

Memo



Date: February 4, 2010
To: Kevin Stewart
From: Markus Ritsch
Subject: January 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 January 1 through January 31, 2010.

II. General System Analysis Summary

A total of 287,480 ALERT data reports were analyzed from the ALERT 2 base station. 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 9,274 reports per day with an average hourly loading of 386 reports. The peak hourly traffic loading was 573 reports, which occurred on January 24, between 3:00 PM and 4:00 PM. A plot of monthly average and peak hourly traffic loading is provided.

A. Specific Issues Identified this Month

The performance of the following sensors, highlighted in yellow (Table 1), was unacceptable this month.

Table 1. Rain Sensors with Unacceptable Performance Characteristics

Rain ID	Description	Timer	Event	Comments
200	Leyden Reservoir	0.07	0	Poor performance
220	Upper Leyden	0.31	1	Poor performance
1000	Maple Grove Reservoir	0.66	0.2	Poor performance
1530	Bear Creek at Lowell	0	0.17	Poor performance
2210	Hiwan G.C.	0.92	1	Large number of invalid reports
2320	Choke Cherry Res	0.94	1	Large number of invalid reports
4030	Red Garden	0.90	1	Large number of invalid reports
4110	Betasso	0.98	0.73	Poor event performance (alarm recorded on 01/12/2010 11:43:52)
4330	Indian Ruins	0.74	0.75	Poor performance
4470	Little Narrows	0.68	1	Poor performance
4710	Ward C-1	0.56	0.66	Poor performance
4750	Louisville Lake	0.95	0.17	Poor event performance (alarm recorded on 01/20/2010 11:18:15)
4830	SBC @ San Souci	0.92	1	Large number of invalid reports
1470	Unknown ID			Is this a new sensor that should be defined at the base?
1950	Unknown ID			Is this a new sensor that should be defined at the base?

III. Rain Sensor Timer Reporting Summary

The following analysis assumes that each rain sensor has a 12-hour timer-reporting interval. System-wide, the ALERT 2 base station received approximately 89 percent of the non-incrementing timer reports. 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
220											
4710											
1000											
4470											
4330											
4240											

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

Sensor ID 1460 and 700 have a 24-hour timer-reporting interval and Sensor ID 1810 and 1640 have an 18-hour timer-reporting interval.

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	5.97	Only the 1-mm rain sensors were included in the analysis
Median	5.00	Only the 1-mm rain sensors were included in the analysis
Standard deviation	5.34	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	22.00	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	Numerous IDs
Maximum total count	36	Louisville Lake (ID 4750)

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												

*-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 More than 6 in Sequential Count

Sensor Description	Sensor ID	Comment
Bear Creek at Lowell	1530	Sequential count series jumps all over the place in January
Louisville Lake	4750	This site recorded 1.37" of precipitation in a 20 minute span on 1/20/2010
Urban Farm	1460	Multiple large jumps in count, count series is not consistent

D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 84 percent. A total of 418 incrementing reports were received and a total of 351 were expected. The total loss of incrementing reports for the month was approximately 16 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
1530											
4750											
1000											
4110											
4170											
4330											

* - Event statistics are poor in February, March, and October due to system start-up.

** - Poor event performance is evident at every station because the ALERT2 base station was unable to receive data for part of this month.

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 hours of highest radio traffic this month are shown (Table 7).

Table 7. Heavy Radio Traffic Periods

Peak Traffic Periods	Reports/hour	Hour Beginning
Peak Hourly Traffic	573	1/24/2010 3:00 PM
2nd Max	543	1/24/2010 2:00 PM
3rd Max	530	1/15/2010 11:00 PM
4th Max	524	1/15/2010 10:00 PM
5th Max	518	1/24/2010 12:00 PM

Each hour exceeding 500 reports was analyzed to quantify the number of missing rain reports for that hour (Figure 1). The following plot shows the loss of data as a function of data loading.

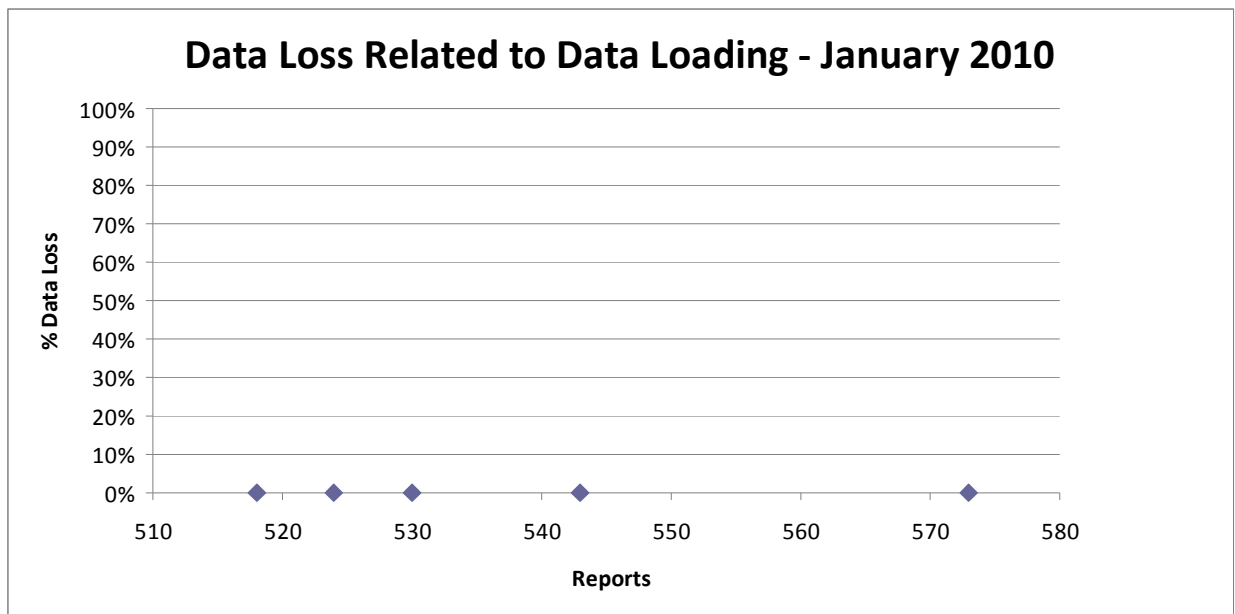


Figure 1. Data Loss vs. Data Loading

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)	382
Total reports from unknown IDs	1,220
Unknown IDs with only a single received report (potential noise)	212
Total reports from all IDs – RecData Log entire month	287,480
Unknown reports as a fraction of total reports	0.42%

The total number of reports from unknown sensors is very small relative to the total reports received for the month.

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 9).

Table 9. Reports Received by Unknown IDs

Unknown ID	Number of Reports
1950	128
1470	30
1423	22
1446	19
1923	16
1953	16
1531	14
1934	14
206	12
1165	12
1443	12
1454	12
1915	12
1926	12
2748	12
1949	11
1458	10
1534	10
1929	10
1933	10
2715	10
154	9
1457	9
1478	9
1486	9
1918	9
1935	9
2754	9
2808	9
1449	8
1450	8
1506	8
1529	8
1954	8
2746	8
4031	8
152	7
1166	7
1445	7
1502	7
1647	7
2716	7
2745	7
2771	7
2775	7
2776	7
148	6
202	6
1167	6
1501	6
1528	6
1631	6
2708	6
2713	6
2753	6
2756	6
2768	6
1588	5
1651	5

The “unknown” device reports are analyzed temporally to understand when they are received during the day (Table 10). 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 10. Temporal Distribution of Unknown Reports

Hour (AM)	Reports	Hour (PM)	Reports
0:00-00:59	88	12:00-12:59	40
1:00-1:59	48	1:00-1:59	40
2:00-2:59	42	2:00-2:59	62
3:00-3:59	24	3:00-3:59	43
4:00-4:59	38	4:00-4:59	67
5:00-5:59	38	5:00-5:59	50
6:00-6:59	22	6:00-6:59	72
7:00-7:59	27	7:00-7:59	89
8:00-8:59	39	8:00-8:59	64
9:00-9:59	64	9:00-9:59	39
10:00-10:59	26	10:00-10:59	73
11:00-11:59	43	11:00-11:59	82

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	Dec 09 Reports	Jan 10 Reports					
220	Upper Leyden	0	5					
310	Guy Hill Ranch	0	0					
900	Aurora Reservoir	0	0					
920	Aurora Town Hall Wx	5	0					
1420	Diamond Hill	6	1					
1460	Urban Farm	1	0					
1530	Bear Creek at Lowell	7	13					
2210	Hiwan G.C.	4	5					
2230	Bear Cr below Cub	0	0					
2320	Choke Cherry Resvr	5	4					
2810	Pine Cliff Road	0	0					
2820	Haskins Gulch Conf	0	0					
2860	CC at Stroh Rd	0	0					
4030	Red Garden	1	7					
4070	Bear Peak	0	1					
4330	Indian Ruins	2	3					
4790	Button Rock	0	2					
4830	SBC at San Souci	0	4					

General System Analysis

P:\A207-UDFCD-Data-Analysis\2010\01-2010\Novastar_extract_2010Jan.mdb

Database Name

First Date in Database

1/1/10 12:00 AM

Total Days

31.0

Last Date in Database

1/31/10 11:59 PM

Total Hours

744.0

Total Records Analyzed

287480

Records by Group

Temperature	55410	19%
Relative Humidity	54376	19%
Wind Gust	41844	15%
Barometric Pressure	24678	9%
Wind Direction	21335	7%
Wind Speed Average	20743	7%
Wind Speed Average & Azimuth	18693	7%
Solar Radiation	8844	3%
Fuel Temperature	5994	2%
Fuel Moisture	5934	2%
Precipitation	5354	2%
Water Level PT-HSE	4649	2%
Battery Voltage HSE	3728	1%
Battery Voltage Analog	3571	1%
Battery Voltage Digital	3139	1%
Water Level Float	3002	1%
Repeater Status Report	2360	1%
Battery	1094	0%
Repeater Pass List	620	0%
Water Level PT	368	0%
12Hr Status Report	335	0%
Wing Gust	75	0%
Soil Moisture	52	0%
Solar Power	31	0%
Handar 585 ALARM Status	30	0%
Battery Voltage	1	0%
Total	286260	

Records by Major Group

Meteorologic Sensors	245923	86%
Sensor Status Transmissions	13814	5%
Soil and Fuel Sensors	11980	4%
Water Level Sensors	8019	3%
Rain Sensors	5354	2%
Total	285090	

Traffic Loading Summary

Alert Reports	287480	
Average Daily Traffic	9274	
Average Hourly Traffic	386	
Median Hourly Traffic	384	hour beginning
Peak Hourly Traffic	573	1/24/10 3:00 PM
2nd Max	543	1/24/10 2:00 PM
3rd Max	530	1/15/10 11:00 PM
4th Max	524	1/15/10 10:00 PM
5th Max	518	1/24/10 12:00 PM

Rain Timer Performance

n Timer Performance

Analyze Rain Sensors

12:27

Ave
Exp

0.888965382

Rain ID	Description	Rcv	Interval	Exp	Performance
140	Blue Mountain	58	12:26	62.00	94%
200	Leyden Reservoir	4	6:53	62.00	6%
220	Upper Leyden	19	4:50	62.00	31%
700	Toll Gate @ 6th	27	0:00	31.00	87%
750	Quincy Reservoir	59	12:21	62.00	95%
900	Aurora Reservoir	59	12:24	62.00	95%
920	Aurora Town Hall Wx	61	12:00	62.00	98%
970	Pump Sta 3	61	12:00	62.00	98%
1000	Maple Grove Resv.	41	12:53	62.00	66%
1420	Diamond Hill	56	13:06	62.00	90%
1440	Elbert	57	12:51	62.00	92%
1460	Urban Farm	33	22:23	31.00	106%
1480	Third Creek at DIA	58	12:36	62.00	94%
1520	Marston Lake North	59	12:12	62.00	95%
1530	Bear Cr @ Lowell	0	12	62.00	0
1570	Brighton Ditch Wx	59	12:24	62.00	95%
1640	SPR at Union Ave.	58	12:26	62.00	94%
1660	SPR at Henderson	57	12:54	62.00	92%
1810	Sand Creek at mouth	60	11:55	62.00	97%
1920	Brighton	61	12:00	62.00	98%
2190	Squaw Mountain	59	12:24	62.00	95%
2210	Hiwan G.C.	57	12:26	62.00	92%
2320	Choke Cherry Resvr	234		248.00	94%
2330	Morrison	60	12:10	62.00	97%
2710	Highlands Ranch WTF	60	12:12	62.00	97%
2730	Salisbury Park	61	12:00	62.00	98%
2750	Castle Rock	59	12:24	62.00	95%
2900	Isselville Gulch-Doug	60	12:12	62.00	97%
2930	King Valley Rd - Doug	58	12:25	62.00	94%
2970	Rampart Range Rd	51	14:27	62.00	82%
2990	Tomah Rd-Douglas Cn	59	12:12	62.00	95%
3020	West Creek WX	58	12:38	62.00	94%
4010	Crescent	57	12:38	62.00	92%
4020	Rio Grande	59	12:23	62.00	95%
4030	Red Garden	56	13:07	62.00	90%
4040	Martin Gulch	60	11:58	62.00	97%
4050	Walker Ranch	60	11:58	62.00	97%
4060	Lakeshore	57	12:38	62.00	92%
4070	Bear Peak	59	12:10	62.00	95%
4080	Twin Sisters	54	13:40	62.00	87%
4090	Magnolia	58	12:25	62.00	94%
4100	Filter Plant	57	12:40	62.00	92%
4110	Betasso	61	12:13	62.00	98%
4130	Swiss Peaks	53	14:02	62.00	85%
4140	Logan Mill	56	12:41	62.00	90%
4150	Gold Hill	55	13:12	62.00	89%
4160	Sunshine	59	12:10	62.00	95%
4170	Pine Brook	55	12:57	62.00	89%
4180	Gold Lake	50	14:30	62.00	81%
4190	Slaughterhouse	59	11:58	62.00	95%
4200	Lazy Acres	60	12:13	62.00	97%
4220	Fling's	55	12:40	62.00	89%
4230	Golden Age	59	12:23	62.00	95%
4240	Sunset	49	14:24	62.00	79%

4250	Geer Canyon	56	12:52	62.00	90%
4260	Taylor Mountain	59	12:37	62.00	95%
4270	Cannon Mountain	56	13:13	62.00	90%
4290	Red Hill	59	12:24	62.00	95%
4300	Big Elk Park	59	12:23	62.00	95%
4310	Johnny Park	57	12:52	62.00	92%
4330	Indian Ruins	46	14:44	62.00	74%
4340	Riverside	58	12:24	62.00	94%
4350	Conifer Hill	56	13:07	62.00	90%
4360	Justice Center	60	12:22	62.00	97%
4470	Little Narrows	42	12:54	62.00	68%
4490	Apple Valley	57	13:03	62.00	92%
4510	Pinewood Springs	58	12:37	62.00	94%
4520	Eagle Ridge	61	12:00	62.00	98%
4530	Winiger Ridge	51	13:52	62.00	82%
4550	Boulder Jail	62	11:54	62.00	100%
4570	St. Antons	53	13:29	62.00	85%
4710	Ward C-1	35	14:54	62.00	56%
4730	Sugarloaf	59	12:40	62.00	95%
4750	Louisville Lake	59	12:23	62.00	95%
4770	Cal-Wood Ranch	61	12:00	62.00	98%
4790	Button Rock	57	12:27	62.00	92%
4810	Shanahan Ridge	61	11:57	62.00	98%
4820	Doudy Draw	57	12:51	62.00	92%
4830	SBC @ San Souci	57	13:05	62.00	92%
4840	SBC@S Boulder Ditch	60	12:24	62.00	97%
4850	Porphory Mtn	53	13:16	62.00	85%
4860	Fairview Peak	55	13:12	62.00	89%

Rain Event Performance

		Reports Received	351		Analyze Rain Sensors									
		Systemwide Avg	Total Tips	418										
		83.97%	Data Loss	16.03%										
Rain ID	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcv	Exp	Miss	Hold	Bucket	
1530	17%	0	0	0	0	0	1	1	1	6	5	0	0.0393701	
4750	17%	3	0	0	1	0	0	2	6	36	3	0	0.0393701	
1000	20%	0	0	0	0	1	0	0	1	5	4	0	0.0393701	
1520	50%	0	1	0	0	0	0	0	1	2	1	0	0.0393701	
1810	67%	1	1	0	0	0	0	0	2	3	1	0	0.0393701	
2970	67%	1	1	0	0	0	0	0	2	3	1	0	0.0393701	
4710	67%	1	1	0	0	0	0	0	2	3	1	0	0.0393701	
4820	67%	1	1	0	0	0	0	0	2	3	1	0	0.0393701	
4110	73%	14	4	0	1	0	0	0	19	26	7	1	0.0393701	
4330	75%	5	0	1	0	0	0	0	6	8	2	0	0.0393701	
4550	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701	
4170	79%	9	1	1	0	0	0	0	11	14	3	1	0.0393701	
4270	80%	3	1	0	0	0	0	0	4	5	1	0	0.0393701	
4160	82%	7	2	0	0	0	0	0	9	11	2	0	0.0393701	
4770	83%	4	1	0	0	0	0	0	5	6	1	0	0.0393701	
1460	86%	5	1	0	0	0	0	1	6	7	1	0	0.0393701	
4310	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701	
4860	88%	12	2	0	0	0	0	0	14	16	2	0	0.01	
4200	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701	
4840	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701	
140	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
220	100%	6	0	0	0	0	0	0	6	6	0	1	0.0393701	
700	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
1420	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
1480	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701	
1640	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701	
1660	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
1920	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	
2320	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
2330	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701	
2710	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701	
2900	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
3020	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
4010	100%	5	0	0	0	0	0	0	5	5	0	1	0.0393701	
4020	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
4030	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701	
4040	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
4050	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
4060	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
4070	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
4080	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
4090	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
4100	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701	
4130	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701	
4140	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701	
4150	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
4180	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
4190	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701	
4220	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
4230	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
4240	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701	
4250	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701	
4260	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
4290	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701	
4300	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
4340	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701	
4350	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701	
4360	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701	
4470	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701	
4490	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701	
4510	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701	
4520	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701	
4530	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
4570	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701	
4730	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
4790	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701	
4810	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701	
4830	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701	
4850	100%	10	0	0	0	0	0	0	10	10	0	0	0.01	
Total Tips		322	21	2	2	1	1	4	351	418	40	4		

Monthly Traffic Loading

