysis
Standard deviation	6.85	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	34.13	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	Many
Maximum total count	30	ID 4040 (Martin Gulch)

B. Monthly Average Tip/Count Summary

A monthly summary of the District-wide mean total tip/count is presented (Table 4).

Table 4. 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											

*- 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 5).

Table 5. Sensors with a Jump of 6 or More in Sequential Count

Sensor Description	Sensor ID	Comment
Dakan Road	2980	Jump of 9 between 2/23 and 2/24
Wx-Bingham Lake Park	3030	Jump of 7 between 2/23 and 2/25
Wx-Marston Lake North	1520	Jump of 9 between 2/23 and 2/24
Wx-Diamond Hill	1420	Jump of 7 between 2/23 and 2/24
All these sensors experienced a large jump in count during the period that coincides with the move of the base station.		

D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 87 percent. A total of 823 incrementing reports were received and a total of 950 reports were expected. The total loss of incrementing reports for the month was approximately 13 percent. Those sensors with the worst event transmission performance are summarized (Table 6).

Table 6. Monthly Summary of Sensors with the Most Missed Tips

Jan*	Feb*	Mar**	Apr	May	Jun	Jul	Aug	Sep	Oct**	Nov*	Dec*
1700	2980										
1420	3030										
4490	4240										
2980	1520										
1660	4490										
4090	1420										

*-Only sensors that are operational year-round (weather stations and stations in Boulder County) are included for the analysis in these months. **-Due to Spring start-up Fall shut-down the performance values in these months are not accurate.

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.

V. Heavy Radio Traffic Analysis

Periods exceeding 700 messages per hour are analyzed independently in an attempt to quantify data loss rates from rain sensors using their sequential tip count series.

A. The Heaviest Hourly Traffic Periods This Month

The hourly periods of highest radio traffic this month are shown (Table 7). Each hour exceeding 700 reports was analyzed to quantify the number of missing rain reports for that hour.

Table 7. Heavy Radio Traffic Periods

Day	Hr	Expected Tips	Received Tips	Total Load	Loss
29	13	0	0	704	0%
23	3	0	0	649	0%
28	17	5	3	640	30%
20	15	0	0	636	0%
22	13	0	0	629	0%

VI. 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 8).

Table 8. Summary of Unknown IDs

Description	Quantity
Total number of unknown IDs (IDs without a device definition)	267
Total reports from unknown IDs	750
Unknown IDs with only a single received report (potential noise)	131
Total reports from all IDs – RecData Log entire month	298,809
Unknown reports as a fraction of total reports	0.25%

The total number of reports from unknown sensors is very small relative to the total reports received for the month. Shown below (Table 9) are the total reports received from unknown sensor IDs for each month of the year.

Table 9. Monthly Summary of Total Reports from Unknown IDs

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										

The fraction of reports from unknown sensors relative to the total number of reports is shown below (Table 10).

Table 10. Monthly Percent of Unknown Sensor Reports

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%										

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 11).

Table 11. Reports Received by Unknown IDs

Unknown ID	Reports
1423	26
1470	25
2811	17
1454	17
2239	15
1453	13
1430	12
1933	12
1934	12
629	11
1446	11
1953	11
1926	10
1929	9
2756	9

2775	9
1415	8
1534	8
2754	8
148	7
1481	7
1923	7

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\2012\02-2012\Novastar_extract_2012Feb.mdb

First Date in Database	2/1/12 12:00 AM	Total Days	29.0
Last Date in Database	2/29/12 11:59 PM	Total Hours	696.0

Total Records Analyzed 298,809

Records by Group

Wind Gust	55,544	19%
Temperature	54,027	18%
Relative Humidity	52,406	18%
Wind Speed Average & Azimuth	27,795	9%
Barometric Pressure	27,744	9%
Wind Direction	15,663	5%
Wind Speed Average	15,232	5%
Battery Voltage	11,500	4%
Water Level	9,924	3%
Solar Radiation	7,321	2%
Precipitation	6,207	2%
Fuel Temperature	4,416	1%
Fuel Moisture	4,415	1%
Repeater Status Report	2,043	1%
Soil Moisture	1,769	1%
Wind ALERT	1,277	0%
Unknown	750	0%
Repeater Pass List	554	0%
12Hr Status Report	181	0%
Solar Power	17	0%
Wind Direction ALERT	15	0%
Handar 585 ALARM Status	9	0%
Total	298,809	

Records by Major Group

Meteorologic Sensors	255,732	86%
Soil and Fuel Sensors	10,600	4%
Water Level Sensors	9,924	3%
Rain Sensors	6,207	2%
Sensor Status Transmissions	2,804	1%
Total	285,267	

Traffic Loading Summary

Alert Reports	298,809	
Average Daily Traffic	10,304	
Average Hourly Traffic	429	
Median Hourly Traffic	445	hour beginning
Peak Hourly Traffic	704	Feb 29, 1:00 PM
2nd Max	649	Feb 23, 3:00 AM
3rd Max	640	Feb 28, 5:00 PM
4th Max	636	Feb 20, 3:00 PM
5th Max	629	Feb 22, 1:00 PM

Rain Timer Performance

Analyze Rain Sensors

12:31

Rain Sensors	Description	Rcv	Timer	Exp	Performance
4550	Boulder Jail	21	13:13	58	36%
1460	Wx-Urban Farm	25	23:40	58	43%
4470	Little Narrows	26	17:21	58	45%
1520	Wx-Marston Lake North	29	18:41	58	50%
1440	Wx-Elbert	30	20:18	58	52%
140	Wx-Blue Mountain	34	16:26	58	59%
1570	Wx-Brighton Ditch	37	17:49	58	64%
4510	Pinewood Springs	44	14:46	58	76%
4330	Hansen Rain	45	13:20	58	78%
4170	Pine Brook	45	13:59	58	78%
4530	Winiger Ridge	46	14:57	58	79%
4240	Sunset	46	14:00	58	79%
4130	Swiss Peaks	47	12:20	58	81%
4090	Magnolia	47	13:09	58	81%
3010	EPC at Hwy 105	47	12:56	58	81%
4570	St. Antons	48	12:32	58	83%
4870	SBC @ SB Road	49	12:00	58	84%
4860	Fairview Peak	49	12:18	58	84%
4490	Apple Valley	49	12:39	58	84%
4360	Justice Center	49	12:33	58	84%
4180	Gold Lake	49	13:17	58	84%
4110	Betasso	49	12:36	58	84%
4080	Twin Sisters	49	13:36	58	84%
4060	Lakeshore	49	13:25	58	84%
3020	Wx-West Creek WX	50	12:18	58	86%
2990	Wx-Tomah Rd-DougCnty	50	12:52	58	86%
920	Wx-Aurora Town Hall	50	12:58	58	86%
4340	Riverside	50	12:32	58	86%
4220	Fling's	50	13:01	58	86%
4150	Gold Hill	50	13:27	58	86%
4140	Logan Mill	50	12:33	58	86%
4010	Cresent	50	12:50	58	86%
2980	Dakan Rd	50	13:03	58	86%
4750	Wx-Louisville Lake	51	12:45	58	88%
2750	Wx-Castle Rock	51	11:44	58	88%
3030	WX-Bingham Lake Park	51	12:32	58	88%
4850	Porphory Mtn	51	12:32	58	88%
4190	Slaughterhouse	51	12:30	58	88%
2930	Wx-Spring Valley Rd-DougCnty	52	13:12	58	90%
4790	Wx-Button Rock	52	13:04	58	90%
4520	Eagle Ridge	52	13:16	58	90%
4200	Lazy Acres	52	12:31	58	90%
4100	Filter Plant	52	12:46	58	90%
4710	Wx-Ward C-1	53	12:48	58	91%
4730	Wx-Sugarloaf	53	13:02	58	91%
2730	Wx-Salisbury Park	53	12:14	58	91%
4770	Wx-Cal-Wood Ranch	53	12:00	58	91%
4230	Golden Age	53	12:41	58	91%
4020	Rio Grande	53	13:01	58	91%
750	Wx-Quincy Reservoir	54	11:41	58	93%
4160	Sunshine	54	12:29	58	93%
2190	Wx-Squaw Mountain	55	12:27	58	95%
4070	Bear Peak	55	12:28	58	95%
4030	Red Garden	55	11:44	58	95%

4310	Johnny Park	56	11:20	58	97%
1420	Wx-Diamond Hill	57	10:46	58	98%
1920	Wx-Brighton	57	12:13	58	98%
4300	Big Elk Park	57	11:43	58	98%
4290	Red Hill	57	10:56	58	98%
2710	Wx-Highlands Ranch WTP	58	11:04	58	100%
4260	Taylor Mountain	58	10:35	58	100%
4250	Geer Canyon	59	11:28	58	102%
4270	Cannon Mountain	60	11:19	58	103%
900	Wx-Aurora Reservoir	61	11:11	58	105%
4350	Conifer Hill	61	10:26	58	105%
2210	Wx-Hiwan G.C.	65	10:39	58	112%
4050	Walker Ranch	68	10:19	58	117%
4830	SBC @ San Souci	73	9:23	58	126%
4040	Martin Gulch	73	9:21	58	126%
4820	Doudy Draw	76	7:55	58	131%
4840	SBC@S Boulder Ditch	78	8:32	58	134%
4810	Shanahan Ridge	94	6:53	58	162%

Rain Event Performance					Analyze Rain Sensors									
		Reports Received	823											
		Systemwide Avg	Total Tips											
		86.63%	Data Loss											
		13.37%												
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	38%	4	4	0	0	0	0	1	8	21	13	0	0.0393701
WX-Bingham Lake Park	3030	53%	8	0	0	0	0	0	1	8	15	7	0	0.0393701
Sunset	4240	63%	3	1	1	0	0	0	0	5	8	3	0	0.0393701
Wx-Marston Lake North	1520	63%	15	0	0	0	0	0	1	15	24	9	0	0.0393701
Apple Valley	4490	64%	5	3	1	0	0	0	0	9	14	5	0	0.0393701
Wx-Diamond Hill	1420	68%	15	0	0	0	0	0	1	15	22	7	0	0.0393701
Wx-Highlands Ranch WTP	2710	71%	9	0	0	0	1	0	0	10	14	4	0	0.0393701
Hansen Rain	4330	74%	12	0	1	1	0	0	0	14	19	5	0	0.0393701
Wx-Tomah Rd-DougCnty	2990	75%	11	0	0	0	1	0	0	12	16	4	0	0.0393701
Wx-Salisbury Park	2730	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701
SBC @ SB Road	4870	75%	11	3	1	0	0	0	0	15	20	5	0	0.0393701
Pinewood Springs	4510	75%	9	2	1	0	0	0	0	12	16	4	0	0.0393701
Slaughterhouse	4190	75%	9	2	1	0	0	0	0	12	16	4	0	0.0393701
Wx-Brighton	1920	77%	9	0	0	1	0	0	0	10	13	3	0	0.0393701
Doudy Draw	4820	78%	13	0	0	0	1	0	0	14	18	4	0	0.0393701
SBC @ San Souci	4830	78%	17	0	0	0	0	1	0	18	23	5	0	0.0393701
Boulder Jail	4550	80%	3	1	0	0	0	0	0	4	5	1	0	0.0393701
Red Garden	4030	80%	10	1	1	0	0	0	0	12	15	3	0	0.0393701
Wx-Button Rock	4790	82%	7	2	0	0	0	0	0	9	11	2	0	0.0393701
Rampart Range Rd	2970	82%	13	0	0	1	0	0	0	14	17	3	0	0.0393701
Shanahan Ridge	4810	83%	23	0	0	0	0	1	0	24	29	5	0	0.0393701
Wx-Cal-Wood Ranch	4770	85%	9	2	0	0	0	0	0	11	13	2	0	0.0393701
Taylor Mountain	4260	85%	10	0	1	0	0	0	0	11	13	2	0	0.0393701
Justice Center	4360	85%	20	2	1	0	0	0	0	23	27	4	0	0.0393701
SBC@S Boulder Ditch	4840	89%	23	0	0	1	0	0	0	24	27	3	0	0.0393701
Logan Mill	4140	89%	15	0	1	0	0	0	0	16	18	2	0	0.0393701
Betasso	4110	89%	15	0	1	0	0	0	0	16	18	2	0	0.0393701
Wx-West Creek WX	3020	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701
Fling's	4220	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701
Twin Sisters	4080	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701
Martin Gulch	4040	90%	26	0	0	1	0	0	0	27	30	3	0	0.0393701
Cannon Mountain	4270	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
Swiss Peaks	4130	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
Geer Canyon	4250	93%	13	1	0	0	0	0	0	14	15	1	0	0.0393701
Magnolia	4090	94%	14	1	0	0	0	0	0	15	16	1	0	0.0393701
Riverside	4340	94%	16	1	0	0	0	0	0	17	18	1	0	0.0393701
Little Narrows	4470	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
Red Hill	4290	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
Lazy Acres	4200	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
Johnny Park	4310	95%	19	1	0	0	0	0	0	20	21	1	0	0.0393701
Wx-Ward C-1	4710	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
Wx-Urban Farm	1460	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
Wx-Sugarloaf	4730	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
Wx-Squaw Mountain	2190	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
Wx-Spring Valley Rd-DougCnty	2930	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
Wx-Quincy Reservoir	750	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
Wx-Louisville Lake	4750	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
Wx-Hiwan G.C.	2210	100%	13	0	0	0	0	0	0	13	13	0	0	0.0393701
Wx-Elbert	1440	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
Wx-Castle Rock	2750	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
Wx-Brighton Ditch	1570	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
Wx-Blue Mountain	140	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
Wx-Aurora Town Hall	920	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
Winiger Ridge	4530	100%	19	0	0	0	0	0	0	19	19	0	0	0.0393701
St. Antons	4570	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
Eagle Ridge	4520	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
Conifer Hill	4350	100%	19	0	0	0	0	0	0	19	19	0	0	0.0393701
Big Elk Park	4300	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
Golden Age	4230	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
Gold Lake	4180	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
Pine Brook	4170	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
Sunshine	4160	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
Gold Hill	4150	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
Filter Plant	4100	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
Bear Peak	4070	100%	17	0	0	0	0	0	0	17	17	0	0	0.0393701
Lakeshore	4060	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
Walker Ranch	4050	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
Rio Grande	4020	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
Crezent	4010	100%	20	0	0	0	0	0	0	20	20	0	0	0.0393701
Wx-Aurora Reservoir	900	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393699
TOTAL			766	36	11	5	3	2	4	823	950	127	0	
EPC at Hwy 105	3010	94%	16	1	0	0	0	0	0	17	18	1	0	0.01
Fairview Peak	4860	100%	33	0	0	0	0	0	0	33	33	0	0	0.01
Porphory Mtn	4850	100%	8	0	0	0	0	0	0	8	8	0	0	0.01

2012 Monthly ALERT Radio Traffic Summary

