

# Memo



**Date:** May 3, 2007  
**To:** Kevin Stewart and Chad Kudym  
**From:** Markus Ritsch  
**Subject:** April 2007 ALERT Data Analysis

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## 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 April 1 through April 30, 2007.

## II. General System Analysis Summary

A total of 239,538 individual data records were analyzed. Meteorological sensors accounted for 57 percent, water level sensors 15 percent and rain sensors 7 percent of the total monthly transmissions.

Ninety-eight percent of the received data reports were flagged as "good" by the Nova Star validation process. Roughly 4,438 reports were flagged as "bad". Of these "bad" reports, 3,324 originated from the wind sensor (ID 2189 and 2187) at Squaw Mountain.

The system-wide radio traffic loading this month was 7,985 reports per day with an average hourly loading of 333 reports. The peak hourly traffic load was 906 reports, which occurred on April 24<sup>th</sup> between 9:00 AM and 10:00 AM. A plot of monthly average and peak hourly traffic loading is provided.

A total of 1,362 reports were received from the Hayman gages this month. The Hayman gages accounted for less than 1% of the total received radio traffic.

The sensors reporting most frequently this month include:

1. Salisbury Park (ID 2727) with 4,072 reports,
2. Quincy Reservoir (ID 747) with 3,229 reports,
3. Boulder Creek at Broadway (ID 4583) with 2,833 reports,
4. Green Ditch (ID 4593) with 2,756 reports, and
5. Stapleton (IDs 1464 and 1466) with 2,747, and 2,768 reports respectively.

The reports from the above sensors are distributed evenly throughout the month.

Of interest this month are several sensors that reported infrequently including:

1. Stapleton (ID 1463 – Barometric Pressure and ID 1469 - Solar) with 5 reports each,
2. SPR at Dartmouth (ID 1626) with 3 reports,
3. Button Rock Outlet (ID 4480) with three reports, and
4. Lena @ U.S. Hwy 6 (ID 1043) with 1 report.

### 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 90 percent of the non-incrementing timer reports. The 5 worst-performing rain sensors for the month are summarized (Table 1).

**Table 1. Monthly Summary of Sensors with Poor Timer Performance**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
750	1330	2310	1810								
4470	1460	1710	540								
4560	2330	2350	310								
4240	4170	2240	850								
4510	4470	2250	1710								

Sand Cr at Mouth (1810), Parker/Mississippi (540), Guy Hill Ranch (310), Flying J (850), and Shop Creek (1710)

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.

*Sensor ID 1460 has a 24-hour timer reporting interval and is not included in the timer reporting analysis.*

The monthly records for sensors with poor timer performance are manual inspected. A brief description of the manual inspection is provided below.

#### 1. Sand Creek at Mouth (ID 1810)

This sensor had a timer percentage of 58% and was active for the entire month. This sensor reported a non-incrementing report every 18-hours and does not seem to be on a 12-hour timer interval.

#### 2. Parker/Mississippi (ID 540)

This sensor had a timer percentage of 60% and was active for the entire month. This sensor was missing reports for a 3-day period beginning April 2 through April 4, 2007 and then again for a 2-day period beginning April 7 through April 8, 2007.

#### 3. Guy Hill Ranch (ID 310)

This sensor had a timer percentage of 62% and was active for the entire month. Nothing suspicious was identified in the time series record.

#### 4. Flying J (ID 850)

This sensor had a timer reporting percentage of 73%. This sensor was missing reports for a 3-day period beginning April 12 through April 15, 2007.

#### 5. Shop Creek (ID 1710)

This sensor had a timer reporting percentage of 73%. This sensor was missing reports for a 2-day period beginning April 2 through April 3, 2007.

## IV. Rain Sensor Event Reporting Summary

### A. District-Wide Total Tip/Count Statistics

The incrementing reports from all 1-mm rain sensors (excluding Hayman sensors) that reported for the entire month were analyzed to quantify the District-wide statistical total monthly tip summary (Table 2).

**Table 2. April District-Wide Total Tip/Count Statistical Summary**

Statistical Parameter	Value	Comments
Mean	65.03	Only the 1-mm rain sensors were included in the analysis
Median	67	Only the 1-mm rain sensors were included in the analysis
Standard deviation	19.04	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	122.15	Several sensors for the month are outside the Mean +/- 3 Std Dev
Minimum total count	8	Fire Station 12 (ID 840)
Maximum total count	132	Chatfield COE (ID 1350)

A monthly summary of the District-wide mean total tip/count is presented (Table 3).

**Table 3. 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									

The average precipitation experienced district-wide in April was considerably more than March and it was considerably more than that experienced in the same month in 2006.

Two sensors experienced a total tip count of greater than the system-wide mean plus 3 standard deviations. These sensors were Chatfield COE (ID 1350) and Morrison (ID 2330).

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

Three rain sensors experienced a jump in their sequential tip count of more than six. The tip count series for these sensors was manually inspected and explored in the following paragraphs.

#### 1. Nott Creek (ID 150)

On 4/26/2007 a timer report was received at 11:32:58 AM with a count of 106. Twelve hours later at 4/26/2007 at 11:33:01 PM another timer report was received with a count of 113. No incrementing tip reports were received during the 12-hour period. A total jump in count of 7 was validated by the base station.

#### 2. Guy Hill Ranch (ID 310)

A timer transmission received on 4/18/2007 at 9:35:23 PM caused a jump in count of 15. No incrementing transmissions were received during in the previous 12-hour period.

Date/Time	Sensor ID	Count
4/17/2007 9:20:15 AM	310	35
4/17/2007 9:39:22 AM	310	36
4/17/2007 9:41:32 AM	310	36
4/18/2007 9:35:23 PM	310	51
4/19/2007 9:33:18 AM	310	51

### 3. Quincy Reservoir (ID 750)

This sensor in general has many missing reports. On 4/24/2007 at 3:26:02 PM a bit-flip error caused an invalid report to be decoded. The actual transmitted count value was 92. Due to the invalid report, the next transmitted count value of 95 caused a jump from the previous validated count value of 88. A total jump of 7 in the count was experienced.

Date/Time	Sensor ID	Count
4/24/2007 3:09:17 PM	750	88
4/24/2007 3:26:02 PM	750	1116
4/24/2007 3:55:43 PM	750	95

### C. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm, tip reports for the month was approximately 88 percent. A total of 8,483 incrementing reports were received and a total of 9,625 were expected. The total loss of incrementing reports for the month was approximately 12 percent. Those sensors with the worst rain event transmission characteristics are summarized (Table 4).

**Table 4. Monthly Summary of Sensors with the Most Missed Tips**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2320	1330	540	1350								
2190	4080	310	310								
4710	1640	4470	1100								
4090	4050	850	860								
4820	4180	4570	540								

\*Chatfield COE (1350), Guy Hill Ranch (310), Louisville Rec Ctr (1100), Sand Creek at Colfax (860), Parker/Mississippi (540)

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.

#### 1. Chatfield COE (ID 1350)

This sensor missed single incrementing reports throughout the month. On 4/24/2007, however this sensor experienced jumps in the sequential count value in excess of 3 and 4 tips. These large jumps were not confined to 1 hour of the day but occurred throughout the day.

#### 2. Guy Hill Ranch (ID 310)

This sensor missed single incrementing reports throughout the month. An abnormal number of missing reports are evident for the period 4/23/2007 through 4/26/2007.

#### 3. Louisville Recreation Center (ID 1100)

This sensor reports consistent single incrementing reports throughout the month. On 4/24/2007 however, an abnormal number of missing reports are evident.

#### 4. Sand Creek at Colfax (ID 860)

This sensor reports consistent single incrementing reports throughout the month. On 4/24/2007 however, an abnormal number of missing reports are evident.

#### 5. Parker/Mississippi (ID 540)

This sensor experiences missing single increment reports throughout the month. On 4/24/2007 it experiences missing reports that exceed 2 tips. One jump in count of 6 tips was observed on 4/24/2007.

## V. Heavy Radio Traffic Hour Analysis

Beginning in 2007 every hour exceeding 600 messages will be analyzed independently. The heavy hour analysis will attempt to identify rain gage sequences where 2, 3, or more, sequential messages are lost.

There were several occurrences of hourly traffic exceeding 600 messages this month.

- 4/17/2007 from 2:00 am to 3:00 am (642 reports)
- 4/24/2007 from 1:00 am to 2:00 am (746 reports)
- 4/24/2007 from 5:00 am to 6:00 am (758 reports)
- 4/24/2007 from 6:00 am to 7:00 am (876 reports)
- 4/24/2007 from 7:00 am to 8:00 am (845 reports)
- 4/24/2007 from 8:00 am to 9:00 am (854 reports)
- 4/24/2007 from 9:00 am to 10:00 am (906 reports)
- 4/24/2007 from 10:00 am to 11:00 am (845 reports)
- 4/24/2007 from 11:00 am to 12:00 pm (805 reports)
- 4/24/2007 from 12:00 pm to 1:00 pm (841 reports)
- 4/24/2007 from 1:00 pm to 2:00 pm (828 reports)
- 4/24/2007 from 2:00 pm to 3:00 pm (794 reports)
- 4/24/2007 from 3:00 pm to 4:00 pm (781 reports)
- 4/24/2007 from 4:00 pm to 5:00 pm (778 reports)
- 4/24/2007 from 5:00 pm to 6:00 pm (726 reports)
- 4/24/2007 from 6:00 pm to 7:00 pm (683 reports)

April 24 was a busy day in terms of radio traffic. The peak hour of radio traffic occurred on 4/24/2007 between 9:00 AM and 10:00 AM when 906 reports were received. The data for the peak hour was examined more closely to characterize the distribution of sensor traffic (Table 5). During this hour the radio traffic was dominated by rain and water level reports.

**Table 5. Peak Traffic Hour Sensor Report Distribution**

Sensor Group	Reports	Percent
Precipitation	336	37.09%
Water Level PT	323	35.65%
Wind Gust	35	3.86%
Precipitation - Mean	31	3.42%
Temperature	12	1.32%
Wind Direction	20	2.21%
Water Level Float	39	4.30%
Battery Voltage HSE	12	1.32%
Wind Speed Ave & Azimuth	59	6.51%
Wind Speed Average	13	1.43%
Relative Humidity	10	1.10%
Solar Radiation	4	0.44%
Barometric Pressure	1	0.11%
Handar 585 Alarm Status	2	0.22%
Fuel Temp/Moisture	2	0.22%
Battery Voltage Digital/Analog	5	0.55%
Repeater Pass List/12 Hr Status	2	0.22%
<b>Total</b>	<b>906</b>	<b>100%</b>

Incrementing rain records for each hour exceeding 600 total reports were examined more closely to characterize the loss of incrementing tip transmissions (Table 6).

**Table 6. Peak Hour Analysis - Monthly Summary**

Heavy Traffic Period	Total Traffic Msgs/hr	Rain reports expected	Rain reports received	Loss of reports	Loss of 3 or more sequential tips during the hour
4/17/2007 2:00 am to 3:00 am	642	102	101	0.98%	None
4/24/2007 1:00 am to 2:00 am	746	174	147	15.5%	Yes
4/24/2007 5:00 am to 6:00 am	758	230	206	10.4%	None
4/24/2007 6:00 am to 7:00 am	876	269	237	11.9%	None
4/24/2007 7:00 am to 8:00 am	845	230	211	8.3%	Yes
4/24/2007 8:00 am to 9:00 am	854	237	197	16.8%	Yes
4/24/2007 9:00 am to 10:00 am	906	238	208	14.3%	Yes
4/24/2007 10:00 am to 11:00 am	845	170	158	7.1%	Yes
4/24/2007 11:00 am to 12:00 pm	805	133	123	7.5%	Yes
4/24/2007 12:00 pm to 1:00 pm	841	132	120	9.1%	Yes
4/24/2007 1:00 pm to 2:00 pm	828	121	109	9.9%	None
4/24/2007 2:00 pm to 3:00 pm	794	129	116	10.1%	Yes
4/24/2007 3:00 pm to 4:00 pm	781	154	142	7.8%	Yes
4/24/2007 4:00 pm to 5:00 pm	778	129	123	4.7%	None
4/24/2007 5:00 pm to 6:00 pm	726	118	112	5.1%	Yes
4/24/2007 6:00 pm to 7:00 pm	683	86	84	2.3%	None

Lost rain reports are evident during the entire day of April 24<sup>th</sup>. Most the lost reports include single tip reports and the loss of 2 sequential tip reports. The bigger issue, however, is the fact that several sensors experienced the loss of 3 or more sequential tip reports during April 24<sup>th</sup>. This is a critical issue for the flood detection network and a closer inspection of the entire day is completed in the next section of this report.

## **A. April 24, 2007 – A Bad Day**

The volume of radio traffic experienced on April 24, 2007 was large and unusual in that it was sustained for most of the day, not just occurring in 1 or 2 hours. The average hourly radio traffic loading for the day was approximately 700 reports per hour.

An analysis for the entire 24-hour period was conducted in an attempt to quantify the magnitude of missing data for the day.

A total of 15,232 reports were received for the day at the base station. Of the total reports, 40% came from water level sensors, 28% came from rain sensors and 22% came from meteorological sensors. The average hourly traffic loading was 684 reports/hour and the median hourly loading was 752 reports/hour. The actual radio traffic loading is on the order of 16% more than what was received at the base, so the average hourly loading was probably on the order of 800-850 reports and the peak hour was probably closer to 1,100 reports/hour.

A total of 5,069 incrementing rain reports were expected and only 4,252 incrementing reports were received. Approximately 16.12% of the incrementing rain reports were lost during the day on April 24, 2007. The vast majority of lost reports are single increment reports. For example the rain count value jumps from, 10 to 12, where the single increment count of 11 was lost. This type of lost report is shown under the column called “2-tip” in the table below. The distribution of lost sequential incrementing reports is shown (Table 7). The column called “3-tip” represents the loss of two sequential incremental reports and “4-tip” represents the loss of 3 sequential reports and so on.

**Table 7. Distribution of Lost Sequential Reports for April 24, 2007**

<b>2-tip (loss of 1 tip increment)</b>	<b>3-tip</b>	<b>4-tip</b>	<b>5-tip</b>	<b>6-tip</b>	<b>&gt; 6-tip</b>
539	96	15	4	5	1

Fourteen rain sensors experienced lost reports that exceed 3 sequential counts. These rain sensor IDs include: 540, 860, 1350, 1710, 200, 700, 750, 850, 1100, 1460, 1520, 1700, 2370, and 2810. Four rain sensors, IDs 860, 1350, 1710, and 750 had multiple occurrences of missed tips exceeding 3 sequential count values during the day.

The loss of 3 or more sequential data reports forms a limit of data degradation that causes a serious problem in the evaluation of alarm threshold conditions to support the flood mitigation needs of emergency responders within the District. The loss of sequential reports is a problem at stream sensors because it could cause the delay in triggering critical alarm conditions. A quick evaluation of water level sensors was conducted to see if the loss of sequential reports was also present in stream sensors.

A pressure transducer connected to a High Sierra transmitter is installed at SPR at Union Avenue (ID 1643). This sensor is configured to report on an event basis and every 15 minutes. It typically reports at 1-minute after the hour, 16-minutes after the hour, 31-minutes after the hour, and 46-minutes after the hour. The following plot shows one example period of received data on April 24<sup>th</sup> for this sensor. Twice on April 24<sup>th</sup>, a gap of 1 full hour was present in the data series. This means that 3 sequential 15-minute timed reports were not received at the base station.

*Why were so many ALERT reports lost on April 24, 2007? Was there a problem with the telemetry system or reception at the base station on this day or is the current telemetry architecture not able to handle the radio traffic generated by the UDFCD monitoring network?*

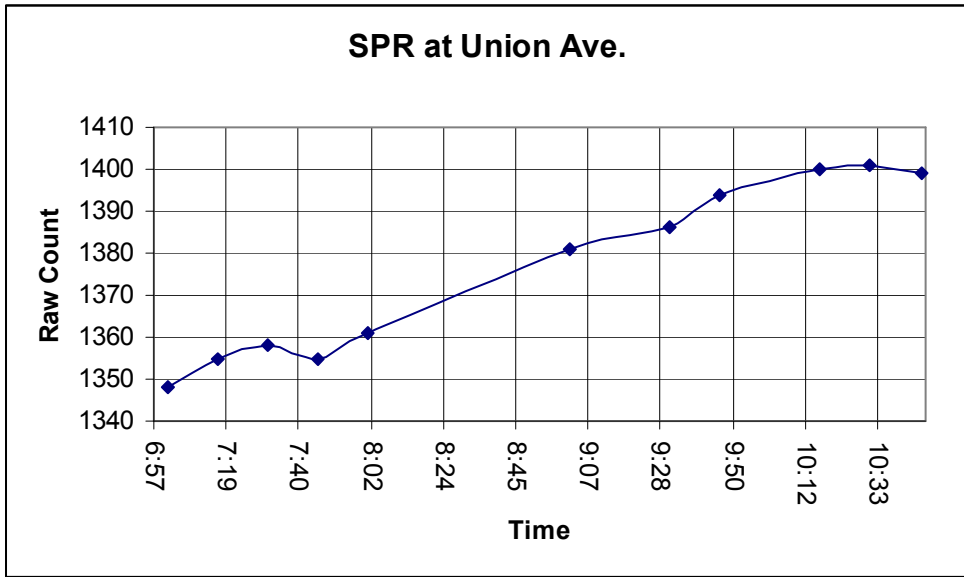


Figure 1. SPR at Union Ave. (1-hour data gap) - 8:01am to 9:01 am

**B. Repeater Loading During April 24**

The sensor reports contained in the NovaStar database for the entire day of 4/24/2007 were correlated to the repeater path taken by each sensor to arrive at the base station (Table 8).

**Table 8. Radio Traffic Handled by Each Radio Repeater**

Radio Repeater Path	Sensor Reports Routed
Blue Mountain	7,037
Smokey Hill	4,839
Lee Hill	1,272
Blue Mtn., Chokeycherry	988
Smokey Hill, Chokeycherry	532
Lee Hill, Eagle Ridge	154
Gold Hill	182
Lee Hill, Louisville	114
West Creek	78
N/A	36
<b>Total</b>	<b>15,232</b>

The majority of sensor reports during the peak hour came through Blue Mountain and Smokey Hill repeaters.

**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 9).

**Table 9. Summary of Unknown IDs**

Description	Quantity
Total number of unknown IDs (IDs without a device definition)	134
Total reports from unknown IDs	1,449
Unknown IDs with only a single received report (potential noise)	93
Total reports from active “known” IDs – entire month	208,964
Unknown reports as a fraction of total active “known” reports	0.69%



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

A number of “unknown” sensors had multiple reports (highlighted in yellow) 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 include:

- ID 754, 1470, 2239, 2754, 4013, and 4793.

The unknown IDs including the number of reports received by each are quantified (Table 10).

**Table 10. Reports Received by Unknown IDs**

Unknown Sensor ID	Reports
160	1
319	1
497	1
542	1
607	1
742	1
754	566
756	1
757	1
763	1
766	3
767	1
892	1
895	3
896	1
1008	1
1016	1
1042	1
1044	1
1046	1
1047	1
1048	1
1054	2
1102	1
1163	2
1307	1
1308	2
1311	1
1327	2
1335	3
1339	2
1342	1
1352	1
1382	1
1410	1
1444	1
1446	1
1448	1
1454	2
1455	1
1457	1
1458	1
1459	1
1470	26
1486	1
1501	2
1502	1

1506	1
1609	1
1611	1
1614	1
1631	2
1635	4
1647	2
1658	1
2200	2
2204	1
2218	2
2219	4
2221	3
2222	1
2239	61
2245	2
2255	1
2258	1
2272	1
2283	1
2329	1
2349	1
2361	1
2362	2
2716	1
2748	1
2754	479
2763	1
2790	1
2792	1
2795	7
2798	1
2799	3
2800	1
2811	1
2812	1
2847	1
4013	58
4039	2
4042	1
4049	1
4061	1
4081	1
4082	1
4087	1
4091	1
4095	1
4131	2
4199	2
4228	1

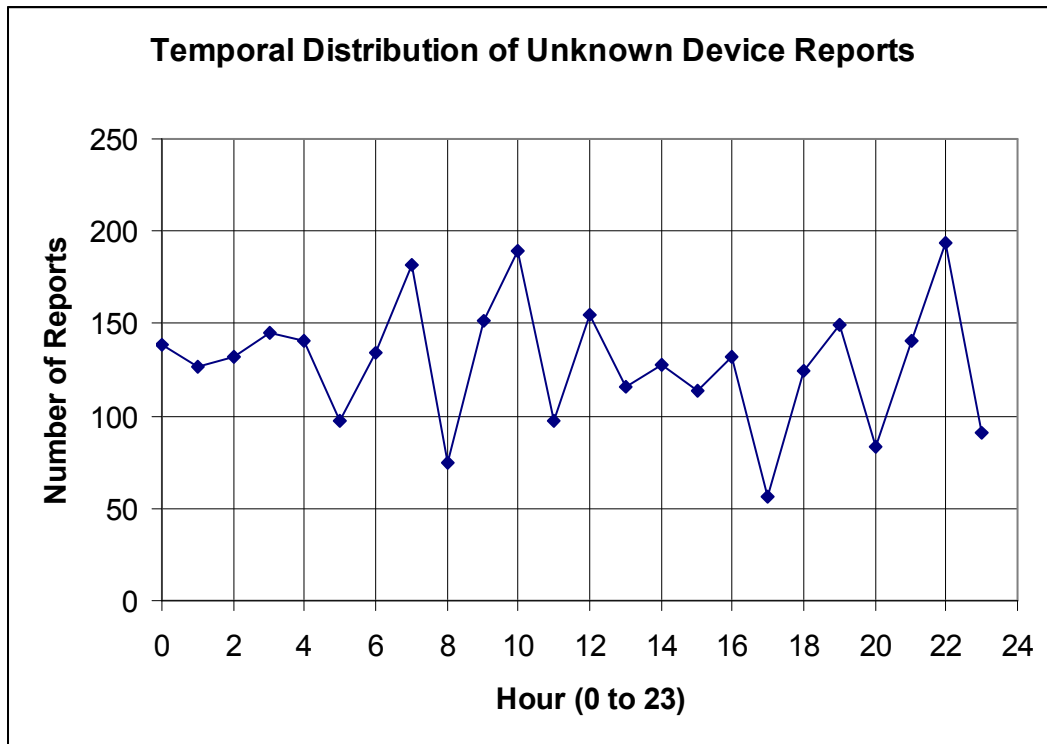
4262	1
4303	2
4306	1
4371	2
4449	7
4462	1
4489	1
4506	2
4509	4
4511	1
4561	1
4566	1
4569	1
4574	1
4599	1
4605	1
4639	1
4643	3
4644	1
4690	1
4736	1
4739	2
4740	4
4742	3
4748	1
4766	2
4775	1
4789	1
4793	71
4796	1
4817	1
4824	1
4828	2
4836	1
4867	1
5532	1
7211	1

The “unknown” device reports were analyzed temporally to understand when they were 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 Unknown Reports**

Hour (AM)	Reports	Hour (PM)	Reports
0:00-12:59	138	12:00-12:59	155
1:00-1:59	127	1:00-1:59	116
2:00-2:59	132	2:00-2:59	128
3:00-3:59	145	3:00-3:59	114
4:00-4:59	141	4:00-4:59	132
5:00-5:59	97	5:00-5:59	56
6:00-6:59	134	6:00-6:59	125
7:00-7:59	182	7:00-7:59	149
8:00-8:59	75	8:00-8:59	83
9:00-9:59	152	9:00-9:59	141
10:00-10:59	189	10:00-10:59	194
11:00-11:59	97	11:00-11:59	91

Unknown reports were received during each hour and their distribution throughout the day is shown (Figure 2).



**Figure 2. Daily Distribution of Unknown Device Reports**

## VII. Issues Continued from Previous Month

The following issues were identified last month.

1. The **Stapleton rain gage (ID 1460)** had a timer reporting interval of 24 hours instead of 12 hours.
2. **Parker/Mississippi (ID 540)**: A timer report on 3/28/2007 at 3:01:02 AM was received with a count value of 23. On 3/30/2007 at 2:50:39 PM another timer report was received with a count value of 30. There were no incrementing reports received from this sensor between 3/28/2007 at 3:01:02 AM and 3/30/2007 at 2:50:39 PM. A total jump in count of 7 was validated by the base station.
3. **Guy Hill Ranch (ID 310)**: This sensor had poor event performance. This sensor was activated on March 6, 2007. The sensor missed many single incrementing tips between 3/24/2007 through 3/30/2007. The performance of this sensor should be observed in the coming months.

## VIII. Issues Identified this Month

Further investigation into the following issues is recommended:

1. Several sensors reported infrequently including:
  - a. Stapleton (ID 1463 – Barometric Pressure and ID 1469 - Solar) with 5 reports each,
  - b. SPR at Dartmouth (ID 1626) with 3 reports,
  - c. Button Rock Outlet (ID 4480) with 3 reports, and
  - d. Lena @ U.S. Hwy 6 (ID 1043) with 1 report
2. **Guy Hill Ranch (ID 310)**: For a second month this sensor continues to exhibit poor timer and event performance.
3. **Parker/Mississippi (ID 540)**: For a second month this sensor continues to exhibit poor timer and event performance.
4. **Sand Creek at Mouth (ID 1810)**: This sensor had a timer percentage of 58% and was active for the entire month. This sensor reported a non-incrementing report every 18-hours and does not seem to be on a 12-hour timer interval.
5. April 24 was a busy day in terms of radio traffic. The peak hour of radio traffic occurred between 9:00 AM and 10:00 AM when 906 reports were received and on the order of 1,100 reports/hour were actually transmitted. In addition, many hours on 4/24/2007 experienced radio traffic loading rates in excess of 800 reports per hour. Several rain sensors and stream sensors lost 3 or more sequential transmissions. These rain sensors include: 540, 860, 1350, 1710, 200, 700, 750, 850, 1100, 1460, 1520, 1700, 2370, and 2810. The loss of 3 or more sequential data reports forms a limit of data degradation that causes a serious problem in the evaluation of alarm threshold conditions to support the flood mitigation needs of emergency responders within the District.
6. The large number of lost sequential reports experienced on April 24, 2007 leads one to raise a critical question. Is the current radio telemetry architecture employed by the UDFCD able to reliably handle the traffic during an extreme event? The quantification of ALERT reports from the NovaStar base station for April 24 indicates the telemetry system is not able to handle large sustained volumes of radio traffic if the design threshold criteria is to miss 3-or-more sequential transmissions from any one gage.
7. 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 include: ID 754, 1470, 2239, 2754, 4013, and 4793.

# General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\2007\_Apr\Novastar\_extract\_2007Apr.mdb

First Date in Database	4/1/07 12:00 AM	Total Days	30.0
Last Date in Database	4/30/07 11:59 PM	Total Hours	720.0

Total Records Analyzed 239538

### Records by Group

Wind Gust	32412	14%
None-ALERT-ID	30574	13%
Water Level PT-HSE	26969	11%
Relative Humidity	26743	11%
Temperature	24754	10%
Wind Speed Average & Azimuth	21100	9%
Precipitation	17386	7%
Wind Direction	14773	6%
Wind Speed Average	10916	5%
Battery Voltage HSE	6361	3%
Water Level PT	5555	2%
Battery Voltage Digital	3530	1%
Solar Radiation	2747	1%
Precipitation - Mean	2702	1%
Water Level Float	2474	1%
Barometric Pressure	2166	1%
Fuel Moisture	1410	1%
Fuel Temperature	1394	1%
Hayman Precipitation	1362	1%
Handar 585 ALARM Status	934	0%
Battery Voltage Analog	637	0%
Repeater Pass List	592	0%
Longmont Flow Gage	518	0%
Repeater Status Report	470	0%
Longmont Water Level PT	370	0%
12Hr Status Report	240	0%
Precipitation - Test	238	0%
Battery	112	0%
Soil Moisture	94	0%
Solar Power	5	0%
<b>Total</b>	<b>239538</b>	

### Records by Major Group

Meteorologic Sensors	135611	57%
Water Level Sensors	35886	15%
Rain Sensors	17386	7%
Sensor Status Transmissions	12769	5%
Soil and Fuel Sensors	2898	1%
<b>Total</b>	<b>204550</b>	

### Records by Validation Type

Good	0	235100	98%
Questionable	1	4438	2%
<b>Total</b>		<b>239538</b>	

### Sensors With Most Invalid Data

Description	Sensor	Reports
Squaw Mountain	2189	2477
Squaw Mountain	2187	847
Elbert	1439	264
Blue Mountain	139	211
Blue Mountain	137	100

### Traffic Loading Summary

Alert Reports	239538	
Average Daily Traffic	7985	
Average Hourly Traffic	333	
Median Hourly Traffic	326	hour beginning
Peak Hourly Traffic	906	4/24/07 9:00 AM

<b>Total Number of Sensors Defined</b>	<b>Total Number of Sensors Reporting</b>
834	556

### Reports per Sensor

Description	Sensor	Reports	Fraction of Total
Salisbury Park	2727	4072	2%
Quincy Reservoir	747	3229	1%
None-ALERT-ID	9233	2968	1%
Boulder Cr at Broadway	4583	2833	1%
Stapleton	1466	2768	1%
Green Ditch	4593	2756	1%
Stapleton	1464	2747	1%
Squaw Mountain	2189	2729	1%
Stapleton	1465	2666	1%
Elbert	1439	2665	1%
Stapleton	1467	2659	1%

# Rain Timer Performance

Analyze Rain Sensors

systemwide average (days)  
0.5206

Systemwide Average  
90%

Rain Sensors	Received	Average Timer Interval	Expected	Performance
100	56	12:26	60.00	93%
110	53	12:47	60.00	88%
120	54	12:45	60.00	90%
140	62	11:14	60.00	103%
150	53	12:17	60.00	88%
200	56	12:28	60.00	93%
210	54	12:59	60.00	90%
220	55	12:00	60.00	92%
300	58	12:12	60.00	97%
310	37	14:21	60.00	62%
320	54	12:44	60.00	90%
330	49	14:06	60.00	82%
400	58	12:12	60.00	97%
410	54	12:42	60.00	90%
420	52	13:00	60.00	87%
440	55	12:43	60.00	92%
500	57	12:41	60.00	95%
510	56	12:42	60.00	93%
520	53	12:43	60.00	88%
530	53	12:28	60.00	88%
540	36	15:33	60.00	60%
600	56	12:12	60.00	93%
610	53	13:05	60.00	88%
620	56	12:47	60.00	93%
630	56	12:15	60.00	93%
640	58	12:29	60.00	97%
650	52	13:01	60.00	87%
700	56	12:14	60.00	93%
710	54	12:56	60.00	90%
720	54	12:28	60.00	90%
730	57	12:27	60.00	95%
740	54	12:16	60.00	90%
750	56	12:29	60.00	93%
760	54	11:57	60.00	90%
800	57	11:57	60.00	95%
810	57	12:12	60.00	95%
820	52	13:44	60.00	87%
830	55	12:43	60.00	92%
840	53	13:01	60.00	88%
850	44	16:40	60.00	73%
860	71	9:30	60.00	118%
870	55	12:00	60.00	92%
900	54	12:31	60.00	90%
1000	52	13:21	60.00	87%
1010	57	12:13	60.00	95%
1020	58	12:12	60.00	97%
1030	53	13:23	60.00	88%
1040	53	12:53	60.00	88%
1050	53	12:47	60.00	88%
1060	57	12:29	60.00	95%
1100	47	14:16	60.00	78%
1110	52	13:18	60.00	87%
1200	52	12:43	60.00	87%
1300	56	12:26	60.00	93%
1310	55	12:42	60.00	92%
1320	57	12:12	60.00	95%
1330	58	12:14	60.00	97%
1340	51	13:42	60.00	85%
1350	53	12:45	60.00	88%
1360	55	12:29	60.00	92%
1370	51	13:25	60.00	85%
1400	55	12:12	60.00	92%
1420	59	12:00	60.00	98%
1440	56	12:48	60.00	93%
1460	28	1:05	60.00	47%
1480	54	13:00	60.00	90%
1500	53	12:29	60.00	88%
1520	57	12:29	60.00	95%
1530	55	12:28	60.00	92%
1540	54	12:28	60.00	90%
1600	51	13:33	60.00	85%
1610	58	12:10	60.00	97%
1620	55	12:13	60.00	92%
1640	53	13:02	60.00	88%
1660	50	12:31	60.00	83%
1700	54	12:47	60.00	90%

1710	44	16:20	60.00	73%
1720	57	12:14	60.00	95%
1800	54	12:57	60.00	90%
1810	35	19:10	60.00	58%
1900	57	12:11	60.00	95%
1920	55	12:00	60	92%
2190	53	13:00	60	88%
2210	59	12:00	60	98%
2220	56	12:37	60	93%
2230	56	12:16	60	93%
2240	55	12:33	60	92%
2250	53	13:08	60	88%
2260	56	12:16	60	93%
2270	51	12:36	60	85%
2280	60	12:00	60	100%
2310	56	12:00	60	93%
2320	214		60	
2330	55	13:02	60	92%
2340	56	12:43	60	93%
2350	57	11:43	60	95%
2360	57	12:16	60	95%
2370	56	12:00	60	93%
2710	59	12:00	60	98%
2730	57	12:28	60	95%
2750	59	12:00	60	98%
2810	52	13:27	60	87%
2820	53	13:03	60	88%
2840	56	12:46	60	93%
4010	57	12:31	60	95%
4020	57	11:58	60	95%
4030	57	11:59	60	95%
4040	55	12:17	60	92%
4050	58	12:10	60	97%
4060	53	13:15	60	88%
4070	56	12:16	60	93%
4080	51	13:32	60	85%
4090	45	13:18	60	75%
4100	55	11:59	60	92%
4110	58	11:59	60	97%
4130	50	12:56	60	83%
4140	49	13:40	60	82%
4150	54	13:11	60	90%
4160	55	12:50	60	92%
4170	51	13:17	60	85%
4180	54	12:13	60	90%
4190	57	11:58	60	95%
4200	61	11:31	60	102%
4220	51	13:51	60	85%
4230	56	12:29	60	93%
4240	51	13:25	60	85%
4250	58	12:14	60	97%
4260	57	12:14	60	95%
4270	55	12:46	60	92%
4290	53	12:14	60	88%
4300	55	11:57	60	92%
4310	58	12:13	60	97%
4330	56	12:30	60	93%
4340	59	11:58	60	98%
4350	56	12:14	60	93%
4360	56	12:31	60	93%
4470	51	13:06	60	85%
4480	2	0:02	60	3%
4490	51	13:27	60	85%
4510	55	11:58	60	92%
4520	57	12:00	60	95%
4530	49	12:01	60	82%
4560	60	11:58	60	100%
4570	51	12:18	60	85%
4710	57	12:00	60	95%
4730	53	12:33	60	88%
4750	53	12:00	60	88%
4770	60	11:55	60	100%
4790	52	12:00	60	87%
4810	54	13:08	60	90%
4820	55	13:04	60	92%
4830	52	13:06	60	87%
4840	53	13:01	60	88%
4850	49	13:45	60	82%
4860	50	12:37	60	83%

Rain Event Performance		Reports Received	8483	Analyze Rain Sensors										
	Systemwide Avg	Total Tips	9625											
	89%	Data Loss	11.86%											
Rain Sensor	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Received	Expected	Missed	Hold-off	Bucket	
100	88%	61	10	0	0	0	0	0	71	81	10	0	0.0393701	
110	80%	48	11	2	0	0	0	0	61	76	15	0	0.0393701	
120	92%	67	4	1	0	0	0	0	72	78	6	0	0.0393701	
140	100%	34	0	0	0	0	0	0	34	34	0	0	0.0393701	
150	79%	47	6	0	3	0	0	1	56	71	15	0	0.0393701	
200	89%	50	2	1	1	0	0	0	54	61	7	0	0.0393701	
210	83%	48	8	2	0	0	0	0	58	70	12	0	0.0393701	
220	85%	64	7	3	0	0	0	0	74	87	13	0	0.0393701	
300	92%	59	6	0	0	0	0	0	65	71	6	0	0.0393701	
310	67%	11	2	0	0	0	1	1	14	21	7	0	0.0393701	
320	87%	58	10	0	0	0	0	0	68	78	10	0	0.0393701	
330	93%	77	4	1	0	0	0	0	82	88	6	0	0.0393701	
400	85%	47	8	1	0	0	0	0	56	66	10	0	0.0393701	
410	90%	48	6	0	0	0	0	0	54	60	6	0	0.0393701	
420	86%	50	8	1	0	0	0	0	59	69	10	0	0.0393701	
440	80%	52	12	2	0	0	0	0	66	82	16	0	0.0393701	
500	85%	48	8	1	0	0	0	0	57	67	10	0	0.0393701	
510	86%	55	8	1	0	0	0	0	64	74	10	0	0.0393701	
520	82%	53	10	2	0	0	0	0	65	79	14	0	0.0393701	
530	89%	57	8	0	0	0	0	0	65	73	8	0	0.0393701	
540	75%	41	9	2	0	0	1	0	53	71	18	0	0.0393701	
600	90%	55	7	0	0	0	0	0	62	69	7	0	0.0393701	
610	94%	68	3	1	0	0	0	0	72	77	5	0	0.0393701	
620	81%	46	7	3	0	0	0	0	56	69	13	0	0.0393701	
630	86%	72	9	2	0	0	0	0	83	96	13	0	0.0393701	
640	88%	46	5	1	0	0	0	0	52	59	7	0	0.0393701	
650	80%	46	8	3	0	0	0	0	57	71	14	0	0.0393701	
700	79%	46	6	3	1	0	0	0	56	71	15	0	0.0393701	
710	90%	54	7	0	0	0	0	0	61	68	7	0	0.0393701	
720	86%	41	8	0	0	0	0	0	49	57	8	0	0.0393701	
730	85%	48	8	1	0	0	0	0	57	67	10	0	0.0393701	
740	98%	49	1	0	0	0	0	0	50	51	1	0	0.0393701	
750	75%	68	15	2	1	2	0	1	88	118	30	0	0.0393701	
760	83%	59	8	3	0	0	0	0	70	84	14	0	0.0393701	
800	84%	43	6	2	0	0	0	0	51	61	10	0	0.0393701	
810	82%	53	10	2	0	0	0	0	65	79	14	0	0.0393701	
820	88%	55	9	0	0	0	0	0	64	73	9	0	0.0393701	
830	87%	51	7	1	0	0	0	0	59	68	9	0	0.0393701	
840	88%	6	1	0	0	0	0	0	7	8	1	0	0.0393701	
850	85%	51	8	0	1	0	0	0	60	71	11	0	0.0393701	
860	74%	40	9	2	2	0	0	0	53	72	19	0	0.0393701	
870	82%	51	7	3	0	0	0	0	61	74	13	0	0.0393701	
900	80%	33	6	2	0	0	0	0	41	51	10	0	0.0393699	
1000	93%	58	5	0	0	0	0	0	63	68	5	0	0.0393701	
1010	87%	60	8	1	0	0	0	0	69	79	10	0	0.0393701	
1030	91%	61	7	0	0	0	0	0	68	75	7	0	0.0393701	
1040	98%	86	2	0	0	0	0	0	88	90	2	0	0.0393701	
1050	88%	58	5	2	0	0	0	0	65	74	9	0	0.0393701	
1060	94%	64	4	0	0	0	0	0	68	72	4	0	0.0393701	
1100	71%	28	3	3	0	0	1	0	35	49	14	0	0.0393701	
1110	83%	24	6	0	0	0	0	0	30	36	6	0	0.0393701	
1200	83%	41	8	1	0	0	0	0	50	60	10	0	0.0393701	
1300	91%	61	7	0	0	0	0	0	68	75	7	0	0.0393701	
1310	85%	52	11	0	0	0	0	0	63	74	11	0	0.0393701	
1320	95%	65	4	0	0	0	0	0	69	73	4	0	0.0393701	
1330	90%	56	5	1	0	0	0	0	62	69	7	0	0.0393701	
1340	78%	42	12	2	0	0	0	0	56	72	16	0	0.0393701	
1350	64%	60	11	10	2	0	2	0	85	132	47	0	0.0393701	
1360	86%	53	10	0	0	0	0	0	63	73	10	0	0.0393701	
1370	92%	41	2	1	0	0	0	0	44	48	4	0	0.0393701	
1400	90%	49	6	0	0	0	0	0	55	61	6	0	0.0393701	
1420	84%	47	7	2	0	0	0	0	56	67	11	0	0.0393701	
1440	100%	29	0	0	0	0	0	0	29	29	0	0	0.0393701	
1460	86%	52	7	0	1	0	0	0	60	70	10	0	0.0393701	
1480	88%	44	3	2	0	0	0	0	49	56	7	0	0.0393701	
1500	88%	65	8	1	0	0	0	0	74	84	10	0	0.0393701	
1520	82%	47	3	3	1	0	0	0	54	66	12	0	0.0393701	
1530	87%	59	6	2	0	0	0	0	67	77	10	0	0.0393701	
1540	90%	49	6	0	0	0	0	0	55	61	6	0	0.0393701	
1600	85%	35	5	1	0	0	0	0	41	48	7	0	0.0393701	
1620	84%	56	9	2	0	0	0	0	67	80	13	0	0.0393701	
1640	89%	56	6	1	0	0	0	0	63	71	8	0	0.0393701	
1660	85%	35	5	1	0	0	0	0	41	48	7	0	0.0393701	
1700	80%	30	4	1	1	0	0	0	36	45	9	0	0.0393701	
1710	80%	51	7	1	2	0	0	0	61	76	15	0	0.0393701	
1720	93%	59	3	1	0	0	0	0	63	68	5	0	0.0393701	



1800	82%	44	6	0	0	0	1	0	51	62	11	0	0.0393701
1810	95%	56	3	0	0	0	0	0	59	62	3	0	0.0393701
1900	87%	35	4	1	0	0	0	0	40	46	6	0	0.0393701
1920	81%	48	7	1	0	1	0	0	57	70	13	0	0.0393701
2190	100%	50	0	0	0	0	0	0	50	50	0	0	0.0393701
2210	95%	52	3	0	0	0	0	0	55	58	3	2	0.0393701
2230	97%	81	3	0	0	0	0	0	84	87	3	0	0.0393701
2240	88%	73	11	0	0	0	0	0	84	95	11	0	0.0393701
2250	87%	58	10	0	0	0	0	0	68	78	10	0	0.0393701
2260	96%	61	3	0	0	0	0	0	64	67	3	0	0.0393701
2270	95%	58	3	0	0	0	0	0	61	64	3	0	0.0393701
2280	93%	53	2	1	0	0	0	0	56	60	4	8	0.0393701
2310	85%	63	7	1	0	1	0	0	72	85	13	0	0.0393701
2320	85%	37	8	0	0	0	0	0	45	53	8	0	0.0393701
2330	84%	88	17	2	0	0	0	0	107	128	21	0	0.0393701
2340	96%	47	0	1	0	0	0	0	48	50	2	0	0.0393701
2350	86%	79	8	1	0	1	0	0	89	103	14	1	0.0393701
2360	94%	77	5	0	0	0	0	0	82	87	5	0	0.0393701
2370	85%	66	9	1	1	0	0	0	77	91	14	0	0.0393701
2710	94%	67	5	0	0	0	0	0	72	77	5	0	0.0393701
2730	85%	41	9	0	0	0	0	0	50	59	9	0	0.0393701
2750	97%	35	1	0	0	0	0	0	36	37	1	0	0.0393701
2810	89%	83	8	0	1	0	0	0	92	103	11	0	0.0393701
2820	94%	83	4	1	0	0	0	0	88	94	6	0	0.0393701
2840	93%	76	6	0	0	0	0	0	82	88	6	0	0.0393701
4010	89%	54	4	0	1	0	0	0	59	66	7	0	0.0393701
4020	92%	59	6	0	0	0	0	0	65	71	6	0	0.0393701
4030	95%	90	5	0	0	0	0	0	95	100	5	0	0.0393701
4040	88%	67	6	2	0	0	0	0	75	85	10	0	0.0393701
4050	93%	47	4	0	0	0	0	0	51	55	4	0	0.0393701
4060	86%	47	5	2	0	0	0	0	54	63	9	0	0.0393701
4070	98%	78	2	0	0	0	0	0	80	82	2	0	0.0393701
4080	95%	50	3	0	0	0	0	0	53	56	3	0	0.0393701
4090	89%	52	4	0	1	0	0	0	57	64	7	0	0.0393701
4100	98%	61	1	0	0	0	0	0	62	63	1	0	0.0393701
4110	95%	52	3	0	0	0	0	0	55	58	3	0	0.0393701
4130	91%	38	4	0	0	0	0	0	42	46	4	0	0.0393701
4140	86%	38	5	1	0	0	0	0	44	51	7	0	0.0393701
4150	87%	39	5	1	0	0	0	0	45	52	7	0	0.0393701
4160	95%	56	3	0	0	0	0	0	59	62	3	0	0.0393701
4170	92%	31	3	0	0	0	0	0	34	37	3	0	0.0393701
4180	81%	36	7	0	1	0	0	0	44	54	10	0	0.0393701
4190	98%	59	1	0	0	0	0	0	60	61	1	0	0.0393701
4200	98%	50	1	0	0	0	0	0	51	52	1	0	0.0393701
4220	96%	44	2	0	0	0	0	0	46	48	2	0	0.0393701
4230	100%	30	0	0	0	0	0	0	30	30	0	0	0.0393701
4240	100%	33	0	0	0	0	0	0	33	33	0	1	0.0393701
4250	100%	48	0	0	0	0	0	0	48	48	0	0	0.0393701
4260	97%	37	1	0	0	0	0	0	38	39	1	0	0.0393701
4270	100%	41	0	0	0	0	0	0	41	41	0	0	0.0393701
4290	87%	30	3	1	0	0	0	0	34	39	5	0	0.0393701
4300	97%	33	1	0	0	0	0	0	34	35	1	0	0.0393701
4310	93%	40	1	1	0	0	0	0	42	45	3	0	0.0393701
4330	94%	48	1	1	0	0	0	0	50	53	3	0	0.0393701
4340	97%	37	1	0	0	0	0	0	38	39	1	0	0.0393701
4350	98%	46	1	0	0	0	0	0	47	48	1	0	0.0393701
4360	90%	57	7	0	0	0	0	0	64	71	7	0	0.0393701
4470	86%	33	2	2	0	0	0	0	37	43	6	0	0.0393701
4490	86%	27	1	2	0	0	0	0	30	35	5	0	0.0393701
4510	95%	39	2	0	0	0	0	0	41	43	2	0	0.0393701
4520	95%	37	2	0	0	0	0	0	39	41	2	0	0.0393701
4530	87%	50	7	1	0	0	0	0	58	67	9	0	0.0393701
4570	85%	47	10	0	0	0	0	0	57	67	10	0	0.0393701
4710	92%	43	4	0	0	0	0	0	47	51	4	0	0.0393701
4730	92%	40	4	0	0	0	0	0	44	48	4	0	0.0393701
4750	80%	27	9	0	0	0	0	0	36	45	9	0	0.0393701
4770	98%	51	1	0	0	0	0	0	52	53	1	0	0.0393701
4790	87%	36	4	1	0	0	0	0	41	47	6	0	0.0393701
4810	92%	61	6	0	0	0	0	0	67	73	6	0	0.0393701
4820	85%	53	7	2	0	0	0	0	62	73	11	0	0.0393701
4830	96%	67	3	0	0	0	0	0	70	73	3	0	0.0393701
4840	94%	60	4	0	0	0	0	0	64	68	4	0	0.0393701
	Total Tips	7539	795	117	21	5	6	3	8483	9625			

# Radio Traffic Plot

