Memo

Water & Earth Technologies, Inc.
Water Resources and Environmental Consulting

Date: June 8, 2006

To: Kevin Stewart, Chad Kudym

From: Markus Ritsch

Subject: **May 2006 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) are analyzed for the period May 1 through May 31, 2006.

II. General System Analysis Summary

A total of 189,737 individual data records were analyzed. Meteorological sensors account for seventy-one (71) percent, water level sensors thirteen (13) percent, and rain sensors seven (7) percent of the total transmissions.

Ninety-nine (99) percent of the received data reports were flagged as "good" by the Nova Star validation process. Roughly two thousand (2,093) reports were flagged as "bad". Of these "bad" reports, approximately half (1,175) originated from the Wind Gust sensor (ID 2189) at Squaw Mountain. Another sixty (60) "bad" reports originated from the Wind Speed Average sensor (ID 2187) at Squaw Mountain. The reception of "bad" data reports from the Squaw Mountain sensor ID's 2189 and 2187 has been a consistent theme for the past five months.

The system-wide radio traffic loading was approximately six thousand one hundred (6,120) reports per day with an average hourly load of two hundred and fifty-five (255) reports. The peak hourly traffic loading was six hundred and fifty (650) reports and occurred on May 22nd between nine and ten in the evening. A plot of monthly average and peak hourly traffic loading is provided.

The sensors reporting most frequently this month include:

1. Boulder Creek at Broadway (ID 4583 this is a water level sensor that reported 4,721 times in the month or one report every ten minutes)
2. Salisbury Park (ID 2727) with 3,227 reports,
3. Urban Farm (IDs 1466, 1465, 1464, 1467) with 10,504 reports, and
4. Castle Rock (ID 2744) with 2,550.

The reports from the above sensors occurred over the entire month and are more-or-less distributed evenly.

III. Rain Sensors Reporting This Month

Approximately one hundred and fifty two (152) rain sensors reported during the month. Several rain sensor IDs had non-incrementing timer reports but had no incrementing rain tip reports during the month (Table 1).

Table 1. Rain Sensors with No Tip Reports

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	1020*							
-----	-----	-----	-----	1610*							
-----	-----	-----	-----	2220*							
-----	-----	-----	-----	4560*							
-----	-----	-----	-----	-----							

* Lena at Nolte Pond (1020), Holly Dam (1610), Evergreen Lake (2220), Lyons Diversion NSV (4560) – These stations do not have an installed rain sensor although they report the rain ID.

IV.Rain Sensor Timer Reporting Summary

The following summary assumes that all rain sensors have a 12-hour timer reporting interval. System-wide the base station received eighty-three (83) percent of the non-incrementing timer reports. The following table summarizes those rain sensors with the worst timer reporting performance (Table 2).

Table 2. Monthly Summary of Sensors with Poor Timer Performance

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1010	1460	1460	2340	1460							
1460	1660	4820	1460	1330							
1640	4240	4570	1330	540							
--	--	--	1610	1600							
			1600	4820							

* Stapleton "Urban Farm" (1460), Roslyn (1330), Parker/Mississippi (540), Englewood Dam (1600), Doudy Draw (4820)

Sensors that are identified as having poor timer performance in multiple months are shaded with unique colors. A developing trend can be identified from the color shading as the year progresses. For example, the sensor 1460 (Stapleton) consistently has a poor timer performance value when its timer reporting is assumed to be on a 12-hour interval. If sensor 1460 has a 24-hour timer reporting interval, its timer performance is actually very good. A further inspection of the count series for sensor 1460 is made (Table 3).

The data series for sensor 1460 clearly shows that the timer reporting interval is twenty-four (24) hours, not twelve (12) hours as originally assumed. The timer reports are received at 11:57:20 pm each day.

The individual records for the other sensors shown in Table 2 were also inspected to confirm their timer reporting interval, which was found to be twelve (12) hours.

Table 3. Stapleton Rain (1460) Monthly Data Series

Date/Time	Sensor ID	Count
5/1/2006 11:57:22 PM	1460	63
5/2/2006 11:57:21 PM	1460	63
5/3/2006 11:57:19 PM	1460	63
5/4/2006 11:48:39 AM	1460	64
5/4/2006 11:57:18 PM	1460	64
5/5/2006 11:57:16 PM	1460	64
5/6/2006 11:57:14 PM	1460	64
5/7/2006 11:57:13 PM	1460	64
5/8/2006 11:57:10 PM	1460	64
5/9/2006 11:34:30 PM	1460	67
5/9/2006 11:57:09 PM	1460	67
5/10/2006 6:45:58 AM	1460	69
5/10/2006 11:57:07 PM	1460	69
5/11/2006 11:57:06 PM	1460	69
5/12/2006 11:57:04 PM	1460	69
5/13/2006 11:57:02 PM	1460	69
5/14/2006 11:57:03 PM	1460	69
5/15/2006 11:56:58 PM	1460	69
5/16/2006 11:56:56 PM	1460	69
5/17/2006 11:56:54 PM	1460	69
5/18/2006 11:56:53 PM	1460	69
5/19/2006 11:56:50 PM	1460	69
5/20/2006 11:56:48 PM	1460	69
5/21/2006 11:56:46 PM	1460	69
5/22/2006 9:35:12 PM	1460	70

Date/Time	Sensor ID	Count
5/22/2006 10:08:52 PM	1460	71
5/22/2006 10:42:33 PM	1460	72
5/22/2006 11:56:44 PM	1460	72
5/23/2006 11:56:42 PM	1460	72
5/24/2006 11:56:40 PM	1460	72
5/25/2006 11:56:38 PM	1460	72
5/26/2006 11:56:36 PM	1460	72
5/29/2006 11:19:12 PM	1460	73
5/29/2006 11:56:30 PM	1460	73
5/30/2006 3:34:39 AM	1460	74
5/30/2006 2:04:11 PM	1460	75
5/31/2006 11:56:24 PM	1460	75

V. Rain Sensor Event Reporting Summary

A. District-Wide Total Tip/Count Statistics

The incrementing reports from one hundred and forty-seven (147) individual 1-mm rain sensors were analyzed to quantify the District-wide statistical total monthly tip summary (Table 4).

Table 4. March District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	19.44	Only the 1-mm rain sensors were included in the analysis
Median	16	Only the 1-mm rain sensors were included in the analysis
Standard deviation	12.00	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	55.44	Several sensors for the month are outside the Mean +/- 3 Std Dev
Minimum total count	3	Multiple stations (ID 1660 and 1900)
Maximum total count	81	Powers Park (ID 1500)

A monthly summary of the District-wide mean total tip/count is presented (Table 5).

Table 5. Monthly Summary of District-Wide Total 1-mm Tip/Count

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.62	5.92	18.39	20.47	19.44							

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

The following rain sensors experienced a jump in their sequential tip count of more than six (6). The data records for these sensors were visually inspected to determine the cause of the large jump.

1. Powers Park, ID 1500
2. Fire Station #12, ID 840

A summary of the visual inspection of the data records for each sensor follows.

1. Powers Park (1500)

On May 9, between 6:02 pm and midnight the count value jumped from sixty-nine (69) to seventy-six (76). This jump of seven (7) raw counts was validated by NovaStar. The monthly count series for this sensor looks reasonable and the total monthly accumulation of eighty-one (81) counts is accurate.

2. Fire Station #12 (840)

On May 17, at 11:14 am the count value jumped from thirty-eight (38) to two thousand forty-seven (2047). This invalid jump appears to be the result of field work performed at the station. The field service records should be reviewed to confirm this assumption. The total monthly accumulation of rain was eleven (11) counts.

C. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing rain tip reports for the month was eighty-six (86) percent. A total of 2,443 incrementing reports were received and a total of 2,858 were expected. The total loss of incrementing reports was approximately fourteen (14.52) percent. Those sensors with the worst rain 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
640	4010	4530	2190	540							
1640	4080	4170	310	1400							
4490	4170	4820	4820	1100							
-----	-----	-----	-----	4820							
-----	-----	-----	-----	1420							

* Parker/Mississippi (540), Upper Sloan Detention (1400), Louisville Rec Ctr (1100), Doudy Draw (4820), Diamond Hill (1420)

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.

The sensors with poor rain tip performance in May all seemed to experience a large jump in sequential count at almost exactly the same time. Between May 9th and May 10th, each sensor had a significant jump in count (Table 7).

Table 7. Jump in Count Values, May 9 - May 10, 2006

Description	ID	Date/Time	Count	Date/Time	Count	Delta Count
Parker/Mississippi	540	5/9/06 7:54:10 AM	37	5/10/06 7:47:51 PM	42	5
Upper Sloan Det	1400	5/9/06 9:34:18 AM	43	5/10/06 12:24:26 AM	49	6
Louisville Rec Ctr	1100	5/9/06 10:15:00 AM	36	5/10/06 7:14:41 AM	41	5
Doudy Draw	4820	5/9/06 12:32:46 PM	25	5/10/06 7:44:12 AM	31	6
Diamond Hill	1420	5/9/06 11:31:52 AM	28	5/10/06 12:12:59 AM	34	6

VI. Issues Continued from Previous Month

The following issues were identified last month.

1. Doudy Draw (4820) exhibits both poor timer and event transmission performance. Continue to observe data from this sensor.

VII. Issues Identified this Month

Further investigation into the following issues is recommended:

1. The PT at Boulder Creek at Broadway (ID 4583) reported 4,721 times this month or one report every ten minutes.
2. The timer reporting interval for Stapleton sensor 1460 (rain) is twenty-four (24) hours, **not** twelve (12) hours as expected. The timer reports are received each day at approximately 11:57:20 pm.
3. The timer reporting interval for Stapleton sensor 1464 (solar radiation) is fifteen (15) minutes, **not** twelve (12) hours as expected.
4. The timer reporting interval for Stapleton sensors 1466, 1465, and 1467, (wind direction, speed, peak) is fifteen (15) minutes, **not** one (1) hour as expected.
5. The ALERT2 base station was completely down and collecting zero data on May 9th from 9:35 PM through 11:28 PM. The observed behavior is most likely the result of an outage in data reception at the base station. There were general rains the evening of May 9th and significant gaps in incrementing tip reports resulted from this outage in data collection. The monthly tip reporting statistics are also negatively influenced.
6. The stations Roslyn (1330), Englewood Dam (1600), and Doudy Draw (4820) have shown poor timer performance statistics for multiple months. These stations may have poor radio paths or deteriorating radios.
7. The records for the following sensors should be reviewed in both the District's maintenance records and the long-term archival database. The rainfall accumulations for these sensors may be incorrect for periods during the month of May due to large jumps in the sequential raw count.
    a. Powers Park, ID 1500
    b. Fire Station #12, ID 840

Database Name P:\A207-UDFCD-Data-Analysis\data_extracts\Novastar_extract_200605.mdb

First Date in Database	5/1/06 12:00 AM	**Total Days**	31.0
Last Date in Database	5/31/06 11:59 PM	**Total Hours**	744.0

Total Records Analyzed 189737

Records by Group

Wind Gust	33036	17%
Relative Humidity	26388	14%
Temperature	25948	14%
Wind Speed Average & Azimuth	17226	9%
Water Level PT-HSE	17087	9%
Wind Direction	15955	8%
Precipitation	12434	7%
Wind Speed Average	10368	5%
Battery Voltage Digital	6545	3%
Battery Voltage HSE	5421	3%
Water Level PT	5177	3%
Solar Radiation	3991	2%
Barometric Pressure	2417	1%
Water Level Float	2186	1%
Fuel Temperature	1357	1%
Fuel Moisture	1354	1%
Repeater Pass List	961	1%
Handar 585 ALARM Status	848	0%
Battery Voltage Analog	567	0%
12Hr Status Report	212	0%
Longmont Flow Gage	133	0%
Soil Moisture	67	0%
Longmont Water Level PT	49	0%
Repeater ON Count	3	0%
Precipitation-ASCII	2	0%
Solar Power	2	0%
Repeater Battery Check	1	0%
Repeater Status Report	1	0%
Snow (water equiv.)	1	0%
Total	189737	

Records by Major Group

Meteorologic Sensors	135329	71%
Water Level Sensors	24632	13%
Sensor Status Transmissions	14561	8%
Rain Sensors	12436	7%
Soil, Fuel and Snow Sensors	2779	1%
Total	189737	

Records by Validation Type

Good	0	187644	99%
Questionable	1	2093	1%
	Total	189737	

Sensors With Most Invalid Data

Description	Sensor	Reports
Squaw Mountain	2189	1175
Quincy Reservoir	753	116
Squaw Mountain	2187	60
Louisville Lake	4744	34
Salisbury Park	2727	31

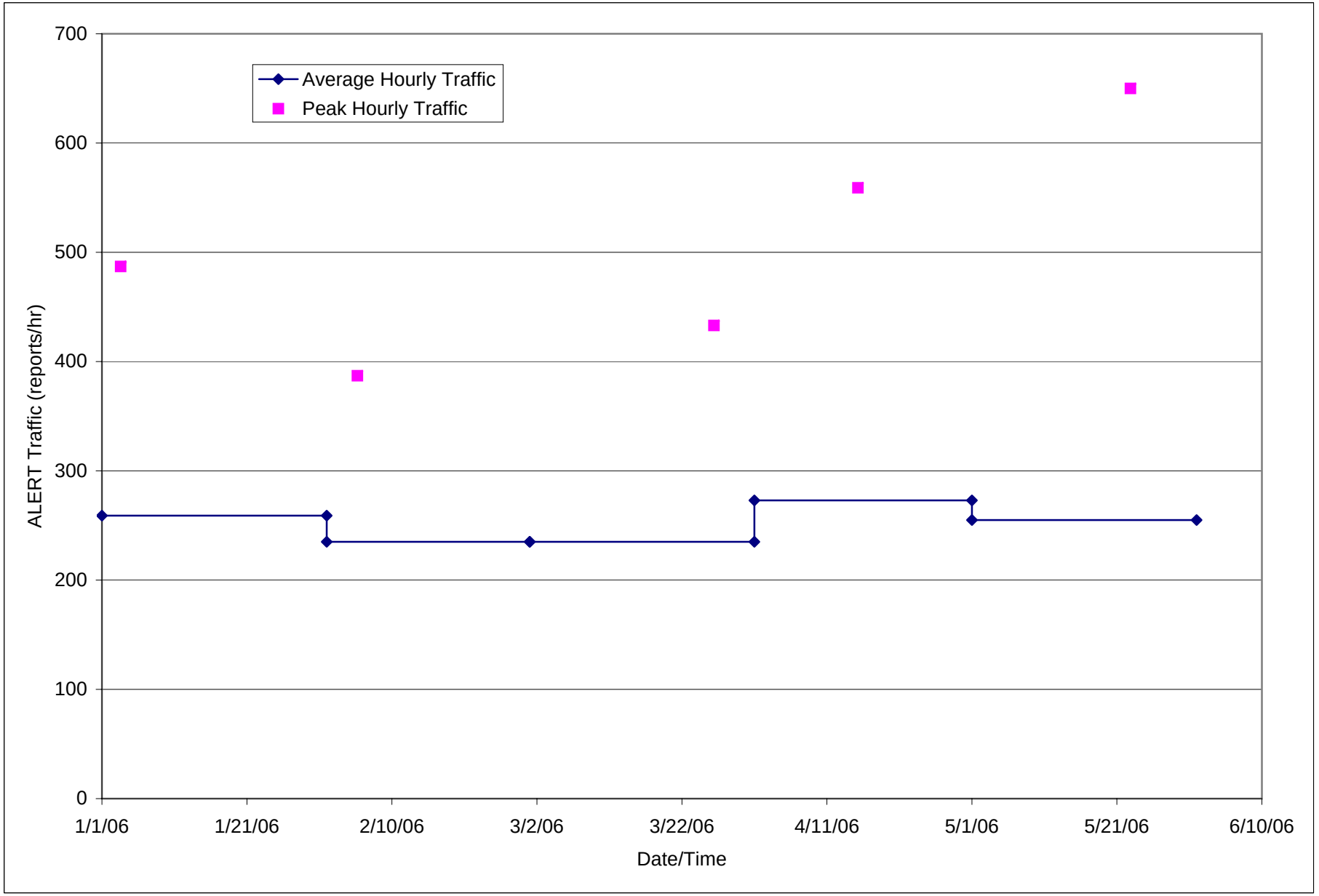
Traffic Loading Summary

Alert Reports	189737	
Average Daily Traffic	6120	
Average Hourly Traffic	255	
Median Hourly Traffic	265	hour beginning
Peak Hourly Traffic	650	5/22/06 9:00 PM

Total Number of Sensors Defined	Total Number of Sensors Reporting
783	519

Reports per Sensor (Highest)

Description	Sensor	Reports	Fraction of Total
Boulder Creek @ Broadway	4583	4721	2%
Salisbury Park	2727	3227	2%
Urban Farm	1466	2671	1%
Urban Farm	1465	2642	1%
Urban Farm	1464	2597	1%
Urban Farm	1467	2594	1%
Castle Rock	2744	2550	1%
Marston Lake North	1526	2522	1%
Salisbury Park	2724	2460	1%
Blue Mountain	138	2431	1%


Average Hourly Traffic
Peak Hourly Traffic
ALERT Traffic (reports/hr)
700
600
500
400
300
200
100
0
1/1/06
1/21/06
2/10/06
3/2/06
3/22/06
4/11/06
5/1/06
5/21/06
6/10/06
Date/Time

Rain Timer Performance

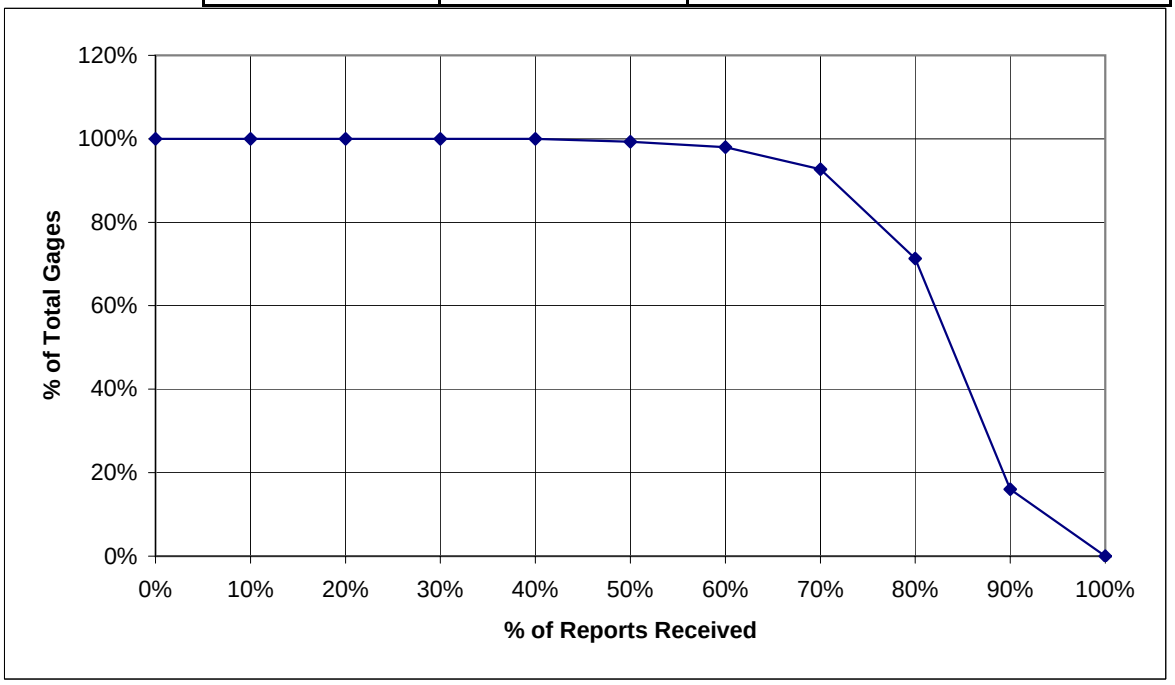
Analyze Rain Sensors

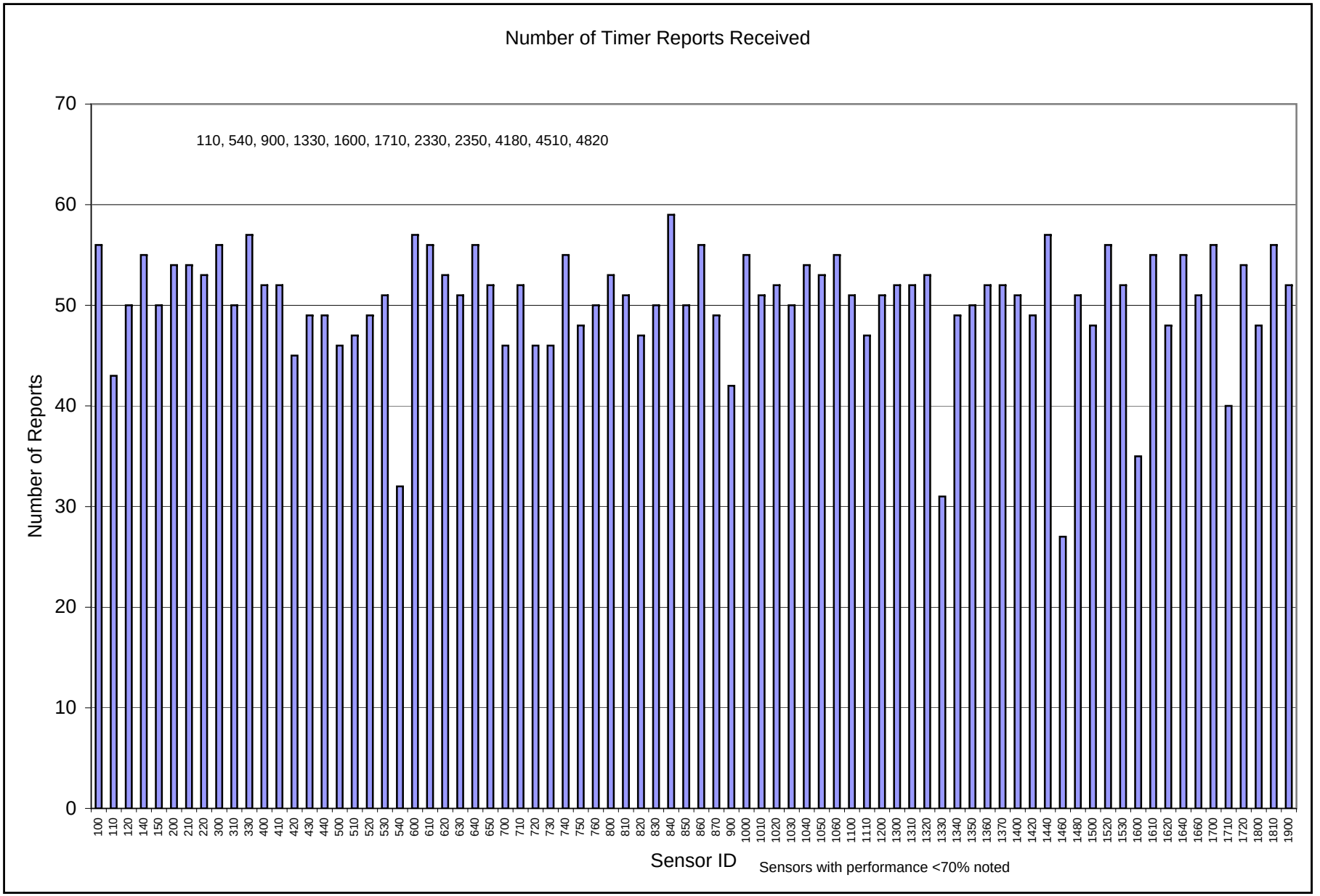
			systemwide average (days) 0.5623		Systemwide Average 82%
Rain Sensors	**Description**	**Number of Received Timer Reports**	**Average Timer Interval**	**Number of expected Timer Reports**	**Performance**
100	Carr Street	56	12:55	62.00	90%
110	Ralston Reservoir	43	15:39	62.00	69%
120	West Woods	50	14:05	62.00	81%
140	Blue Mountain	55	12:45	62.00	89%
150	Nott Creek	50	14:02	62.00	81%
200	Leyden Reservoir	54	13:40	62.00	87%
210	Leyden Confluence	54	13:40	62.00	87%
220	Upper Leyden	53	13:15	62.00	85%
300	Van Bibber Park	56	12:54	62.00	90%
310	Guy Hill Ranch	50	14:14	62.00	81%
330	Van Bibber @ Hwy 93	57	12:56	62.00	92%
400	Montview Park	52	13:44	62.00	84%
410	Kelly Dam	52	13:36	62.00	84%
420	Expo Park	45	12:33	62.00	73%
430	Utah Park	49	11:58	62.00	79%
440	Fire Station #7	49	13:40	62.00	79%
500	Havana Park	46	13:50	62.00	74%
510	Virginia Court	47	12:20	62.00	76%
520	Jewell Detention	49	13:23	62.00	79%
530	Fire Station #19	51	13:01	62.00	82%
540	Parker/Mississippi	32	20:30	62.00	52%
600	Harvard Gulch Park	57	12:26	62.00	92%
610	Harvard @ Jackson	56	12:25	62.00	90%
620	Quincy/Highline	53	13:25	62.00	85%
630	Temple Pond at DTC	51	12:20	62.00	82%
640	Goldsmith @ Eastman	56	12:18	62.00	90%
650	Iliff Pond	52	12:44	62.00	84%
700	Toll Gate @ 6th	46	13:56	62.00	74%
710	Horseshoe Park Drop	52	12:44	62.00	84%
720	Confluence Pond	46	14:25	62.00	74%
730	No Name @ Quincy	46	14:18	62.00	74%
740	Smoky Hill	55	12:28	62.00	89%
750	Quincy Reservoir	48	12:32	62.00	77%
760	Mission Viejo Park	50	13:25	62.00	81%
800	Sable Ditch @ 18th	53	13:25	62.00	85%
810	Granby Ditch @ 6th	51	13:07	62.00	82%
820	ETG @ Buckley	47	13:25	62.00	76%
830	Side Creek Park	50	13:12	62.00	81%
840	Fire Station 12	59	11:46	62.00	95%
850	Flying J	50	12:32	62.00	81%
860	Sand Cr at Colfax	56	10:28	62.00	90%
870	Murphy Creek GC	49	12:51	62.00	79%
900	Aurora Reservoir	42	14:24	62.00	68%
1000	Maple Grove Resv.	55	13:24	62.00	89%
1010	Denver West	51	14:08	62.00	82%
1020	Lena @ Nolte Pond	52	14:06	62.00	84%
1030	NREL/S. Table Mtn.	50	14:11	62.00	81%
1040	Lena @ U.S. Hwy 6	54	13:15	62.00	87%
1050	Jeffco Fairgrounds	53	13:15	62.00	85%
1060	Heritage Square	55	13:14	62.00	89%
1100	Louisville Rec Ctr	51	13:44	62.00	82%
1110	Gunbarrel	47	14:42	62.00	76%
1200	Broomfield 3207	51	14:18	62.00	82%
1300	Hidden Lake	52	14:00	62.00	84%
1310	LDC at 64th	52	13:57	62.00	84%
1320	SPR at 3rd Ave	53	13:40	62.00	85%
1330	Roslyn	31	14:46	62.00	50%
1340	Sanderson at Xavier	49	14:51	62.00	79%
1350	Chatfield COE	50	13:08	62.00	81%
1360	Denver Zoo	52	14:08	62.00	84%
1370	West Metro FS13	52	13:54	62.00	84%
1400	Upper Sloan Det.	51	14:27	62.00	82%
1420	Diamond Hill	49	14:10	62.00	79%
1440	Elbert	57	12:54	62.00	92%
1460	Urban Farm	27	23:59	31.00	87%
1480	Third Creek at DIA	51	13:30	62.00	82%
1500	Powers Park	48	12:24	62.00	77%
1520	Marston Lake North	56	12:44	62.00	90%
1530	Bear Creek @ Lowell	52	14:04	62.00	84%
1600	Englewood Dam	35	16:59	62.00	56%
1610	Holly Dam	55	13:17	62.00	89%
1620	Slaughterhouse Glch	48	13:43	62.00	77%
1640	SPR at Union Ave.	55	13:01	62.00	89%
1660	SPR at Henderson	51	14:00	62.00	82%
1700	Cherry Cr @ Champa	56	12:55	62.00	90%

Rain Sensors	Description	Number of Received Timer Reports	Average Timer Interval	Number of expected Timer Reports	Performance
1710	Shop Creek	40	17:08	62.00	65%
1720	Cherry Cr @ Steele	54	12:46	62.00	87%
1800	Sand Creek Park	48	14:11	62.00	77%
1810	Sand Creek at mouth	56	12:56	62.00	90%
1900	Niver Detention	52	13:27	62.00	84%
1920	Brighton	57	12:27	62.00	92%
2190	Squaw Mountain	48	14:46	62.00	77%
2210	Hiwan G.C.	50	14:31	62.00	81%
2220	Evergreen Lake	54	13:19	62.00	87%
2230	Bear Cr below Cub	52	12:51	62.00	84%
2240	Cold Sprg Glch conf	52	13:54	62.00	84%
2250	Rosedale	49	13:48	62.00	79%
2260	Brook Forest	51	12:50	62.00	82%
2270	Cub Cr below Blue	47	15:00	62.00	76%
2280	Kinney Peak	52	13:42	62.00	84%
2310	Genesee Village	48	13:12	62.00	77%
2330	Morrison	39	16:04	62.00	63%
2340	El Rancho	44	15:31	62.00	71%
2350	Idledale	41	13:49	62.00	66%
2360	Indian Hills	58	12:30	62.00	94%
2370	Red Rocks Park	52	13:54	62.00	84%
2710	Highlands Ranch WTP	55	12:29	62.00	89%
2730	Salisbury Park	50	13:20	62.00	81%
2750	Castle Rock	59	12:13	62.00	95%
2810	Pine Cliff Road	52	12:59	62.00	84%
2820	Haskins Gulch Conf	54	12:29	62.00	87%
2840	Sulphur Gulch	53	13:02	62.00	85%
4010	Cresent	50	14:48	62.00	81%
4020	Rio Grande	56	12:30	62.00	90%
4030	Red Garden	54	13:03	62.00	87%
4040	Martin Gulch	51	14:03	62.00	82%
4050	Walker Ranch	56	12:27	62.00	90%
4060	Lakeshore	48	13:51	62.00	77%
4070	Bear Peak	57	12:28	62.00	92%
4080	Twin Sisters	53	13:54	62.00	85%
4090	Magnolia	50	14:52	62.00	81%
4100	Filter Plant	57	12:44	62.00	92%
4110	Betasso	55	13:03	62.00	89%
4130	Swiss Peaks	51	13:29	62.00	82%
4140	Logan Mill	54	12:48	62.00	87%
4150	Gold Hill	51	14:25	62.00	82%
4160	Sunshine	50	13:45	62.00	81%
4170	Pine Brook	50	14:10	62.00	81%
4180	Gold Lake	40	17:31	62.00	65%
4190	Slaughterhouse	55	13:04	62.00	89%
4200	Lazy Acres	53	13:06	62.00	85%
4220	Fling's	51	12:51	62.00	82%
4230	Golden Age	55	13:49	62.00	89%
4240	Sunset	46	13:32	62.00	74%
4250	Geer Canyon	56	13:03	62.00	90%
4260	Taylor Mountain	56	12:19	62.00	90%
4270	Cannon Mountain	54	13:33	62.00	87%
4290	Red Hill	45	17:02	62.00	73%
4300	Big Elk Park	59	12:26	62.00	95%
4310	Johnny Park	55	13:29	62.00	89%
4330	Indian Ruins	51	13:45	62.00	82%
4340	Riverside	53	13:27	62.00	85%
4350	Conifer Hill	50	13:30	62.00	81%
4360	Justice Center	57	12:16	62.00	92%
4470	Little Narrows	49	13:15	62.00	79%
4490	Apple Valley	50	13:23	62.00	81%
4510	Pinewood Springs	42	15:20	62.00	68%
4520	Eagle Ridge	55	12:29	62.00	89%
4530	Winiger Ridge	50	14:25	62.00	81%
4560	Lyons Diversion NSV	45	16:21	62.00	73%
4570	St. Antons	50	14:12	62.00	81%
4710	Ward C-1	52	14:02	62.00	84%
4730	Sugarloaf	48	13:50	62.00	77%
4750	Louisville Lake	50	14:20	62.00	81%
4770	Cal-Wood Ranch	57	12:46	62.00	92%
4790	Button Rock	54	13:25	62.00	87%
4810	Shanahan Ridge	47	14:39	62.00	76%
4820	Doudy Draw	38	18:08	62.00	61%
4830	SBC @ San Souci	47	14:00	62.00	76%
4840	SBC@S Boulder Ditch	47	15:23	62.00	76%

Rain Timer Performance

	total number of gages 150	
% of reports received	frequency	% of gages receiving % or reports or greater
0%	0	100%
10%	0	100%
20%	0	100%
30%	0	100%
40%	0	100%
50%	1	99%
60%	2	98%
70%	8	93%
80%	32	71%
90%	83	16%
100%	24	0%



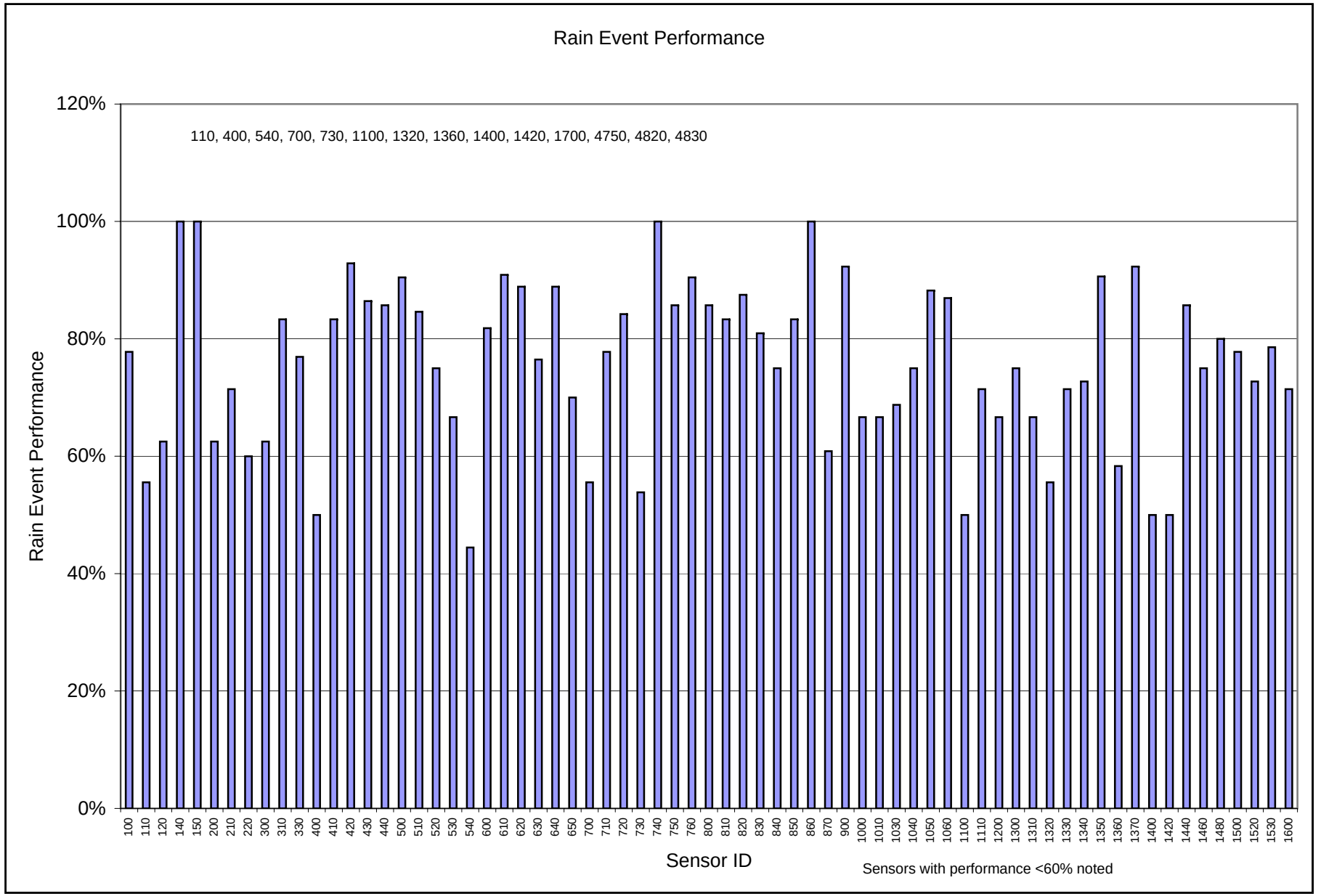

Number of Timer Reports Received
110, 540, 900, 1330, 1600, 1710, 2330, 2350, 4180, 4510, 4820
Number of Reports
0
10
20
30
40
50
60
70
100 110 120 140 150 200 210 220 300 310 330 400 410 420 430 440 500 510 520 530 540 600 610 620 630 640 650 700 710 720 730 740 750 760 800 810 820 830 840 850 860 870 900 1000 1010 1020 1030 1040 1050 1060 1100 1110 1200 1300 1310 1320 1330 1340 1350 1360 1370 1400 1420 1440 1460 1480 1500 1520 1530 1600 1610 1620 1640 1660 1700 1710 1720 1800 1810 1900
Sensor ID
Sensors with performance <70% noted

Rain Event Performance Analysis

Rain Sensor	Total Performance	Number of 1-tips	Number of 2-tips	Number of 3-tips	Number of 4-tips	Number of 5-tips	Number of 6-tips	Number of >6-tips	Number of actual tips	Number of expected tips	Number of missed tips	Number of hold-off transmissions	Bucket size from Sensordef
100	78%	6	0	1	0	0	0	0	7	9	2	0	0.0393701
110	56%	4	0	0	0	1	0	0	5	9	4	0	0.0393701
120	63%	4	0	0	1	0	0	0	5	8	3	0	0.0393701
140	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
150	100%	18	0	0	0	0	0	0	18	18	0	0	0.0393701
200	63%	4	0	0	1	0	0	0	5	8	3	0	0.0393701
210	71%	4	0	1	0	0	0	0	5	7	2	0	0.0393701
220	60%	5	0	0	0	1	0	0	6	10	4	0	0.0393701
300	63%	4	0	0	1	0	0	0	5	8	3	0	0.0393701
310	83%	9	0	1	0	0	0	0	10	12	2	0	0.0393701
330	77%	9	0	0	1	0	0	0	10	13	3	2	0.0393701
400	50%	2	1	0	1	0	0	0	4	8	4	0	0.0393701
410	83%	9	0	1	0	0	0	0	10	12	2	0	0.0393701
420	93%	49	2	1	0	0	0	0	52	56	4	0	0.0393701
430	86%	46	3	1	1	0	0	0	51	59	8	0	0.0393701
440	86%	10	2	0	0	0	0	0	12	14	2	0	0.0393701
500	90%	18	0	1	0	0	0	0	19	21	2	0	0.0393701
510	85%	21	0	0	0	1	0	0	22	26	4	0	0.0393701
520	75%	8	0	0	1	0	0	0	9	12	3	0	0.0393701
530	67%	6	1	0	1	0	0	0	8	12	4	0	0.0393701
540	44%	2	1	0	0	1	0	0	4	9	5	0	0.0393701
600	82%	8	0	1	0	0	0	0	9	11	2	0	0.0393701
610	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701
620	89%	15	0	1	0	0	0	0	16	18	2	0	0.0393701
630	76%	23	1	1	0	0	1	0	26	34	8	0	0.0393701
640	89%	22	1	1	0	0	0	0	24	27	3	0	0.0393701
650	70%	5	1	1	0	0	0	0	7	10	3	0	0.0393701
700	56%	3	0	2	0	0	0	0	5	9	4	0	0.0393701
710	78%	6	0	1	0	0	0	0	7	9	2	0	0.0393701
720	84%	14	1	1	0	0	0	0	16	19	3	0	0.0393701
730	54%	5	0	1	0	1	0	0	7	13	6	0	0.0393701
740	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
750	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701
760	90%	18	0	1	0	0	0	0	19	21	2	0	0.0393701
800	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701
810	83%	13	1	1	0	0	0	0	15	18	3	0	0.0393701
820	88%	6	1	0	0	0	0	0	7	8	1	0	0.0393701
830	81%	29	4	0	0	1	0	0	34	42	8	0	0.0393701
840	75%	7	1	1	0	0	0	1	9	12	3	0	0.0393701
850	83%	4	1	0	0	0	0	0	5	6	1	0	0.0393701
860	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
870	61%	10	2	1	0	0	1	0	14	23	9	0	0.0393701
900	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393699
1000	67%	6	1	0	1	0	0	0	8	12	4	0	0.0393701
1010	67%	9	0	0	0	0	1	0	10	15	5	0	0.0393701
1030	69%	10	0	0	0	0	1	0	11	16	5	0	0.0393701
1040	75%	14	0	0	0	0	1	0	15	20	5	0	0.0393701
1050	88%	14	0	1	0	0	0	0	15	17	2	0	0.0393701
1060	87%	19	0	0	1	0	0	0	20	23	3	0	0.0393701
1100	50%	3	0	0	0	1	0	0	4	8	4	0	0.0393701
1110	71%	9	0	0	0	1	0	0	10	14	4	0	0.0393701
1200	67%	3	0	1	0	0	0	0	4	6	2	0	0.0393701
1300	75%	5	0	1	0	0	0	0	6	8	2	0	0.0393701
1310	67%	3	0	1	0	0	0	0	4	6	2	0	0.0393701
1320	56%	4	0	0	0	1	0	0	5	9	4	0	0.0393701
1330	71%	4	0	1	0	0	0	0	5	7	2	0	0.0393701
1340	73%	7	0	0	1	0	0	0	8	11	3	0	0.0393701
1350	91%	27	1	1	0	0	0	0	29	32	3	0	0.0393701
1360	58%	5	1	0	0	1	0	0	7	12	5	0	0.0393701
1370	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393701
1400	50%	4	0	0	0	0	1	0	5	10	5	0	0.0393701
1420	50%	4	0	0	0	0	1	0	5	10	5	0	0.0393701
1440	86%	10	2	0	0	0	0	0	12	14	2	0	0.0393701
1460	75%	7	1	1	0	0	0	0	9	12	3	0	0.0393701
1480	80%	3	1	0	0	0	0	0	4	5	1	0	0.0393701
1500	78%	57	4	0	1	1	0	1	63	81	18	0	0.0393701
1520	73%	7	0	0	1	0	0	0	8	11	3	0	0.0393701
1530	79%	10	0	0	1	0	0	0	11	14	3	0	0.0393701
1600	71%	3	2	0	0	0	0	0	5	7	2	0	0.0393701
1620	77%	9	0	0	1	0	0	0	10	13	3	0	0.0393701
1640	83%	9	0	1	0	0	0	0	10	12	2	0	0.0393701
1660	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
1700	57%	3	0	0	1	0	0	0	4	7	3	0	0.0393701

Rain Event Performance Analysis

Rain Sensor	Total Performance	Number of 1-tips	Number of 2-tips	Number of 3-tips	Number of 4-tips	Number of 5-tips	Number of 6-tips	Number of >6-tips	Number of actual tips	Number of expected tips	Number of missed tips	Number of hold-off transmissions	Bucket size from Sensordef
1710	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
1720	67%	7	0	0	0	1	0	0	8	12	4	0	0.0393701
1800	67%	3	3	0	0	0	0	0	6	9	3	0	0.0393701
1810	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701
1900	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
1920	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701
2190	94%	27	2	0	0	0	0	0	29	31	2	0	0.0393701
2210	90%	18	0	1	0	0	0	0	19	21	2	0	0.0393701
2230	95%	19	1	0	0	0	0	0	20	21	1	0	0.0393701
2240	88%	21	0	0	1	0	0	0	22	25	3	0	0.0393701
2250	88%	19	1	1	0	0	0	0	21	24	3	0	0.0393701
2260	90%	25	1	1	0	0	0	0	27	30	3	0	0.0393701
2270	84%	28	2	2	0	0	0	0	32	38	6	0	0.0393701
2280	78%	26	1	0	1	1	0	0	29	37	8	0	0.0393701
2310	77%	17	2	0	0	1	0	0	20	26	6	0	0.0393701
2320	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
2330	73%	9	0	2	0	0	0	0	11	15	4	0	0.0393701
2340	73%	9	1	0	1	0	0	0	11	15	4	0	0.0393701
2350	89%	15	2	0	0	0	0	0	17	19	2	0	0.0393701
2360	95%	19	1	0	0	0	0	0	20	21	1	0	0.0393701
2370	82%	14	4	0	0	0	0	0	18	22	4	0	0.0393701
2710	78%	6	0	1	0	0	0	0	7	9	2	0	0.0393701
2730	86%	16	3	0	0	0	0	0	19	22	3	0	0.0393701
2750	75%	5	0	1	0	0	0	0	6	8	2	0	0.0393701
2810	60%	4	1	0	1	0	0	0	6	10	4	0	0.0393701
2820	60%	3	2	1	0	0	0	0	6	10	4	0	0.0393701
2840	90%	25	1	1	0	0	0	0	27	30	3	0	0.0393701
4010	96%	24	1	0	0	0	0	0	25	26	1	0	0.0393701
4020	96%	25	1	0	0	0	0	0	26	27	1	0	0.0393701
4030	70%	12	0	1	0	1	0	0	14	20	6	0	0.0393701
4040	83%	17	1	0	1	0	0	0	19	23	4	0	0.0393701
4050	100%	22	0	0	0	0	0	0	22	22	0	0	0.0393701
4060	90%	23	3	0	0	0	0	0	26	29	3	0	0.0393701
4070	100%	24	0	0	0	0	0	0	24	24	0	0	0.0393701
4080	89%	22	3	0	0	0	0	0	25	28	3	0	0.0393701
4090	89%	21	3	0	0	0	0	0	24	27	3	0	0.0393701
4100	91%	18	2	0	0	0	0	0	20	22	2	0	0.0393701
4110	100%	26	0	0	0	0	0	0	26	26	0	0	0.0393701
4130	90%	24	3	0	0	0	0	0	27	30	3	0	0.0393701
4140	100%	25	0	0	0	0	0	0	25	25	0	0	0.0393701
4150	85%	25	1	2	0	0	0	0	28	33	5	0	0.0393701
4160	100%	35	0	0	0	0	0	0	35	35	0	0	0.0393701
4170	94%	14	1	0	0	0	0	0	15	16	1	0	0.0393701
4180	92%	32	1	1	0	0	0	0	34	37	3	0	0.0393701
4190	85%	29	3	0	1	0	0	0	33	39	6	0	0.0393701
4200	100%	26	0	0	0	0	0	0	26	26	0	0	0.0393701
4220	100%	39	0	0	0	0	0	0	39	39	0	0	0.0393701
4230	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701
4240	92%	22	2	0	0	0	0	0	24	26	2	0	0.0393701
4250	96%	25	1	0	0	0	0	0	26	27	1	0	0.0393701
4260	89%	30	2	1	0	0	0	0	33	37	4	0	0.0393701
4270	94%	28	2	0	0	0	0	0	30	32	2	0	0.0393701
4290	100%	28	0	0	0	0	0	0	28	28	0	0	0.0393701
4300	100%	30	0	0	0	0	0	0	30	30	0	0	0.0393701
4310	97%	27	1	0	0	0	0	0	28	29	1	0	0.0393701
4330	97%	32	1	0	0	0	0	0	33	34	1	0	0.0393701
4340	100%	31	0	0	0	0	0	0	31	31	0	0	0.0393701
4350	97%	29	1	0	0	0	0	0	30	31	1	0	0.0393701
4360	77%	16	0	0	0	0	1	0	17	22	5	0	0.0393701
4470	85%	20	2	1	0	0	0	0	23	27	4	0	0.0393701
4490	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
4510	100%	33	0	0	0	0	0	0	33	33	0	0	0.0393701
4520	94%	14	1	0	0	0	0	0	15	16	1	0	0.0393701
4530	100%	33	0	0	0	0	0	0	33	33	0	0	0.0393701
4570	90%	24	1	1	0	0	0	0	26	29	3	0	0.0393701
4710	93%	39	3	0	0	0	0	0	42	45	3	0	0.0393701
4730	89%	21	3	0	0	0	0	0	24	27	3	0	0.0393701
4750	57%	3	0	0	1	0	0	0	4	7	3	0	0.0393701
4770	94%	32	2	0	0	0	0	0	34	36	2	0	0.0393701
4790	82%	19	3	1	0	0	0	0	23	28	5	0	0.0393701
4810	72%	11	1	0	0	1	0	0	13	18	5	0	0.0393701
4820	50%	6	0	0	1	0	1	0	8	16	8	0	0.0393701
4830	58%	6	0	0	0	0	1	0	7	12	5	0	0.0393701
4840	67%	7	0	0	0	1	0	0	8	12	4	0	0.0393701
	Total Tips	2222	122	48	24	17	10		2443	2858			


Rain Event Performance
110, 400, 540, 700, 730, 1100, 1320, 1360, 1400, 1420, 1700, 4750, 4820, 4830
120%
100%
80%
60%
40%
20%
0%
Rain Event Performance
100 110 120 140 150 200 210 220 300 310 330 400 410 420 430 440 500 510 520 530 540 600 610 620 630 640 650 700 710 720 730 740 750 760 800 810 820 830 840 850 860 870 900 1000 1010 1030 1040 1050 1060 1100 1110 1200 1300 1310 1320 1330 1340 1350 1360 1370 1400 1420 1440 1460 1480 1500 1520 1530 1600
Sensor ID
Sensors with performance <60% noted

Measured Rain Event Analysis

		Outliers Removed
	(mm of rain measured)	(mm of rain measured)
Rain Sensor	Measured Bucket Tips	Measured Bucket Tips
100	9	9
110	9	9
120	8	8
140	16	16
150	18	18
200	8	8
210	7	7
220	10	10
300	8	8
310	12	12
330	13	13
400	8	8
410	12	12
420	56	
430	59	
440	14	14
500	21	21
510	26	26
520	12	12
530	12	12
540	9	9
600	11	11
610	11	11
620	18	18
630	34	34
640	27	27
650	10	10
700	9	9
710	9	9
720	19	19
730	13	13
740	12	12
750	7	7
760	21	21
800	7	7
810	18	18
820	8	8
830	42	42
840	12	12
850	6	6
860	4	4
870	23	23
900	13	13
1000	12	12
1010	15	15
1030	16	16
1040	20	20
1050	17	17
1060	23	23
1100	8	8
1110	14	14
1200	6	6
1300	8	8
1310	6	6
1320	9	9
1330	7	7
1340	11	11
1350	32	32
1360	12	12
1370	13	13
1400	10	10
1420	10	10
1440	14	14
1460	12	12
1480	5	5
1500	81	
1520	11	11
1530	14	14
1600	7	7
1620	13	13
1640	12	12
1660	3	3
1700	7	7
1710	4	4
1720	12	12
1800	9	9

		Outliers Removed
	(mm of rain measured)	(mm of rain measured)
Number of 3-tips	Measured Bucket Tips	Measured Bucket Tips
1800	9	9
1810	7	7
1900	3	3
1920	4	4
2190	31	31
2210	21	21
2230	21	21
2240	25	25
2250	24	24
2260	30	30
2270	38	38
2280	37	37
2310	26	26
2320	16	16
2330	15	15
2340	15	15
2350	19	19
2360	21	21
2370	22	22
2710	9	9
2730	22	22
2750	8	8
2810	10	10
2820	10	10
2840	30	30
4010	26	26
4020	27	27
4030	20	20
4040	23	23
4050	22	22
4060	29	29
4070	24	24
4080	28	28
4090	27	27
4100	22	22
4110	26	26
4130	30	30
4140	25	25
4150	33	33
4160	35	35
4170	16	16
4180	37	37
4190	39	39
4200	26	26
4220	39	39
4230	23	23
4240	26	26
4250	27	27
4260	37	37
4270	32	32
4290	28	28
4300	30	30
4310	29	29
4330	34	34
4340	31	31
4350	31	31
4360	22	22
4470	27	27
4490	17	17
4510	33	33
4520	16	16
4530	33	33
4570	29	29
4710	45	45
4730	27	27
4750	7	7
4770	36	36
4790	28	28
4810	18	18
4820	16	16
4830	12	12
4840	12	12

Bucket Tip Data Analysis	
Mean	19.44
Median	16.00
Std Deviation	12.00
Mean + 3 st dev	55.44
Mean - 3 st dev	-16.55
Min	3
Max	81