

Memo



Date: December 7, 2010
To: Kevin Stewart
From: Markus Ritsch
Subject: November 2010 ALERT Data Analysis

I. ALERT Data Source

Raw ALERT data records extracted from the Urban Drainage and Flood Control District's Nova Star 4.0 base station (ALERT 2) were analyzed for the period November 1 through November 30, 2010.

II. General System Analysis Summary

A total of 306,400 ALERT (legacy) data reports were analyzed from the ALERT 2 base station. Meteorological sensors account for 82 percent, water level sensors 4 percent, and rain sensors 3 percent of the total monthly records.

The system-wide radio traffic loading was 10,213 reports per day with an average hourly loading of 426 reports. The peak hourly traffic loading was 852 reports, which occurred on November 7, between 1:00 AM and 2:00 AM. 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 unacceptable this month.

Table 1. Rain Sensors with Unacceptable Performance Characteristics

Rain ID	Description	Timer	Event	Comments
1460	Wx-Urban Farm	67 %	90 %	Poor timer performance
4010	Crescent	70 %	100 %	Unknown sensor reports, invalid sensor reports
4060	Lakeshore	88 %	100 %	Unknown sensor reports, invalid sensor reports
4070	Bear Peak	87 %	67 %	Poor performance
4080	Twin Sisters	80 %	67 %	Unknown sensor reports, invalid sensor reports
4090	Wx-Magnolia	73 %	83 %	Invalid sensor reports, poor performance
4110	Betasso	80 %	61 %	Poor performance
4490	Apple Valley	63 %	71 %	Poor performance
4850	Porphyry Mountain	67 %	100 %	Poor performance

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**
--	--	--	2970	2970	2970	2980	2980	2230	--	4490	
--	--	--	3010	700	1710	2930	2930	4270	--	1460	
--	--	--	700	2240	4330	2990	2990	4040	--	4850	
--	--	--	4860	4330	2270	3020	3020	4330	--	4010	
--	--	--	4330	4490	2240	2810	2810	2240	--	4790	
--	--	--	4170	4270	4470	4330	4330	1710	--	140	

*- Due to system start-up/shut-down, timer statistics are not evaluated for the months of March and October. **-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).

Table 3. District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	8.30	Only the 1-mm rain sensors were included in the analysis
Median	8	Only the 1-mm rain sensors were included in the analysis
Standard deviation	4	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	21.01	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	Multiple Sensors
Maximum total count	18	ID 4110 (Betasso Rain Boulder County)

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		

*-Event statistics are skewed in these months because system start-up/shut-down occurs. The rain network is operational between April 1 and October 15. Only the weather stations remain operational throughout the year.

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
		There were no sensors this month that experienced a jump in count exceeding 6!

D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 89.05 percent. A total of 488 incrementing reports were received and a total of 548 were expected. The total loss of incrementing reports for the month was approximately 10.95 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**
--	--	--	2970	700	2900	870	2270	110	--	4110	
--	--	--	700	2280	2190	540	2980	2970	--	4080	
--	--	--	940	2970	2930	2980	2280	720	--	4070	
--	--	--	430	2980	4330	2900	4090	1900	--	4470	
--	--	--	2900	2190	2980	4330	310	2270	--	4490	
--	--	--	4330	2240	2970	2230	4330	4040	--	4510	

*- Due to system start-up/shut-down, timer statistics are not evaluated for the months of March and October. **-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 500 messages per hour were analyzed independently in an attempt to quantify data loss rates from rain sensors using the 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 500 reports was analyzed to quantify the number of missing rain reports for that hour.

Table 7. Heavy Radio Traffic Periods

Peak Traffic Periods	Reports/hour	Missing Rain Reports (% loss)	Hour Beginning
Peak Hourly Traffic	852	0 %	11/7/2010 1:00 AM
2nd Max	659	5.4 %	11/9/2010 2:00 PM
3rd Max	630	6.7 %	11/9/2010 3:00 PM
4th Max	620	0 %	11/23/2010 8:00 PM
5th Max	582	0 %	11/16/2010 4:00 PM

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)	494
Total reports from unknown IDs	2,857
Unknown IDs with only a single received report (potential noise)	224
Total reports from all IDs – RecData Log entire month	306,400
Unknown reports as a fraction of total reports	0.93%

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	Ave
2010	1,220	1,474	1,276	1,174	721	5,707	610	1,738	442	533	2,857		

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 10).

Table 10. Reports Received by Unknown IDs

Unknown ID	Reports
2993	217
4094	149
4091	131
4093	128
4063	124
4087	124
4062	69
4086	57
4061	55
4092	53
4083	41
4863	38
4607	36
4011	27
4014	24
4088	22
4831	22
4603	20
4847	20
4859	20
4862	20
4081	19
4084	19
4606	19
1470	18
4861	18
4082	17
4855	17
2239	16
4599	16
1923	15
4013	15
1423	14
1954	13
2748	13
4735	13
1454	12
2706	12
4605	12
4671	12
1430	11
1502	10
1534	10
1926	10
1933	10

2756	10
4591	10
4733	10
4839	10
1443	9
1486	9
2705	9
2768	9
2811	9
4389	9
4601	9
4823	9
4853	9
1433	8
1453	8
1478	8
1929	8
2771	8
2775	8
4012	8
4590	8
4597	8
4663	8
4846	8
4851	8
1953	7
2746	7
2784	7
2808	7
4559	7
4586	7
4719	7
1319	6
1501	6
1507	6
1531	6
4064	6
4339	6
4551	6
4558	6
4571	6
4574	6
4598	6
4602	6
4604	6
4827	6
4857	6

The “unknown” device reports are analyzed temporally to understand when they are received during the day (Table 11). The goal of this analysis is to determine a pattern of occurrence that may correspond to a source of noise in the system, such as the use of a wireless microphone nearby.

Table 11. Temporal Distribution of Received Reports

Hour (AM)	Reports	Hour (PM)	Reports
0:00-00:59	121	12:00-12:59	84
1:00-1:59	112	1:00-1:59	99
2:00-2:59	128	2:00-2:59	108
3:00-3:59	101	3:00-3:59	111
4:00-4:59	120	4:00-4:59	142
5:00-5:59	163	5:00-5:59	168
6:00-6:59	130	6:00-6:59	117
7:00-7:59	103	7:00-7:59	111
8:00-8:59	124	8:00-8:59	142
9:00-9:59	99	9:00-9:59	120
10:00-10:59	116	10:00-10:59	97
11:00-11:59	124	11:00-11:59	117

VII. Sensors with Invalid Reports

The following precipitation sensors had a large number of invalid reports (bit flip/contention errors/random decode):

Sensor ID	Description	Nov 10	Dec 10	Jan 11	Feb 11	Mar 11
140	Wx-Blue Mountain	3				
1420	Wx-Diamond Hill	2				
1440	Wx-Elbert	2				
1460	Wx-Urban Farm	2				
2190	Wx-Squaw Mountain	2				
4010	Crescent	13				
4030	Red Garden	4				
4060	Lakeshore	13				
4080	Twin Sisters	5				
4090	Magnolia	65				
4530	Winiger Ridge	3				
4570	St. Antons	3				
4730	Wx-Sugarloaf	7				
4770	Wx-Cal Wood Ranch	2				
4830	SBC- San Souci	7				
4840	SBC – S. Boulder Ditch	3				
4860	Fairview Peak	8				

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\2010\11-2010\Novastar_extract_2010No

First Date in Database	11/1/10 12:00 AM	Total Days	30.0
Last Date in Database	11/30/10 11:59 PM	Total Hours	720.0

Total Records Analyzed 306400

Records by Group

Wind Gust	53412	17%
Temperature	51406	17%
Relative Humidity	50259	16%
Wind Speed Average & Azimuth	26544	9%
Barometric Pressure	23558	8%
Wind Direction	18845	6%
Wind Speed Average	18567	6%
Solar Radiation	8464	3%
Precipitation	7729	3%
Water Level PT-HSE	7516	2%
Battery Voltage HSE	5762	2%
Fuel Temperature	5274	2%
Fuel Moisture	5260	2%
Battery Voltage Analog	3547	1%
Battery Voltage Digital	3399	1%
Battery	2900	1%
Unknown IDs	2857	1%
Water Level Float	2799	1%
Soil Moisture	2394	1%
Repeater Status Report	2333	1%
Water Level PT	1744	1%
Wing Gust	711	0%
Repeater Pass List	592	0%
12Hr Status Report	345	0%
Battery Voltage	119	0%
Handar 585 ALARM Status	46	0%
Solar Power	17	0%
ALERT/A2 Testing	1	0%
Total	306400	

Records by Major Group

Meteorologic Sensors	251055	82%
Sensor Status Transmissions	16041	5%
Soil and Fuel Sensors	12928	4%
Water Level Sensors	12059	4%
Rain Sensors	7729	3%
Total	299812	

Traffic Loading Summary

Alert Reports	306400	
Average Daily Traffic	10213	
Average Hourly Traffic	426	
Median Hourly Traffic	431	hour beginning
Peak Hourly Traffic	852	11/7/10 1:00 AM
2nd Max	659	11/9/10 2:00 PM
3rd Max	630	11/9/10 3:00 PM
4th Max	620	11/23/10 8:00 PM
5th Max	582	11/16/10 4:00 PM

Rain Timer Performance

Boulder County and UDFCD Weather Stations

Analyze Rain Sensors

Rain Sensors	Description	Received	Average Timer Interval	Ave	Performance
4490	Apple Valley	38	14:50	60.00	63%
1460	Wx-Urban Farm	40	15:44	60.00	67%
4850	Porphory Mtn	40	17:58	60.00	67%
4010	Crescent	42	16:02	60.00	70%
140	Wx-Blue Mountain	44	15:29	60.00	73%
4790	Wx-Button Rock	44	13:28	60.00	73%
4090	Magnolia	44	14:02	60.00	73%
4470	Little Narrows	44	12:50	60.00	73%
1440	Wx-Elbert	45	16:00	60.00	75%
1520	Wx-Marston Lake North	45	16:04	60.00	75%
4330	Hansen Rain	45	13:08	60.00	75%
4510	Pinewood Springs	46	13:41	60.00	77%
4020	Rio Grande	47	15:12	60.00	78%
4100	Filter Plant	47	12:15	60.00	78%
4530	Winiger Ridge	48	15:26	60.00	80%
4080	Twin Sisters	48	14:36	60.00	80%
4570	St. Antons	48	14:22	60.00	80%
4860	Fairview Peak	48	14:19	60.00	80%
4110	Betasso	48	12:15	60.00	80%
4050	Walker Ranch	49	12:27	60.00	82%
4160	Sunshine	49	12:29	60.00	82%
4190	Slaughterhouse	49	12:46	60.00	82%
4340	Riverside	49	12:45	60.00	82%
4140	Logan Mill	49	13:34	60.00	82%
4360	Justice Center	49	12:29	60.00	82%
4250	Geer Canyon	49	12:13	60.00	82%
1570	Wx-Brighton Ditch	50	14:13	60.00	83%
4170	Pine Brook	50	14:22	60.00	83%
4220	Fling's	50	13:34	60.00	83%
4350	Conifer Hill	50	12:13	60.00	83%
2990	Wx-Tomah Rd-DougCnty	51	13:02	60.00	85%
4750	Wx-Louisville Lake	51	13:34	60.00	85%
4770	Wx-Cal-Wood Ranch	51	11:58	60.00	85%
4260	Taylor Mountain	51	13:54	60.00	85%
4240	Sunset	51	12:57	60.00	85%
4290	Red Hill	51	13:02	60.00	85%
4040	Martin Gulch	51	12:13	60.00	85%
4310	Johnny Park	51	12:12	60.00	85%
4200	Lazy Acres	52	12:27	60.00	87%
4270	Cannon Mountain	52	12:27	60.00	87%
4550	Boulder Jail	52	12:56	60.00	87%
4070	Bear Peak	52	12:42	60.00	87%
4130	Swiss Peaks	53	12:56	60.00	88%
4810	Shanahan Ridge	53	13:14	60.00	88%
4030	Red Garden	53	11:58	60.00	88%
4060	Lakeshore	53	13:28	60.00	88%
4180	Gold Lake	53	13:39	60.00	88%
4520	Eagle Ridge	53	12:14	60.00	88%
4840	SBC@S Boulder Ditch	54	12:57	60.00	90%
4300	Big Elk Park	54	11:41	60.00	90%
2750	Wx-Castle Rock	55	12:27	60.00	92%
4710	Wx-Ward C-1	55	11:37	60.00	92%
4730	Wx-Sugarloaf	55	12:54	60.00	92%
4230	Golden Age	55	11:56	60.00	92%

4150	Gold Hill	56	11:56	60.00	93%
4820	Doudy Draw	56	12:25	60.00	93%
900	Wx-Aurora Reservoir	57	12:25	60.00	95%
920	Wx-Aurora Town Hall	57	12:12	60.00	95%
1420	Wx-Diamond Hill	57	12:12	60.00	95%
2930	Wx-Spring Valley Rd-DougCnty	57	12:38	60.00	95%
2190	Wx-Squaw Mountain	58	12:11	60.00	97%
2210	Wx-Hiwan G.C.	58	12:11	60.00	97%
2730	Wx-Salisbury Park	58	12:12	60.00	97%
3020	Wx-West Creek WX	58	12:12	60.00	97%
4830	SBC @ San Souci	58	12:24	60.00	97%
750	Wx-Quincy Reservoir	60	11:56	60.00	100%
1920	Wx-Brighton	60	11:58	60.00	100%
2710	Wx-Highlands Ranch WTP	60	11:58	60.00	100%

Rain Event Performance													
		Reports Received	488	Analyze Rain Sensors					Boulder County and UDFCD Weather Stations				
Systemwide Avg		Total Tips	548										
89.05%		Data Loss	10.95%										
Rain ID	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcv	Exp	Miss	Hold	Bucket
4110	61%	8	1	1	0	1	0	0	11	18	7	1	0.0393701
4080	67%	1	1	0	0	0	0	0	2	3	1	0	0.0393701
4070	67%	4	1	1	0	0	0	0	6	9	3	0	0.0393701
4470	70%	6	0	0	1	0	0	0	7	10	3	0	0.0393701
4490	71%	4	0	1	0	0	0	0	5	7	2	0	0.0393701
4510	75%	4	2	0	0	0	0	0	6	8	2	0	0.0393701
4330	75%	6	3	0	0	0	0	0	9	12	3	0	0.0393701
4310	75%	8	0	0	1	0	0	0	9	12	3	0	0.0393701
4260	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701
4030	75%	5	0	1	0	0	0	0	6	8	2	0	0.0393701
4270	78%	6	0	1	0	0	0	0	7	9	2	0	0.0393701
4190	79%	8	3	0	0	0	0	0	11	14	3	0	0.0393701
4810	80%	9	3	0	0	0	0	0	12	15	3	0	0.0393701
4570	80%	3	1	0	0	0	0	0	4	5	1	0	0.0393701
4290	80%	11	0	0	1	0	0	0	12	15	3	0	0.0393701
4170	80%	3	1	0	0	0	0	0	4	5	1	0	0.0393701
4100	80%	3	1	0	0	0	0	0	4	5	1	0	0.0393701
4090	83%	4	1	0	0	0	0	0	5	6	1	0	0.0393701
1570	83%	4	1	0	0	0	0	0	5	6	1	0	0.0393701
4820	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701
4530	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701
4340	86%	10	2	0	0	0	0	0	12	14	2	0	0.0393701
4160	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701
4520	89%	7	1	0	0	0	0	0	8	9	1	0	0.0393701
4750	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701
1460	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701
4710	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701
4360	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701
4350	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701
4200	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701
2990	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393701
1420	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
4040	93%	13	1	0	0	0	0	0	14	15	1	1	0.0393701
4250	94%	14	1	0	0	0	0	0	15	16	1	0	0.0393701
1520	94%	16	1	0	0	0	0	0	17	18	1	0	0.0393701
4840	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
4830	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
4790	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4770	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
4730	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4550	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4300	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
4240	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4230	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4220	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
4180	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
4150	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
4140	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
4130	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4060	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4050	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4020	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4010	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
140	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
750	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
900	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393699
920	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
1440	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
1920	100%	17	0	0	0	0	0	0	17	17	0	0	0.0393701
2190	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
2210	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
2710	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
2730	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
2750	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
2930	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
3020	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
	Total Tips	442	37	5	3	1	0	0	488	548	60	2	
4850	100%	5	0	0	0	0	0	0	5	5	0	0	0.01
4860	86%	5	1	0	0	0	0	0	6	7	1	0	0.01

Monthly Traffic Loading

2010 Monthly ALERT Radio Traffic Summary

