

Memo

Date: April 5, 2012
To: Kevin Stewart
From: Markus Ritsch
Subject: March 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 March 1 through March 31, 2012. Interruptions in the data feeds for both legacy and A2 were identified in early March that lasted to March 7th.

II. General System Analysis Summary

A total of 368,057 legacy ALERT data reports were analyzed. Meteorological sensors account for 82 percent, water level sensors 5 percent, and rain sensors 3 percent of the total monthly records.

The system-wide radio traffic loading was 11,873 reports per day with an average hourly loading of 495 reports. The peak hour of radio traffic loading was 709 reports, which occurred on March 26th, between 12:00 PM and 1:00 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
4270	Cannon Mountain	77%	100%
4870	SBC @ SB Road	79%	100%
1643	SPR at Union Ave. (level)	Large number of invalid reports that have a raw count of zero (0) interspersed with good data.	
2851	Unknown sensor IDs with excessive reports (these IDs emanated from station 2850, Cherry Creek at Bayou Gulch and was fixed on March 20, 2012)		
2852			
2856			
2857			

B. Continuous Operation of Base Receiver/Decoder

The ALERT and ALERT2 data feeds on the NS5 base computer were not in continuous operational for the entire month. Both data feeds experienced outages in the early portion of the month due to the move of the base station. Both data feeds were fully operational beginning approximately March 7th, 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	4270									
1460	1460	4870									
1520	4470	4790									
1440	1520	4850									
1000	1440	4570									
4520	140	4070									

*. 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	2.35	Only the 1-mm rain sensors were included in the analysis
Median	2	Only the 1-mm rain sensors were included in the analysis
Standard deviation	0.95	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	5.21	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	Many
Maximum total count	6	ID 4050 (Walker Ranch)

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	2.35										

*- 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
No sensors experienced a jump in sequential count of more than 6 this month.		

D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 95 percent. A total of 121 incrementing reports were received and a total of 127 reports were expected. The total loss of incrementing reports for the month was approximately 5 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	2710									
1420	3030	4860									
4490	4240	2930									
2980	1520	3030									
1660	4490	2990									
4090	1420	4050									

*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.

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
26	12	3	3	709	0%
19	1	0	0	700	0%
26	11	7	6	688	14%
26	13	8	7	683	13%
26	14	3	3	671	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)	370
Total reports from unknown IDs	1,575
Unknown IDs with only a single received report (potential noise)	220
Total reports from all IDs – RecData Log entire month	368,057
Unknown reports as a fraction of total reports	0.43%

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	1,575									

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%	0.43%									

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 Sensor ID	Total Number of Reports
2856	182
2852	151
2851	148
2857	135
2854	121
2858	109
209	20
4839	16
2239	15
609	14
1423	12
1609	12
4469	10
1919	9
409	8

2219	8
611	7
612	7
1631	7
1953	7
614	6

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\2012\03-2012\Novastar_extract_2012Mar.mdb

First Date in Database	3/1/12 12:00 AM	Total Days	31.0
Last Date in Database	3/31/12 11:59 PM	Total Hours	744.0

Total Records Analyzed 368,057

Records by Group

Wind Gust	66,741	18%
Temperature	63,164	17%
Relative Humidity	59,254	16%
Wind Speed Average & Azimuth	32,914	9%
Barometric Pressure	30,225	8%
Wind Direction	20,536	6%
Wind Speed Average	20,105	5%
Battery Voltage	17,783	5%
Water Level	17,562	5%
Precipitation	9,590	3%
Solar Radiation	9,297	3%
Fuel Moisture	5,700	2%
Fuel Temperature	5,694	2%
Soil Moisture	2,728	1%
Repeater Status Report	2,454	1%
Wind ALERT	1,627	0%
Unknown	1,575	0%
Repeater Pass List	623	0%
12Hr Status Report	411	0%
Handar 585 ALARM Status	61	0%
Wind Direction ALERT	9	0%
Solar Power	3	0%
Longmont Flow Gage	1	0%
Total	368,057	

Records by Major Group

Meteorologic Sensors	302,236	82%
Water Level Sensors	17,563	5%
Soil and Fuel Sensors	14,122	4%
Rain Sensors	9,590	3%
Sensor Status Transmissions	3,552	1%
Total	347,063	

Traffic Loading Summary

Alert Reports	368,057	
Average Daily Traffic	11,873	
Average Hourly Traffic	495	
Median Hourly Traffic	495	hour beginning
Peak Hourly Traffic	709	Mar 26, 12:00 PM
2nd Max	700	Mar 19, 1:00 AM
3rd Max	688	Mar 26, 11:00 AM
4th Max	683	Mar 26, 1:00 PM
5th Max	671	Mar 26, 2:00 PM

Rain Timer Performance

Analyze Rain Sensors

Rain Sensors	Description	Rcv	Timer	Exp	Performance
4270	Cannon Mountain	48	15:01	62	77%
4870	SBC @ SB Road	49	14:21	62	79%
4790	Wx-Button Rock	54	13:35	62	87%
4850	Porphyry Mtn	54	12:56	62	87%
4570	St. Antons	55	13:07	62	89%
4070	Bear Peak	55	12:52	62	89%
4510	Pinewood Springs	56	13:19	62	90%
4490	Apple Valley	56	13:19	62	90%
4830	SBC @ San Souci	57	12:37	62	92%
1520	Wx-Marston Lake North	58	11:54	62	94%
920	Wx-Aurora Town Hall	58	12:26	62	94%
4470	Little Narrows	58	12:38	62	94%
4340	Riverside	58	12:10	62	94%
4330	Hansen Rain	58	12:37	62	94%
4180	Gold Lake	58	12:35	62	94%
4130	Swiss Peaks	58	12:37	62	94%
4090	Magnolia	58	12:50	62	94%
4050	Walker Ranch	58	12:37	62	94%
3030	WX-Bingham Lake Park	59	12:14	62	95%
4550	Boulder Jail	59	12:22	62	95%
4360	Justice Center	59	12:22	62	95%
4350	Conifer Hill	59	12:10	62	95%
4310	Johnny Park	59	12:22	62	95%
4290	Red Hill	59	12:23	62	95%
4220	Fling's	59	12:37	62	95%
4170	Pine Brook	59	12:25	62	95%
4060	Lakeshore	59	12:23	62	95%
3020	Wx-West Creek WX	60	12:12	62	97%
2190	Wx-Squaw Mountain	60	12:12	62	97%
4750	Wx-Louisville Lake	60	11:59	62	97%
1440	Wx-Elbert	60	12:12	62	97%
140	Wx-Blue Mountain	60	12:12	62	97%
4860	Fairview Peak	60	12:12	62	97%
4820	Doudy Draw	60	11:57	62	97%
4810	Shanahan Ridge	60	12:10	62	97%
4300	Big Elk Park	60	12:10	62	97%
4260	Taylor Mountain	60	12:23	62	97%
4150	Gold Hill	60	12:10	62	97%
4140	Logan Mill	60	11:58	62	97%
4100	Filter Plant	60	11:59	62	97%
4040	Martin Gulch	60	12:10	62	97%
4030	Red Garden	60	11:59	62	97%
4010	Crescent	60	12:10	62	97%
4710	Wx-Ward C-1	61	12:00	62	98%
1460	Wx-Urban Farm	61	12:00	62	98%
2930	Wx-Spring Valley Rd-DougCnty	61	11:58	62	98%
750	Wx-Quincy Reservoir	61	11:57	62	98%
2210	Wx-Hiwan G.C.	61	12:05	62	98%
1570	Wx-Brighton Ditch	61	12:00	62	98%
1920	Wx-Brighton	61	12:00	62	98%
4530	Winiger Ridge	61	12:10	62	98%
4250	Geer Canyon	61	12:10	62	98%
4240	Sunset	61	12:10	62	98%
4200	Lazy Acres	61	12:12	62	98%

4190	Slaughterhouse	61	11:58	62	98%
4110	Betasso	61	12:12	62	98%
4730	Wx-Sugarloaf	62	12:00	62	100%
4520	Eagle Ridge	62	11:50	62	100%
4160	Sunshine	62	11:58	62	100%
4080	Twin Sisters	62	11:58	62	100%
4020	Rio Grande	62	11:56	62	100%
2990	Wx-Tomah Rd-DougCnty	63	11:27	62	102%
2730	Wx-Salisbury Park	63	11:37	62	102%
2710	Wx-Highlands Ranch WTP	63	11:29	62	102%
4770	Wx-Cal-Wood Ranch	63	11:37	62	102%
4230	Golden Age	63	11:46	62	102%
2750	Wx-Castle Rock	64	11:25	62	103%
1420	Wx-Diamond Hill	66	11:08	62	106%
4840	SBC@S Boulder Ditch	69	10:42	62	111%
900	Wx-Aurora Reservoir	74	9:51	62	119%

Rain Event Performance			Reports Received	121	Analyze Rain Sensors										
		Systemwide Avg	Total Tips	127											
		95.28%	Data Loss	4.72%											
Description	Sensor	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcv	Exp	Miss	Hold	Bucket	
Wx-Highlands Ranch WTP	2710	50%	0	1	0	0	0	0	0	1	2	1	0	0.0393701	
Fairview Peak	4860	50%	0	1	0	0	0	0	0	1	2	1	0	0.01	
Wx-Spring Valley Rd-DougC	2930	67%	1	1	0	0	0	0	0	2	3	1	0	0.0393701	
WX-Bingham Lake Park	3030	67%	1	1	0	0	0	0	0	2	3	1	0	0.0393701	
Wx-Tomah Rd-DougCnty	2990	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701	
Walker Ranch	4050	83%	4	1	0	0	0	0	0	5	6	1	0	0.0393701	
Wx-West Creek WX	3020	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Wx-Ward C-1	4710	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701	
Wx-Sugarloaf	4730	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Wx-Squaw Mountain	2190	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701	
Wx-Marston Lake North	1520	100%	2	0	0	0	0	0	0	2	2	0	1	0.0393701	
Wx-Louisville Lake	4750	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Wx-Hiwan G.C.	2210	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Wx-Diamond Hill	1420	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Wx-Castle Rock	2750	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701	
Wx-Cal-Wood Ranch	4770	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Wx-Aurora Town Hall	920	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Winiger Ridge	4530	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
SBC @ SB Road	4870	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Porphory Mtn	4850	100%	4	0	0	0	0	0	0	4	4	0	1	0.01	
SBC@S Boulder Ditch	4840	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
SBC @ San Souci	4830	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Doudy Draw	4820	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Shanahan Ridge	4810	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
St. Antons	4570	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Eagle Ridge	4520	100%	2	0	0	0	0	0	0	2	2	0	1	0.0393701	
Pinewood Springs	4510	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Apple Valley	4490	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Little Narrows	4470	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Conifer Hill	4350	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
Riverside	4340	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Hansen Rain	4330	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Red Hill	4290	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Taylor Mountain	4260	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Geer Canyon	4250	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Sunset	4240	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Golden Age	4230	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Fling's	4220	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Lazy Acres	4200	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Slaughterhouse	4190	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Pine Brook	4170	100%	2	0	0	0	0	0	0	2	2	0	1	0.0393701	
Sunshine	4160	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Gold Hill	4150	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Logan Mill	4140	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Swiss Peaks	4130	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701	
Betasso	4110	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Filter Plant	4100	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Magnolia	4090	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Twin Sisters	4080	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Bear Peak	4070	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
Lakeshore	4060	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Red Garden	4030	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Rio Grande	4020	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Crescent	4010	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
Total			115	6	0	0	0	0	0	121	127	6	4		

2012 Monthly ALERT Radio Traffic Summary

