DMS Travel Time Pilot Project Evaluation

Final Report

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Any questions about the contents of the report should be directed to Lydia Warnick, ADOT Transportation Technology Group.

ACRONYM DEFINITIONS

AADT – Average Annual Daily Traffic
ADOT – Arizona Department of Transportation
API – Applications Program Interface
ATMS – Advanced Transportation Management System
Caltrans – California Department of Transportation
CCIT – California Center for Innovative Transportation
CCTV – Closed-Circuit Television camera
CFR940 – Final Rule on ITS Architecture and Standards Conformity
DMS – Dynamic Message Sign
DOT – Department of Transportation
DPS – Arizona Department of Public Safety
DTT – Data Transfer Type
EB – Eastbound
FHWA – Federal Highway Administration
FMS – Freeway Management System
FO – Fiber Optic
FTP – File Transfer Protocol
GDOT – Georgia Department of Transportation
HOV – High-Occupancy Vehicle
ISTHA – Illinois State Toll Highway Authority
ITS – Intelligent Transportation Systems
LED – Light-Emitting Diode
MAG – Maricopa Association of Governments
NB – Northbound
O&M – Operations and Maintenance
ODOT – Oregon Department of Transportation
PAD – Passive Acoustic Detector
PMD – Phoenix Maintenance District
RADS – Regional Archived Data System
SB – Southbound
SMSA – Standard Metropolitan Statistical Area
TAC – Technical Advisory Committee
TOC – Traffic Operations Center
TTG – Transportation Technology Group
TxDOT – Texas Department of Transportation
UDOT – Utah Department of Transportation
US – United States
WB – Westbound

EXECUTIVE SUMMARY

History and Overview

The Arizona Department of Transportation (ADOT) has been actively developing freeway travel times for the last several years on Phoenix metropolitan area freeways. Travel times in the region were first developed by the AZTech™ partnerships. ADOT loop detector data was used and the travel time algorithm was tested and validated on I-17. In January 2008, ADOT initiated a pilot project to display freeway travel times on selected dynamic message signs (DMS) in the Phoenix metropolitan area. The Travel Time Pilot Project included travel time messages being displayed on 12 DMS (six inbound locations during the AM peak travel period, and six outbound locations in the PM peak travel). These sign locations were intended to be visible to the largest number of freeway weekday commuters on the most heavily traveled freeway corridors in the Phoenix metropolitan area.

An evaluation of the pilot project was conducted to identify if there were any impacts to freeway speed, mobility, or crash rates. An integral part of the evaluation also was to obtain user feedback on the Travel Time Pilot Program. Although difficult to quantify, the perceived value of the DMS travel times by regular users of the freeway network during peak travel hours will be an important justification for ADOT to continue and/or expand the DMS Travel Time Pilot Program.

The goals of the DMS Travel Time Pilot Program evaluation were to:

- Evaluate impacts to freeway operations and freeway mobility as a result of posting travel time messages on DMS during peak hour travel;
- Evaluate and document customer response to freeway travel time messages for use in development enhancements or recommended modifications to the DMS Travel Time Pilot Program; and
- Compare the accuracy of travel time messages being displayed with actual travel times.

Best Practices

Overall, positive public feedback has been commonly reported by cities that provide travel time messaging on DMS. However, a recurring notation is that there is a perceived slowdown during the initial stages of DMS travel time activation (made by either motorists or law-enforcement), and few studies were available that specifically addressed that claim. Based on the literature reviewed, a number of cities have indicated that a more focused and planned public outreach program on DMS travel times can help to reduce public concerns over slowdowns and information accuracy. Another lesson learned from other metropolitan areas that post DMS travel times is that travel times are not suitable for every DMS or for every hour of the day – a systematic approach is advisable before beginning to post travel times.

The best practices from other areas displaying travel times on their DMS was used to guide the deployment and recommendations for the ADOT Travel Time Pilot Program moving forward.

Factors Influencing the Evaluation

The following three factors, occurring during the evaluation period, may have influenced the evaluation outcomes:

Speed enforcement cameras on Phoenix area freeways. The presence and operation of speed enforcement cameras between September, 2008 and July, 2010 may have influenced some of the crash and mobility data, although positively, but it is difficult to isolate the travel time display impacts on speeds.

Overall reduction in traffic volumes over the last three years. Arizona DOT's Annual Average Daily Traffic (AADT)volumes showed declining numbers in several locations of the Travel Time Pilot Program. Exceptions to this are I-10 in the West and East Valley, and I-17 near downtown Phoenix.

Corridor widening project on Loop 202. Loop 202 from the I-10/SR-51 interchange to Loop 101 in Tempe was widened to include new eastbound HOV and auxiliary lanes. Construction began in December, 2008 and was completed in 2010. Loop 202 AADTs in the pilot program area dropped significantly between 2008 and 2010.

Outcomes

The evaluation of the Travel Time Pilot Program yielded very positive support from the traveling public, including several comments asking for more signs and travel times on more freeways. The majority of comments received via the website were positive. Similarly, the telephone surveys showed strong support for keeping the Travel Time Pilot Program moving forward. Other parameters that were evaluated during the Travel Time Pilot Program, including speed/mobility and safety, showed no adverse impact of the travel time displays.

The Travel Time Pilot Program's literature review and best practices evaluation revealed some conclusions and outcomes from other jurisdictions, which were used in part to establish research hypotheses for ADOT's program. The project was structured to confirm or refute these hypotheses, and the outcomes are summarized in the table below.

Hypotheses	Summary of Outcome
Minimal reductions to AM freeway speeds/mobility during travel time messages, due to already concentrated AM conditions on weekdays.	The speed assessment showed minimal impact to the freeway mobility upstream of the DMS with active travel times. Variability in the AM drive was higher than PM. I-10 and I-17 demonstrated the most variability.
More noticeable reduction in speed during PM travel periods due to distribution of PM traffic over time.	PM drive showed some degradation of speeds, but in a consistent pattern with the baseline for January 2008.
More noticeable reduction in travel speeds near DMS with two destinations than those with one destination.	There was no discernable correlation between speed reductions at DMS with one versus two destinations.
More positive public feedback is expected on the value of inbound travel time messaging than outbound (inbound travel is expected to have more time constraints than outbound)	Telephone surveys did not indicate a statistically significant difference in perceived accuracy of the information in inbound vs. outbound travel. Commuters who used the freeways primarily in the afternoon were more likely to feel the signs are accurate than those who use the freeways in the mornings or both mornings and afternoons.
Commuters will notice and/or complain about the slowdowns (perceived or real) near the DMS while messages are active.	Some respondents to the survey commented that drivers slow down near the signs (11 comments). These comments were more frequent during the first six weeks of operation.
There is not expected to be an impact on crash frequency as a result of deploying travel time messages on DMS	There were no negative impacts to crash rates near the DMS in the pilot program. In fact, several locations saw reduced crash rates. With other influences on the freeway network, including reduced volumes in many locations and speed cameras widely deployed, it cannot be concluded that the travel time messages were responsible for this reduction in crash rate.
The Travel Time Pilot Program and its associated outreach activities will increase the awareness of and usage of ADOT's 511 and AZ511.gov traveler information systems	Based on the data reviewed, there was not an increase not decrease in usage of the 511 systems as a result of the Travel Time Pilot Program.

Expansion Plan and Costs

The current Travel Time Pilot Program in the Phoenix metropolitan area includes a limited number of DMS on a limited number of corridors. Given the popularity of the program and the current and near-term Freeway Management System (FMS) infrastructure to support travel times, it is recommended that ADOT expand the program to include additional DMS and additional corridors and destinations only in AM and PM peak hours. In June 2010, ADOT proposed an expansion to the FMS program over the next six years to continue and incrementally expand the Travel Time Program, and this was unanimously approved by the MAG ITS Committee. Key recommendations from the expansion plan include:

Do not remove any signs from program – It is recommended to not significantly modify the current travel time DMS locations used and routes reported because they have established known routes to the public. Minor adjustments may be warranted based on major interchanges (such as Bell Rd, Shea Blvd, 83rd Ave, etc.) and new definition of FMS boundaries that do not limit reporting routes.

Add new signs to program – It is recommended to expand the Travel Time Pilot Program to other freeway corridors and DMS in AM and PM peak hours due to new phases of the FMS program being installed as well as the *potential* for private sector speed data to supplement ADOT's detection (for corridors where detection has not been deployed). ADOT proposed and the MAG ITS Committee meeting unanimously agreed to *plans* for introducing new DMS every year to the Travel Time Program prior to completing this final report with the phasing plan as discussed below.

All major corridors that have been instrumented with FMS or have planned FMS in the future have been included in the expansion of the Travel Time Pilot Program in AM and PM peak hours. The phasing plan is summarized as follows:

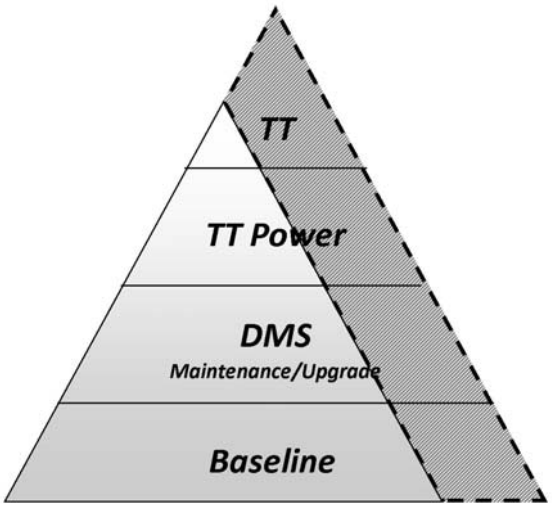
- **Existing (2010, 12 DMS) –** Travel time messages currently being displayed as part of the program.
- **Phase 1 (2011, 19 DMS) –** Minor modifications to current travel time messages and new travel time messages recommended due to the expansion of FMS and detection in the Valley that has occurred since the original launch of the Travel Time Pilot Program.
- **Phase 2 (2012, 23 DMS) –** Travel time message recommendations based on FMS expansion plans by 2012.
- **2013-2016 (23 DMS) –** Continue operating Phase 2 due to anticipated coverage of existing logical corridors.
- **Phase 3 (2017, 25 DMS) –** Travel time message recommendations based on FMS expansion plans by 2017.

Costs of the Travel Time Pilot Program

The project management team was challenged with identifying the costs associated with the travel time expansion program. After much deliberation, the following costs were identified:

- Travel time algorithm development/support;
- Incremental weekday power costs associated with posting travel times on DMS during peak hours;
- Maintenance/upgrade costs for a set number of DMS regardless of the types of messages posted;
- Hardware, software, and licensing costs used to support the entire state ITS program, not just travel times on DMS;
- ADOT TOC facility costs used to support the entire state ITS program, not just travel times on DMS;
- ADOT TOC staff costs used to support the entire state ITS program, not just travel times on DMS; and
- DMS lifecycle costs.

The first two bullets are specific to travel times on DMS operations. If the travel time program was cut, this savings would be realized. Bullet three refers to the maintenance/upgrade of a set number of DMS regardless of the type of message posted. If the travel time program was cut, this cost would still be there because the DMS are used for posting other messages besides travel time and would still need to be maintained/upgraded. Bullets four, five, and six are baseline costs that support the entire state ITS program, not just travel times on DMS.



In the event there are changes to funding the program, the Travel Time Pilot Program will be proportionately affected. Funding shortfalls will significantly reduce the program capabilities and will thereby affect the travelers who have come to expect the information displayed on DMS along their route.

Maintenance/Upgrade Costs

Regular maintenance checks are required for ADOT DMS. These maintenance checks may incorporate bulb replacement costs or shutter costs for additional use of the DMS display, but these costs are estimated as insignificant when compared to the general maintenance costs of the DMS. New LED technology signs offer power and maintenance savings making for a more cost effective operations of DMS. This is important as ADOT is currently utilizing the new LED technology for new DMS locations as well as upgrading older signs to newer and more cost-effective LED sign technology. The LED technology has different operating characteristics than the fiber optic display systems previously used.

Lifecycle Costs

The LED light component of the panel that makes up the DMS display is the main component that is affected by continuous use. Panels on the DMS display can be maintained or replaced without a forklift replacement of the full DMS structure. To date, ADOT is on a 15-year replacement cycle for DMS. As technology improves and becomes more cost effective, it becomes more prudent to upgrade the technology in advance of failure. Many of ADOT's DMS, part of the initial phases of ADOT's FMS program, were installed in 1995 and are currently being upgraded to LED technology. To date, ADOT has not had to replace any LED panels on DMS that were deployed as part of Loop 101 and US-60 phases of FMS approximately five years ago. It can be assumed that an LED or LED panel should be replaced 20% faster due to travel time peak period posting; however, the LED mean time between failure of 11.5 years exceeds the timeframe for ADOTs standard replacement for LED panels. This means that even though the use of the DMS increases, the lifecycle costs remains the same if ADOT continues to replace DMS every ten years.

1. INTRODUCTION

1.1 Travel Time Pilot Program Background

The Arizona Department of Transportation (ADOT) has been actively developing freeway travel times for the last several years on Phoenix metropolitan area freeways. Travel times in the region were first developed by the AZTech™ partnerships. ADOT loop detector data was used and the travel time algorithm was tested and validated on I-17. Corridors where travel times are available are limited to those corridors where ADOT has Freeway Management System (FMS) detection in place to generate real-time speed, occupancy and volume data. Freeway travel times had previously only been available via 511 and www.AZ511.gov (including the 511 mobile application, **shown in Figure 1**), as well as on traveler information screens at the Phoenix Sky Harbor Airport Rental Car Center owned and operated by Maricopa County DOT. Several local media outlets also provide travel time information during AM and PM radio and television traffic reports.

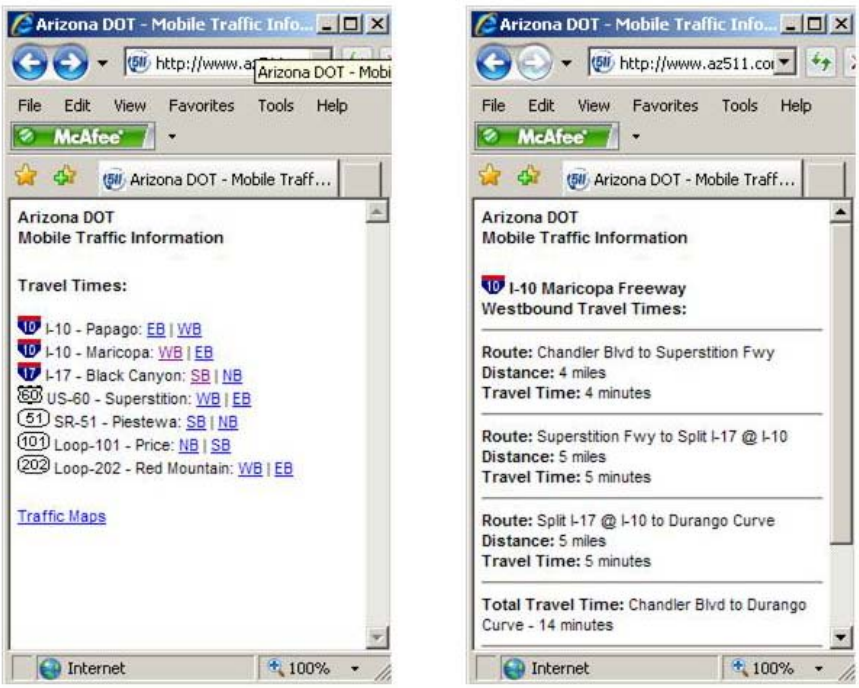


Figure 1 - Travel Time Displays from www.AZ511.gov Mobile Application

1.2 Pilot Program Initiation

In January 2008, ADOT initiated a pilot program to display freeway travel times on selected dynamic message signs (DMS) in the Phoenix metropolitan area. The pilot program included travel time messages being displayed on 12 DMS (six inbound locations during the AM peak travel period, and six outbound locations in the PM peak travel). **Figure 2** shows the locations of the inbound and outbound DMS that are part of the Travel Time Pilot Program, and **Figure 3** shows an active travel time message on a Phoenix-area DMS.

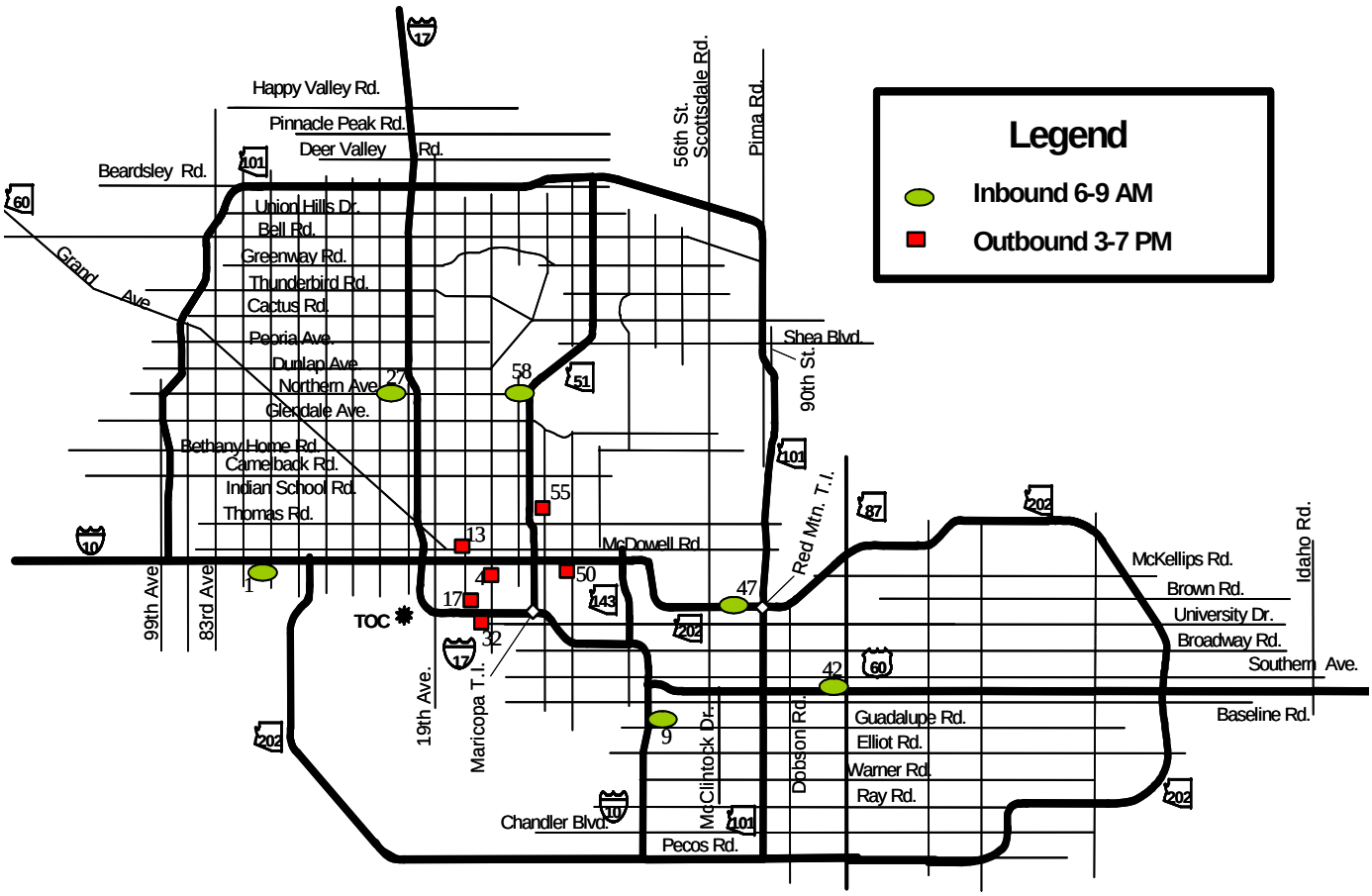


Figure 2 - DMS Locations for Travel Time Pilot Program

Figure 3 – DMS Sign with Travel Time Display

ADOT had several criteria for the basis of corridor, segment and sign selection:

- Freeways in the pilot corridor needed to be instrumented with ADOT FMS detection in order to calculate segment travel times;
- Sign locations were selected to provide the motorist with information about travel times in advance of a decision point or potential alternate on another ADOT-operated corridor; and
- Inbound travel times were intended to provide a central reference point of the I-10 tunnel, and outbound travel times typically originated at the I-10 tunnel.

These sign locations were intended to be visible to the largest number of freeway weekday commuters on the most heavily traveled freeway corridors in the Phoenix metropolitan area. **Table 1** shows the selected DMS and their corresponding travel time segments for inbound and outbound messages.

Table 1 – DMS Locations and Messages for Inbound and Outbound Displays

Inbound 6 AM - 9 AM					
DMS #	**Corridor**	**Direction of Travel**	**Location**	**Primary Travel Time Destination**	**Secondary Travel Time Destination**
1	I-10 West Valley	EB	67th Ave.	TUNNEL	AIRPORT EXIT
9*	I-10 East Valley	NB	Guadalupe Rd.	SR-143 EXIT	TUNNEL
27	I-17	SB	Northern Ave.	I-10 TUNNEL	N/A
42	US-60 Superstition Fwy	WB	Extension Rd.	TUNNEL	VIA I-10
47**	L202 Red Mtn	WB	McClintock Dr.	SR-143 EXIT	I-10 TUNNEL
58	SR-51	SB	Northern Ave.	I-10 TUNNEL	N/A
Outbound 3 PM - 7 PM					
DMS #	**Corridor**	**Direction of Travel**	**Location**	**Primary Travel Time Destination**	**Secondary Travel Time Destination**
4	I-10 Downtown	EB	10th St.	RAY RD	SR-51 BELL RD
13	I-10 Downtown	WB	7th Ave.	83RD AVE	I-17 PEORIA AVE
50	L202 Red Mtn	EB	24th St.	LOOP 101	N/A
32	I-17 Downtown	SB	Central Ave.	I-10 RAY RD	US-60 VAL VISTA
17	I-17 Downtown	NB	4th Ave.	PEORIA AVE	I-10 83RD AVE
55	SR-51	NB	Osborn Rd.	BELL RD	N/A

*On May 18, 2010, DMS 9 inbound DMS was changed to DMS 8 (I-10 WB Ray, with the same destinations).
**On January 25, 2011, destinations and display was changed to 44th Street and I-10 Tunnel

1.3 DMS Travel Time Pilot Program Timeframe

The expected timeframe for the DMS Travel Time Pilot Program was 12 months, commencing January 21, 2008 and ending January 21, 2009. ADOT extended the evaluation to cover a three-year operating period ending on January 21, 2011.

1.4 Project Evaluation Overview and Goals

An evaluation of the pilot project was conducted to identify if there were any impacts to freeway speed, mobility, or crash rates. An integral part of the evaluation also was to obtain user feedback

on the Travel Time Pilot Program. Although difficult to quantify, the perceived value of the DMS travel times by regular users of the freeway network during peak travel hours will be an important justification for ADOT to continue and/or expand the DMS Travel Time Pilot Program.

The goals of the DMS travel time evaluation were to:

- Evaluate impacts to freeway operations and freeway mobility as a result of posting travel time messages on DMS during peak hour travel;
- Evaluate and document customer response to freeway travel time messages for use in developing enhancements or modifications to the DMS Travel Time Pilot Program; and
- Compare the accuracy of travel time messages being displayed with actual travel times.

The evaluation was comprised of several tasks:

- Review literature and document pertinent evaluation outcomes from other travel time programs in the United States that could be used to establish hypotheses for the Phoenix metropolitan area DMS Travel Time Pilot Program;
- Develop an evaluation strategy and plan, including timing of key evaluation activities, data collection requirements, and documentation requirements;
- Monitor freeway speeds near the DMS that are part of the Travel Time Pilot Program once travel time messaging is activated, and identify if or where there are any significant impacts to freeway travel and mobility as a result of the messages;
- Conduct a comprehensive user satisfaction survey among frequent freeway commuters to determine users' perception of the value, accuracy and overall benefit of freeway travel times during peak travel periods; and
- Develop a final report and presentation summarizing findings from the pilot program evaluation.

An additional task, although directly related to the evaluation, is to develop systems engineering documentation for the Travel Time Pilot Program.

1.5 Focus and Organization of This Report

This report is organized into the following sections:

Section 1

Introduction and background on ADOT's Travel Time Pilot Program and Evaluation.

Section 2

Literature Review, presents findings from comparable urban-area travel time programs around the country with a focus on lessons learned and outreach strategies.

Section 3

Evaluation Strategy, which presents the methodology for the different components of the Travel Time Pilot Program evaluation. This includes the speed and mobility study basis of evaluation, safety assessment and methodology, and the different methods by which public perception was gauged and evaluated, among other evaluation parameters. This section also identified factors that influenced the evaluation, including the overall traffic volume decline and the speed enforcement camera program which was active during most of the Travel Time Pilot Program.

Section 4

Evaluation results and summary provides the output of the evaluation strategies, and includes a summary of the outcomes against the initial hypotheses.

Section 5

Systems Engineering Analysis, a federal requirement, demonstrates compliance with the systems engineering process to develop, design and implement the Travel Time Pilot Program.

Section 6

Expansion Plan, describes expansion strategies to include additional corridors and signs/locations over time, and provides cost estimates for continuation of the Travel Time Pilot Program.

2. LITERATURE REVIEW

This section contains summaries of the literature and documentation review from other metropolitan areas' travel time program evaluations. The following areas are included in these summaries:

- Atlanta, Georgia
- Chicago, Illinois
- Houston, Texas
- Los Angeles, California
- Portland, Oregon
- Salt Lake City, Utah
- San Antonio, Texas
- San Francisco, California

2.1 Atlanta, Georgia

Georgia DOT (GDOT) began posting travel times information on DMS in 1998. It was reported that Atlanta drivers responded positively to the time-based travel time message, such as "8-10 minutes." Display of a range for posted travel times (such as 8-10 minutes) helps to ensure the accuracy of the information. Because the accuracy of estimated travel time decreases over longer distances, GDOT does not provide travel time information for distances greater than 15 miles away from the DMS. GDOT receives complaints from the public if travel time information is not displayed since travelers are accustomed to the availability of travel time information. Travel time messages are currently the default message on the 80 DMS in Atlanta area. GDOT utilizes CCTV cameras as an inexpensive approach to measure the travel times of easily identifiable vehicles through a segment in its network.

Georgia DOT also provides travel times for HOV lanes. A second-phase message was used to display the historical savings that HOV travel affords.

2.2 Chicago, Illinois

Illinois State Toll Highway Authority (ISTHA) reported that public feedback on posted travel time information has been extremely positive. Through customer e-mail and calls to customer service, motorists have expressed dissatisfaction over other messages, particularly a non-incident related message, being posted onto the DMS in place of travel time. Accuracy of estimated travel time is very important as ISTHA hears from motorists if they feel that travel time messages are incorrect. During the initial stages of the travel time program, CCTV monitoring of traffic conditions were utilized to compare with travel time estimates provided by software in order to ensure accuracy. An on-call consultant also conducted a series of probe-vehicle travel time tests to check data quality. (Travel Time Messaging on Dynamic Message Signs – Chicago, IL, ISTHA, May 2005.)

Illinois DOT also reported that travel times are calculated for express lanes and local lanes separately, and they are posted on separate DMS.

2.3 Houston, Texas

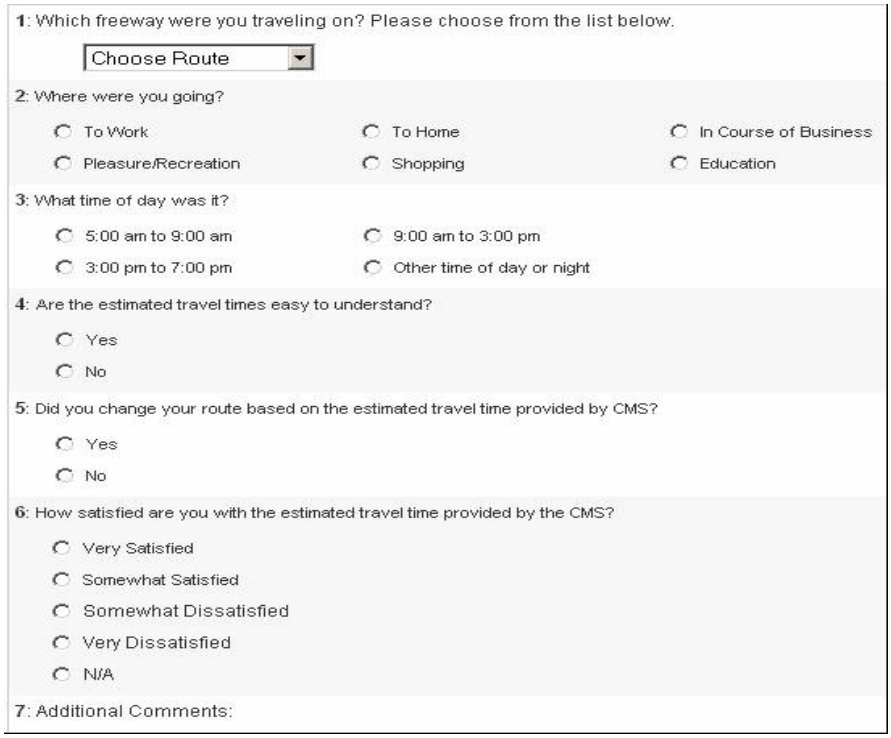
Texas DOT (TxDOT) reported that there were no available quantitative results to support a positive impact of travel time messaging on DMS; however, a number of surveys were conducted between April-May 2004 to assess motorist satisfaction and evolving needs. The results of the surveys were as follows:

- 85% of respondents changed route in response to travel time information; 66% felt that this reduced their travel time, 29% were unsure
- Freeway travel times messaging – 82 percent indicated positive benefits
- Time sensitive messages should not be older than 15 minutes
- Many respondents stated that incident information is nice, but that they also need travel time information to better determine how the incident impacts their travel.
- Drivers prefer single-phase messages

2.4 Los Angeles, California

Caltrans District 7 (Los Angeles metropolitan area) has been providing travel times on freeway DMS since 2005. Caltrans reported that motorists slowed noticeably during the first few days of DMS travel time activation, but speed returned to base line level after two weeks. Caltrans District 7 also provides an e-mail alert service for travel times; it is free, but users must register through the Caltrans web site.

Caltrans implemented an on-line customer feedback survey which asks users to let Caltrans know the routes they travel, how accurate they experienced the travel times to be, if they are easy to understand, and whether travelers are satisfied with the travel time program. A sample of the on-line survey form developed by Caltrans is shown below:



(http://www.dot.ca.gov/dist07/travel_time)

2.5 Portland, Oregon

During the initial stages of DMS travel time activation, State Police informed Oregon DOT (ODOT) that motorists actually slowed down to read the posted messages. As a result, ODOT then initiated a more aggressive outreach campaign to educate the public about travel time messaging. Regardless whether the travel time message has one or two destinations, ODOT only uses single-phase DMS messaging in order to reduce overall driver distraction. Public feedback and comments are collected via ODOT's "Tripcheck" website. ODOT recommends travel time estimate accuracy to be at least 70% in order to gain and maintain public trust. It was also found that the travel time estimate is more accurate during free-flow conditions than during periods of congestion. A survey, conducted by ODOT, found that the public did not want travel time information when traffic was flowing freely. (Travel Time Messaging on Dynamic Message Signs – Portland, Oregon, ODOT, May 2005.)

ODOT conducted a Travel Time Estimation Project to assess the performance of the detectors and algorithm currently adopted to estimate travel times for DMS messaging. The statistical analysis concluded that the most travel times estimates by ODOT's Advanced Transportation Management System (ATMS) performed very well in comparison with the probe vehicle times. The project also included an assessment of recommended locations where additional detectors would improve travel time estimates.

2.6 Salt Lake City, Utah

Utah DOT (UDOT) began its DMS travel time pilot project in January of 2005. A online survey on the CommuterLink web site was adopted to collect public feedback on DMS travel time messages. The majority of respondents (86% of 1800 surveys collected) viewed the travel time messages beneficial even though some felt that the messages were distracting. Those who favored the display of travel times would like to see the travel time program expanded. However, travel time is only calculated and displayed when 80% of speed sensors are reporting data, and travel time message never show times faster than the posted speed limit.

During the initiation of travel time messaging, motorists were initially were confused and slowed down to read the messages, resulting further traffic delays. However, once UDOT increased its efforts in the outreach campaign, complaints about slowed vehicles have stopped. (ITE, 2005)

Some motorists have stated that they begin to tune out DMS travel time messages as the information remains static all the time. Thus, when important is displayed, they tune it out as well. (Driver Use of En Route Real-Time Travel Time Information – Task 2, WESTAT, June, 2007.)

2.7 San Antonio, Texas

San Antonio was among the first regions in the country to display freeway travel times on DMS. TransGuide reported that the display of travel time has been well received by the public, and has been widely used by media stakeholders in their daily traffic reporting. The travel time destinations on specific DMS are maintained so that they are always consistent. This approach hoped to familiarize motorists with the travel times posted during their daily commutes, resulting in fewer slowdowns and a benchmark of what to expect during on-and-off peak hours. (White Paper Response: ITS America RFI Travel Time Projects in North America, San Antonio TransGuide)

San Antonio demonstrated its creativity in building up to the initiation of travel time messages by displaying DMS messages that informed motorists that "travel times are coming in xx days."

Now, the general public and media expect the availability and reliability (to be accurate) of travel time information even to the extent of expecting travel times to be available through construction zones. (San Antonio TransGuide Travel Time Program, Southwest Research Institute, September, 2005.)

The TxDOT San Antonio District is embarking on implementing toll facilities (through a private partner) in the near term. The vision is to integrate this tollway system with the TransGuide system, and provide information about travel time comparisons between the toll lanes and general purpose lanes.

2.8 San Francisco Bay Area, California

A pilot deployment of travel time messaging on DMS, which started in May 2005, enabled the evaluation of its robustness and public acceptance. For this pilot project, two signs were operated on I-80. In October 2005, a survey, both online and paper form, was conducted to collect and analyze the public's reaction. Two channels were adopted to promote commuters to complete the online survey: advertisements on the AZ511.gov homepage and through FasTrak toll monthly billing statement. The paper surveys were distributed at the regional carpool locations. A total of 12 questions were developed in the survey:

1. Have you seen the travel time sign on I-80?
2. Which travel time message(s) have you seen?
3. Are the travel time messages located on your regular commute?
4. When you last saw a travel time message, where were you traveling from and to?
5. How useful do you consider the travel time message to be?
6. How accurate do you find the travel time estimations?
7. How difficult was it to read the sign while driving?
8. Do you get the impression that the travel time messages are updated?
9. Does displaying three travel time messages on one sign provide too much information to read while driving?
10. Do you like the current travel time estimation?
11. Please suggest any other destinations that you would find useful.
12. Please share with us any comments/suggestions you may have.

From the responses in the write-in portion of the survey (Question 12), slowdowns which could be perceived or real were reported. However, the travel time messages were not directly targeted, suggesting their usefulness. The most important survey results are as follows:

- Majority found posted travel times useful and accurate; only 10% of respondents gave a negative rating in terms of usefulness and accuracy.
- 82% of respondents indicated that they liked the current travel time destinations.
- There were no strong opinions on the travel time update rate.
- Some expressed confusion on the data source, assuming that travel times differ on HOV and general-purpose lanes.

In 2005, California Center for Innovative Transportation (CCIT) conducted a separate before-and-after analysis of the effects of the two DMS on driving speed. A statistical regression analysis was performed on loop detector data nearby the locations of the two DMS. Two month-period data in both 2004 (DMS inactive) and 2005 (DMS active) were collected and analyzed. Analysis done on eastbound DMS showed a uniform 3 mph speed reduction; however, the effect

was less apparent during congested periods. On the other hand, a clear or measurable effect could not be concluded for the westbound DMS. It was speculated that sign legibility may be the potential cause for the difference observed. **Overall, the DMS activation appeared to have a limited effect on speed. To the extent that the effect wears out over time, CCIT claimed a 3 mph speed reduction in the first 2 months seems acceptable**. (Travel Times on Changeable Message Signs in District 4, CCIT, July, 2006)

2.9 Summary of Findings

Overall, positive public feedback has been commonly reported by cities that provide travel time messaging on DMS. However, a recurring notation is that there is a perceived slowdown during the initial stages of DMS travel time activation (made by either motorists or law-enforcement), and few studies were available that specifically addressed that claim (with the exception of San Francisco/Caltrans District 4).

Survey is the most common tool adopted to assess the impacts of DMS travel time messaging on drivers. On-line surveys or some form of web-based feedback from users were the most common methods of DOTs receiving direct feedback from drivers. Most of the cities have utilized the survey responses as guidelines of making modifications to specifications of the DMS travel time system, including message-phasing, message format and broadcast requirements.

Based on the literature reviewed, a number of cities have indicated that a more focused and planned public outreach program on DMS travel times can help to reduce public concerns over slowdowns and information accuracy.

The results of a survey conducted in Portland, Oregon regarding their travel time program during 2002 indicated that drivers did not want travel time data during free flow conditions. Posting messages during peak periods alerts drivers to the travel time information. Posting during free flow conditions allows drivers to become used to the messages posted and thus reduces the alerting ability of the message if it shows an increased travel time along the route.

3. EVALUATION STRATEGY

There are several overarching strategies that guided the evaluation component of the DMS Travel Time Pilot Program.

- Monitor freeway speeds near DMS on pilot study corridors during launch and post-launch;
- Identify any impacts – positive or negative – to freeway speed and mobility on pilot study corridors where travel time messages are being posted on DMS;
- Obtain feedback from commuters about their perception of the value, accuracy, and clarity of the travel time information being displayed;
- Validate the correlation between displayed travel time messages and actual drive times; and
- Document the outcomes of the speed impact assessment and customer feedback.

3.1 Research and Evaluation Hypothesis

The hypotheses and potential activities for evaluating the effectiveness, accuracy and usefulness of travel time messages on DMS are presented in **Table 2** and also includes data sources that the evaluation team utilized to support the analysis.

Table 2 - Hypothesis Testing Measures

Hypothesis	Performance Measures	Data Sources
Minimal reductions to AM freeway speeds/mobility during travel time messages, due to already concentrated AM conditions on weekdays.	Differences in AM traffic flow based on comparison of active travel time message speeds vs. baseline speeds	-FMS speed data from DMS buffer zones -ADOT freeway crash data
More noticeable reduction in speed during PM travel periods due to distribution of PM traffic over time.	Differences in PM traffic flow based on comparison of active travel time message speeds vs. baseline speeds	-FMS speed data from DMS buffer zones -ADOT freeway crash data
More noticeable reduction in travel speeds near DMS with two destinations than those with one destination.	FMS detector data analysis and comparison of corridors with one destination message and two destination message	-FMS speed data from DMS buffer zones
More positive public feedback is expected on the value of inbound travel time messaging than outbound (inbound travel is expected to have more time constraints than outbound)	Quantitative survey measures on DMS travel time message's usefulness, accuracy and legibility to the drivers	-Commuter Surveys -Public feedback via AZ511.gov
Commuters will notice and/or complain about the slowdowns (perceived or real) near the DMS while messages are active.	Cross-examine the comments made by the survey respondents with the FMS detector data results.	-Commuter Surveys -FMS speed data from DMS buffer zones
There is not expected to be an impact on crash frequency as a result of deploying travel time messages on DMS	Differences in crash rates nearby DMS before and after the travel time messaging	-ADOT freeway crash data
The Travel Time Pilot Program and its associated outreach activities will increase the awareness of and usage of ADOT's 511 and AZ511.gov traveler information systems	The usage rate (or hit rate) of 511 system and AZ511.gov website before and after the activation of DMS travel time messages	-511 and AZ511.gov usage data

3.2 Year 1 Initial Launch and Mid-Year Adjustment

When the Travel Time Pilot Program was launched in January 2008, ADOT made the decision to present travel times in rounded five-minute increments. This was based on feedback from other regions that cited customer complaints if travel times were not accurate. This strategy rounded up until the next five minute increment was reached. For example, if the algorithm calculated a segment travel time of 16 minutes, the presentation on the DMS was rounded to 20. Similarly if it was calculated for 17, 18 or 19 minutes. Travelers quickly noticed this rounding strategy, and the on-line survey received several comments from users about inaccurate travel times and specific questions about why ADOT was rounding travel times to five-minute increments.

In July 2008, six months after the initial launch, ADOT modified the travel time presentation to display travel times in more precise numbers. This eliminated travel times being displayed in five-minute increments, although there was a buffer added of one to two minutes above the system-generated travel time. There were no other changes made to the display, and the corridors and destinations remained the same as the initial launch.

3.3 Factors Influencing the Evaluation

During the course of the Travel Time Pilot Program evaluation, there were several factors that influenced the speed and crash analyses:

Speed enforcement cameras on Phoenix area freeways. In September, 2008, the Arizona Department of Public Safety (DPS) began installing and operating speed enforcement cameras on freeways throughout the Phoenix metropolitan area, as well as statewide. These freeways included most of the corridors included in the Travel Time Pilot Program; in some cases, multiple speed cameras were located in relatively close proximity on certain corridors. This speed enforcement program was intended to make drivers aware of speed limits, and harmonize speeds at speed limit levels. DPS had indicated through media interviews that within the first year of the program, there were 22% fewer fatal collisions in metropolitan Phoenix, which equates to 12 fewer fatal collisions (which statistically equates to 13 saved lives). This statement would point to a reduced crash rate as a result of more harmonized speeds. Cameras were in effect September 2008 until July 2010, when DPS opted not to renew the camera vendor's contract. The presence and operation of these cameras may have influenced some of the crash and mobility rates, although positively, but difficult to isolate travel time display benefits.

Overall reduction in traffic volumes over the last three years. Arizona DOT's Annual Average Daily Traffic volumes showed declining numbers in several locations of the Travel Time Pilot Program. Exceptions to this are the location on I-10 in the West and East Valley, and I-17 near downtown Phoenix. Most other locations saw a decline in volumes between 2007 (baseline year) and 2009 (last year for which data is available).

Corridor widening project on Loop 202. Loop 202 from the I-10/SR-51 interchange to the Loop 101 in Tempe was widened to include new eastbound HOV and auxiliary lanes. Construction began in December 2008 and was completed in 2010. Loop 202 AADTs in the Travel Time Pilot Program area dropped significantly between 2008 and 2010.

Another factor influencing the research and expansion plan was the unanimous decision by the MAG ITS Committee to expand ADOT's Travel Time Pilot Program. In June 2010, the MAG ITS Committee approved a proposal by ADOT to incrementally expand the program with additional funding identified in the FMS program over a six year period (through 2015). At the time of this decision, the Expansion Plan was not yet complete, and this demonstrates the strong regional support for continuation and expansion of this successful traveler information tool.

3.4 Impacts to Freeway Speeds and Mobility

Many of the cities researched in the literature review commented that commuters complained about the slowdowns caused by DMS travel time messaging. The travel impact study evaluated the impacts of DMS travel time message displays on freeway travel speeds near the DMS. It was important to identify if there are noticeable impacts to freeway speeds in the days immediately following the launch, as opposed to one to two months following the launch when motorists are more accustomed to seeing the travel time messages.

Special attention was taken on the differences in speed to test the common claim that drivers slow down to read the new travel time messages on DMS during the initial phases of the activation. The evaluation also analyzed the possible differences in commuter behavior during AM and PM peak hours due to the different levels of congestion and the temporal differences of the AM and PM commutes. Identifying speed impact trends was important information for ADOT to consider if ADOT decides to expand the Travel Time Pilot Program to other DMS locations.

This task of the evaluation included a before-and-after data analysis of freeway segments near the 12 DMS that are part of the Travel Time Pilot Program. The research team established typical baseline freeway speeds for these corridors, and used loop detector data from ADOT within an approximate one-mile buffer zone of each DMS for AM inbound and PM outbound travel periods (this is approximate because in some instances, the closes upstream detector may have been more than one mile away from the DMS).

Specific strategies used by the research team included:

- Established 'typical' before speed conditions in the DMS buffer zone for each corridor in the pilot program;
- Monitored freeway speeds in the buffer zones the days and weeks following the launch (up to two months), and note any significant speed impacts or trends;
- Documented post-launch speeds and compare to typical before speeds in the buffer zones; and
- Note if there were any extraneous circumstances that could have impacted or influenced significant speed changes (such as a work zone or incident).

There are several factors that can influence overall mobility on the freeways – non-recurring congestion as a result of incidents or work zones will definitely have an impact on speeds. Similarly, large-scale special events could have the potential to generate much more traffic on certain freeway corridors than typically experienced during the AM or PM peak. The research team coordinated with ADOT to obtain information about planned closures or restrictions on the corridors within the pilot study area. Special event dates and locations for large-scale events will also be identified. Based on the findings from other areas, there was not expected to be a significant impact to mobility on the freeways as a result of displaying travel times.

3.4.1 Define Analysis Zones and Establish Baseline Speeds

The first step of the evaluation was to define the analysis zone and establish 'typical' before speed conditions in the DMS buffer zone for each corridor in the pilot program. It was assumed that slowdowns caused by the DMS travel time messaging would not impact beyond one to two miles upstream of the DMS location.

The following schematic in **Figure 4** illustrates the concept of buffer zone for the data collection and speed analysis:

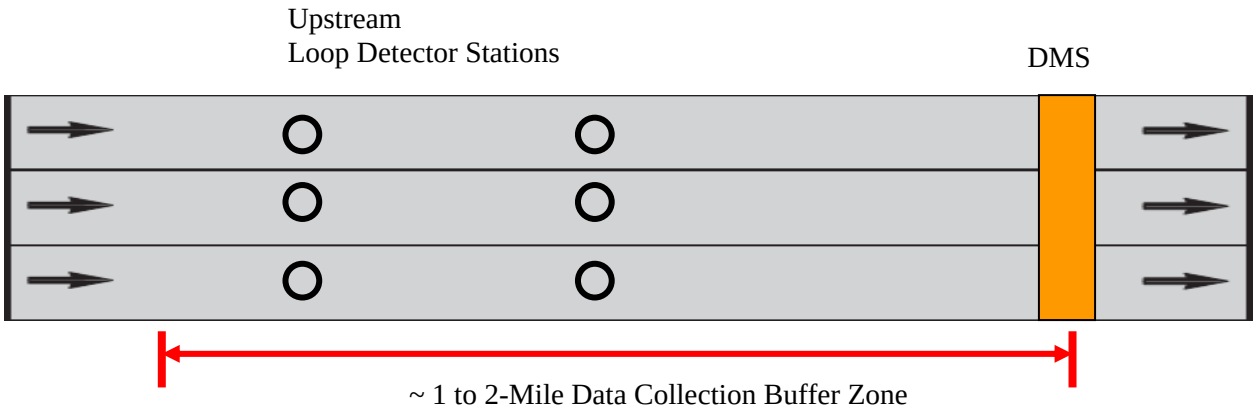


Figure 4 – Speed Analysis Zone Concept

For the purpose of evaluating the impacts of DMS Travel Time Pilot Program, archived data from ADOT's FMS detectors was utilized to monitor the traffic conditions before and after the launch of DMS travel time messages. There were 519 operational detector stations prior to the decommissioning effort that took place starting mid-January 2005. As of 11/26/2007, there were 199 operational detector stations.

Based on the defined buffer zone for each DMS, the inventory list of existing operational detectors that will be used to collect the traffic data is shown in **Table 3** below. It is important to note that the detection is primarily loop, but also included a limited amount of acoustic detectors on some segments.

For each of 12 DMS, at least two detector stations were utilized to collect the necessary traffic speed data. Due to the variability of the detector locations in relation to the DMS, the measurable distance for each speed evaluation varies to within two miles upstream of the DMS.

Table 3 – ADOT Detector Stations for Speed Evaluation

Direction	DMS Location	Detector #	Cross-street	Detector Type	Milepost	Dist. from DMS (mile)
Inbound	DMS 1 I-10 EB 67th Ave	8	73RD AVE	1 SAS PAD	136.901	0.8
		2	81ST AVE	1 SAS PAD	135.883	1.8
Outbound	DMS 13 I-10 WB 7th Ave	84	4TH ST	Loops	145.681	1.0
		139	15TH ST	Loops	146.823	2.1
Inbound	DMS 9 I-10 WB Guadalupe Rd	417	LA PUENTA AVE	Loops	157.590	1.1
		414	TAMBLO DR	Loops	158.560	2.0
Outbound	DMS 4 I-10 EB 10th St	85	9TH ST	Loops	146.058	0.2
		80	5TH AVE	Loops	144.955	1.2

Table 3 – ADOT Detector Stations for Speed Evaluation (continued)

Direction	DMS Location	Detector #	Cross-street	Detector Type	Milepost	Dist. from DMS (mile)
Inbound	DMS 47 L-202 WB McClintock Dr	272*	89TH ST	Loops	009.538	0.1
Outbound	DMS 50 L-202 EB 24th ST	229*	23RD ST	Loops	000.572	0.2
Inbound	DMS 42 US-60 WB Extension Rd	482	VINEYARD	2 SAS PADs	179.370	0.5
		479	POMEROY	2 SAS PADS	180.350	1.5
Outbound	DMS 32 I-17 SB Central Ave	108	4TH AVE	Sawcut loops	196.888	0.5
		114	18TH AVE	Sawcut loops	197.956	1.6
Inbound	DMS 27 I-17 SB Northern Ave	361	TOWNLEY AVE	1 SAS PAD	207.690	0.9
		358	BERYL AVE	1 SAS PAD	208.690	1.9
Outbound	DMS 17 I-17 NB 4th Ave	104	5TH ST	Sawcut loop	196.198	0.5
		98	15TH ST	Sawcut loop	195.198	1.5
Inbound	DMS 58 SR-51 SB Northern Ave	297	TOWNLEY AVE	2 SAS PAD	008.160	0.7
		299	SB 29TH PL	1 SAS PAD	008.830	1.3
Outbound	DMS 55 SR-51 NB Osborn Rd	206	AVALON DR	1 SAS PAD	001.790	0.5
		203	AVALON DR	1 SAS PAD	000.720	1.6

Note: * indicates that the loop detector station is the end of the existing FMS detection coverage

Fifteen-minute aggregated and averaged values of speed and volume from ADOT's detector data archive were collected from the identified detectors, and were used for the analysis. The evaluation team obtained data from the specified detector locations within the archive (accessible via ADOT's File Transfer Protocol [FTP] site). Speed is the main parameter for comparison to evaluate the before-and-after impacts of the DMS travel time messages near the signs. During the process of establishing 'typical' before traffic conditions, as well as during the speed analysis once the travel time messages are activated, any loop-detector data irregularity that was determined to be attributed by non-recurring closures and restrictions was discarded.

Detector data from the DMS travel time activation periods: 6-9 AM (Inbound DMS) and 3-7 PM (Outbound DMS) were analyzed. In order to obtain sufficient *baseline* data for the before-and-after analysis of the effects of DMS travel time messaging on traffic, the evaluation team compiled three weeks worth of ADOT detector data in the buffer zone of each DMS that is part of the Travel Time Pilot Program. Because the launch occurred in January 2008, the team utilized comparable detector sets that correspond with the 'winter' driving season due to the fact that the Phoenix area seasonal differences are more pronounced on average than other areas in the nation[1]. For example, a "Monday" baseline

[1] Monitoring Urban Roadways in 2001: Examining Reliability and Mobility with Archived Data, Texas Transportation Institute (October 2003)

will be established that includes typical Monday traffic volumes in the DMS buffer zone for Mondays in December and January. Furthermore, in order to accurately capture typical weekday driving conditions, the dates selected to establish the baseline speeds do not include a holiday, and do not include when major schools/universities are not in session.

3.4.2 Analyze Freeway Speeds with Active Travel Time Message Displays

The next step of the evaluation included monitoring freeway speeds in the buffer zones the days and weeks following the DMS travel time activation, and noted any significant speed impacts or trends. In order to establish the appropriate data framework for before-and-after comparison, the identical data collection parameters and methodologies of baseline speeds were also be adopted in collecting post-activation traffic data and information. ADOT's loop data was collected and compared to the baseline for one month after initial activation of the travel time messages. At the six-month mark of the pilot program, ADOT did make a change to the presentation of travel time data, and migrated from a rounded five-minute increment travel time to an actual plus buffer travel time. For the month following the initial activation, summary comparison charts were compiled to compare typical before speeds with the post-launch speeds within the DMS travel time buffer zones of the 12 DMS that are part of the Travel Time Pilot Program.

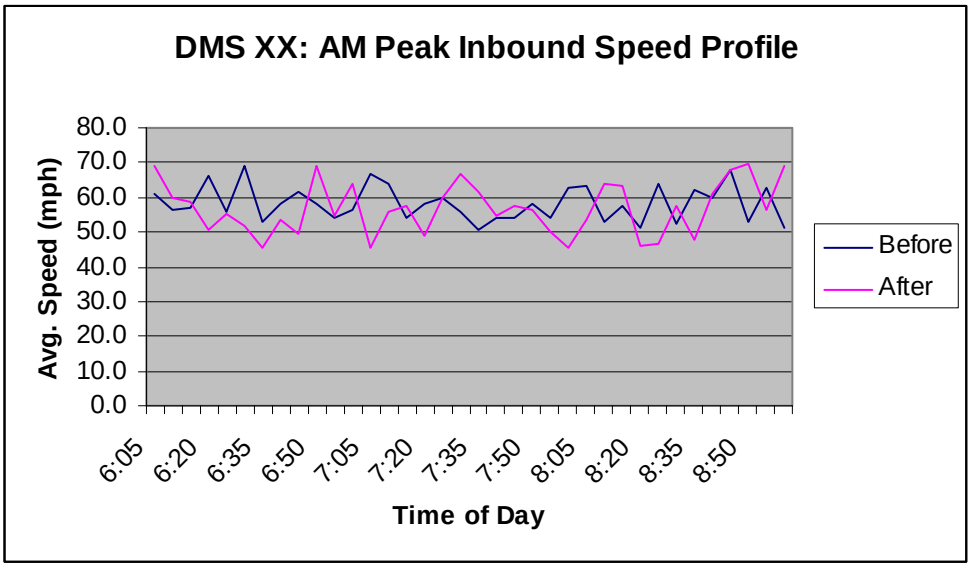
Speed data was compared for weekday AM and PM travel periods for the following weeks:

- January 22, 23, 24 and 25 (launch week), 2008
- Week of January 28, 2008
- Week of February 4, 2008
- Week of February 11, 2008
- Week of February 18, 2008
- Week of July 22, 2008
- Week of July 28, 2008
- Week of August 4, 2008

2009 and 2010 data followed similar analysis methodologies.

For detailed time-dependent trend analysis of before-and-after conditions, a 15 minute-interval averaged speed profile graph of each of the 12 DMS in the Travel Time Pilot Program was developed. The speed profile graphs enhances the identification and cross-examination of any extraneous circumstances (other than DMS travel time messaging) that could have impacted or influenced significant speed changes. **Figure 5** shows sample speed profile graphs to illustrate the proposed reporting mechanism for AM Peak Inbound DMS and PM Peak Outbound DMS. The evaluation team compiled graphs that show the baseline speed, plus one month (four analysis points) of data mapped against those baseline speeds; these will be shown in one graphic per DMS. Time values may be adjusted to account for the hour prior to and following travel time display timeframes.

Speed difference trends were important information for ADOT to consider if ADOT decides to expand the Travel Time Pilot Program to other DMS locations.



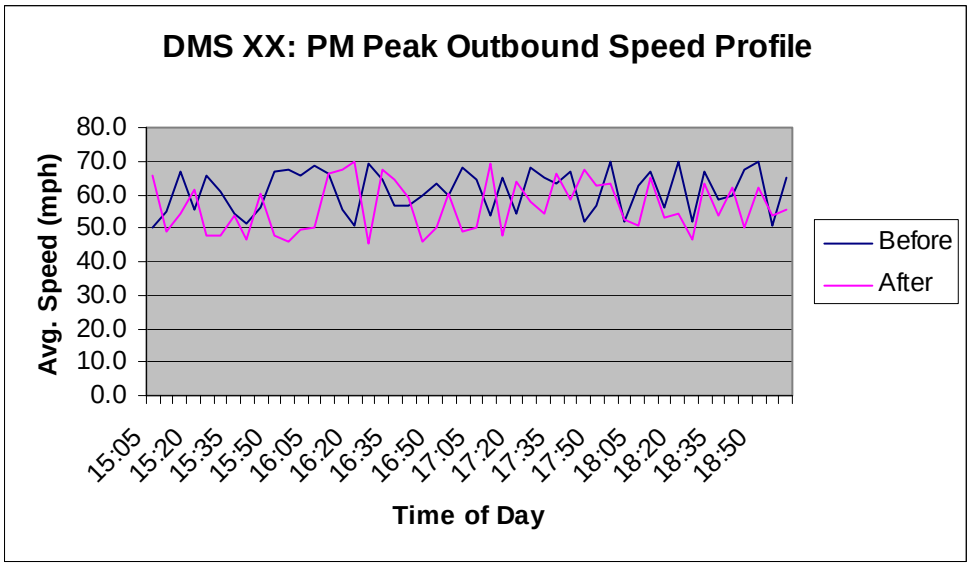


Figure 5 – Sample Speed Comparison Graphs

With available timestamp logs with DMS travel time message activation provided by ADOT, the evaluation team could correlate precise speed impacts with the detailed timeline of DMS travel time message activation of each of 12 DMS.

3.5 Assess Impacts of Travel Times on Crash Rates near DMS

Crashes and incidents are among the leading causes of non-recurring congestion, and can severely impact mobility on freeways that are near or at capacity during peak travel periods. Although travel time messages on DMS are not expected to have any adverse impacts on crash rates, the evaluation team reviewed ADOT's crash data for corridor segments corresponding to the DMS Buffer Zone described in section 3.4.1. The focus of the crash data analysis was on the corridor segments upstream of the DMS, as it would be difficult to attribute the DMS message to a crash that occurs downstream. Mileposts that correspond to the buffer zones were identified so as to isolate specific locations of the corridors for the analysis, and because ADOT's crash data is

identified by milepost. ADOT began posting travel time messages in January 2008, hence this analysis compared crash rates in the vicinity of the travel time DMS for 2007 (to establish a baseline) and for subsequent years 2008 through 2010.

For this portion of the analysis, crash data from ADOT was used to establish baseline (2007) and subsequent year studies (2008, 2009 and 2010). Knowing that the availability of 2008 data would be the limiting factor, evaluators requested 2007 crash data for January through May in order to compare data from the same time period. ADOT's crash data comes in Microsoft Excel format and contains information such as the date and time of the crash, milepost, crash severity, crash type, number of injuries, number of fatalities, weather conditions, etc. The data was filtered to remove all records after May 30, 2007, considering that was the cutoff date for the 2008 data. With the extension of the evaluation to cover through January 2011, the crash analysis also was extended to include 2009. The intent was to extend into 2010; however, complete Average Annual Daily Traffic (AADT) data for 2010 was not available at the time of the analysis.

The following equation is typically used to calculate crash rates:

$$\frac{1{,}000{,}000 \times (\#\text{ of crashes})}{\text{AADT} \times (\text{Length of segment in miles}) \times 365 \text{ days} \times (\text{number of years})}$$

Crash statistics typically are presented in rate form. Crash rates are given as the number of crashes per million vehicles entering (intersections), or million vehicle miles traveled (roadway segments). The rate would indicate the average number of crashes that occur at a particular location per every one million vehicles passing through that location.

The variables to be determined were AADT, the length of the segment over which the crash rate was being calculated, and the analysis period. Each of these variables was to be determined for each of the 12 Travel Time Pilot Program DMS.

3.6 Public Perception of Travel Time Messages

Feedback from users who travel the freeway corridors frequently during the peak weekday travel periods will be a key component to the overall evaluation. Travel time messages on the DMS was a new service for many motorists in the Valley. The public/customer insights on the perceived value, accuracy, and overall benefit of ADOT's DMS Travel Time Pilot Program, if positive, will serve as a key justification for continuing the DMS travel time displays beyond the pilot program timeframe, as well as for expanding the Travel Time Pilot Program to include other DMS and corridors.

The evaluation focused primarily on commuters who routinely use the freeway corridors during AM and PM peak travel times, and considered the geographic distribution of the target commuter audience. User feedback was collected through two channels in order to obtain a broad cross-section of commuter participation: a phone survey and web-based forms for user feedback.

The methodology for the phone user survey included identifying a random sample of commuters within proximity of a pilot corridor. From this broad sample, a representative number of 1200 target surveys was been established for the region, with a goal of 200 individual surveys per corridor. Surveys were conducted approximately one month following the launch of the travel time signs to allow for motorists to become accustomed to seeing them. Phone research was conducted by Bruce Merrill of Merrill Research.

User feedback focused on the following objectives:

- How many times per week (average) does the commuter use this freeway corridor for inbound/outbound commutes on weekdays?
- Does this commuter use the HOV lane? If so, do they notice a difference for their travel time in the HOV lane versus the travel time displayed on the DMS?
- Do drivers find the freeway travel time information useful?
- Do drivers perceive the freeway travel time information on the DMS to be accurate? If not, what is the perceived (or experienced) inaccuracy? (such as 1 minute off, 5 minutes off, etc.)
- Is the information easy to understand? (particularly if there is more than 1 destination provided)
- Do drivers find the destination information displayed to be relevant? (XX minutes to tunnel, airport, interchange, etc.). Are there other destinations for their corridor that would be more useful?
- Do they perceive a greater benefit to having information about freeway travel times based on direction/time of travel (is there greater benefit during inbound AM travel vs. outbound PM travel)?
- Do drivers change travel routes based on the travel time information displayed? (e.g., use alternate freeway route, use alternate arterial route)
- Are there other DMS locations on the freeway corridor they frequently travel where travel times should be displayed?
- Do these drivers also obtain freeway travel time information from other sources? Which ones? (radio, television, web, 511)
- Does the DMS travel time information conflict with other sources? (radio, web, 511 phone, etc.)

3.6.1 On-Line Surveys

A short, anonymous survey was accessible to users through the www.AZ511.gov web site. A third-party survey program (Survey Monkey) was used for ease of visual presentation and compilation of the results. Seven questions were structured as multiple choice questions to allow for ease of comparison and analysis of responses. One free-form option was given to allow users to provide comments, if they chose, about their perception or experience with the travel times posted on DMS messages. Users were asked to identify primary corridors for their weekday commute (both AM and PM); more detailed origin destination information will be asked as part of the phone surveys. The survey also asked about use of the HOV lane.

The on-line survey questions are presented in **Table 4**.

Table 4 - On-line Survey Questions

Question	Response Options
On which freeways do you typically travel? (check all that apply) **Inbound (Morning 6 – 9 AM)**	▪ I-10 in West Phoenix (Eastbound) ▪ I-10 near Broadway Curve (Westbound) ▪ Loop 202 (Westbound) ▪ US 60 (Westbound) ▪ Interstate 17 (Southbound) ▪ State Route 51 (Southbound) ▪ I travel on other freeways that are not listed above.
On which freeways do you typically travel? (check all that apply) **Outbound (Afternoon/Evening 3 – 7 PM)**	▪ I-10 near the Tunnel (Westbound) ▪ I-10 near the Tunnel (Eastbound) ▪ Loop 202 (Eastbound) ▪ I-17 Southbound (south of Durango Curve) ▪ I-17 Northbound (approaching Durango Curve) ▪ State Route 51 (Northbound) ▪ I travel on other freeways that are not listed above.
Do you often see travel time messages during your commute?	▪ Yes, almost always ▪ Yes, sometimes but I wish it was posted more often ▪ No, there are no travel time messages for the parts of the freeway I typically travel ▪ No, I don't use the freeways during rush hours
Do you (legally) use the High Occupancy Vehicle (HOV) lanes?	▪ Yes, I usually travel in the HOV lane ▪ No, I do not typically travel in the HOV lane
Is the travel time information easy to understand?	▪ Yes ▪ No ▪ Somewhat
Do you find the travel times estimates to be accurate?	▪ Yes, I find them to be close to my actual travel time ▪ Yes, but I usually find that my travel time is less than what is posted ▪ Most of the time they are accurate ▪ I have found several instances where they were not accurate
Have you changed your commuting route based on the travel time information on the sign?	▪ Yes ▪ No
Do you have any other comments you would like to provide to ADOT about the freeway travel time information?	▪ Free form comment field.

Feedback from the on-line user survey was monitored on a regular basis in order to track any trends or shifts in perception about the travel time information that might have occurred over time. For example, as users become more accustomed to seeing the messages, it was thought it would be valuable to see if feedback (either positive or negative) shows a demonstrated shift. Feedback from users also was to provide input to any expansion or modification strategies for the Travel Time Pilot Program.

It is important to note that the web survey included a specific demographic of users – those who were familiar with AZ511.gov and who used AZ511.gov. Background information about the Travel Time Pilot Program and "Frequently Asked Questions" also were provided as part of the link to the survey.

3.6.2 Phone Interviews

The purpose of the phone survey was to determine the degree to which drivers commuting to and from the central Phoenix area recall ADOT signs that drivers what the travel time is from their present location to various destinations. The survey was designed to also measure whether commuters find these signs helpful and to determine if the sign program should be kept of discontinued. Surveys were conducted during a three-week period following the January 2008 launch (March 2008).

The evaluation team included specialists in surveys and interview survey analysis to lead the phone interview component. The telephone study was designed, pre-tested, and conducted by Dr. Bruce D. Merrill, Professor Emeritus in the Walter Cronkite School at Arizona State University.

A total of 1,000 adult heads of households residing in the Phoenix SMSA (Standard Metropolitan Statistical Area) who use the freeway system frequently or occasionally were interviewed via the phone survey. Of that sample, 512 respondents indicated they had seen the travel time signs (51%), and these were the respondents that were given the full questionnaire. The final information generalized to all travelers on the designated corridors with a known amount of error to be determined based on the sample sizes in the individual corridors. The sampling error was expected to vary within plus or minus 4 percent to 7 percent when generalizing to the population of all travelers.

Phone interviews were structured so as to obtain similar information to the on-line survey (corridors traveled, ease of understanding, accuracy), but also allowed more flexibility to discussion specific comments that travelers may have about the travel times they see on their commute corridors. In total, 31 questions were posed to interviewees, and included more information on origin-destination, demographic information, and travel patterns (carpool, frequency of travel).

3.6.3 Customer Feedback Reporting

The evaluation team provided interim updates to ADOT and the TAC about the user feedback received. This included providing copies of free-form comments, as well as summaries of responses to the multiple choice questions.

3.7 Impact of Travel Time Outreach Activities on 511 and AZ511.gov Usage

As part of the launch of the DMS Travel Time Pilot Program, ADOT will be conducting an outreach campaign to educate motorists about the program and ADOT's efforts to provide travelers with timely, accurate information. The evaluation will assess whether or not the outreach for the travel times has any impact on 511 and www.AZ511.gov usage. ADOT already collects usage data for both the phone and web components; this usage data will be collected from ADOT to assess the level of user activity in the traveler information systems before and after the launch of DMS Travel Time Pilot Program. The customer feedback comments collected from 511 system and ADOT website also are excellent indicators of public's interest on the new deployment of travel time messaging.

3.8 Travel Time Validation

The estimation accuracy of the travel times posted on DMS has a significant and direct correlation to motorists' trust of the travel time messages, which ultimately decides whether or not the posted message plays a role on motorists' route decision-making process. A series of

periodic travel time measurements were conducted by the evaluation team to validate that the travel times displayed on DMS align with the actual corridor travel times under typical peak-hour conditions.

The evaluation team will conducted AM and PM travel time runs during the times that the messages are posted in the days following the January 22, 2008 launch and in the days following the July 22, 2008 display change. Each evaluator was equipped with a stopwatch, and was instructed to drive in the general purpose lanes (travel times are not calculated for HOV lanes) and to clock the drive time from the time they pass the sign until they reach the destination. Evaluators on corridors that had more than one destination along the same corridor (such as I-10 eastbound in the AM, which includes the tunnel and the airport) were equipped with a stopwatch capable of doing a split time calculation to capture the time to the first destination, as well as continue to clock the time to the second destination. Evaluators were instructed to drive the speed limit and to drive in the general purpose lanes (no HOV). Results were transcribed from the stopwatch once evaluators were off of the freeway and parked.

A standardized field sheet for logging travel times was developed and provided to each evaluator. Field sheets included:

- Evaluator name and date
- Corridor, direction and destination information
- Blanks for time of day (time and AM or PM) (evaluator – enter in approx time)
- Blank space to log travel time displayed on DMS
- Blank space to log actual travel time as clocked with the stopwatch
- Space for evaluator comments (so evaluators can note if there were any usual circumstances on their corridor such as an incident, bottleneck, free-flow conditions, etc.).

4. EVALUATION RESULTS AND SUMMARY

Evaluation activities comprised the first three years of the pilot deployment, with the exception of the user feedback, which was monitored for one year. The evaluation was heavily focused on the initial three months of the pilot program, as that was thought to be the time period that would yield the most interesting analysis outcomes with it being a new program for motorists. Trends over time – particularly with user feedback – also are an important component of gauging user acceptance of the program.

This section presents the results of the evaluation activities.

4.1 Crash Analysis Assessment and Summary

Crash rates in the vicinity of the DMS in the Travel Time Pilot Program were analyzed to determine if there were any negative impacts of posting travel time messages. ADOT crash data was reviewed and AADT data through 2009 was utilized to arrive at the crash rate comparison.

Typically, crash statistics are presented in rate form. Usually crash rates are given as the number of accidents per million vehicles entering (intersections), or million vehicle miles traveled (roadway segments). The crash rate indicates the average number of crashes that occur at a particular location per every one million vehicles passing through that location. The length of segment variable takes into account the length of the roadway over which the accident analysis will be conducted. The value can range anywhere from several miles to a few hundred feet. In this case, the research team used 1,584 feet (0.3 miles). The intent was to capture the crashes that occurred within view of the DMS. According to ADOT's 2007 *Freeway Management System Design Guidelines*, posted DMS messages should be visible from a minimum of 1,000 feet, while driver visibility up to 2,000 feet is recommended. Therefore, only the crashes that occurred within 0.3 miles upstream of the DMS were included in the crash rate calculation.

Typically, crash rate calculations are based on multiple years of data. In this case, the analysis is only comparing the number of crashes before travel time messages were posted on freeway DMS against the number of crashes after the posting of travel time messages. Due to the seasonal fluctuations in traffic volumes, which are typical throughout Arizona, crash statics were compared for the same months during different years. Rather than using 365 days x number of years, the 365 days was replaced with the number of days during the analysis period which is equal to 150 in 2007, 151 in 2008, 150 in 2009, and 150 in 2010. 150 days is equal to 1,050 hours for the purposes of the equation below. Further, because the travel times are only displayed during peak weekday travel hours, a factor of seven hours was included. Once all modifications and adjustments were made to the original equation in order to account for difference in our calculation, the following equation was used:

$$\frac{1{,}000{,}000 \times (\#\text{ of crashes})}{\text{AADT} \times (0.3\text{ miles}) \times (150 \text{ or } 151\text{ days}) \times (7\text{ hours})}$$

Data from 2009 and 2010 was added to the analysis, after the 2007 and 2008 analyses were completed and once those year's data became available. The 2009 data was analyzed using the same methodologies outlined above. 2010 crash data was available, but the 2010 AADT data was not available prior to the completion of this study; as a result, 2010 is not included in this analysis. **Table 5** summarizes the results of the crash rate analysis for each of the 12 study area DMS.

Table 5 – Crash Rates During Week Day Peak Hours

	DMS 1 I-10 EB 67th Ave			DMS 13 I-10 WB 7th Ave			DMS 9 I-10 WB Guadalupe Rd			DMS 4 I-10 EB 10th St		
	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
AADT	92500	93000	108000	130500	131500	138000	88900	96800	104000	132100	132900	127000
# of Crashes	8	15	2	40	8	33	7	11	5	5	4	5
Crash Rate	***0.27***	***0.51***	***0.06***	***0.97***	***0.19***	***0.75***	***0.25***	***0.36***	***0.15***	***0.12***	***0.09***	***0.12***
	DMS 47 L-202 WB McClintock Dr			**DMS 50 L-202 EB 24th St**			**DMS 42 US 60 WB Extension Rd**			**DMS 32 I-17 SB Central Ave**		
	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
AADT	80000	77500	73000	60500	62500	55000	94000	95000	111000	56500	57500	65000
# of Crashes	13	8	2	15	8	6	9	6	3	3	2	0
Crash Rate	***0.52***	***0.33***	***0.09***	***0.79***	***0.40***	***0.34***	***0.30***	***0.20***	***0.09***	***0.17***	***0.11***	***0.00***
	DMS 27 I-17 SB Northern Ave			**DMS 17 I-17 NB 4th Ave**			**DMS 58 SR 51 SB Northern Ave**			**DMS 55 SR 51 NB Osborn Rd**		
	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
AADT	102500	101000	99000	56500	57500	65000	69500	74000	65000	91500	81000	68000
# of Crashes	5	13	4	8	3	1	4	3	6	4	4	3
Crash Rate	***0.15***	***0.41***	***0.13***	***0.45***	***0.16***	***0.05***	***0.18***	***0.13***	***0.29***	***0.14***	***0.16***	***0.14***

The data presented in Table 5 shows that during 2007, while ADOT was not posting travel times on freeway DMS, crash rates were the same or higher than 2008 and 2009 rates at each location, with the exception of DMS 27 along southbound I-17 at Northern Avenue and DMS 58 along southbound SR 51 at Northern Avenue and DMS 58 along southbound SR 51 at Northern Ave. However, the total number of crashes at these locations did not increase dramatically enough to indicate that recurring travel time messages were the cause.

Several factors can contribute to reducing crash rates, and in the case of the timeframe for the Travel Time Pilot Program pilot project, the freeway speed cameras and overall reductions in traffic volumes may have had a role. Alternatively, those corridors where AADT's increased (including DMS 1 on eastbound I-10 at 67th Ave. and DMS 13 on WB I-10 at 7th Ave) AADT's increased while crash rates were substantially reduced. There were no noticeable accident trends and there did not appear to be any conclusive evidence that posting travel time messages on freeway DMS affected accident frequency in the vicinity of those DMS.

It is important to note that this crash analysis does not include 2010 due to an incomplete data set.

4.2 Speed/Mobility Impact Assessment and Summary

This speed and mobility impact assessment analyzed 2008, 2009 and 2010 speed data collected by ADOT FMS loop detectors to determine what effect, if any, ADOT's DMS travel time displays have had on average vehicle speeds along valley freeways that were part of the pilot program.

The initial speed analysis, conducted in fall 2008, concluded that there is no clear indication that the travel time displays have any noticeable impact, adverse or otherwise, on average vehicle speeds along the freeway. The preliminary conclusion of this follow up study, which includes data from 2009 and 2010 in addition to the original 2008 data, does not yield any significant impact as a result of the Travel Time Pilot Program implementation. Based on review of the 2009 and 2010 data, it appears that average vehicle speeds have either improved or remained the same, which could be attributed to several factors, including an overall reduction in freeway volumes (not specifically studied as part of this), as well as speed cameras being operational from 2008 to mid-2010.

Graphs of the preliminary speed summary data are included in **Appendix A**. Some of the graphs show incomplete data – this is because the baseline data collection may have been available but by the time the data collection on specific days for analysis occurred, the detector was not functional. Or the reverse happened where the detector was not functioning for the baseline data collection but was available for at least one of the specific days for analysis. These graphs represented two specific locations: DMS 17 I-17 NB 4th Ave (Detectors 104 and 98) and DMS 58 SR-51 SB Northern Ave (Detector 297).

A review of the figures shows generally consistent trends. There are dips in average speed during the typical peak periods. There are no noticeably consistent trends in this small sample; and based on the fact that there are a number of factors contributing to unpredictable traffic patterns, consistent trends are not expected.

Speed data was obtained at each of the six inbound DMS and six outbound DMS which display travel times during the morning and afternoon peak periods respectively. The speed data used in the analysis was collected at two FMS count stations located directly upstream of each DMS. The two count stations are typically spaced one mile apart, with the farthest count station being no more than two miles upstream of the DMS. Comparison between the speed data from each of the two count stations provides an indication as to whether or not speeds are potentially affected by the posted travel time message. If the speeds being recorded at the farthest upstream count station are consistently higher than the speeds being recorded at the station immediately upstream of the DMS, there is the potential that the posted message on the DMS could be causing motorists to slow down.

The loop detector raw speed data was taken from ADOT's FMS traffic data .ftp site and compiled using Microsoft Excel software. The data summaries consist of a baseline graph showing average speed versus time-of-day for a typical summertime weekday prior to launch of the new format. On the same figure, a graph showing average speed versus time-of-day for two separate typical summertime weekdays after the new format was launched. A graph was developed for each weekday, Monday through Friday, and each count station and corresponding DMS. For the inbound DMS, the graph shows the time period from 5:00 AM to 10:00 AM. For the outbound DMS, the graph shows the time period from 2:00 PM to 8:00 PM.

Results show what is expected of both winter and summertime traffic patterns. Some of the data shows signs of congestion in the form of reduced speeds, at particular locations; however, the congestion is not nearly as prolonged as in winter months. Data at loop detectors closer to downtown such as the loops upstream of the DMS on westbound I-10 at 7th Avenue is a bit more difficult to interpret. During the peak travel periods, the downtown sections of the freeway system are typically congested due to the number of vehicles as well as the high rate of traffic incidents in comparison to less congested freeway segments. Congestion at these locations are not typically affected by seasonal changes in traffic volumes, considering most of the people heading into and out of downtown during the peak periods are not seasonal residents.

4.3 User Feedback

4.3.1 Phone Survey Results and Summary

In March 2008, a phone survey was conducted with 1,000 adult heads of household in the Phoenix SMSA who use the freeway system frequently or occasionally. Fifty-seven percent of those interviewed said they used the freeways system frequently; 43 percent occasionally. The sampling error for the sample when the proportion (P) giving a

dichotomous response to a question is 50 percent and assuming the 95 percent level of significance is plus or minus 3.1 percent.

Because drivers must be aware of the signs in order to evaluate them, the sample was further screened by asking respondents the following question: "The Arizona Department of Transportation has put signs on the freeways telling drivers what the travel time is from where they are on the freeway to various destinations. Do you recall seeing any of these signs?" The information which follows is based on the 512 drivers (51 percent) who said they recall seeing the signs. The sampling error for those who have seen the signs is plus or minus 4.3 percent.

The following summarizes the feedback received from the questionnaire. The full results are tabulated and presented in **Appendix B**, including responses corresponding to the specific questions.

- Drivers who use the freeways frequently are more likely to see the signs than those who drive the freeways occasionally. People who drive the freeways both morning and afternoon are more likely to see the signs than those who drive mainly mornings or mainly afternoons. Carpoolers are more likely to see the signs than non-carpoolers. There were no statistically significant differences found in awareness of the signs on the 13 routes commuters use for in-bound and out-bound traffic.
- In response to the question about whether or not drivers change routes based on the information presented in the travel time, 69% indicated they did not change their routes. Carpoolers change their routes more than non-carpoolers.
- Commuters who use the freeways primarily in the afternoon are more likely to feel the signs are accurate than those who the freeways in the mornings or both mornings and afternoons. In all, 84% indicated that they felt the information on the sign was accurate. For those that indicated it was not accurate or not precise, 20% indicated they were within five minutes of their experienced travel time, and 38% indicated they were approximately 10 minutes off of their experienced travel time.
- 75% of respondents indicated the destinations provided on the travel time displays were relevant.
- 81% supported keeping the Travel Time Pilot Program, and of those respondents, 53% indicated there should be more signs added to the program. Respondents recommended the following corridors for new or additional travel time signs (these are presented in order):
    - Loop 101
    - Interstate 10
    - Loop 202
    - Near Sky Harbor Airport
    - I-17
    - SR-51
    - Near Arizona State University

From this feedback, there was no statistical difference among the corridors included in the Travel Time Pilot Program.

4.3.2 User Feedback from Web Survey

A web-based survey on www.AZ511.gov was launched on January 22, 2008 to solicit user feedback on the Travel Time Pilot Program. Feedback was monitored throughout the first few weeks and months of the study to ascertain any changes in driver response, acceptance or changes in travel patterns. The survey was 're-started' on July 22, 2008 to capture feedback following the change in travel time display format.

From January 22, 2008 to January 22, 2009, there were a total of 647 responses to the web survey. Of those, 326 included feedback in the free-form comment.

Respondents represented the full cross-section of freeways covered during the AM and PM travel time display timeframes. There was more variability among the corridors in response to the PM corridor travel period. **Figure 6** shows a comparison of AM and PM travelers.

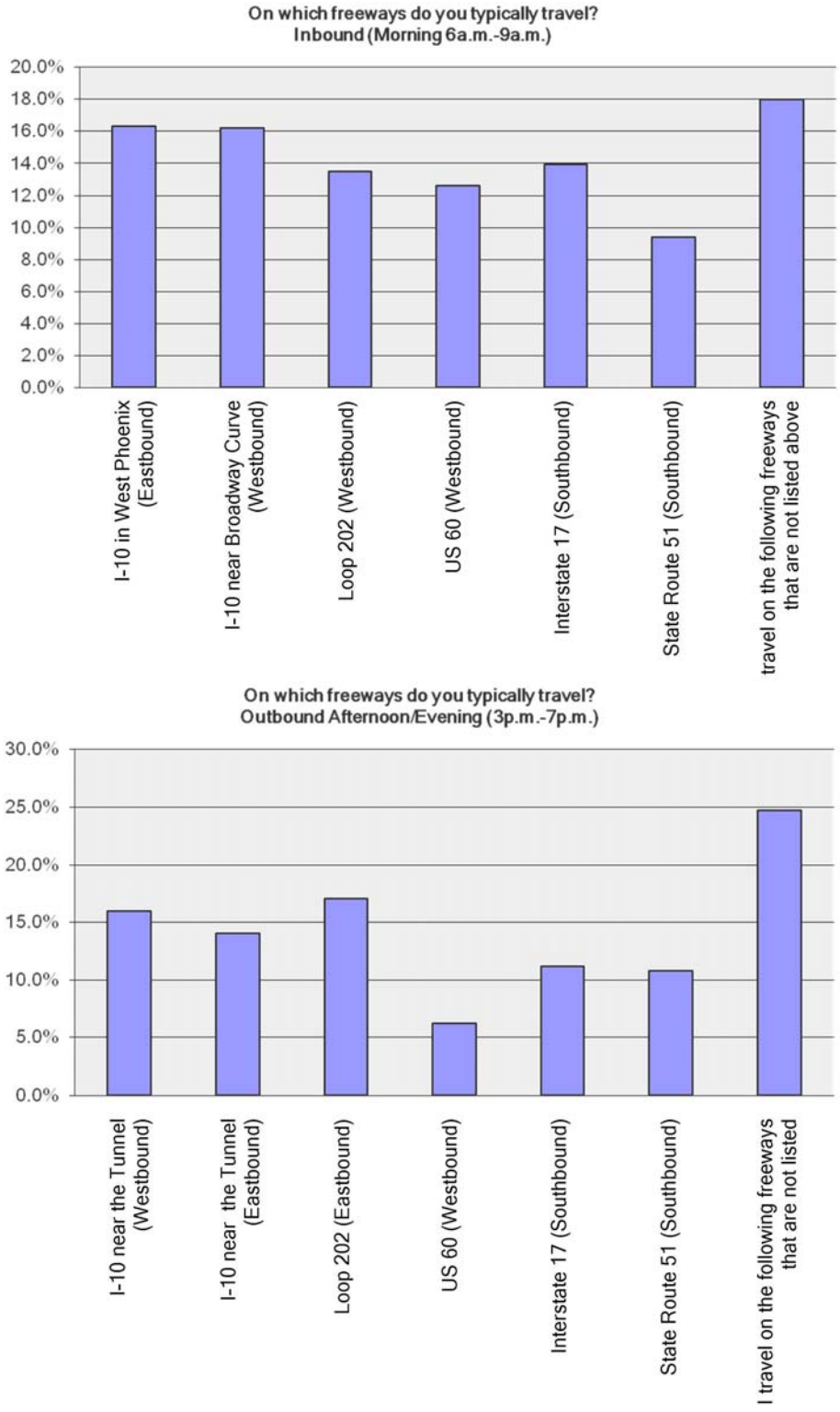


Figure 6 - AM and PM Corridor Distribution of Web Survey Respondents

Other relevant survey outcomes include:

83.4% of travelers indicated they see the travel time messages during their commute: 53.3% indicated yes, almost always, while another 30.1% indicated sometimes. This reflects that the Travel Time Pilot Program initial deployment has captured a large majority of travelers in the Phoenix metropolitan area who utilize traveler information tools available to them such as 511 phone and web.

Of the travelers who indicated that they see the travel time messages during their commute, 83.5% indicated the information was easy to understand.

Responses to the question on accuracy showed some changes between the first six months of the pilot program year 1 and the second six months of that year. **Figure 7** shows that in the first six months of the Travel Time Pilot Program, nearly 30% had indicated travel times were not perceived as accurate. In the six months following the accuracy numbers increased. This could be due to the change in display format (ADOT eliminated rounding and displayed a more precise time beginning July 22, 2008), ongoing enhancements to the travel time algorithm, or increased traveler confidence in the times being presented.

This number is contrasted with the phone survey responses where 84% indicated the information was relatively accurate. The lower accuracy confidence level from the web participants could be due to the narrow demographic that is captured by the internet survey. Respondents got to the travel time survey via www.AZ511.gov, so the respondents were those who were familiar with and use technology tools for traveler information. A further assumption would be that this group is more discerning about accuracy of real-time information.

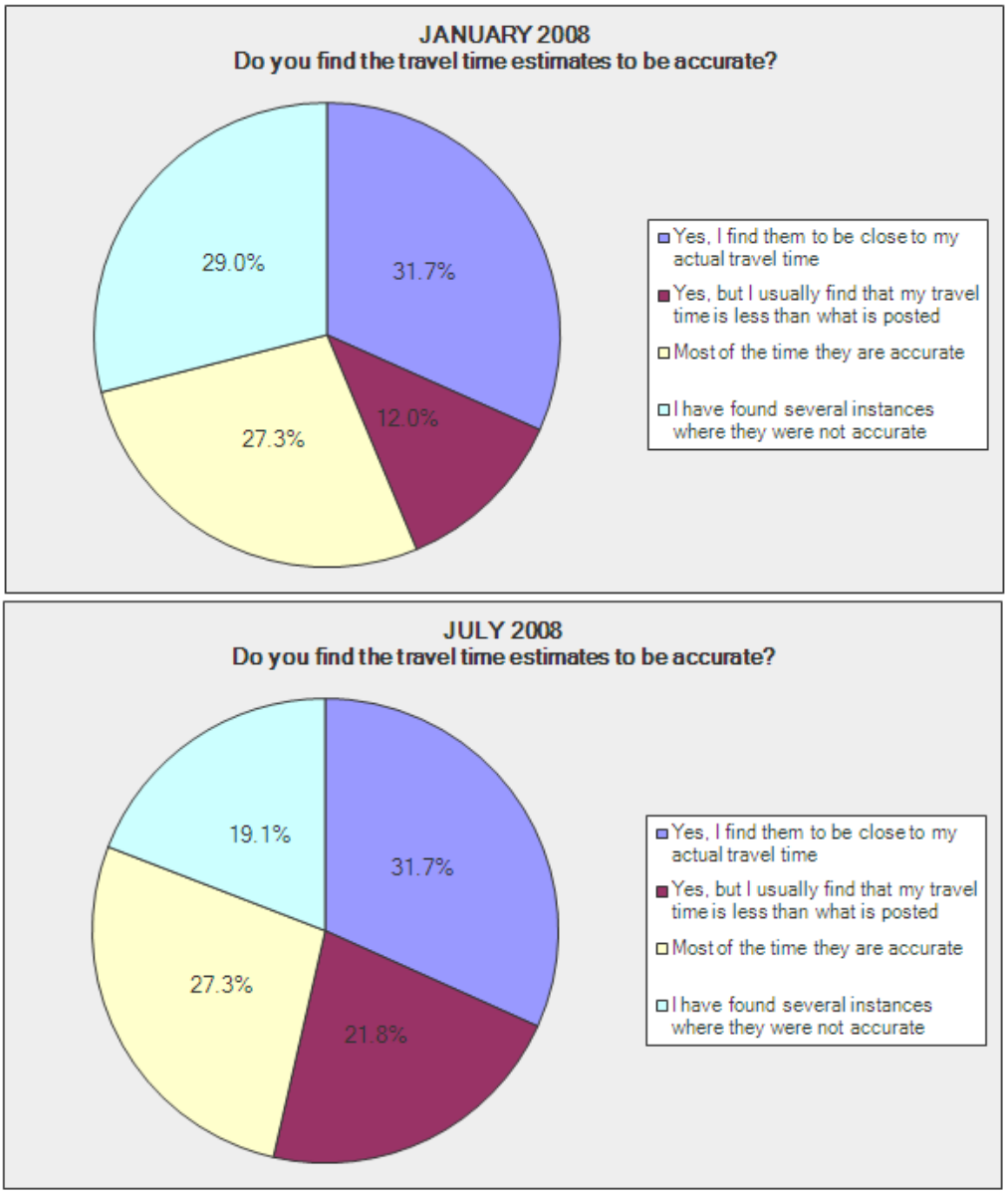


Figure 7 - Accuracy Perception of the Travel Time Messages

Another important indicator of the success of the Travel Time Pilot Program was the response to the question about whether or not drivers are using the travel time information to change their route. This also showed differences between the first six months of the study and the second six months. **Figure 8** shows that as the first year progressed, drivers were more inclined to make changes to their route based on the information being provided. This shows an increased acceptance and confidence in drivers of the information being displayed. As the travel time message program became more established in the traveler's daily commute, the survey showed that the message became more useful toward making better decisions about their travel route.

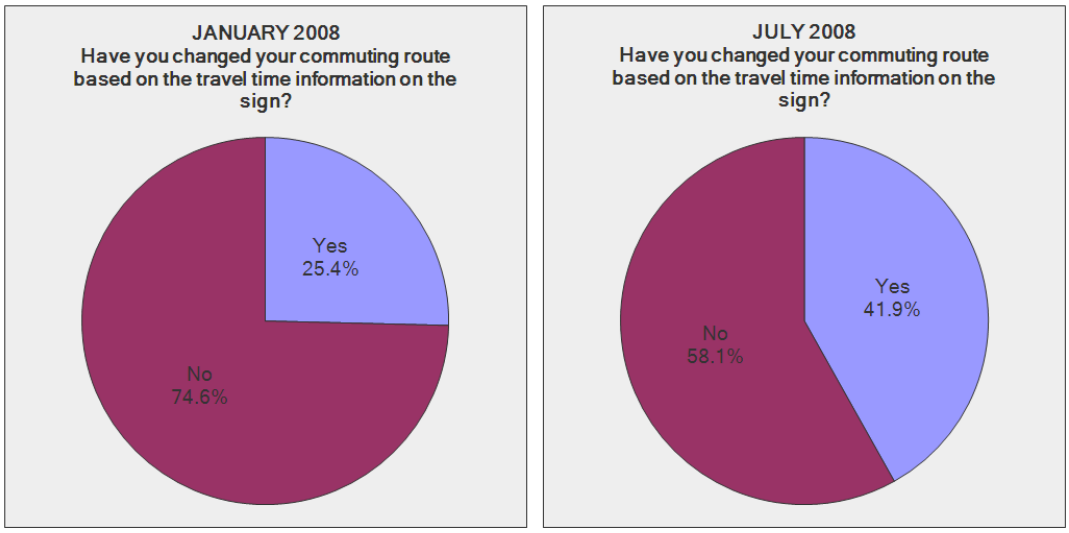


Figure 8 - Drivers Indicating Changing Commute Route Based on Travel Time Information

Free form comments provided a broad spectrum of feedback. Comments ranged from positive comments about the signs and program, negative comments about accuracy, requests for additional freeways to be included, comments about drivers slowing near the signs, and several unrelated comments (such as construction, ramp meters, traffic lights, etc.).

Comments were summarized and categorized in the following general areas:

- Inaccurate display times
- More sign locations/expand travel times/more destinations
- Speed slowing near signs
- Rounding and estimating
- Always the same time shown
- Add travel times to website
- Expand hours
- HOV travel time posting
- Locations past decision points
- General negative comments
- General positive comments
- Additional information to display
- Unrelated comments

Appendix C includes the full tabulation of the comments received. Some notable highlights are presented below:

- Comments related to inaccurate display times were generally within the first six months of the program when rounded estimates were provided on DMS. Since the display was modified to show a more precise number, only three comments pointed to inaccurate times.
- Loop 101 was one of the most requested corridors. Respondents also indicated more information for East Valley commuters would be beneficial.

- Comments related to drivers slowing down accounted for only 11 comments of the 300+ that were received. All but one of these comments was during the first four months of the pilot program.
- Rounding and estimating comments did not appear following the change in display in July 2008. Similarly, there were very few comments after the July 22 change regarding drivers always seeing the same time.
- Several comments requested that ADOT make this information available via the 511 web site. The new www.AZ511.gov site has travel times more easily identifiable.
- General positive comments indicated that travel times are useful, reduces stress, and helps drivers to plan their commute.
- Several of the unrelated comments focused on HOV lane violators, wanting the DMS to display incident information more frequently, or wanting more information for areas outside of Phoenix.
- Some comments included suggestions for modifying how and what is displayed to convey travel times. For instance, a comment suggested that more trend-related information (such as arrows up or down to indicate the current drive time is greater than or less than typical conditions). Other comments suggested that a range be displayed (such as 12-14 minutes instead of one single number).

4.4 Travel Time Validation Runs

Motorists' perception of DMS travel time accuracy has a significant effect on their route decision-making process. The evaluation strategy included travel time runs for the research team to validate the travel times displayed on DMS align with actual corridor travel times.

Displayed times were compared with actual times recorded by the research team. This was done in the immediate days following the January 22, 2008 launch and the July 22, 2008 time format change. Two runs per corridor for the AM and PM display time were performance, and results were recorded and provided to ADOT. This was in addition to any travel time checks/validity runs being conducted by ADOT or the System Integrator.

The travel time validation runs yielded mixed results. For the January 2008 launch, travel time runs were conducted on January 23 and 24th in the AM and PM. Two runs on each day were performed for each of the signs and respective destinations.

- On January 23, the outbound PM travel time runs showed higher variability (actual times longer than the displayed times) than the inbound runs. There were three incidents noted on outbound corridors, although none of the DMS were preempted with an incident message.
- On January 24th, there was a similar pattern of variability during the PM drive time, although the morning also showed several instances where actual drive times were longer than what was displayed. Incidents and inclement weather were noted.

In July 2008, following the time display change, the travel time runs yielded different results.

On July 23rd, almost all of the recorded times were less than what was displayed on the signs. Most were within one to four minutes of what was posted, although a couple were significantly less actual drive time than what was displayed (12 and 20 minute variances were noted).

On July 24th, all of the recorded times were less than what was displayed on the signs. Most were within one to four minutes of what was posted, although there was a time that was 16 minutes under what was displayed. Where incidents or no travel times were posted, these were noted.

Summaries of the travel time validation runs were submitted to the ADOT project manager immediately following tabulation. These are included in **Appendix D.**

4.5 511 Usage Comparison

Usage of ADOT's 511 systems (phone and www.AZ511.gov web sites) were monitored to see if there were any impacts or influences of the Travel Time Pilot Program on usage of these systems. The hypothesis established the possibility that Travel Time Pilot Program and its associated outreach activities may facilitate more usage on 511 system and ADOT website will be tested

A review of the usage data does not indicate that the Travel Time Pilot Program had an influence on 511 usage. **Figure 9** shows web and phone usage during the time periods of January 2008 and January 2011.

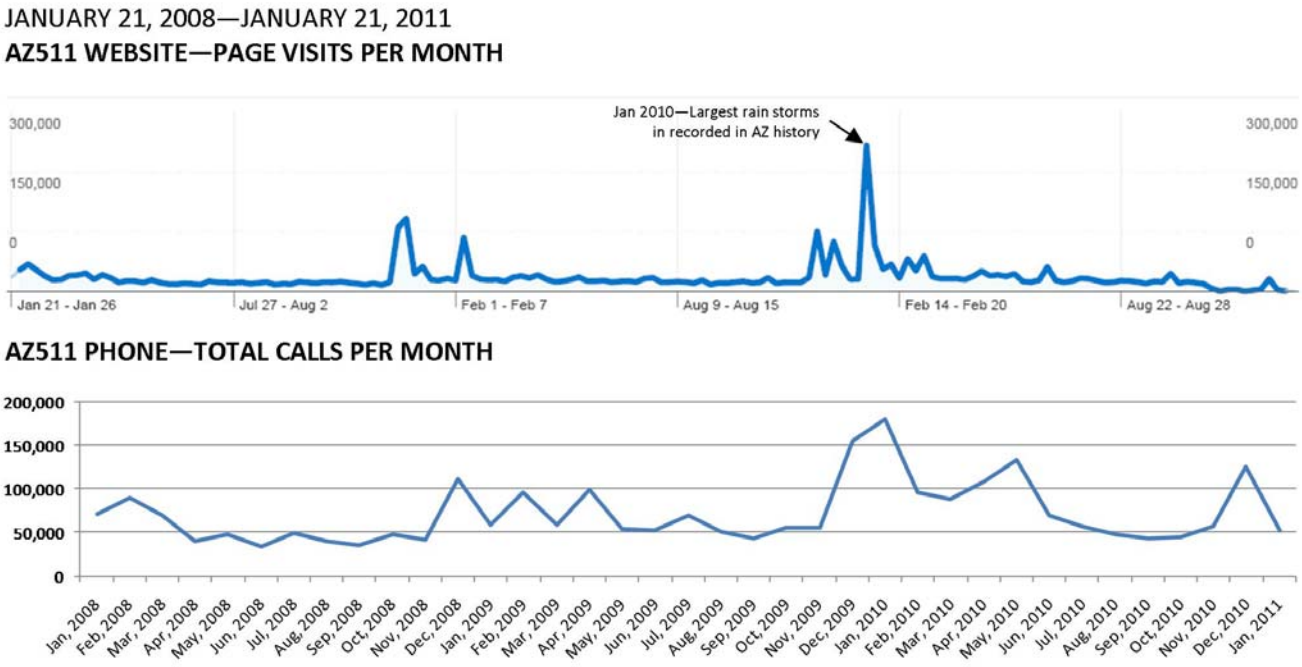


Figure 9 - 511 Phone Usage (January 2008 – January 2011)

4.6 Summary of Findings

The evaluation of the Travel Time Pilot Program yielded very positive support from the traveling public, including several comments asking for more signs and travel times on more freeways. The majority of comments received via the website were positive. Similarly, the telephone surveys showed strong support for keeping the Travel Time Pilot Program.

Other parameters that evaluated, including speed/mobility and safety, showed no adverse impact of the travel time displays. **Table 6** summarizes the outcomes with the original hypothesis measures.

Table 6 - Hypothesis Testing Measures and Outcomes

Hypothesis	Summary of Outcome
Minimal reductions to AM freeway speeds/mobility during travel time messages, due to already concentrated AM conditions on weekdays.	The speed assessment showed minimal impact to the freeway mobility upstream of the DMS with active travel times. Variability in the AM drive was higher than PM. I-10 and I-17 demonstrated the most variability.
More noticeable reduction in speed during PM travel periods due to distribution of PM traffic over time.	PM drive showed some degradation of speeds, but in a consistent pattern with the baseline for January 2008.
More noticeable reduction in travel speeds near DMS with two destinations than those with one destination.	There was no discernable correlation between speed reductions at DMS with one versus two destinations.
More positive public feedback is expected on the value of inbound travel time messaging than outbound (inbound travel is expected to have more time constraints than outbound)	Telephone surveys did not indicate a statistical significant difference in perceived accuracy of the information in inbound vs. outbound travel. Commuters who use the freeways primarily in the afternoon were more likely to feel the signs are accurate than those who use the freeways in the mornings or both mornings and afternoons.
Commuters will notice and/or complain about the slowdowns (perceived or real) near the DMS while messages are active.	Some respondents to the survey commented that drivers slow down near the signs (11 comments). These comments were more frequent during the first six weeks of operation.
There is not expected to be an impact on crash frequency as a result of deploying travel time messages on DMS	There were no negative impacts to crash rates near the DMS in the pilot program. In fact, several locations saw reduced crash rates. With other influences on the freeway network, including reduced volumes in many locations and speed cameras widely deployed, it cannot be concluded that the travel time messages were responsible for this reduction in crash rate.
The Travel Time Pilot Program and its associated outreach activities will increase the awareness of and usage of ADOT's 511 and AZ511.gov traveler information systems	Based on the data reviewed, there was not an increase not decrease in usage of the 511 systems as a result of the Travel Time Pilot Program.

5. SYSTEMS ENGINEERING ANALYSIS

5.1 Systems Engineering Overview

A systems engineering analysis is required for all federally-funded Intelligent Transportation Systems (ITS) projects using Federal funds according to the Final Rule on ITS Architecture and Standards Conformity (CFR940) issued on January 8, 2001. Conformance with the National ITS Architecture is defined as the development of a Regional ITS Architecture and the subsequent adherence of ITS projects to the Regional ITS Architecture. The Maricopa Association of Governments (MAG) developed its first regional ITS architecture as part of the MAG ITS Strategic Plan in 1995 and updated that plan in the 2009 MAG Regional ITS Strategic Plan Update to be able to meet newly developed federal requirements for ITS architectures. Since the update, the National ITS Architecture has been revised to include new requirements and new ITS services consistent with evolving technology. This systems engineering analysis conforms to the National ITS Architecture Version 6.0 and documents the applicability of this project to the regional ITS architecture updated by MAG in 2009.

This Systems Engineering Analysis incorporates information from design and development activities that occurred prior to the Travel Time Pilot Program initiation. Specifically, the following:

Travel Time Estimates, Displays and Forecasts, Final Report, December 2004. AZTech™ Phase III Traveler Information Project.

Freeway Travel Time Display on ADOT Dynamic Message Signs, Revision 1.3, December 2007. OZ Engineering.

5.1.1 Systems Engineering Goals and Objectives of this Project

The goals of the DMS travel time project and evaluation are to:

- Develop software to automatically calculate travel times using essentially real-time detector data and post on ADOT DMS without requiring additional ADOT operators;
- Display accurate and reliable travel times on DMS;
- Evaluate impacts to freeway operations and freeway mobility as a result of posting travel time messages on DMS during peak hour travel;
- Evaluate and document customer response to freeway travel time messages, and provide input to potential enhancements or recommended modifications to the DMS Travel Time Program based on user feedback; and
- Evaluate accuracy of travel time messages being displayed with actual travel times.

This report describes how the ADOT DMS Travel Time Pilot Program evaluation project meets this Federal requirement by following the Interim Guidelines for Systems Engineering Analysis developed by MAG and the Federal Highway Administration (FHWA) in August 2006. **Figure 10** below shows the process followed in the Systems Engineering Analysis. The analysis utilized relevant products from ITS and systems planning projects in the Phoenix metropolitan area.

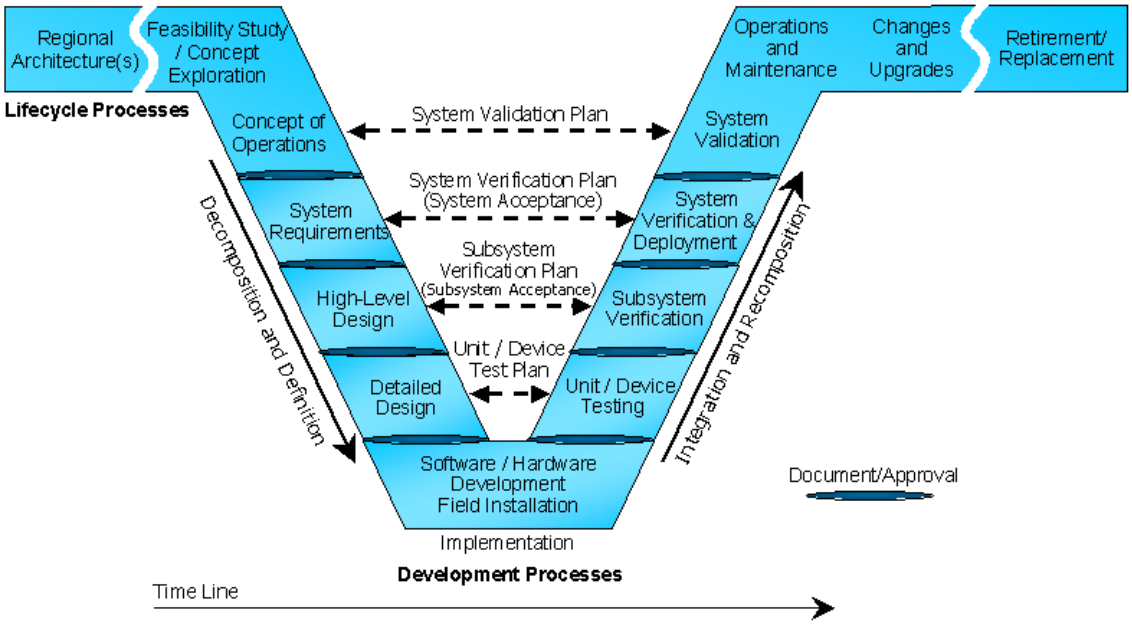


Figure 10 – System Engineering Analysis "V" Diagram

5.1.2 Interfacing with the Regional ITS Architecture

The ability to post travel time messages on DMS throughout the Phoenix metropolitan area requires the use of the ADOT FMS system to collect real-time detector data in one location for analysis and use the same system to post messages on specific DMS. According to the MAG ITS Strategic Plan Update completed in April, 2001, regional ITS objectives identified for the MAG region included **"improving accuracy, timeliness and availability of real-time traveler information to the public"** and **"increasing the use of VMS for more types of traffic and incident information."** A specific need that resulted from the first objective mentioned was the **"need to increase use of detector data/travel time data."**

A recommended mid-term project (2007-2011) for the freeway management system identified in the plan is described as:

Travel Time Display on FMS: Develop software to allow VMS display of travel times to known points in the Valley

Implementing Agency: ADOT

Managing and Operating Agency: ADOT

Associated User Needs: 7 – Information Management

ADOT detectors and DMS were installed with the first phases of the FMS and have been operational since 1995. The first phase of the FMS system was 29 miles of detection, cameras, ramp metering, DMS, and fiber optic communications on I-10 from 83rd Avenue to Southern Avenue and I-17 from I-10 to Thomas Road. The detector and DMS system has substantially expanded since then to other corridors.

Initially detectors were implemented in third-mile spacing and that design standard has since been changed to one-mile spacing and includes the use of both intrusive (loops or microloops in roadway) and non-intrusive (passive acoustic detectors mounted on side of road) detection devices. Detection has typically been installed with all new freeway build outs but is not integrated into the FMS system until connected via fiber optics. Loop 101 (Agua Fria Freeway) is an exception; in order to fast-track this implementation, detection was omitted from the FMS implementation.

5.2 Feasibility Study

5.2.1 ITS Applications Supported

Displaying freeway travel times to motorists utilizes many devices integrated into the ADOT FMS system and supports regional ITS initiatives for traveler information dissemination. **Table 7** provides a summary of the services supported by the project.

Table 7 – Alignment of User Services from MAG ITS Strategic Plan Update (2001)

Applications	User Services (Strat. Plan pg 13)	User needs (Strat. Plan pg 14)	Market Packages (Strat. Plan pg 18)
DMS	1.1 Pre-Trip Travel Information	52	ATIS01
	1.2 En-Route Travel Information	7	ATMS04
	1.7 Incident Management	7, 52	ATMS04
	7.1 Archived Data	52	ATMS01,ATMS04,ATMS07

Subsystems (Strat Plan pg 24)	Descriptions
Centers	ADOT TOC
Roadside	DMS
Traveler	General Public
Vehicle	none

User Services document what ITS should do from a user's perspective and allows system or project definition to begin by establishing the high level services that will be provided to address identified problems and needs. The Archived Data User Service 7.1 provides an ITS historical data archive for all relevant ITS data and incorporates the planning, safety, operations, and research communities into ITS. It provides the data collection, manipulation, and dissemination functions of these groups, as they relate to data generated by ITS, and more specifically DMS. The Pre-Trip and En-Route Travel Information User Services allow travelers to access transportation information at home, work, or on the road. This project provides travel time information on DMS to support the existing speed network map and coincide with the regional travel times currently calculated through the AZTech™ Regional Archived Data Server (RADS) operational since 2005. The AZTech™ RADS housed at the ADOT Traffic Operations Center (TOC) is operated and maintained by the Maricopa County DOT.

5.2.2 Technical Feasibility

Travel time estimates of various corridors are currently being calculated by AZTech™ RADS using the instrumented portions of the ADOT FMS system. The results of these calculations are currently being provided to the following:

- Four wall map displays at the Sky Harbor Rental Car Center;
- One wall map display at the Maricopa County Transportation building;
- Two wall map displays at the Maricopa County downtown office;
- Arizona public website: www.AZ511.gov and mobile application; and
- Statewide interactive telephone system: 5-1-1.

Travel times estimates provided on the wall map displays and the 511 traveler information services are provided from the origins and destinations of key inbound (morning peak period) and outbound routes throughout the valley.

This pilot project developed an additional means of disseminating travel time information by placing these travel time estimates on existing ADOT DMS.

Established as part of the ADOT AZ511.gov web site, maps of travel speeds are provided where detector information is available. There are functional detectors at locations throughout the Valley that are routinely downloaded by ADOT planning personnel physically connecting to the detector – these are called automated traffic recorders. These detectors cannot be used for calculating travel times, highlighting the importance for having an accumulation of values of travel time between successive detectors in the direction of flow in order to be able to calculate the time between detectors.

The prerequisites for developing travel times include:

- Reliable on-going stream of data from detectors – detector data is the foundation of this travel time project and the increase in quantity and quality of data available increases the accuracy of travel time information;
- Long and short-term data archival system that can be queried when needed – the ADOT FMS supports archived detector information at the AZTech™ RADS;
- Calculator for snap shot and after-the-fact travel times – developing a historical data set of travel time patterns for use during comparison of real-time travel time calculations; and
- Seasonal sets of anticipated travel time patterns – understanding of how current conditions are varying from the historic patterns due to season, day-of-the-week, and time-of-day changes.

A fiber optic communications network, installed as part of the ADOT FMS system, currently links all freeway DMS in the Phoenix metro area with the RADS network which is housed at the ADOT TOC. This connection enables the communication of travel time information to the appropriate DMS.

5.2.3 Financial Feasibility

The opinion of probable costs for developing the software necessary to allow DMS to display travel times throughout the Valley as discussed in the *2001 MAG ITS Strategic Plan Update* was $400,000. The agency identified to lead the project was ADOT, because it owned the DMS as well as the FMS data and data archive.

Cost of this specific project for the Travel Time Pilot Program is $420,000 and includes travel time development, system integration, software enhancements, and evaluation. ADOT is funding this project through available state funding sources.

The costs associated with the actual infrastructure used to display the messages are relative to the design, operations, and maintenance needs of the ADOT FMS system and AZTech™ RADS server. Displaying travel times as the standard message on specific DMS throughout the Valley during peak periods will require ongoing maintenance (preventive and responsive), and may increase operational costs as a result of increased power requirements and more frequent replacement of bulbs/LEDs for the DMS. Section 6 describes cost implications in more detail.

The major investments to deliver the Travel Time Pilot Program – meaning the DMS and structure infrastructure and telecommunications – are part of a broader FMS program that utilizes the signs for purposes beyond travel times. In fact, sign priorities indicate that incidents, alerts, lane restrictions/work zones, special events and other warnings take precedence over travel time displays.

5.2.4 Institutional Feasibility

FHWA and MAG initially recommended travel times be posted on ADOT permanent DMS. This capability is integrated within a broader suite of operational and traveler information strategies already in place through the ADOT FMS program.

A very recent Federal Rule 1201 (23 CFR Part 511) has implemented the Real-Time System Management Information Program. One of the requirements in this Federal rule is for the provision of travel times on Interstates and other limited access routes (to be determined through a 'routes of significance' process in each region) in metropolitan areas with a population of 1,000,000 or greater. The Phoenix metropolitan area falls under this requirement. The timeline for implementing this capability on Interstates is November 8, 2014; for other routes of significance, November 8, 2016. (Reference: Federal Register / Vol. 75, No. 215 / Monday, November 8, 2010 / Rules and Regulations, 23 CFR Part 511).

The baseline capabilities are in place to support this requirement institutionally, although expansion of the program would be needed to fully comply with this requirement, specifically routes of significance beyond Interstates in the Phoenix metropolitan area. Rule 1201 does not specify a technology for delivering this information.

5.3 Concept of Operations

As part of the pilot project, multiple freeway corridors were selected strategically for displaying travel times on DMS. Real-time travel times were calculated using FMS detector data through the RADS server. The calculated travel time estimates were displayed on the corresponding DMS along with appropriate text for easy legibility of motorists. This section provides the background information of travel times in the Phoenix metropolitan area and the decisions that were made to develop the travel time pilot project.

5.3.1 Concept Development

Developing the appropriate components to be able to calculate the travel times and then post them on the DMS required strategic planning and evaluation. The components of this project included:

- Establishing an approach to defining and measuring travel times:
  - Conceptual approach to developing and applying the travel time algorithm;
  - Characteristics of observed corridor travel times;
  - Basic components of the algorithm approach to estimate corridor travel time; and
  - Data quality and reliability considerations.
- Implementing the travel time software:
  - Developing software to calculate travel times;
  - Developing application to automatically post messages on DMS as determined by permission;
- Evaluating the accuracy and reliability of travel times displayed:
  - Determine impacts to traffic due to travel time messages being displayed;
  - Identify quantitative and qualitative analyses and the associated measures that will be used to verify accuracy and reliability;
  - Conduct commuter survey and outreach performance evaluation; and
  - Estimate performance of travel times compared to real-time traveling conditions (conducted through drive times).

It is important to note that travel times have been calculated in the region for many years and this project works to use the existing capabilities to benefit travelers directly on the roadways.

5.3.2 Roles and Responsibilities

ADOT is the owning, operating and maintaining agency of the detector devices, detector data, freeway DMS, and the AZ511.gov traveler information services (phone and web). ADOT houses the AZTech™ RADS, and the RADS is operated and maintained by Maricopa County DOT. Operators that monitor DMS messages from the Traffic Operations Center are ADOT employees.

Contracted tasks have included the algorithm development, implementation and modification, as well as system integration (OZ Engineering). Evaluation of the pilot program was conducted by Kimley-Horn and Associates.

A multi-agency Technical Advisory Committee was established to provide review and feedback during the pilot project. Agencies represented included: ADOT (Transportation Technology Group, Communication and Community Partnerships, Phoenix Maintenance District, Traffic Engineering, and Arizona Transportation Research Center), FHWA, Arizona Department of Public Safety, Maricopa Association of Governments, Maricopa County, and the City of Phoenix.

5.3.3 Operational Concept

ADOT has implemented a system of detector stations and DMS in the Phoenix metro area including loop and passive acoustic detector data. Detector station information is currently available and is retrieved at 20-second intervals which is then sent directly to the RADS server where it can be used for travel time calculation and archived indefinitely. Data from the FMS archive provides historical data of travel patterns for any instrumented route that is queried. **Figure 11** shows the process of how data is acquired from the detection stations.

Figure 11 - FMS Incident Processing System Sensor Data Transmittal to RADS

Speed calculations are currently performed every 60 seconds and use the stored 20-second detector station data. Once the speeds for each detector station have been calculated, the travel time for the entire corridor is calculated. For the purposes of calculating travel times, the detector station speed was initially capped at 55 miles per hour which will result in sometimes overestimated travel times if traffic is exceeding the posted freeway speed limits. As of January, 2011, the travel times are now calculated using the posted speed limits of each roadway (55 or 65 miles per hour).

The DMS travel time (DTT) process connects to the RADS server every two minutes and generates the text to be displayed on the DMS. The DTT then connects to the appropriate DMS and determines the state of the sign. If the sign is blank, or is currently displaying travel time text, the DTT automatically overwrites the text with the latest travel time text. If the sign is displaying text that it cannot recognize, it will take no action, and provide an indication of this on the DTT monitor screen. A history of all DMS transactions undertaken by the DTT will be archived into the database. The system was configurable as to the hours of operation for this travel time text. This process is shown in **Figure 12** below.

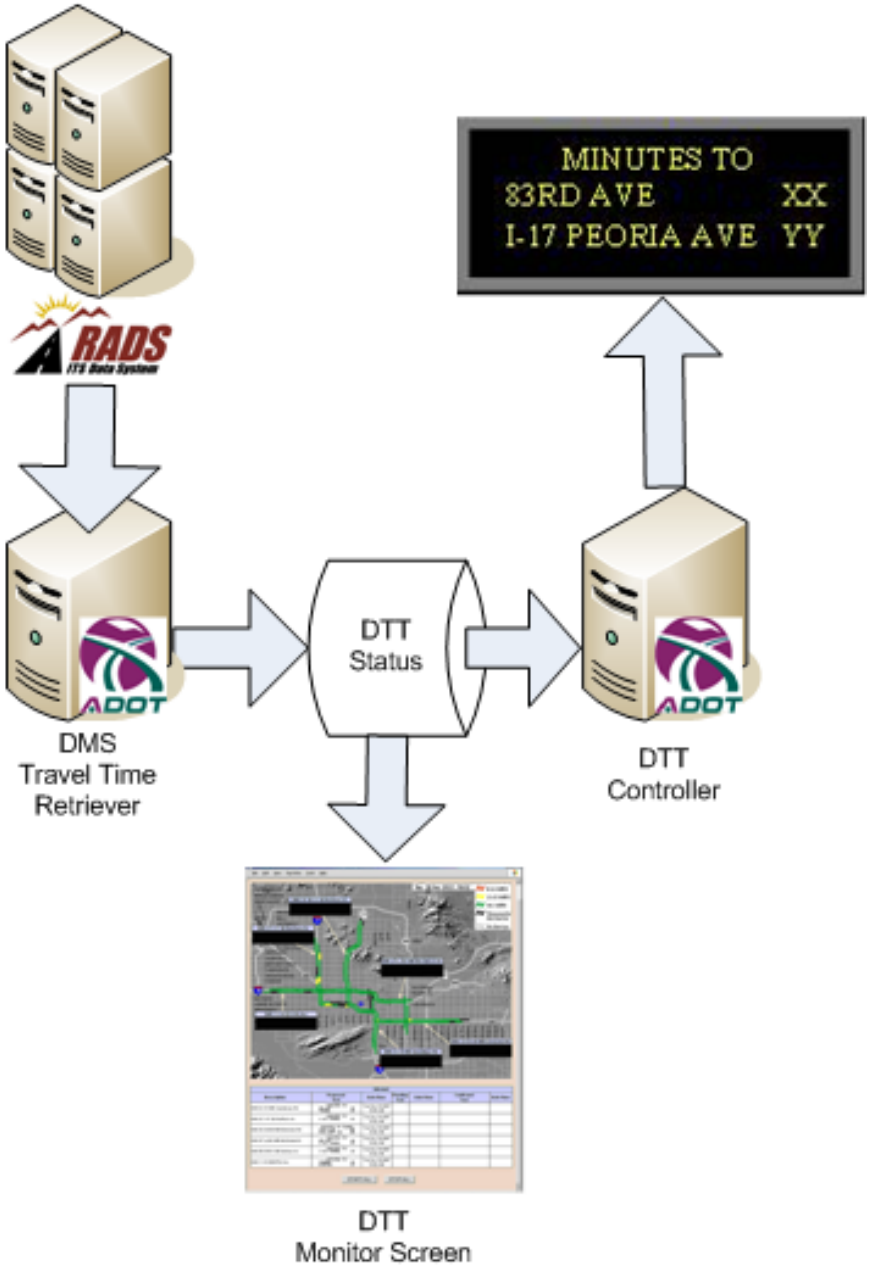


Figure 12 - Travel Time Concept of Operations

5.3.4 Operational Guidelines

Travel times are the default message for the six inbound and six outbound signs that are part of the pilot program during the time periods specified. Operators at the ADOT TOC can monitor active travel time display messages at the DMS, including proposed and confirmed travel time text. Any pre-empts to travel time messages (such as an incident message) are noted in the travel time monitor screen. Operators can override travel time messages to post a higher priority message. This screen is shown in **Figure 13.**

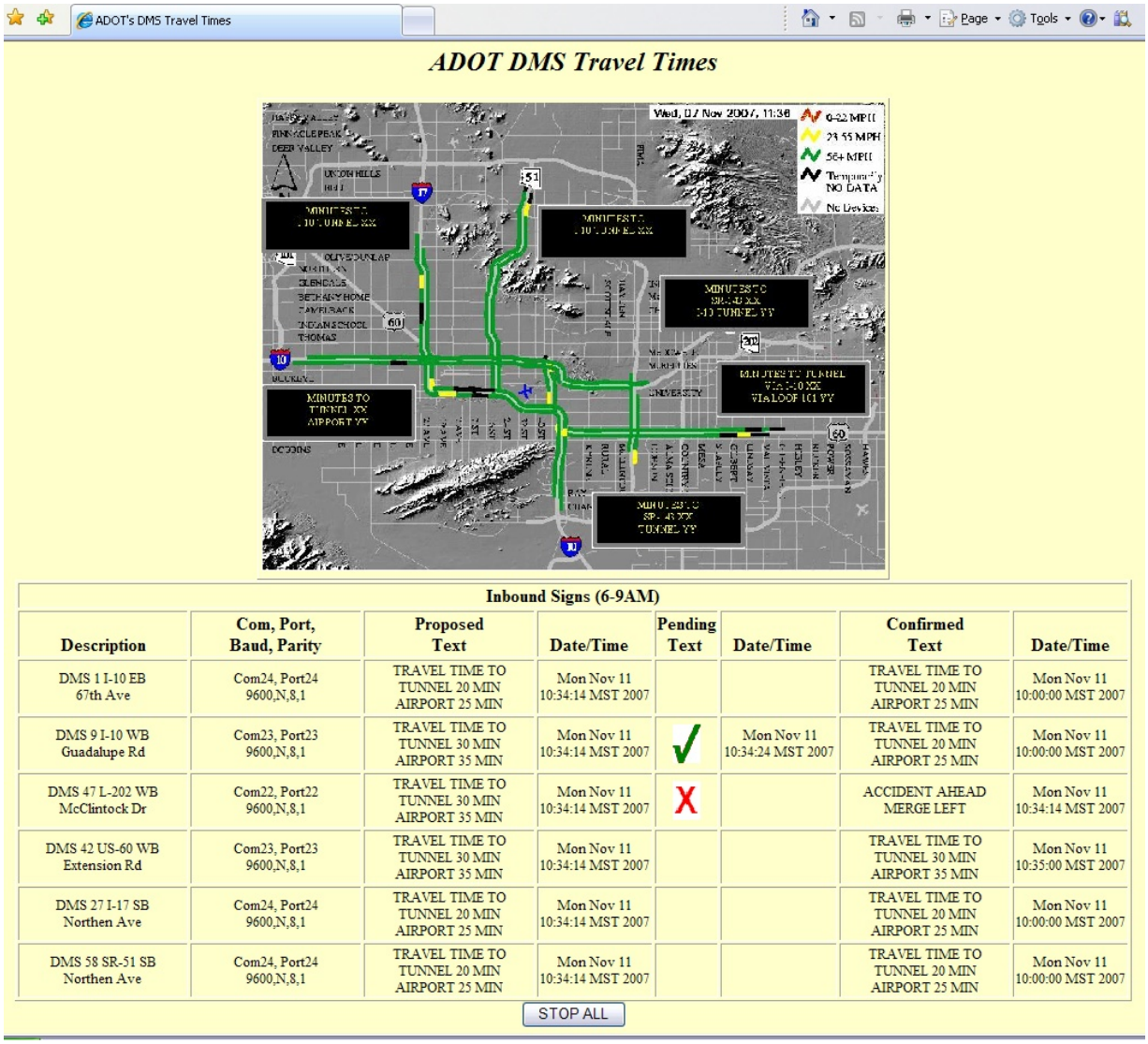


Figure 13 - DMS Travel Time Monitor Screen

ADOT has established a hierarchy of messages for the DMS. Travel times are intended to be the default message during AM and PM peak travel periods for the identified DMS, unless a higher priority event requires an alternate message (per the hierarchy below):

1. Roadway Closure
2. Safety (such as crash, construction or roadwork)
3. Mass Evacuation
4. AMBER Alert
5. Special Event
6. Travel Time
7. Minor Traffic Impact

8. Pre-warning (construction)
9. Test
10. Public Service Information
11. High Pollution Advisory and Ozone Alert

5.4 System Requirements and Design

5.4.1 System Requirements

Requirements are derived from the operational concept of what the system is intended to do (provide travel times on DMS) and describes in more detail how that system will perform. There are high-level and low-level requirements to consider: high-level requirements are presented in the form of "shall" statements which identifies the specific intentions of the system while the low-level requirements define what is needed to be able to achieve those specific intentions. The high-level requirements identified for this travel time pilot project as they relate to the function of the system and the associated low-level requirements are shown in **Table 8** shown below.

Table 8 – ADOT DMS Travel Time Requirements

Function	High-Level Requirement	Low-Level Requirement
System Monitoring Capability	System shall provide the capability of monitoring the status of all DMS during travel time messaging operation	A Dynamic Message Sign Travel Time interface shall be developed to provide an overview status of all controlled DMS.
System Reliability	System shall provide available cross-examination mechanism for performance validation purposes	During message confirmation stage, both real-time freeway speeds and sign text shall be displayed on the same screen for validation purposes.
DMS Message Prioritization	System shall provide the mechanism of prioritizing display of multiple messages	A set of rules shall be established within the system to identify which message to post first. This prioritization mechanism is implemented independently by the DMS control system.
Detection Capability	System shall integrate available detection data source in the field	Loop detection data is retrieved every 20 seconds from the field – if more than 33% of the sensors in a segment are not available, the travel time estimation shall not be performed.
Detection Reliability	System shall integrate reliable detection data source in the field	Sensor errors and other anomalies shall be logged to allow future trouble-shooting analysis by ADOT to determine detection needing repair/replacement if warranted.
Real-time Travel Time Availability	System shall develop a frequent update mechanism of the travel time estimate	DMS travel time update process shall periodically (every two minutes configurable) connect to the RADS and request the latest travel time to be displayed on the DMS
Travel Time Message Usefulness	System shall determine the best format for posted information that is useful to motorists	The composition of the text to be displayed is configurable by means of a text template and is readily changeable. The Technical Advisory Committee, with feedback provided from the public via surveys, has established the format to be displayed.
System Security	System shall establish different security-level accesses for different users	System shall provide authorized users with the ability to control the automation posting of DMS travel times. Other users are provided with view only status of all controlled DMS.

5.4.2 System Design

Lessons learned from other metropolitan areas that post travel times on their DMS offer that travel times are not suitable for every DMS or for every hour of the day – systematic approach is advised to begin posting travel times. When travel times were initially developed in the Phoenix metro area, ADOT tested displaying travel time messages on I-17.

The alternatives that were considered and the rationale behind selection decisions are outlined below:

- Alternative One – I-10 Corridor between Loop 101 (western border in Phoenix) and Loop 202 (eastern border in Chandler) – this route serves as a major collector between west valley and east valley travelers and is heavily used by daily commuter traffic as well as commercial vehicle traffic.
- Alternative Two – Select DMS throughout the Valley along a range of corridors – this alternative provides travel time information to a majority of traffic that travels to/from the downtown Phoenix area to the various parts of the Valley and encompasses all of the major freeways.
- Alternative Three – Super Bowl Corridor – this event was planned to produce traffic patterns and volumes not seen in the Phoenix valley and providing travel time information to travelers may mitigate some congestion, in addition to the increasing demand on Loop 101 in the west valley.
- Alternative Four – Destination of Sky Harbor International Airport – as one of the largest international airports in the country, Sky Harbor is a major destination route for travelers from all corners of the Valley.

The ADOT Transportation Technology Group (TTG) and Phoenix Maintenance District (PMD) selected Alternative Two to be able to most effectively distribute the beneficial data to the greatest volume of travelers. This decision also supported evaluating the project during the one-year period originally planned, which was later extended to the three-year time period.

5.5 System Implementation

ADOT is the lead agency in initiating the development of the travel time software, posting messages on DMS, and evaluating the system accuracy and reliability during the project. ADOT has integrated the travel time capability with existing operations processes at the TOC. Implementation began on January 22, 2008, following testing, verification and validation in the previous months.

Ongoing enhancements to the program have been addressed throughout the pilot. System changes have been made to address communications issues with specific detectors and accommodation of the new Cameleon Sign Control Server Applications Program Interface (API). Some modifications to the algorithms have been necessitated, including:

- Changing the sign blanking algorithm to accommodate a controller that was not reporting blank state of DMS in all cases.
- Improving the interpolation algorithm to fill in values for missing detector stations along the pilot corridors.

At the outset of this project, ADOT made the decision to provide rounded travel time displays to avoid potential traveler complaints about actual times not being precisely what they experienced. Through the outreach effort, ADOT emphasized that the displays were “estimates”, and that

travel conditions could change at any time. Travelers quickly noticed the travel times were always presented in five-minute increments, and some provided feedback on the on-line survey.

ADOT and its System Integrator modified the calculation strategy to provide for a more precise travel time estimate display. The system was modified to calculate actual travel time plus a 20% buffer, using a minimum value of one minute, and a maximum value of 10 minutes. On July 22, 2008, displays no longer presented travel times at the nearest five-minute interval, but were instead presented at one-minute estimates.

5.6 System Test and Verification

The connectivity, devices, and software will need to be tested, verified and validated. This section describes, at a high level, the activities and tools that were used to accomplish this requirement.

5.6.1 Subsystem Verification and Validation

Verification and validation is the process of checking that the system meets specifications and that it fulfills its intended purpose. Subsystem verification of the ADOT DMS travel time project requires that each of the components/devices of the project operates as intended to fulfill the needs of the project. The method of verification for each component/device is described below:

- ***Dynamic Message Sign*** – ADOT is able to query each DMS via fiber optic communications for working status as requested and the DMS will also send an alert message to the ADOT TOC operators managing the FMS system if the connection to the DMS is not working properly. ADOT is also able to identify, in some cases, that the DMS is displaying the appropriate message by using CCTV camera images to view the face of the DMS.
- ***Software –*** The software to calculate travel times, generate text messages and send those messages to the DMS has automatic checks and system failure strategies built-in to the software that minimize complications during message posting. The software was developed to be responsive to the various uses of the ADOT DMS including incident messages and AMBER Alert messages as well as to RADS network issues without failure.

5.6.2 Program Evaluation

The accuracy and reliability of travel times displayed on DMS is required to be beneficial for travelers. If the travel time calculations do not reflect actual travel times, motorists will not be able to use the information they are given to make informed decisions about their travel. The evaluation plan included in this project is intended to measure the travel time messages effect on travelers through a variety of methods. The evaluation is comprised of several tasks:

- Review literature and document pertinent evaluation outcomes from other travel time programs in the United States (US) that could be used to establish a hypothesis for the Phoenix metropolitan area DMS Travel Time Pilot Program;
- Evaluate freeway speeds in the vicinity of the DMS that are part of the pilot program once travel time messaging is activated, and identify if or where there are any significant impacts to freeway travel as a result of the messages;
- Verify displayed times with actual times during travel time runs immediately following the initiation of the program;

- Conduct a comprehensive user satisfaction survey among frequent freeway commuters to determine users' perception of the value, accuracy and overall benefit of freeway travel times during peak travel periods;
- Provide input at key points to ADOT's Project Manager and the System Integrator about any anomalies or findings during the evaluation; and
- Develop a final report and presentation summarizing findings from the pilot program evaluation.

5.7 System Operations, Maintenance and Lifecycle

Travel times are part of a broader suite of FMS traffic and incident management capabilities currently operated, managed and maintained by ADOT. Travel times added a component to the operating system to calculate and display the travel time estimates, but the core infrastructure (DMS, telecommunications, TOC, central system, and operators) would be in place with or without the Travel Time Pilot Program.

Operations and maintenance requirements for the DMS travel time system include annual monitoring/updating/troubleshooting of the algorithms, screen monitor, and RADS functionality to maintain the travel time calculation display processes. Through other processes at the TOC, sign status and verification is carried out through standard operating procedures of the operators.

Maintenance of the core infrastructure is the responsibility of the ADOT Phoenix Maintenance District. This includes preventive maintenance checks on the DMS, telecommunications, controllers, and detectors, as well as responsive maintenance when there is an identified device failure. This is integrated in to the standard operating procedures and processes for the Maintenance District personnel.

6. EXPANSION PLAN

This chapter outlines the plan for continuing and expanding the Travel Time Pilot Program to provide more coverage of metropolitan area freeways. Because of the popularity of the Travel Time Pilot Program, ADOT proposed, and the MAG ITS Committee unanimously supported, an incremental expansion of the program, and funding is programmed to continue and expand the Travel Time Program through Fiscal Year 2015. Scenarios for expansion were developed and include additional locations, additional corridor segments and different destinations.

6.1 2002 Estimate of Travel Time Pilot Program Costs

A report was prepared in November 2002 summarizing the benefits and costs of travel time messages in the Phoenix metropolitan area, titled *Displaying Travel Time Message on Freeway Variable Message Signs in the Phoenix Metropolitan Area*. At this time, FMS was deployed on limited routes along I-10 and I-17 in the central Phoenix area and 511/AZ511.gov was not yet deployed. Travel times, if they were developed, were not shared with the traveling public via DMS or other reporting tools. This report reviewed the original I-17 travel time pilot study completed in 2002, other travel time programs in the country, recommended formats for the travel time messages, and the existing DMS available and planned for the freeway network at the time. Within the report was also a cost estimate of the travel time message program.

The following assumptions in the 2002 report were used when calculating total estimated costs for the program:

- All existing DMS would be utilized for the program = 48 existing and 10 planned locations recommended for use in the program
- Costs based on an ADOT estimate of $8 per DMS per hour, which included electricity, communication and maintenance costs (a breakdown of this $8/hour cost was not included in the report).
- Annual costs include 250 non-holiday weekdays per year.

The report concluded that for the peak period times for which travel times should be posted on DMS (6AM to 9AM and 3PM to 7PM on weekdays only) that it would cost $8 per hour for 7 hours per day for each DMS involved in the program. The challenge with the report is not necessarily that the assumptions that were used were incorrect – it was that the travel time recommendations that those costs are applied to were not realistic.

The report calculates daily and annual costs for the travel times using all 58 DMS that were existing or planned in the Valley in 2002, for all seven hours of the peak periods. This would require that every DMS in the Valley be used for AM peak period travel times and then in the evening provide PM peak period travel times. This assumption totaled $3,200 per day for the travel times to be displayed and an annual cost of $812,000.

The reality is that it is not beneficial, nor justified, to use every DMS in the Valley to display travel times. Travel times are a tool for the traveling public to use while they are en route to their destination at various locations throughout the Valley. The Travel Time Pilot Program launched in 2008 identified 12 DMS locations that would provide either AM peak or PM peak period messages for inbound or outbound travelers of the I-10 Tunnel/Central Phoenix area; six DMS were used for inbound and six used for outbound messages. This Travel Time Pilot Program has been successful in establishing origin/destination points that are recognizable and have prompted network users in reporting that they generally would like to see additional DMS used for travel

times. There is no added benefit in providing travel times on every DMS in the Valley and therefore the costs should not be applied to consider that application.

It is recommended to not significantly modify the current travel time DMS locations used and routes reported because they have established known routes to the public without the costs recommended by the 2002 report. Minor adjustments are warranted based on major interchanges (such as Bell Rd, Shea Blvd, 83rd Ave, etc.) and new definition of FMS boundaries that do not limit reporting routes. It is recommended to expand the Travel Time Pilot Program to other freeway corridors and DMS due to new phases of the FMS program being installed as well as the potential for private sector speed data to supplement ADOT's detection (for corridors where detection has not been deployed).

If the value of $8 per DMS per hour was applied to the six pairs of DMS actively used in the program today used during the peak periods, this would cost ADOT approximately $84,000 per year. A DMS Overview summary sheet was provided by the Phoenix Maintenance District in July 2006 which stated that an increased cost for utilities, parts, and maintenance, resulted in a cost of $10 per hour for ADOT DMS.

6.2 Costs of Travel Time Program

The project management team was challenged with identifying the costs associated with the travel time expansion strategies. After much deliberation, the following costs were identified:

- Travel time algorithm development/support;
- Incremental weekday power costs associated with posting travel times on DMS during peak hours;
- Maintenance/upgrade costs for a set number of DMS regardless of the types of messages posted;
- Hardware, software, and licensing costs used to support the entire state ITS program, not just travel times on DMS;
- ADOT TOC facility costs used to support the entire state ITS program, not just travel times on DMS;
- ADOT TOC staff costs used to support the entire state ITS program, not just travel times on DMS; and
- DMS lifecycle costs.

The first two bullets are specific to travel times on DMS. If the travel time program was cut, this savings would be realized. Bullet three refers to the maintenance/upgrade of a set number of DMS regardless of the type of message posted. If the travel time program was cut, this cost would still be there because the DMS are used for posting other types of messages in addition to travel times, and these signs would still need to be maintained/upgraded. Bullets four, five, and six are baseline costs that support the entire state ITS program, not just travel times on DMS.

In the event there are changes to funding the program, the Travel Time Pilot Program will be proportionately affected. Funding shortfalls will significantly reduce the program capabilities and will thereby affect the travelers who have come to expect the information displayed on DMS along their route.

6.2.1 Travel Time Algorithm Development/Support

As described in Section 5, an algorithm was developed and support was given to allow for travel times to be posted on 12 DMS as part of the Travel Time Pilot Program. The

algorithm will require updates as new corridors, different segments, and additional DMS are added to the program, as well as periodic troubleshooting and verification for message reporting accuracy, and are therefore included as direct costs specific to providing travel times.

6.2.2 Incremental Week Day Power Costs Associated With DMS Posting Travel Time During Peak Hours

The DMS technology initially deployed along ADOT routes utilized fiber optic technology rear-access signs. Signs of that generation have additional power requirements to support the display component of the sign. Power is transmitted to the display whether or not display is showing a message. A majority of the signs used in ADOT's current Travel Time Pilot Program routes utilize this older sign technology.

New technology for DMS utilized by ADOT features a walk-in display that requires ventilation systems which adds additional power requirements to the DMS. However, the new DMS technology reduces the power requirements of the actual display due to Light-Emitting Diode (LED) bulbs rather than the fiber optic bulbs used in older signs. Loop 101 and US-60 DMS use this new sign technology.

Power costs shown in the calculations are based on the cost of the DMS being active and are not necessarily solely attributed to the cost of posting travel time messages, or any messages, on the DMS. The cost of a DMS will not increase or decrease substantially based on whether it is displaying a message or not because the DMS still remains active, it is cooled properly using the ventilation, and it is operational via communications equipment. This active state is essential to keeping the components of the DMS equipment in proper functioning order.

The costs per the manufacturer's specification are for the operation of the DMS regardless of whether or not there are messages displayed; therefore, the actual cost of travel time messages specifically being placed on the DMS are actually a small percentage of the costs.

Sample Power Bill

SRP power bills from DMS #42 (currently used in the Travel Time Pilot Program) for the month of October 2010 shows a DMS power cost of $54.24. The SRP power bill from DMS #40 (currently not used in the Travel Time Pilot Program) for the month of November 2010 shows a DMS power cost of $40.12. While those two values are from different months, DMS #42 was actively displaying travel times during the time period and DMS #40 was not displaying travel times. The difference in costs over the course of the year for one DMS to be displaying travel times equates to an extra $169.44 in power costs for that DMS alone to be part of the Travel Time Pilot Program ($54.24 - $40.12 = $14.12 x 12 months = $169.44).

Using that $169.44 value, that equates to $2033.28 per year ($169.44 x 12 total DMS) for the 12 DMS to be part of the Travel Time Pilot Program during the peak hours. For all of the existing 12 DMS locations to be included in the Travel Time Pilot Program, $2033.28 is the value above base power operating costs. ***The additional cost in DMS power due to the Travel Time Pilot Program usage is only a portion of the total larger costs of powering the DMS in general***.

It is important to note that the $2033.28 value was using the example of power consumption for two specific DMS in the Phoenix valley, not the manufacturer's specifications. That

value also is reflective of powering the DMS sign 24 hours per day (a total of $7810.56 to power the 12 DMS that are part of the Travel Time Pilot Program, 24 hours per day, 260 days per year). Power costs were derived utilizing manufacturer's specifications applied to only the travel time peak hour power usage (7 hours per day), which generalizes this value significantly higher than what is experienced in reality. Based on the manufacturer's specifications, the total cost for powering 12 DMS throughout the year is $30,258.92, of which the $2033.28 additional costs due to displaying travel times is a small fraction. Manufacturer's specifications are utilized in the analysis in the calculation tables because the cost of the entire Travel Time Pilot Program will not be accurate if based on only a sample of two DMS monthly power bills.

6.2.3 Maintenance/Upgrade Costs for DMS Used to Post Travel Times

The ADOT DMS throughout the metropolitan area were installed initially for traffic and incident management purposes. These DMS required capital costs initially and now require ongoing power costs, operator costs, and maintenance costs. While the DMS were not implemented to provide travel times, they are required devices to provide the Travel Time Pilot Program to the public. Other infrastructure such as detection, communications, DMS operating software, controllers, and other field and central infrastructure, although critical to delivering travel times, serve multiple traffic and incident management purposes. Isolating the costs of just the Travel Time Pilot Program from the overall operations and maintenance costs is challenging.

ADOT's Travel Time Pilot Program has been developed as an automated system using FMS detector data to calculate travel times and automatically post them to designated DMS. Verification of the message is periodically checked by the ADOT TOC Operators; however, there is no significant extra effort required from the operators in order to verify travel time messages. ADOT has processes in place to monitor DMS for any malfunctions of DMS and alert operators of abnormal operations. Operators can override travel time displays to post higher priority messages (such as incident messages).

Regular maintenance checks are required for ADOT DMS and are performed by the ADOT Phoenix Maintenance District. These maintenance checks may incorporate bulb replacement costs or shutter costs for additional use of the DMS display, but these costs are estimated as insignificant when compared to the general maintenance costs of the DMS. New LED technology signs offer power and maintenance savings making for more cost-effective operations of DMS. This is important as ADOT is currently utilizing the new LED technology for new DMS locations, as well as upgrading older signs to newer and more cost-effective LED sign technology.

The LED technology has different operating characteristics than the fiber optic display systems previously used:

- The LED light component of the panel that makes up the DMS display is the main component that is affected by continuous use. Panels on the DMS display can be maintained or replaced without a forklift replacement of the full DMS structure.
- At full intensity (maximum power, maximum brightness, all pixels activated), LED lights will last approximately five years per Daktronics specifications. It is not standard practice, nor recommended, to operate LED DMS with full intensity.
- To date, ADOT is on a 15-year replacement cycle for DMS. As technology improves and becomes more cost-effective, it becomes more prudent to upgrade the technology in advance of failure. Many of ADOT's DMS were part of the initial phases of ADOT's

FMS program, which were installed in 1995. These are currently being upgraded to LED technology.

- LED lights have an approximate mean time between failure of 100,000 hours (which equates to approximately 11.5 years) assuming average intensity and continuous 24x7 usage. Mean time between failure is the average length of time that it would take for one LED light to cease functioning. Travel time messages displayed on one sign accounts for 1,820 hours of use annually if displayed during peak travel periods. ADOT travel times account for approximately 20% of the total available display time of a DMS throughout the year (8,760 potential hours in one year if 24x7 display time is assumed).
- It can be assumed that an LED or LED panel should be replaced 20% faster due to travel time peak period posting; however, the LED mean time between failure of 11.5 years exceeds the timeframe for ADOTs standard replacement for LED panels. To date, ADOT has not had to replace any LED panels on signs that were deployed as part of Loop 101 and US-60 phases of FMS. This means that even though the use of the DMS increases, the lifecycle costs remains the same if ADOT continues to replace DMS every ten years.

Per a white paper developed by the FMS Working Group in 2005, $150,000 of ITS Preservation Funds was set aside for DMS, and a portion of the DMS cost is utilized for ITS infrastructure outside of Phoenix. Periodic or routine calibration of all installed FMS mainline vehicle detection equipment at the time did not have a plan, schedule or budget for maintenance. Fiberoptic Display System (FDS – manufacturer of FO [fiber optic] sign technology) is under contract to provide DMS repair, replacement and parts.

6.2.4 Hardware, Software, Licensing Costs Used to Support the Entire State ITS Program

The FMS program is operated and controlled by a series of software systems and hardware components located at the TOC. Software includes the signal system, Camera Cameleon, and other systems that collect, manage, and archive the data. Some softwares require licensing fees for their use, such as Camera Cameleon, which is covered by ADOT to allow local agencies to use for the operation of their cameras. Hardware includes the switches, routers, encoders/decoders, servers, and equipment for the Node buildings throughout the Phoenix metropolitan area. This hardware requires regular maintenance checks, periodic updates, and periodic repairs.

These hardware, software, and licensing costs are used to support the state ITS program, not just the Phoenix metropolitan area FMS system and are essential components to the travel time program.

6.2.5 TOC Facility Costs Used to Support the Entire State ITS Program

These costs include the building, power, security, equipment repair/replacement, maintenance, and other costs involved in maintaining the TOC facility to support the TOC staff, the TOC equipment and the state's ITS program.

The TOC facility costs are used to support the state ITS program, not just the Phoenix metropolitan area FMS system and are essential components to the travel time program.

6.2.6 TOC Staff Costs Used to Support the Entire State ITS Program

TOC staff includes the operators, information technology personnel, program managers, and other supporting staff from the ADOT Transportation Technology Group which are located at the TOC to operate, maintain, and control the state's FMS program on a day-to-day basis.

The TOC staff costs are used to support the state ITS program, not just the Phoenix metropolitan area FMS system and are essential components to the travel time program because of the continuous operations and management of the state's DMS.

6.2.7 Lifecycle Costs

The typical lifecycle cost associated with the use of DMS for displaying messages involves the power costs to operate the DMS (captured under Section 6.2.2), lifecycle maintenance/upgrade costs (captured under Section 6.2.3), and the lifecycle display costs (captured under Section 6.2.3 as well).

6.2.8 Updated Costs of Program

In order to validate a value per DMS per hour, a summary of power/communications costs and maintenance/upgrade costs has been defined below as justification. **Table 9** defines the costs of operating DMS signs during the current Travel Time Pilot Program using manufacturer's sign specifications for power consumption and estimated maintenance requirements for the signs.

It is important to note that the maintenance costs listed below are for DMS maintenance required throughout the year and are not necessarily specific to the use of travel times on that DMS; therefore, the actual maintenance costs associated with the specific use during the Travel Time Pilot Program are estimated as insignificant when compared to the general maintenance costs of the DMS (see page 55). The total costs are used to introduce a factor of safety in estimation purposes.

Estimated below are maintenance costs associated with at least a once every three month preventative maintenance check (total of four per year per ADOT's typical maintenance schedule) and it is anticipated that with the increased usage of the DMS display, that there would be regular replacement of bulbs as warranted. The additional bulb costs involved with replacement needs are minimal. Per ADOT PMD staff, LED DMS locations have required less maintenance than the older FO technology, and suggests that where the older technology DMS are utilized it might be less maintenance on signs that are used more often for travel times or other purposes. The newer LED technology does not work like the older generation "bulb" technology, where additional hours of use equated to significantly faster degradation of parts. LEDs are capable of displaying levels of intensity which account for their longer lifespan depending on the intensity used during displays. Older technology was purely "on" or "off", whereas LEDs can be adjusted to reduce power consumption and have a longer lifespan. There could be some alteration to maintenance priorities on corridors supporting travel times. For example, detection systems along these corridors may have maintenance response of failures elevated from non-critical to emergency for response purposes. However, the total numbers of repairs on an annual basis and the regimen for preventative maintenance would likely remain unchanged. Therefore, the costs associated with these changes are expected to be nominal.

The method for the calculations in the tables are as follows:

DMS Power Costs Calculation

(Total kW) × (Cost of power / kWh) × (# of weekdays) = Total cost to power one DMS during one hour

(Total cost to power one DMS during one hour) × (# of hours DMS is in use) × (# of DMS) = Total cost to power AM or PM DMS during the year

(Total cost to power AM DMS during the year) + (Total cost to power PM DMS during the year) = Total cost to power DMS in travel time program during the year

DMS Maintenance/Upgrade Costs Calculation

{(# of major preventative maintenance checks) × (Cost of major preventative maintenance check) + (# of minor preventative maintenance checks) × (Cost of minor preventative maintenance check) + (# of minor repairs and upgrades per year) × (Cost of minor repair or upgrade)}

X (# of DMS) = Total cost for maintenance and upgrades on DMS per year (used for travel times or other purposes)

Future Year Values

{(Total cost for maintenance and upgrades on DMS in 2011 (used for travel times or other purposes)) X (1 + 0.03)} ^ (20XX (future year) — 2011) = Total cost for maintenance and upgrades on DMS in 20XX (used for travel times or other purposes)

2011 DOLLAR VALUE **3% ANNUAL INFLATION** **20XX DOLLAR VALUE**

Table 9 – Travel Time Pilot Program O&M Costs (12 DMS in the Current Program)

FO Technology (FDS 3-Line Existing DMS)	
4.5	kW for one DMS and for ventilation, communications and other supporting infrastructure
$ 0.0898	Cost per kWh (per US Energy Information Administration using commercial rates)
260	Each weekday during year
= $105.07	Total cost to power one DMS during one hour (applied to DMS used for AM and PM peak period hours to calculate total cost for AM and PM DMS below)
3	Hours of use during AM peak period (travel time messages only provided in one direction)
6	DMS used in AM peak period
$1,891.19	**Total cost to power AM DMS currently during the year**
4	Hours of use during PM peak period (travel time messages only provided in one direction)
6	DMS used in PM peak period
$2,521.58	**Total cost to power PM DMS currently during the year**
$ 4,500	**Total cost to power DMS during the year on 12 DMS rounded to nearest $500 (used for travel times or other purposes)**

Maintenance and/or Upgrade of 12 DMS	
2	Major preventative maintenance checks per year
$ 2,800	Cost of major preventative maintenance check
2	Preventative maintenance checks per year (recommendation based on ADOT typical maintenance schedule)
$ 100	Cost of minor preventative maintenance check
1	Minor repairs and upgrades per year
$ 2,100	Cost of minor repair
$ 7,900	Total cost for maintenance and upgrades on one DMS per year
12	Total DMS in use now to support Travel Time Pilot Program
$ 95,000	**Total cost for maintenance and upgrades on 12 DMS per year rounded to nearest $500 (used for travel times or other purposes)**

Total costs for utilizing 12 DMS (6 pairs of DMS for 7 hrs/day, 5 days/week, and 52 weeks/year) for messages is estimated at approximately $100,000 per year. This value is not specific to travel time usage, and encompasses the maintenance and power costs of DMS in general. This is generally consistent with the DMS costs using the $10/sign/hour rate which valued using 12 DMS signs during the AM and PM peak periods at $109,200 ($10/hour X 7 hours X 6 pairs of DMS X 260 weekdays).

6.3 Travel Time Pilot Program Expansion Planning

There are opportunities to expand the Travel Time Pilot Program to support more freeway corridors used around the Phoenix Valley beyond the 12 locations utilized in the Pilot Program. There is already strong support from the region to continue and expand travel times on DMS in the Phoenix metropolitan area. In order to appropriately plan for expansion, a number of factors need to be considered to define where travel times should be displayed and what destination points should be displayed to travelers. These factors to support expansion of the Travel Time Pilot Program are identified below:

- **Expansion of FMS –** ADOT has expanded the FMS since 2008 including DMS and detection along key corridors (Loop 101, US-60, and SR-51) with central control at ADOT TOC.
- **Existing travel time algorithm –** Expansion of the travel time algorithm is nominal effort, although new segments and destinations will require additional integration effort.
- **Public perception of expansion needs –** Loop 101 was the most commonly requested corridor from the public feedback collected in 2008. Some portions of Loop 101 have been instrumented with detection, thus the data capability exists to provide travel times, but other segments (such as the L101 Agua Fria) are not yet instrumented with loops.
- **Recognizable Segment Destinations –** The most useful travel time messages will include destinations that large percentages of travelers are familiar with and can relate them to their current travel even if it is not their current destination. The strategy for the Pilot Program used the downtown area (I-10 tunnel) as a major travel time destination for inbound travelers, and served as an origination point for outbound travel times. This strategy could change for expansion of the program to be able to incorporate segments of I-10 through the downtown area.
- **Corridor Trip Length –** Short distance travel time estimates are of little value to travelers. Longer segments are needed to support useful travel time messages. On the other hand, with a longer segment, there is a greater chance for variability in the travel time estimates. More frequent displays along a corridor could provide updated information if conditions change. This was noted in some of the comments received in the surveys.
- **Congestion does not occur during the peak periods along all corridors in the Valley –**The best candidate corridors will encounter significant deviation in travel time, but will likely have predictable congestion patterns (i.e., AM inbound lanes with heavier congestion; PM outbound lanes with heavier congestion) and known bottlenecks. If travel times are typically uniform and the traveler sees the same message every time they travel the corridor, they will tend to discount the value of the message and eventually even start to ignore the message completely. These travel time deviations are most common in corridors approaching capacity deficiencies.
- **Decentralize –** Not all corridors that could support travel times would have destination points near Central Phoenix (current "central" destination is the I-10 tunnel) – recommendation to expand scope of Travel Time Pilot Program to include other hub locations in the Valley. Additional AM peak period destination points were included beyond the I-10 Tunnel and Airport due to Loop 101 being instrumented with FMS. Destination and decision points for the AM peak period were added to encompass the Loop 101 typical congestion patterns. Additional PM peak period destination points were included which are known to travelers that live toward the northwest, southwest, northeast, and southeast valleys.

This section provides expansion opportunities for the Travel Time Pilot Program through the use of existing FMS capabilities as well as new data collection capabilities available.

6.3.1 Phased Expansion Plan Based on FMS Data

The ability to expand the Travel Time Pilot Program is based primarily on the operations and maintenance funding constraints to provide and sustain the service for the traveling public. The existing program has established a large percentage of travel times that would be beneficial to offer the metropolitan travelers already; this expansion plan would add new locations and new routes where applicable to an already robust Travel Time Pilot Program.

Table 10 summarizes the phasing plan for the expansion of the Travel Time Pilot Program. Bolded parts of messages are recommended updates to existing messages being displayed. Bolded full messages are recommended new messages to display on new DMS locations. The travel time corridor ID# listed at the left in this table corresponds to the numbers in the circles for the AM peak and PM peak periods in **Figure 14** and **Figure 15**. The phasing plan is summarized as follows:

- **Existing (2010, 12 DMS) –** Travel time messages currently being displayed as part of the program.
- **Phase 1 (2011, 19 DMS) –** Minor modifications to current travel time messages and new travel time messages recommended due to the expansion of FMS and detection in the Valley that has occurred since the original launch of the Travel Time Pilot Program.
- **Phase 2 (2012, 23 DMS) –** Travel time message recommendations based on FMS expansion plans by 2012.
- **2013-2016 (23 DMS) –** Continue operating Phase 2 due to anticipated coverage of existing logical corridors.
- **Phase 3 (2017, 25 DMS) –** Travel time message recommendations based on FMS expansion plans by 2017.

Table 10 – Phasing Plan for Travel Time Pilot Program Expansion

EXISTING – 12 DMS				
1	AM PEAK	DMS # 1 I-10 EB	I-10 / 67TH AVE	MINUTES TO TUNNEL XX AIRPORT YY
2		*DMS # 8 I-10 WB	I-10 / RAY RD	MINUTES TO SR-143 XX TUNNEL YY
3		**DMS # 47 L-202 WB	L-202 / MCCLINTOCK DR	MINUTES TO 44TH ST XX I-10 TUNNEL YY
4		DMS #42 US-60 WB	US-60 / EXTENSION RD	MINUTES TO TUNNEL VIA I-10 XX VIA LOOP 101 YY
5		DMS # 58 SR-51 SB	SR-51 / NORTHERN AVE	MINUTES TO I-10 TUNNEL XX
6		DMS # 27 I-17 SB	I-17 / NORTHERN AVE	MINUTES TO I-10 TUNNEL XX
1	PM PEAK	DMS # 13 I-10 WB	I-10 / 7TH AVE	MINUTES TO 83RD AVE XX I-17 PEORIA AVE YY
2		DMS # 4 I-10 EB	I-10 / 10TH ST	MINUTES TO RAY RD XX SR-51 BELL RD YY
3		DMS # 50 L-202 EB	L-202 / 24TH ST	MINUTES TO LOOP 101 XX
4		DMS # 32 I-17 SB	I-17 / CENTRAL AVE	MINUTES TO I-10 RAY RD XX US-60 VAL VISTA YY
5		DMS # 17 I-17 NB	I-17 / 4TH AVE	MINUTES TO PEORIA AVE XX I-10 83RD AVE YY
6		DMS # 55 SR-51 NB	SR-51 / OSBORN RD	MINUTES TO BELL RD XX
PHASE 1 – 19 DMS (can be implemented with current FMS coverage)				
5	AM PEAK	DMS # 58 SR-51 SB	SR-51 / NORTHERN AVE	MINUTES TO I-10 TUNNEL XX **202 RURAL RD YY**
6		DMS # 27 I-17 SB	I-17 / NORTHERN AVE	MINUTES TO I-10 TUNNEL XX **I-10 67TH AVE YY**
7		DMS # 101 L-101 NB	L-101 / MCKELLIPS RD	**MINUTES TO BELL RD XX**
8		DMS # 105 L-101 WB	L-101 / SCOTTSDALE RD	**MINUTES TO SR-51 XX I-17 YY**
9		DMS # 84 L-101 EB	L-101 / 7TH AVE	**MINUTES TO SR-51 BELL RD XX**
10		DMS #100 L-101 NB	L-101 / ELLIOT RD	**MINUTES TO SHEA BLVD XX 202 RED MTN YY**
11		DMS # 71 US-60 WB	US-60 / GREENFIELD RD	**MINUTES TO LOOP 101 XX I-10 YY**

*On May 18, 2010, DMS 9 inbound DMS was changed to DMS 8 (I-10 WB Ray, with the same destinations).
**On January 25, 2011, destinations and display was changed to 44th Street and I-10 Tunnel

Table 10 – Phasing Plan for Travel Time Pilot Program Expansion (continued)

PHASE 1 – 19 DMS (continued)				
2	PM PEAK	DMS # 4 I-10 EB	I-10 / 10TH ST	MINUTES TO **I-10** RAY RD XX SR-51 **SHEA BLVD** YY
7		DMS # 89 L-101 SB	L-101 / THUNDERBIRD RD	**MINUTES TO** **L202 RED MTN XX** **US-60 YY**
8		DMS # 104 L-101 NB	L-101 / CACTUS RD	**MINUTES TO** **SR-51 XX** **I-17 YY**
9		DMS # 45 L-101 SB	L-101 / MAIN ST	**MINUTES TO** **US-60 VAL VISTA XX** **L202 SANTAN YY**
PHASE 2 – 23 DMS (2012)				
9	AM PEAK	DMS # 84 L-101 EB	L-101 / 7TH AVE	**MINUTES TO** **SR-51 BELL RD XX** **SR-51 NORTHERN YY**
6	PM PEAK	DMS # 55 SR-51 NB	SR-51 / OSBORN RD	MINUTES TO **SHEA BLVD** XX **LOOP 101 YY**
10		DMS # 130 SR-51 NB	SR-51 / NORTHERN AVE	**MINUTES TO** **I-17 VIA L101 XX** **SCOTTSDALE RD YY**
11		DMS # 22 I-17 NB	I-17 / PEORIA AVE	**MINUTES TO** **LOOP 101 XX** **L101 75TH AVE YY**
PHASE 3 – 25 DMS (2017)				
12	AM PEAK	DMS # TBD L-101 EB	L-101 / 75TH AVENUE AREA	**MINUTES TO** **I-17 XX** **SR-51 YY**
13		DMS # 81 I-10 EB	I-10 / BULLARD AVENUE	**MINUTES TO** **I-17 XX** **TUNNEL YY**

Figure 14 and 15 are maps of the recommended travel time displays for use in the AM peak and PM peak periods. The circle represents the location of the DMS, the number in the circle corresponds to the travel time corridor ID# listed in **Table 10**, and the solid line represents the corridor/s calculated for the travel time destination for that particular DMS. The diamonds in the AM peak travel time routes indicate the I-10 tunnel, the SR-51/Loop 101 intersection, and the US-60/Loop 101 intersection which are destination points for many of the travel time messages as part of the expanded program through 2017. All major corridors that have been instrumented with FMS or have planned FMS in the future have been included in the Travel Time Pilot Program.

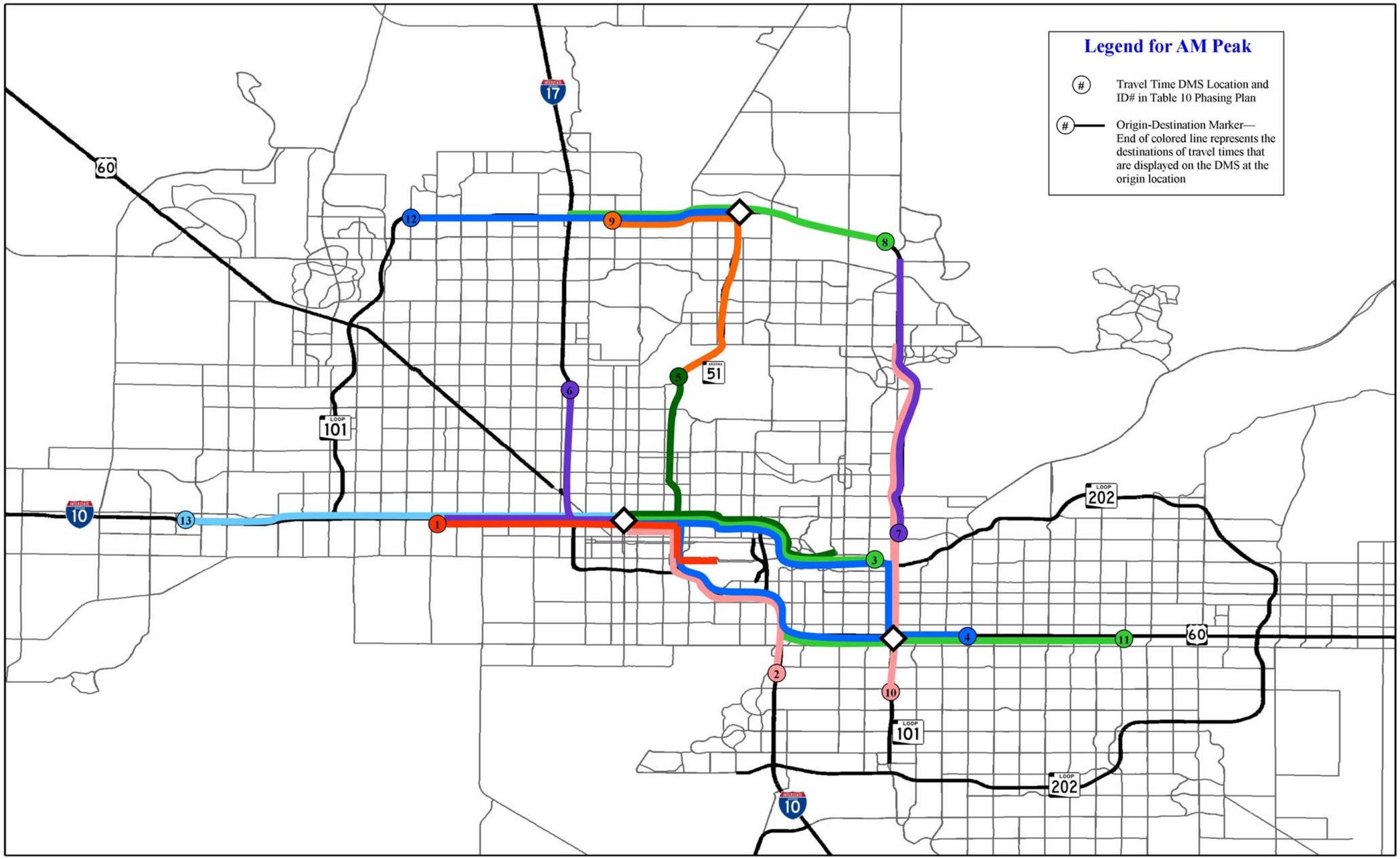


Figure 14 – Map of AM Peak Travel Times

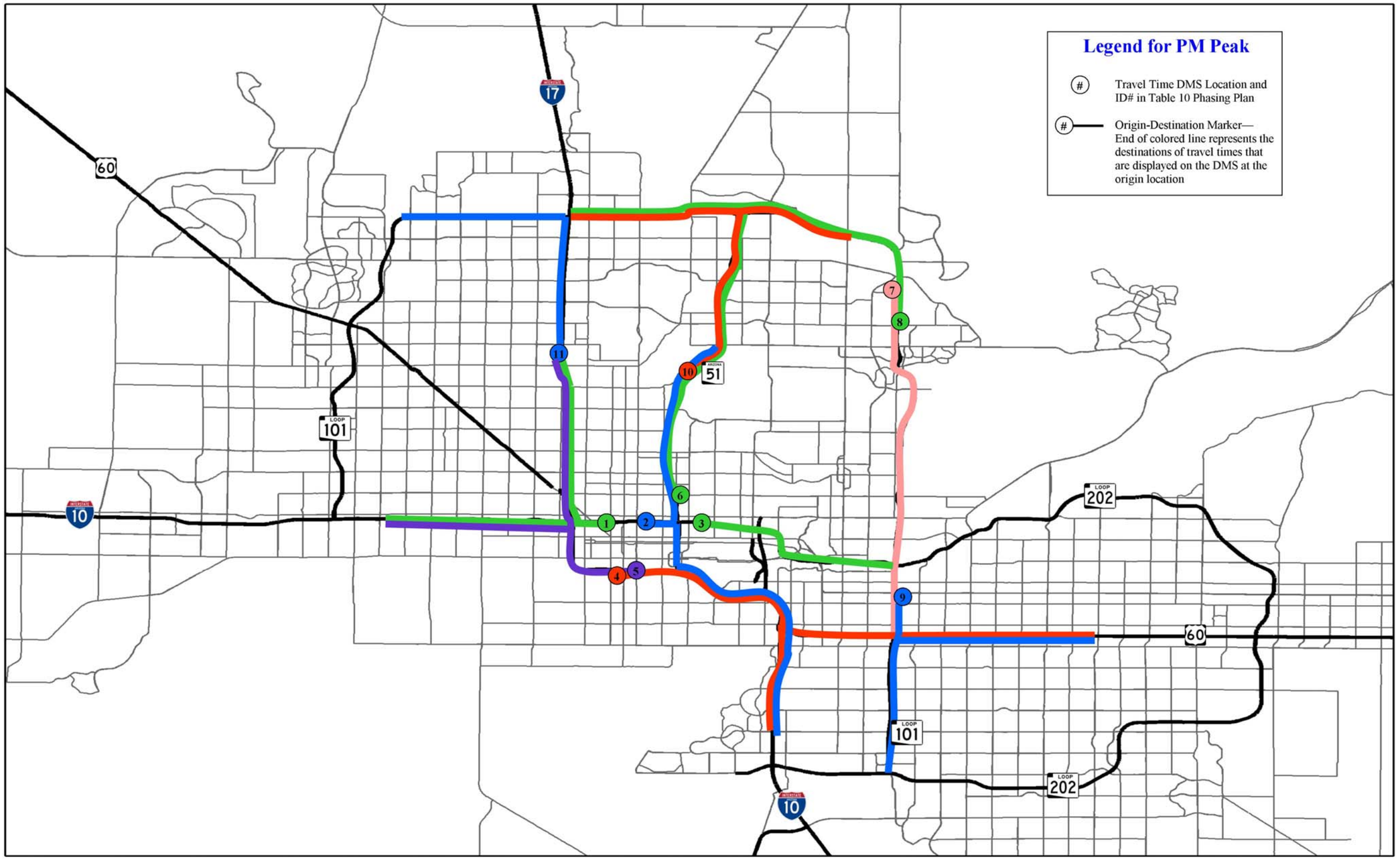


Figure 15 – Map of PM Peak Travel Times

6.3.2 Addressing Speed Data Needs

There is an opportunity to utilize private sector data to further expand the Travel Time Pilot Program to freeway corridors that are not instrumented yet with ADOT loop detection. This would offer travel times for additional types of travelers, such as commercial vehicles, or travelers going beyond the metropolitan area to benefit from the Arizona Travel Time Pilot Program. ADOT and the Maricopa Association of Governments have had preliminary discussions on the feasibility of supplementing regional data with private sector speed data. Private sector data could potentially support statewide application of travel times.

While there are opportunities to provide travel times on other corridors in the Phoenix Valley based on private sector data, the actual need for those travel times is captured effectively by the FMS deployments programmed through 2017. However, by using private sector data in the interim for Phase 2 and Phase 3, travel times can be offered prior to FMS mainline detection installation for public agency data collection needs. The travel time messages that can be displayed using private sector data will be constrained by operations and maintenance costs associated with the usage of those signs.

If ADOT moves forward with procuring private sector data, rather than displaying one message on a specific sign in the AM peak and another message on a specific separate sign in the PM peak – messages could be posted throughout both peak periods because of ongoing commercial vehicle traffic. The destinations refer to the generally recognized locations along the interstates at the opposite ends of the metropolitan area from where the DMS is displaying the message. This is recommended to be provided to travelers who plan to travel through the Valley, and the other travel time messages provided along key parts of their travel through the Valley will provide them with the interim route travel times to closer destinations.

6.4 Travel Time Pilot Program Expansion Costs

Using the phasing plan identified in the previous section, Phase 1, Phase 2, and Phase 3 costs will be higher than the current Travel Time Pilot Program costs because of program expansion to utilize additional DMS in the area. These costs are shown in **Table 11, 12, and 13**.

A primary component of future program expansion is the maintenance costs (in addition to base costs for FMS and power). The assumptions contained in Tables 11 and 12 are consistent with best practices and other agency maintenance activities identified through research for the costs of the preventative major and minor maintenance checks as well as maintenance repairs on DMS. The tables include using ADOT's maintenance schedule for the number of checks throughout the year. Costs are calculated using today's dollars, and a 3% increase has been added to the 2012 estimate in Table 12.

Table 11 – Travel Time Pilot Program O&M Costs – After Phase 1 Implementation (2011)

FO Technology (FDS 3-Line Existing DMS)	
4.5	kW for one DMS and for ventilation, communications and other supporting infrastructure
$ 0.0898	Cost per kWh (per US Energy Information Administration using commercial rates)
260	Each weekday during year
= $105.07	Total cost to power one DMS during one hour (applied to DMS used for AM and PM peak period hours to calculate total cost for AM and PM DMS below)
3	Hours of use during AM peak period (travel time messages only provided in one direction)
6	DMS used in AM peak period
$1,891.19	**Total cost to power AM DMS during the year**
4	Hours of use during PM peak period (travel time messages only provided in one direction)
6	DMS used in PM peak period
$2,521.58	**Total cost to power PM DMS during the year**
LED Technology (FDS 3-Line Existing DMS)	
1.75	kW for one DMS and for ventilation, communications and other supporting infrastructure
$ 0.0898	Cost per kWh (per US Energy Information Administration using commercial rates)
260	Each weekday during year
= $40.86	Total cost to power one DMS during one hour (applied to DMS used for AM and PM peak period hours to calculate total cost for AM and PM DMS below)
3	Hours of use during AM peak period (travel time messages only provided in one direction)
5	DMS used in AM peak period
$612.89	**Total cost to power AM DMS during the year**
4	Hours of use during PM peak period (travel time messages only provided in one direction)
2	DMS used in PM peak period
$326.87	**Total cost to power PM DMS during the year**
$ 5,500	**Total cost to power DMS during the year on 23 DMS rounded to nearest $500 (used for travel times or other purposes)**

Maintenance and/or Upgrade of 19 DMS	
2	Major preventative maintenance checks per year
$ 2,800	Cost of major preventative maintenance check
2	Preventative maintenance checks per year
$ 100	Cost of minor preventative maintenance check
1	Minor repairs and upgrades per year
$ 2,100	Cost of minor repair
$ 7,900	Total cost for maintenance and upgrades on one DMS per year
19	Total DMS in use to support Travel Time Pilot Program
$ 150,000.00	**Total cost for maintenance and upgrades on 19 DMS per year rounded to nearest $500 (used for travel times or other purposes)**

Table 12 – Travel Time Pilot Program O&M Costs – After Phase 2 Implementation (2012)

FO Technology (FDS 3-Line Existing DMS)	
4.5	kW for one DMS and for ventilation, communications and other supporting infrastructure
$ 0.0898	Cost per kWh (per US Energy Information Administration using commercial rates)
260	Each weekday during year
= $105.07	Total cost to power one DMS during one hour (applied to DMS used for AM and PM peak period hours to calculate total cost for AM and PM DMS below)
3	Hours of use during AM peak period (travel time messages only provided in one direction)
6	DMS used in AM peak period
$1,891.19	**Total cost to power AM DMS during the year**
4	Hours of use during PM peak period (travel time messages only provided in one direction)
8	DMS used in PM peak period
$3,362.11	**Total cost to power PM DMS during the year**
LED Technology (FDS 3-Line Existing DMS)	
1.75	kW for one DMS and for ventilation, communications and other supporting infrastructure
$ 0.0898	Cost per kWh (per US Energy Information Administration using commercial rates)
260	Each weekday during year
= $40.86	Total cost to power one DMS during one hour (applied to DMS used for AM and PM peak period hours to calculate total cost for AM and PM DMS below)
3	Hours of use during AM peak period (travel time messages only provided in one direction)
7	DMS used in AM peak period
$858.04	**Total cost to power AM DMS during the year**
4	Hours of use during PM peak period (travel time messages only provided in one direction)
2	DMS used in PM peak period
$326.87	**Total cost to power PM DMS during the year**
$ 6,438	**Total cost to power DMS during the year on 23 DMS rounded to nearest $500 (used for travel times or other purposes)**
$ 7,000	**2012 costs = 3% per year added from 2011 dollars (this value used in Figure 16)**

Maintenance and/or Upgrades of 23 DMS	
2	Major preventative maintenance checks per year
$ 2,800	Cost of major preventative maintenance check
2	Preventative maintenance checks per year
$ 100	Cost of minor preventative maintenance check
1	Minor repairs and upgrades per year
$ 2,100	Cost of minor repair
$ 7,900	Total cost for maintenance and upgrades on one DMS per year
23	Total DMS in use to support Travel Time Pilot Program
$ 181,700	**Total cost for maintenance and upgrades on 23 DMS per year rounded to nearest $500 (used for travel times or other purposes)**
$187,000	**2012 costs = 3% per year added from 2011 dollars (this value used in Figure 16)**

Table 13 – Travel Time Pilot Program O&M Costs – After Phase 3 Implementation (2017)

FO Technology (FDS 3-Line Existing DMS)	
4.5	kW for one DMS and for ventilation, communications and other supporting infrastructure
$ 0.0898	Cost per kWh (per US Energy Information Administration using commercial rates)
260	Each weekday during year
= $105.07	Total cost to power one DMS during one hour (applied to DMS used for AM and PM peak period hours to calculate total cost for AM and PM DMS below)
3	Hours of use during AM peak period (travel time messages only provided in one direction)
6	DMS used in AM peak period
$1,891.19	**Total cost to power AM DMS during the year**
4	Hours of use during PM peak period (travel time messages only provided in one direction)
8	DMS used in PM peak period
$3,362.11	**Total cost to power PM DMS during the year**
LED Technology (FDS 3-Line Existing DMS)	
1.75	kW for one DMS and for ventilation, communications and other supporting infrastructure
$ 0.0898	Cost per kWh (per US Energy Information Administration using commercial rates)
260	Each weekday during year
= $40.86	Total cost to power one DMS during one hour (applied to DMS used for AM and PM peak period hours to calculate total cost for AM and PM DMS below)
3	Hours of use during AM peak period (travel time messages only provided in one direction)
9	DMS used in AM peak period
$1,103.19	**Total cost to power AM DMS during the year**
4	Hours of use during PM peak period (travel time messages only provided in one direction)
2	DMS used in PM peak period
$326.87	**Total cost to power PM DMS during the year**
$ 7,000	**Total cost to power DMS during the year on 25 DMS rounded to nearest $500 (used for travel times or other purposes)**
$ 8,500	**2017 costs = 3% per year added from 2011 dollars (this value used in Figure 16)**

Maintenance and/or Upgrades of 25 DMS	
2	Major preventative maintenance checks per year
$ 2,800	Cost of major preventative maintenance check
2	Preventative maintenance checks per year
$ 100	Cost of minor preventative maintenance check
1	Minor repairs and upgrades per year
$ 2,100	Cost of minor repair
$ 7,900	Total cost for maintenance and upgrades on one DMS per year
25	Total DMS in use to support Travel Time Pilot Program
$ 197,500	**Total cost for maintenance and upgrades on 25 DMS per year rounded to nearest $500 (used for travel times or other purposes)**
$243,000	**2017 costs = 3% per year added from 2011 dollars (this value used in Figure 16)**

6.5 Travel Time Pilot Program and Supporting Costs – 2010 Through 2017

Travel Time Program specific costs are defined as the travel time algorithm development/support and incremental week day power costs for the DMS that are used in the program. In 2010, the algorithm development/support costs totaled $45,000 and was used to maintain and upgrade the travel time calculations as the system expanded/updated messages provided to travelers. The $45,000 per year costs assumed that the baseline and system funding remains the same, and includes a 3% per year inflation. The operations of the DMS (power costs) are reflected as travel time specific costs.

In 2010, it cost $400,000 to support the ADOT FMS system in the Phoenix metropolitan area where the Travel Time Pilot Program is performing. It costs another $1,040,000 to support the TOC facility and personnel to operate the FMS every year. These costs are not Travel Time Program specific costs, however they are essential to provide the Travel Time Program.

The projected annual maintenance cost for 25 DMS (used for travel times or other purposes) after Phase 3 implementation in 2017 will be approximately $243,000.

Total costs to support the Travel Time Pilot Program expansion are shown for 2010 and through the Phase III program expansion plan by 2017 in **Figure 16**. All values after 2012 received a 3% inflation increase to reach 2017 costs for each component supporting the Travel Time Program. All values are rounded to the nearest $500.

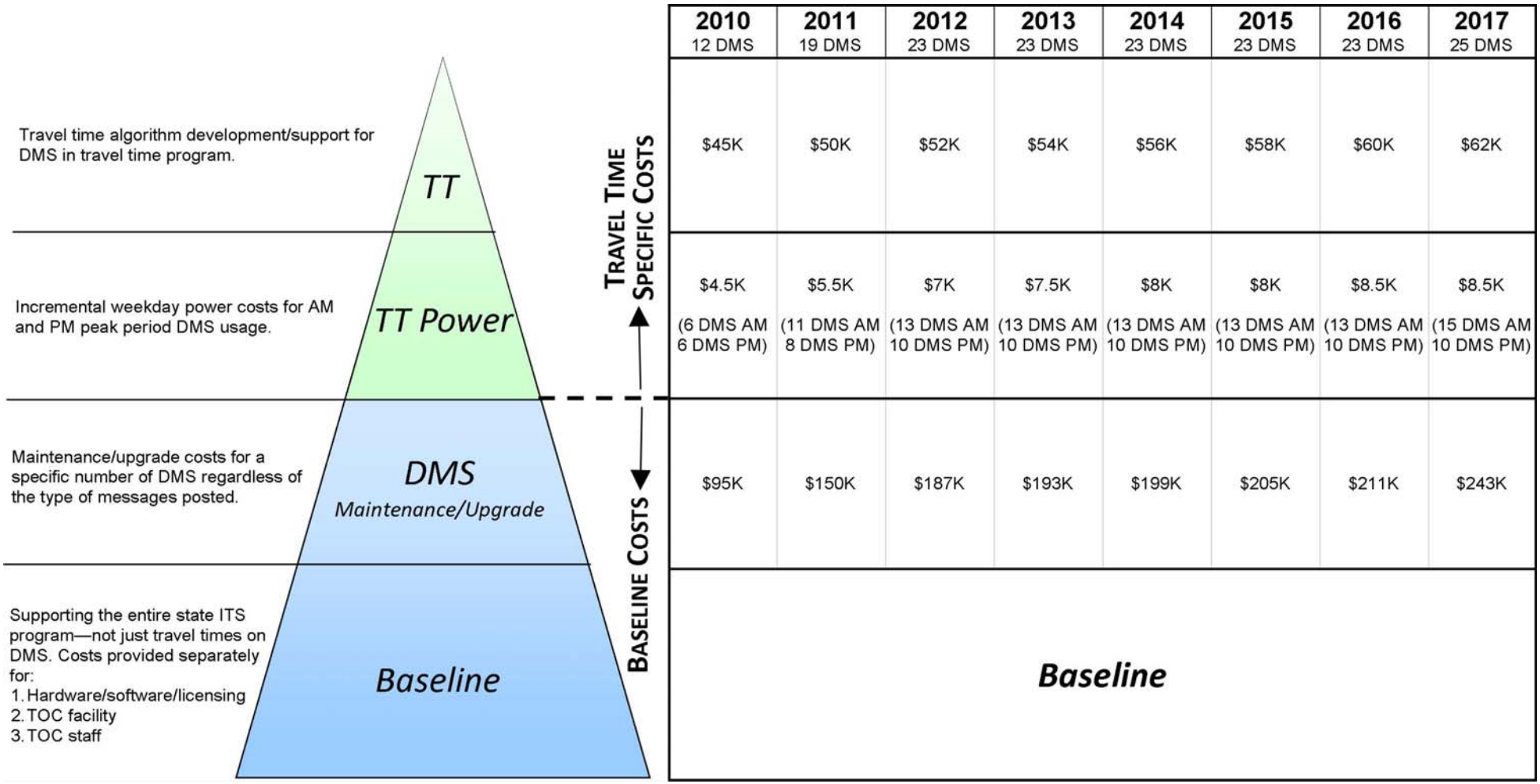
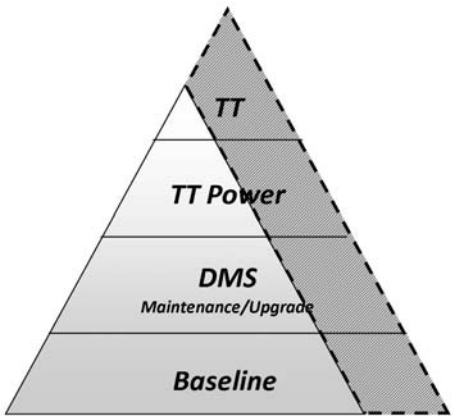


Figure 16 – Travel Time Pilot Program and Supporting Costs – 2010 Through 2017

In the event there are changes to the baseline, or travel time specific budgets supporting the Travel Time Pilot Program, the following are the resulting effects on the program:

- The component in the Travel Time Pilot Program expansion that will increase the costs of the program is the operations/maintenance and upgrades of the DMS to support the Travel Time Pilot Program. These costs support the DMS operations uses beyond just the Travel Time Pilot Program and are therefore essential for ADOT FMS system purposes.
- If the budget for the TOC facility/personnel or the FMS system is reduced, which will require the technology deployed to be managed/maintained/troubleshot less regularly or be abandoned altogether, this will ultimately result in a proportionate cut of the Travel Time Pilot Program because of the inability to use the technology (fiber, node buildings, DMS, etc.) for posting travel times. This concept of cutting the baseline funding and its effects on the system and travel time specific programs is shown in the diagram to the right. Baseline costs are vital to the Travel Time Pilot Program functioning at its current capacity and for the ability to expand the program in the future. Funding shortfalls will significantly reduce the program capabilities and will thereby affect the travelers who have come to expect the information displayed on DMS along their route.



In June 2010, ADOT proposed an update to the FMS program (2011-2015), which was unanimously approved by the MAG ITS Committee. This FMS program expansion included incremental increases for expanding the Travel Time Program through 2015. This provides valuable funding to sustain and expand the program, including upgrades to equipment required to provide travel times, ongoing operations, and to support the ongoing system costs. These funding additions were approved for inclusion in the Regional Transportation Plan.

6.6 Strategies for Reducing Operations and Maintenance Costs

There are a number of potential measures that could be reviewed to reduce costs, although these cost-saving measures would not be solely attributable to the Travel Time Pilot Program.

One of the most significant cost saving strategies, over the long term, is upgrading technology. ADOT is in fact already moving forward with several technology and system upgrades to address this need. Related to this program is the utilization and/or replacement of older DMS sign technology that is reaching its lifecycle. The newer LED signs have lower power requirements, longer lifecycle, and fewer maintenance demands than older sign technology. Further, ADOT is converting its copper telecommunications (which was widely used during the initial FMS installation) to fiber in the Phoenix metropolitan area, which will provide for a more reliable communications network. Both of these upgrades will yield cost savings over the longer term.

Other potential considerations include:

- Coordinating with power companies to revisit the current rate ADOT is paying. ADOT has been assigned the “commercial” rate, which is on par with major retailers, technology companies, and other “commercial” entities. Given the nature of the ADOT FMS to support mission-critical transportation network mobility, there may be an opportunity to explore a more favorable rate with power companies. This may need to be a higher-level discussion with Arizona Department of Administration and the Arizona Corporation Commission.

- Modifying maintenance schedules and reducing the number of annual preventative maintenance checks on the DMS would reduce the overall cost of maintenance. This is not a recommended primary strategy, as regular preventive maintenance is needed to keep signs in working and reliable condition; doing so could decrease the lifecycle of the DMS. Given the number of DMS ADOT envisions deploying, and in reviewing historic maintenance activity records, there may be an opportunity to reduce checks from four per year to three per year, but this would be dependent on ADOT verifying that it would not compromise the reliability of the sign by doing so.
- Detection infrastructure (and associated operations and maintenance) could be supplemented with private sector data. Actual costs will need to be negotiated with private sector companies, but competition within the private sector has made this arena very competitive. This concept would need to be reconciled with other ADOT business processes that rely on the detector data, because while private sector speed data could support traveler information applications, it lacks the volume and occupancy data aspects that are utilized by other functions (such as planning).

Another option for travel time posting on DMS was the use of hybrid static/dynamic travel time message signs. These signs are static MUTCD-compliant signs designed for the specific freeway they are installed on which have the dynamic message sign component only where the number of minutes would display. ADOT did not choose this type of sign because of two reasons. The first reason is that these signs would have required a large capital cost (at minimum approximately $40,000 per sign for equipment, installation, and communications connections to detection for completely automated system not requiring access to the RADS network). The cost for the sign and dynamic display alone averages between $5,000 and $10,000 per sign if the system were tied into the existing FMS network. The second reason is that these signs have fixed messages that cannot be easily expanded upon or changed in the future which will require upgrades to the signs and more capital budget to support that venture. The use of existing DMS and the capital cost that was applied to installing/integrating those comes highly recommended over using any additional capital cost for permanent signs. Any potential transition to this hybrid sign method is not recommended for ADOT purposes.

Figure 17 – Example Hybrid Travel Time Message Sign

Devices that would limit DMS power during non-active times were reviewed, but are not recommended as a cost saving strategy. As mentioned earlier in this report, active state is necessary to keep DMS components cooled, ventilated, and in a state-of-ready operation for when needed. Allowing the DMS to remain in prolonged inactive states could cause more damage to components and could result in unreliable operations over time.

7. CONCLUSION

The evaluation of the Travel Time Pilot Program yielded very positive support from the traveling public and requests for more signs and travel times on more freeways. Other parameters that evaluated, including speed/mobility and safety, showed no adverse impact of the travel time displays. 75% of survey respondents indicated the destinations provided on the travel time displays were relevant. 81% supported keeping the Travel Time Pilot Program, and of those respondents, 53% indicated there should be more signs added to the program.

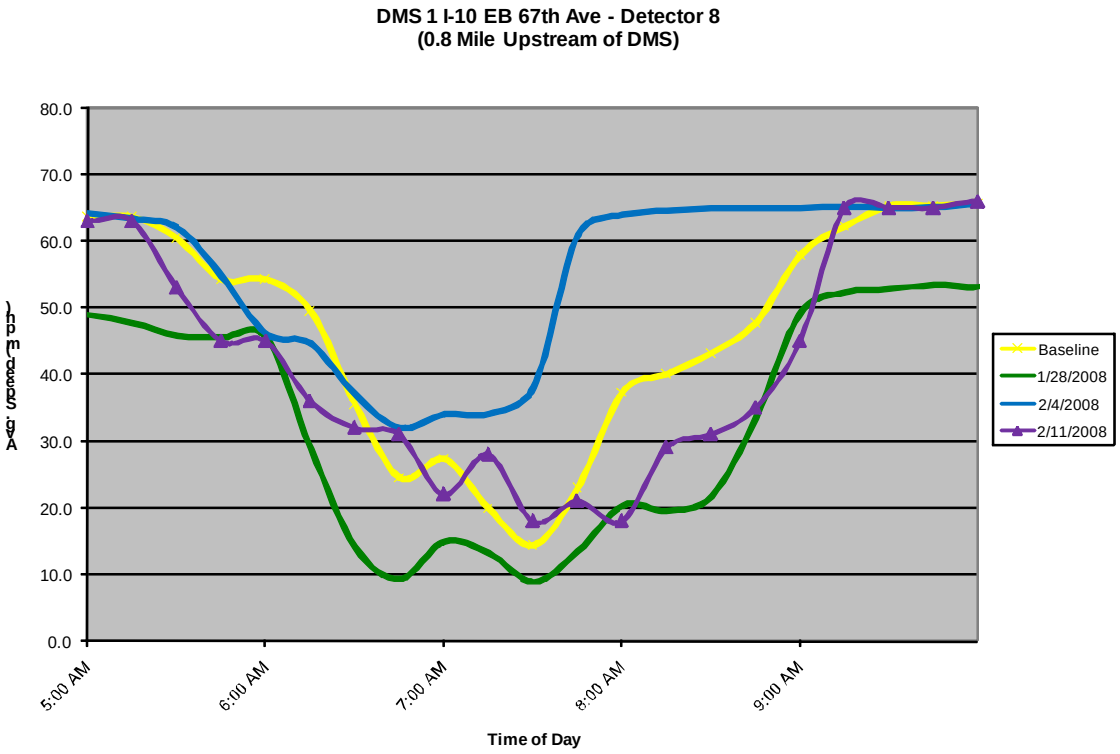
Because feedback from the surveys, the TAC, and the Arizona ITS community was positive, ADOT management decided to plan for an expansion of the Travel Time Pilot Program prior to the evaluation report being finalized. The expansion will be phased as outlined in Chapter 6 and as shown below:

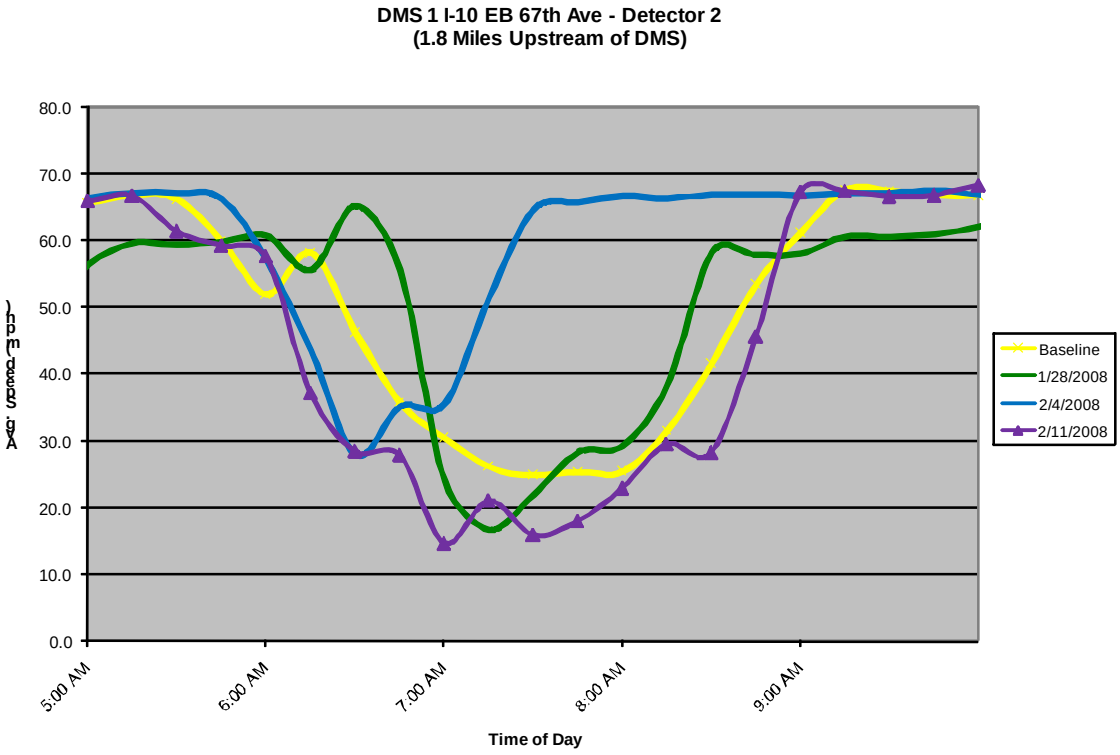
- **Existing (2010, 12 DMS) –** Travel time messages currently being displayed as part of the program.
- **Phase 1 (2011, 19 DMS) –** Minor modifications to current travel time messages and new travel time messages recommended due to the expansion of FMS and detection in the Valley that has occurred since the original launch of the Travel Time Pilot Program.
- **Phase 2 (2012, 23 DMS) –** Travel time message recommendations based on FMS expansion plans by 2012.
- **2013-2016 (23 DMS) –** Continue operating Phase 2 due to anticipated coverage of existing logical corridors.
- **Phase 3 (2017, 25 DMS) –** Travel time message recommendations based on FMS expansion plans by 2017.

APPENDIX A – SPEED GRAPHS

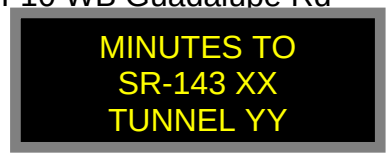
DMS 1 I-10 EB 67th Ave

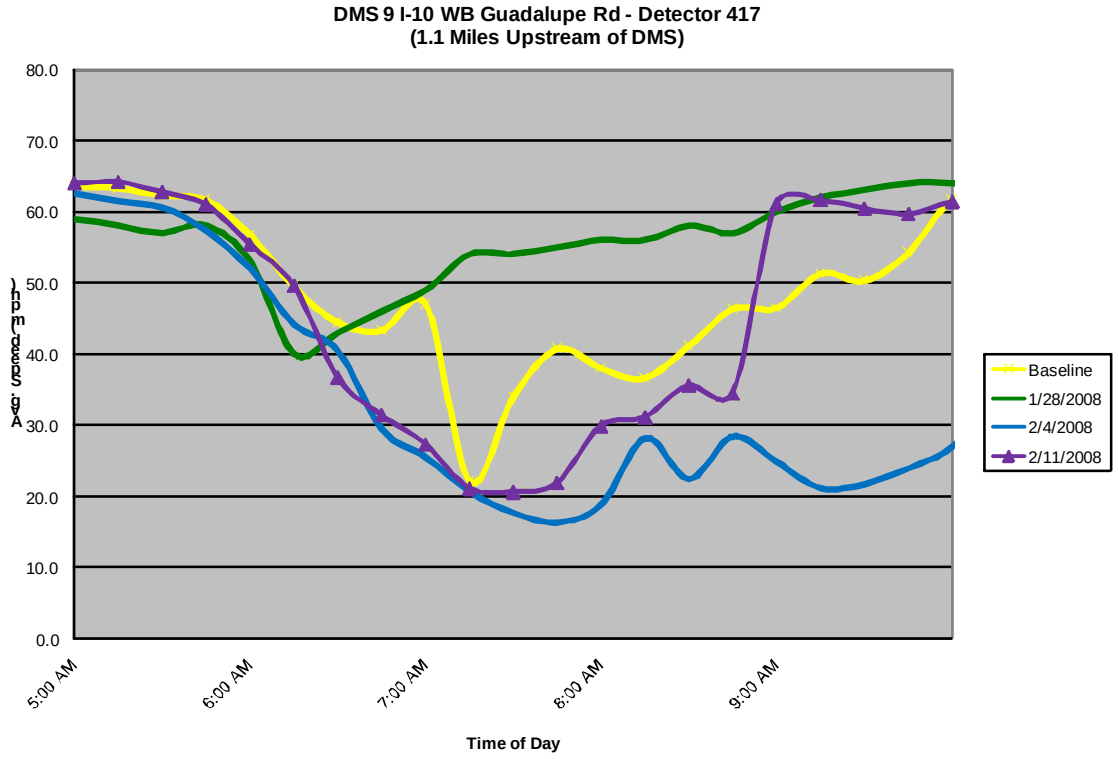
MINUTES TO
TUNNEL XX
AIRPORT YY

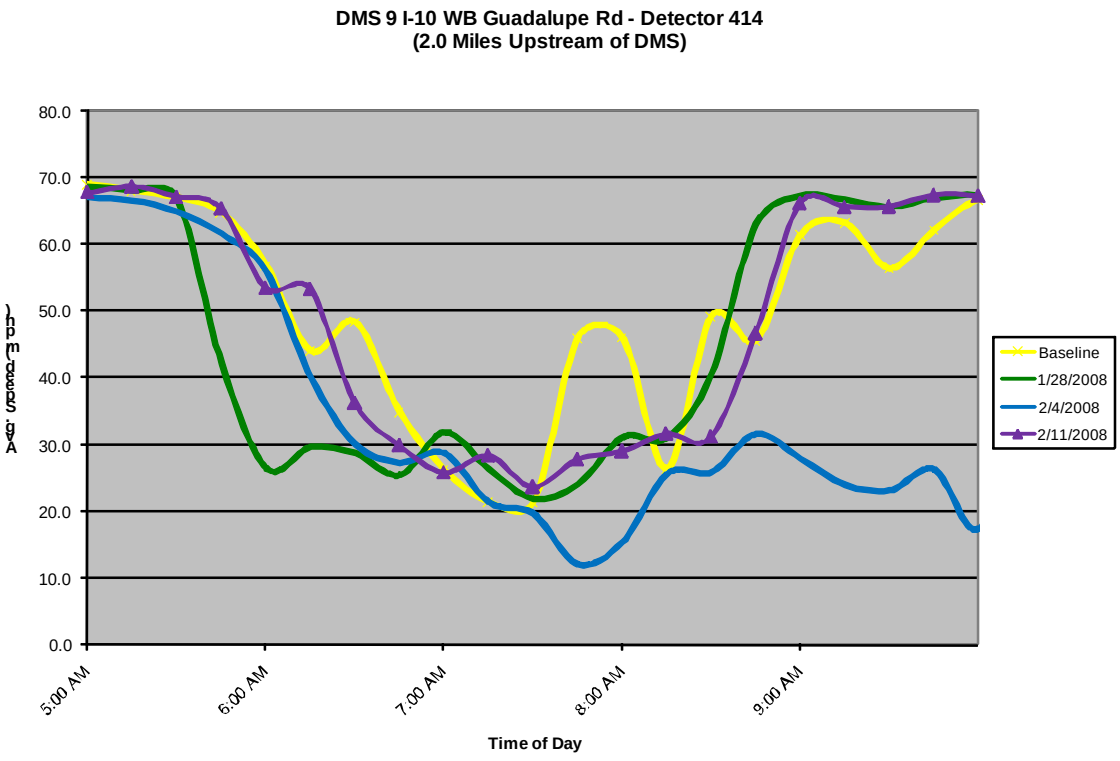




DMS 9 I-10 WB Guadalupe Rd

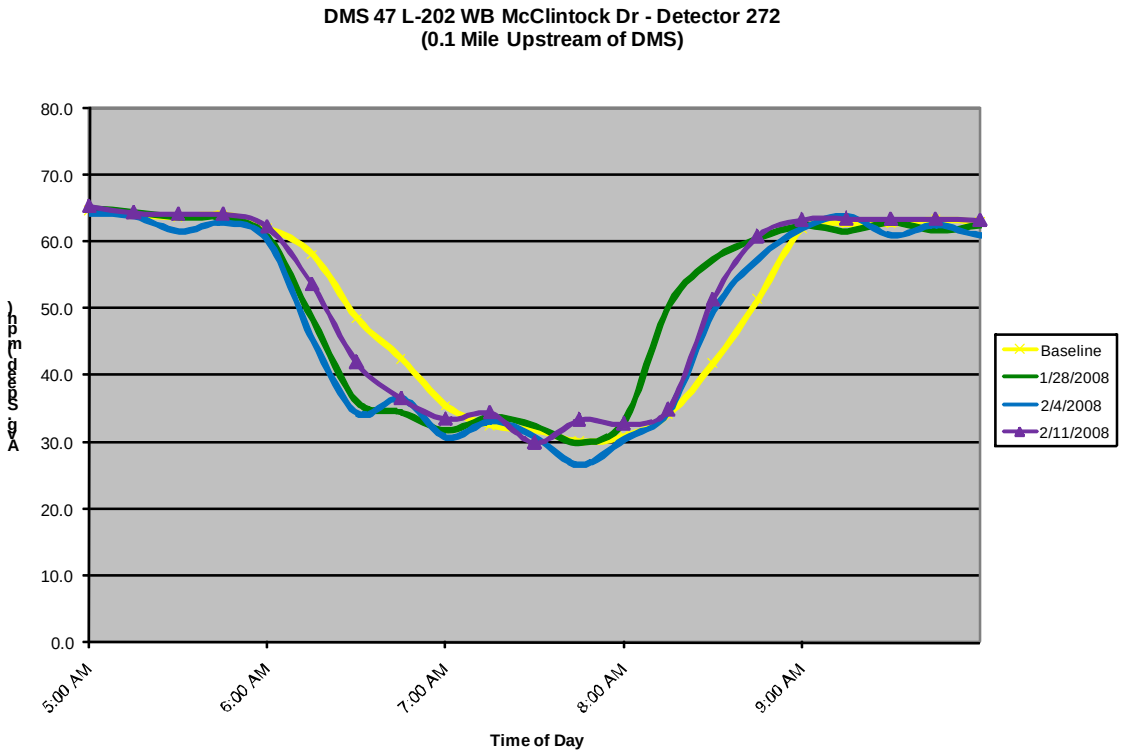




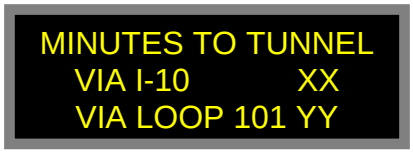


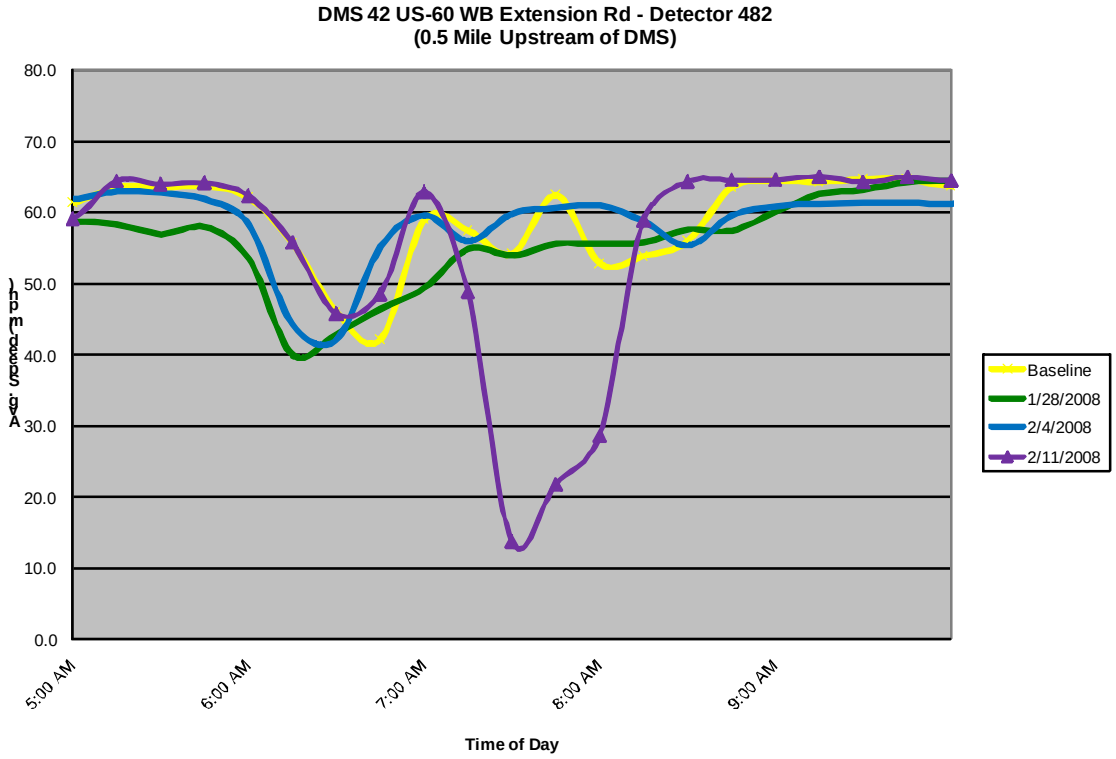
DMS 47 L-202 WB McClintock Dr

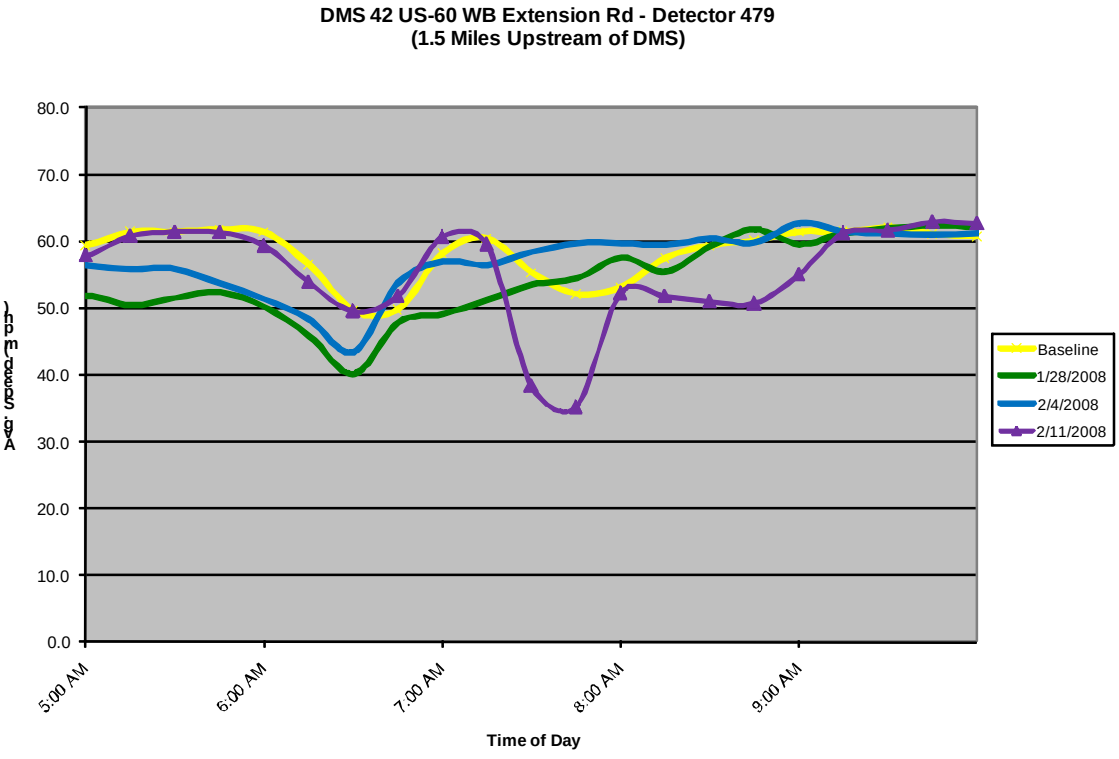
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd



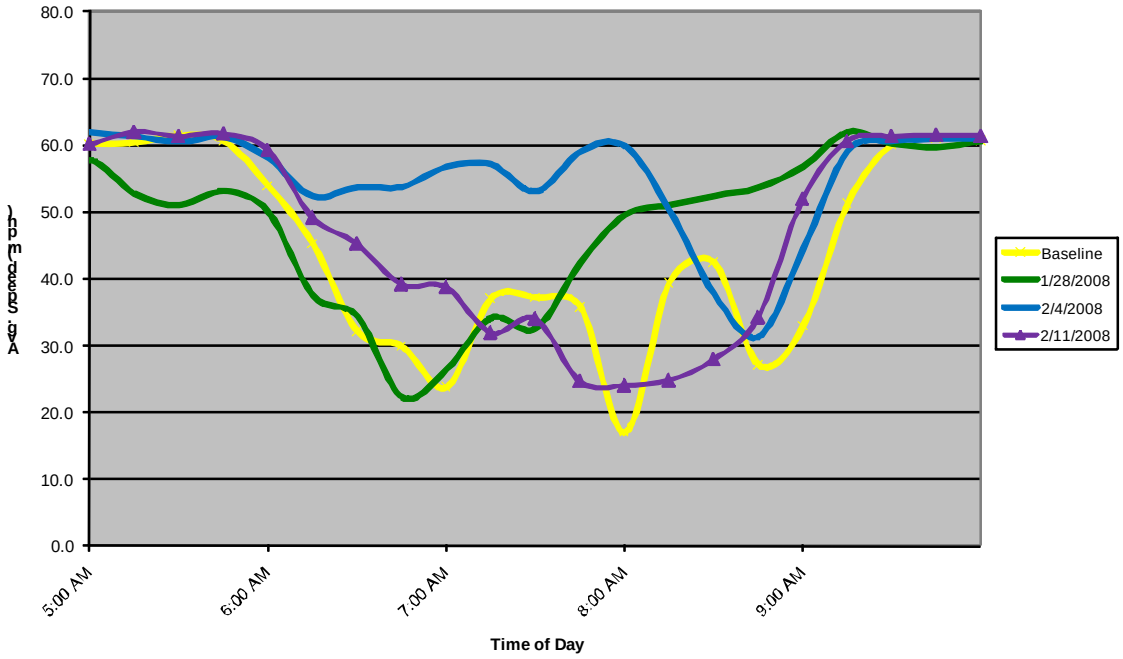




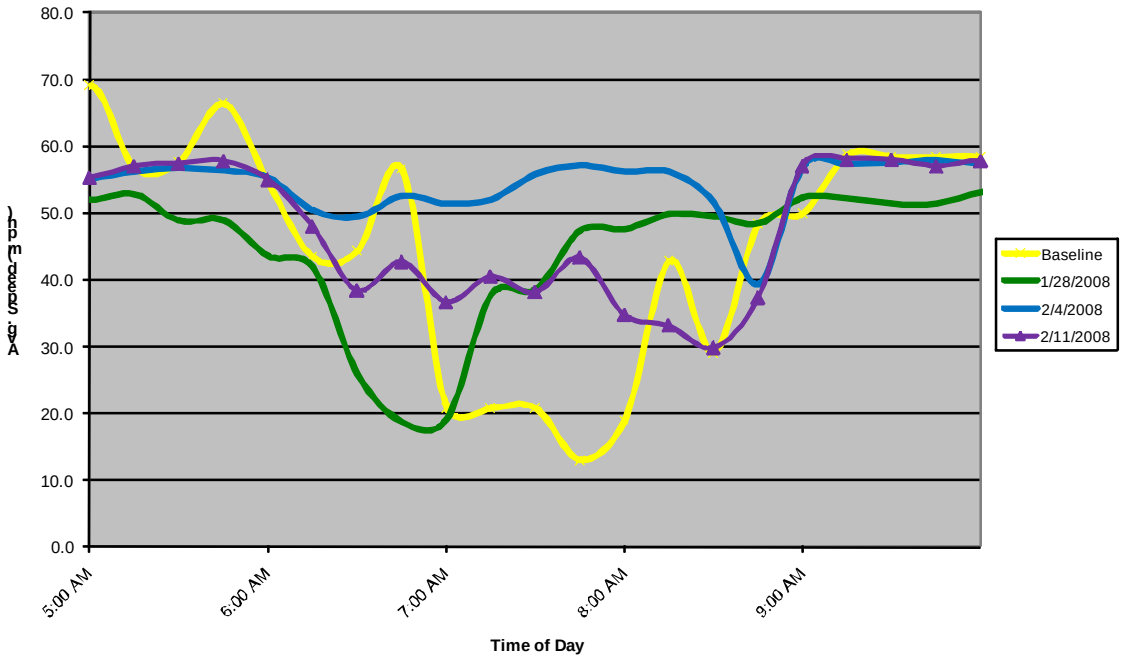
DMS 27 I-17 SB Northern Ave

MINUTES TO
I-10 TUNNEL XX

DMS 27 I-17 SB Northern Ave - Detector 361
(0.9 Mile Upstream of DMS)



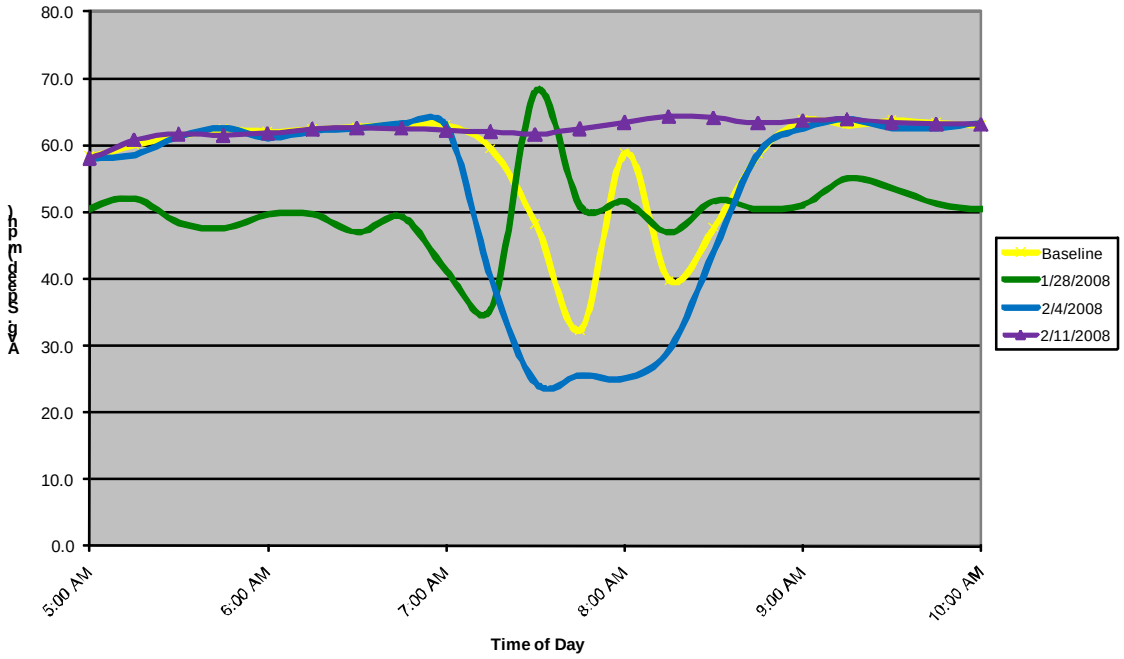
DMS 27 I-17 SB Northern Ave - Detector 358
(1.9 Miles Upstream of DMS)



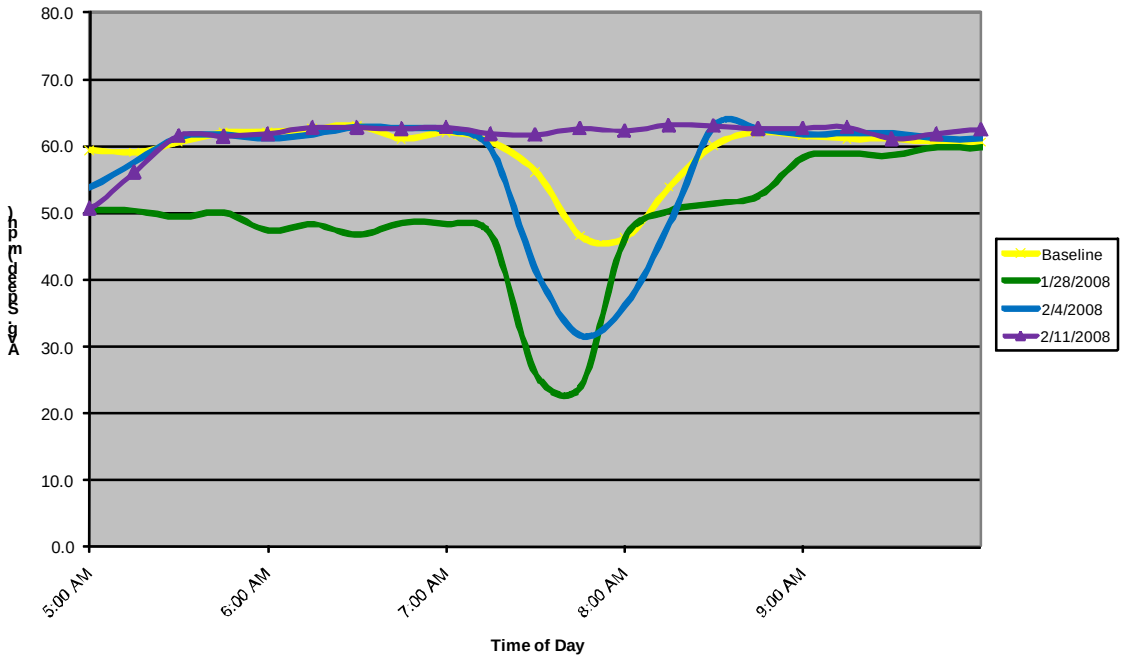
DMS 58 SR-51 SB Northern Ave

MINUTES TO
I-10 TUNNEL XX

DMS 58 SR-51 SB Northern Ave - Detector 297
(0.7 Mile Upstream of DMS)

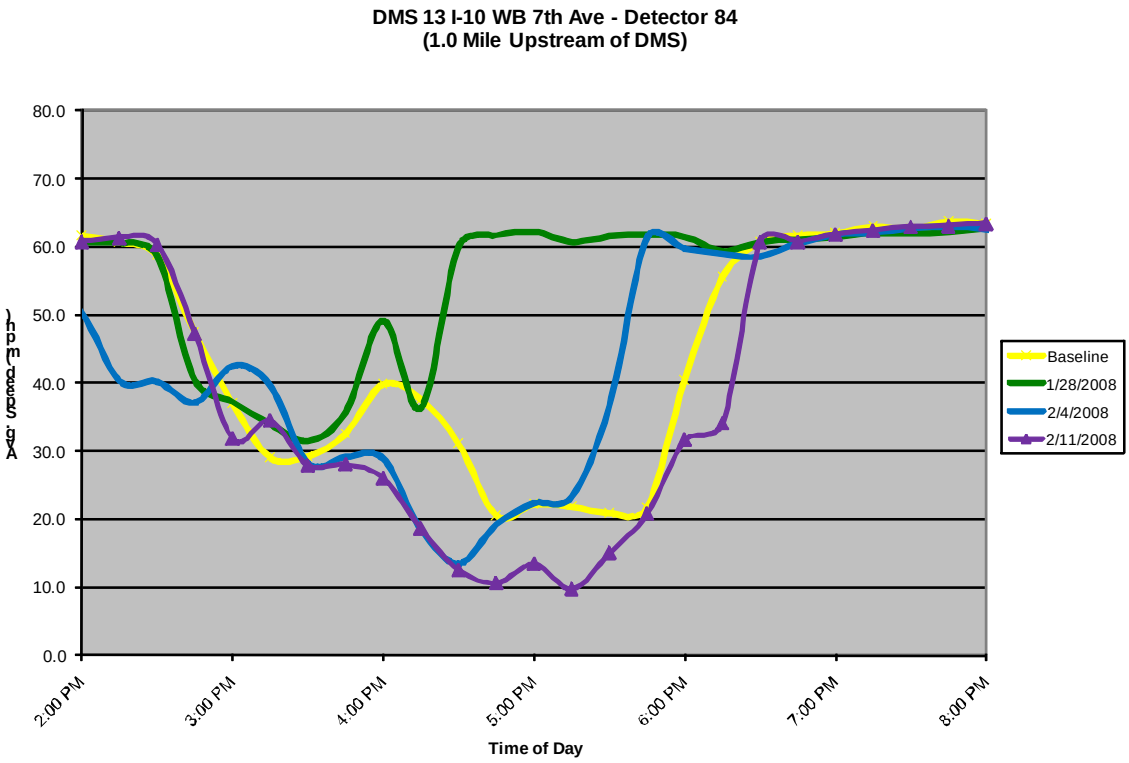


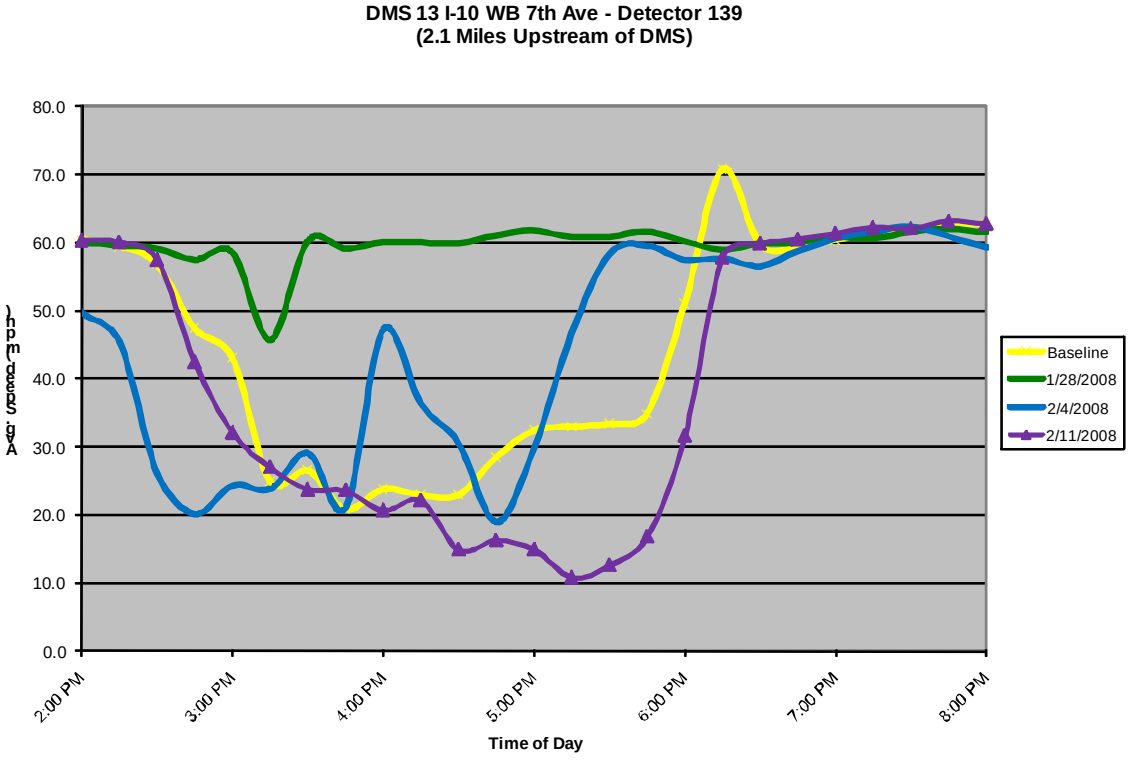
DMS 58 SR-51 SB Northern Ave - Detector 299
(1.3 Miles Upstream of DMS)



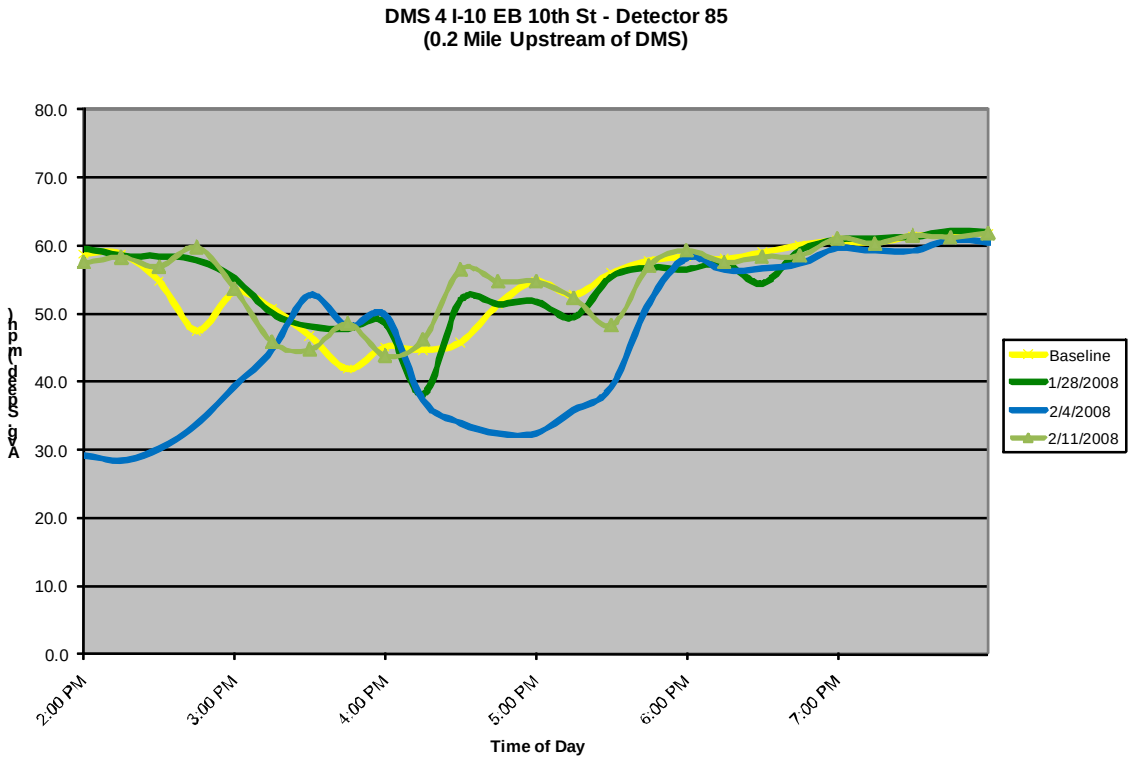
DMS 13 I-10 WB 7th Ave

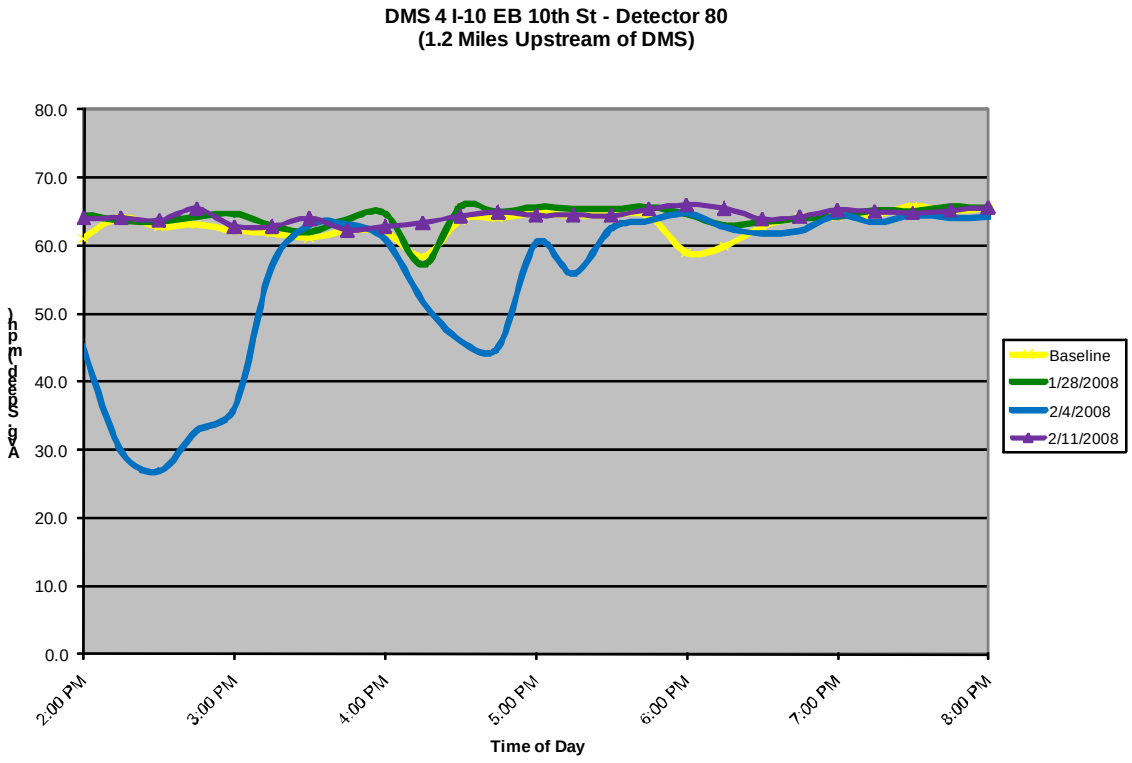
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





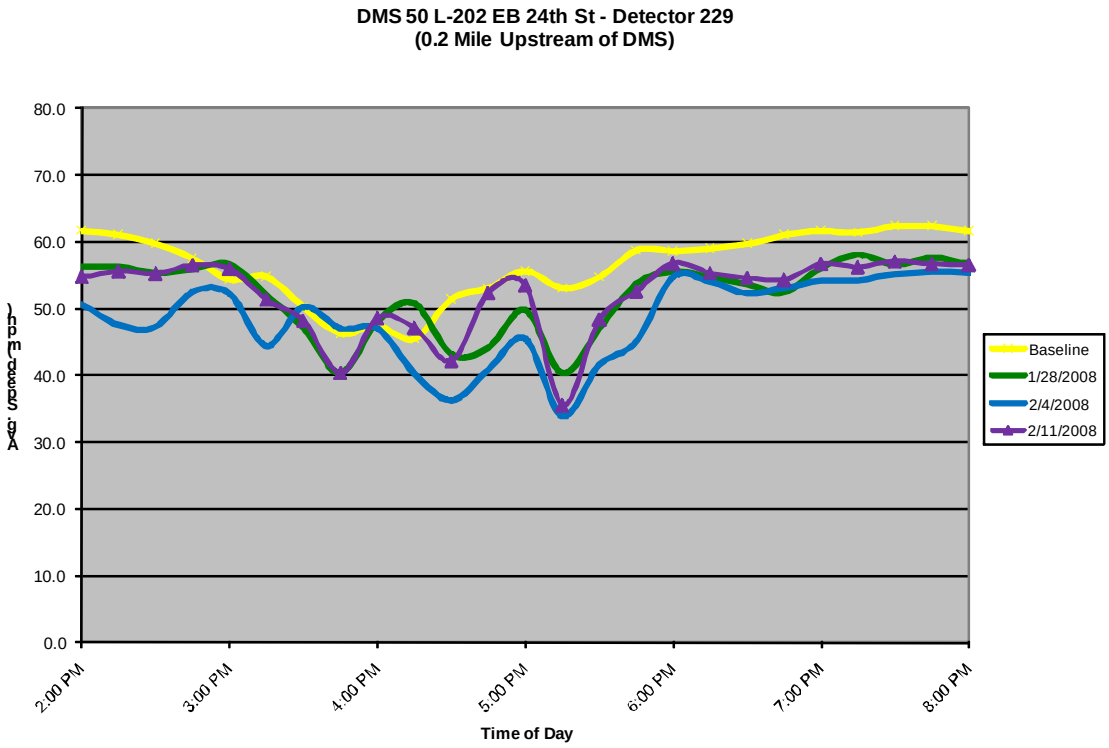
DMS 4 I-10 EB 10th St





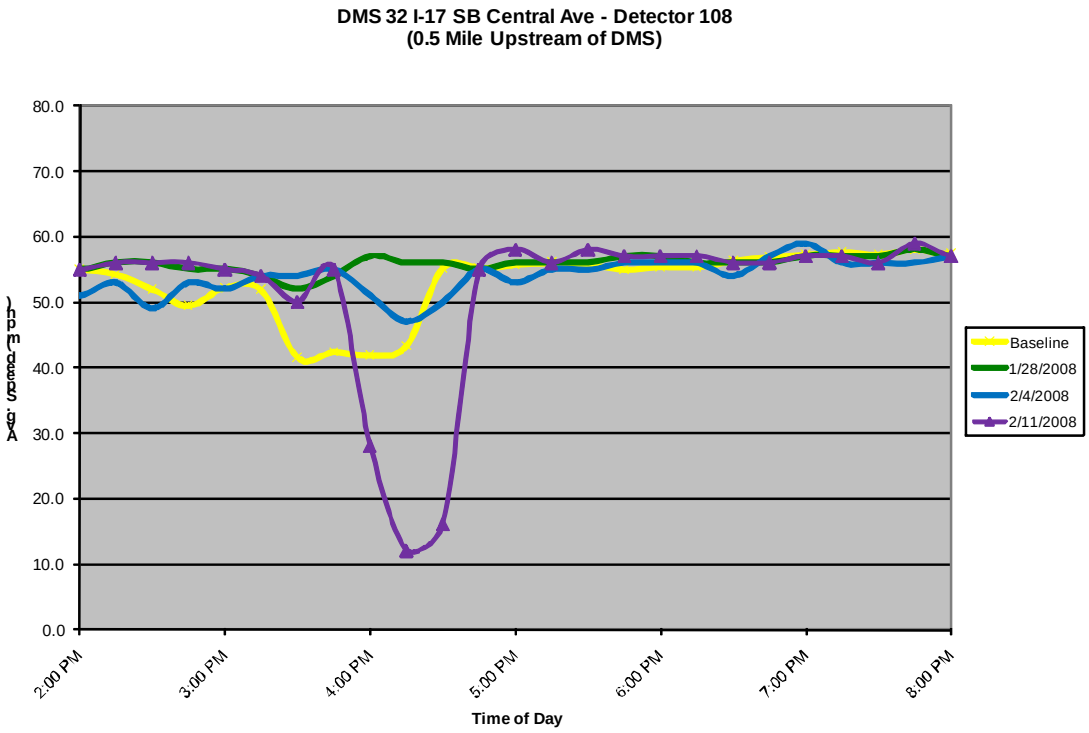
DMS 50 L-202 EB 24th ST

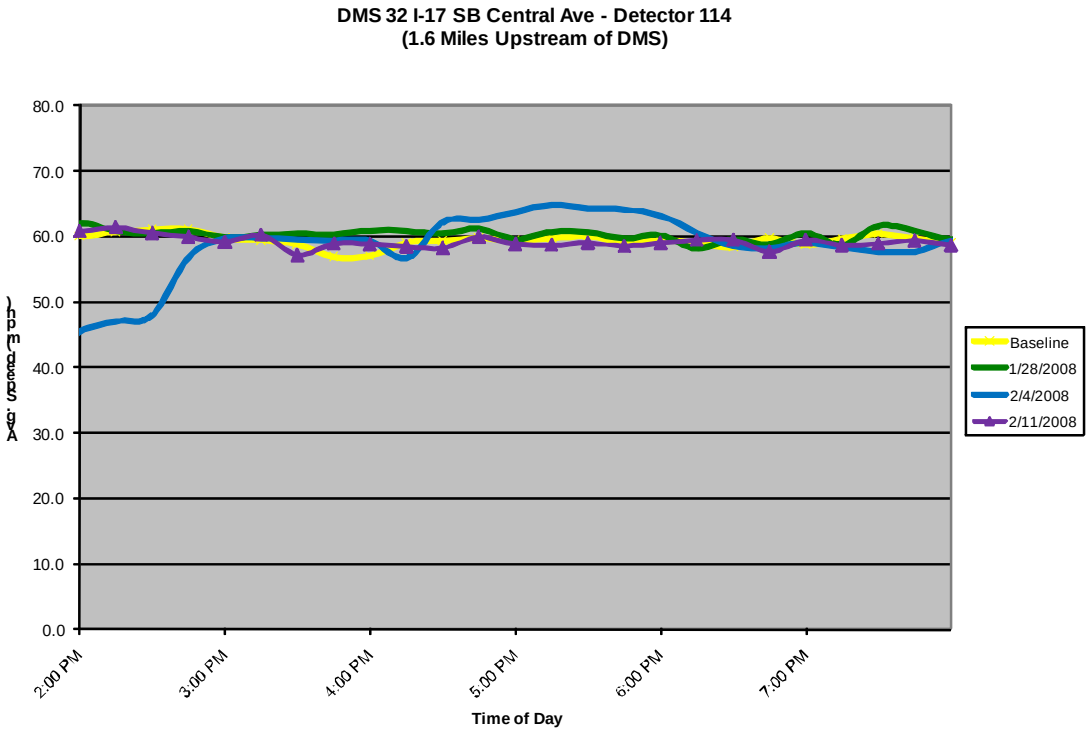
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY





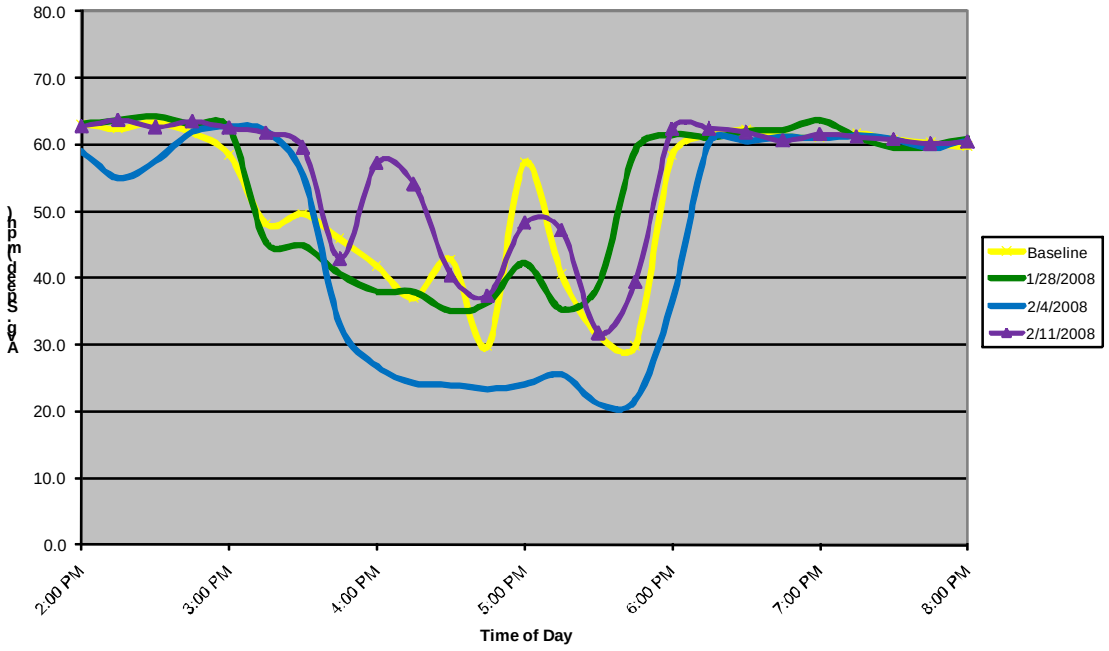
DMS 17 I-17 NB 4th Ave

No Available Data on both Detector 104 and 98

DMS 55 SR-51 NB Osborn Rd

MINUTES TO
BELL RD XX

DMS 55 SR-51 NB Osborn Rd - Detector 206
(0.5 Mile Upstream of DMS)



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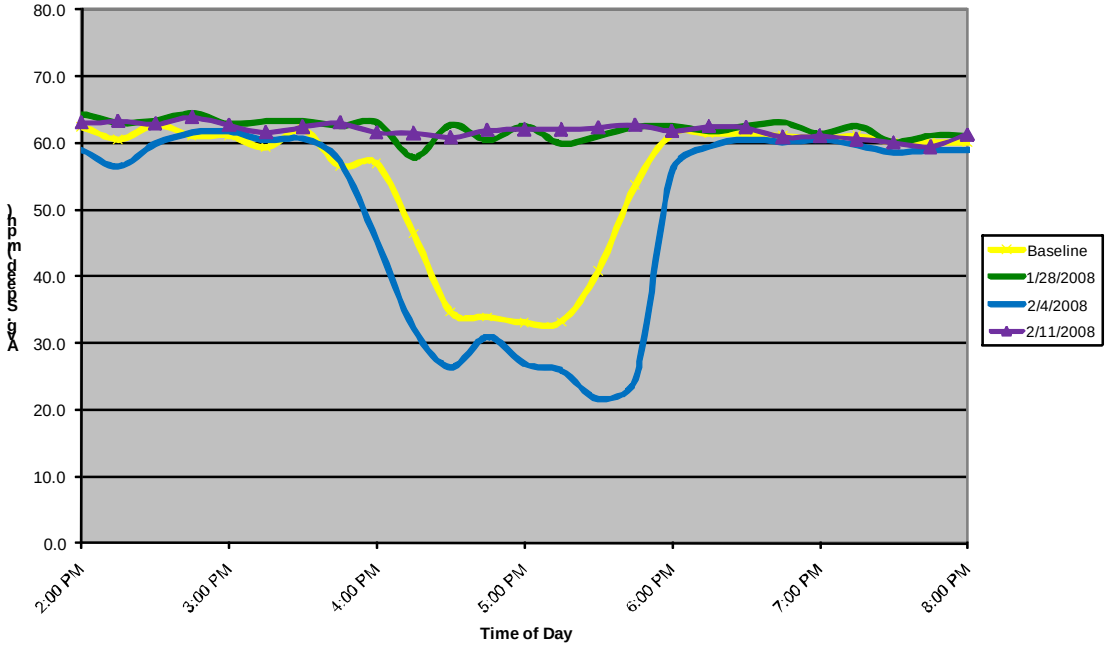
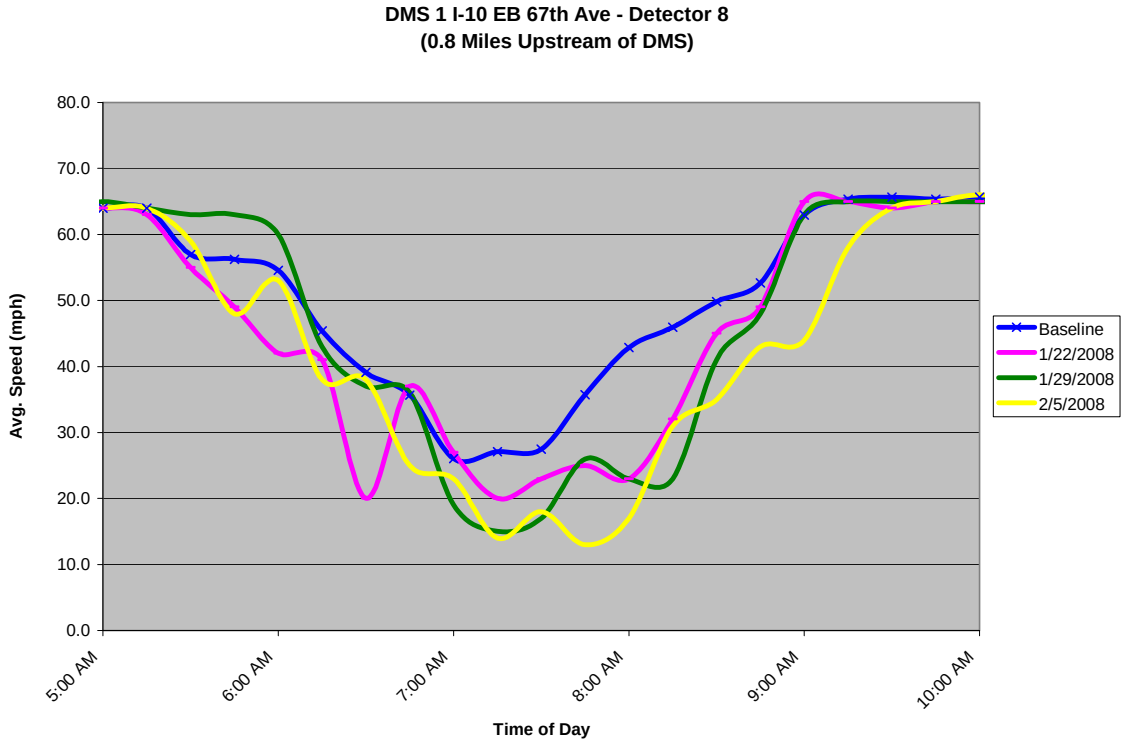
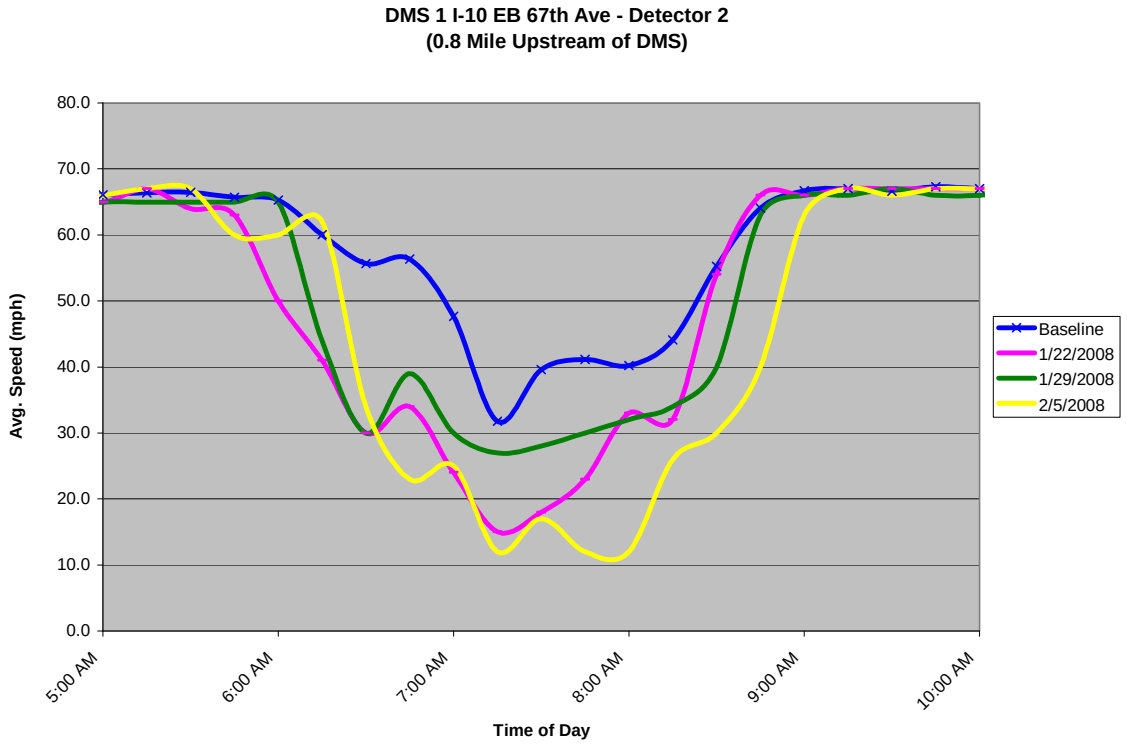
(1.6 Miles Upstream of DMS)

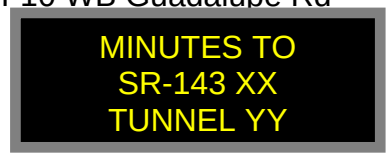


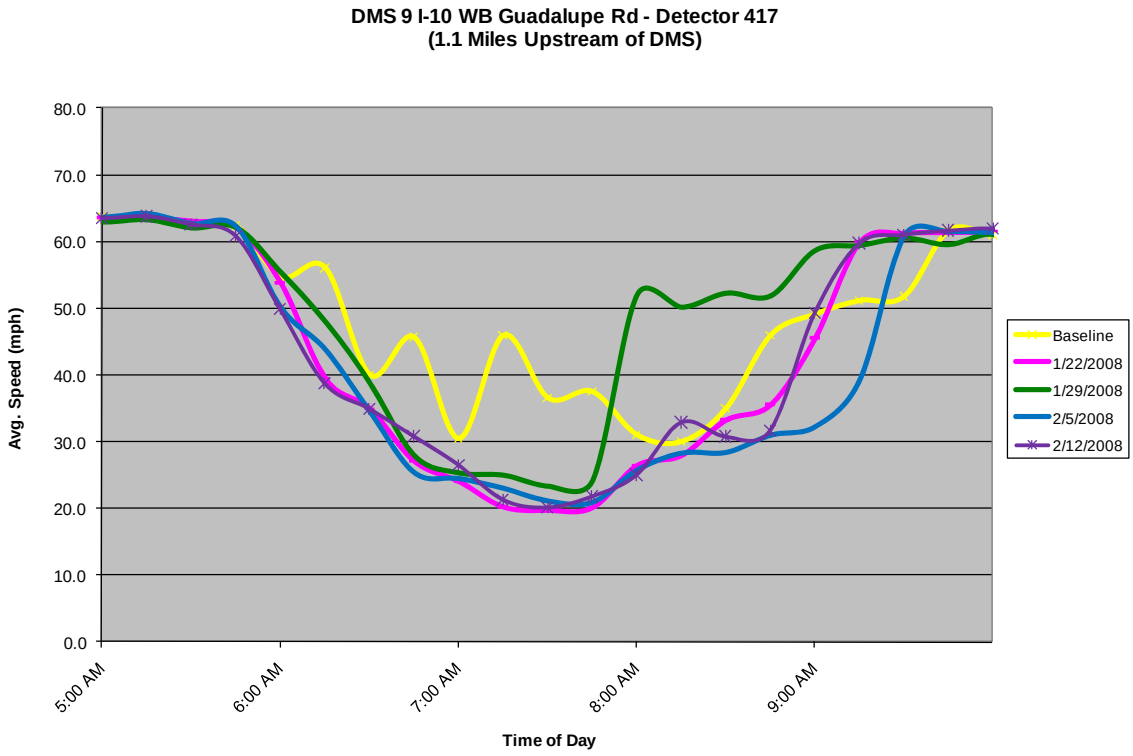
DMS 1 I-10 EB 67th Ave

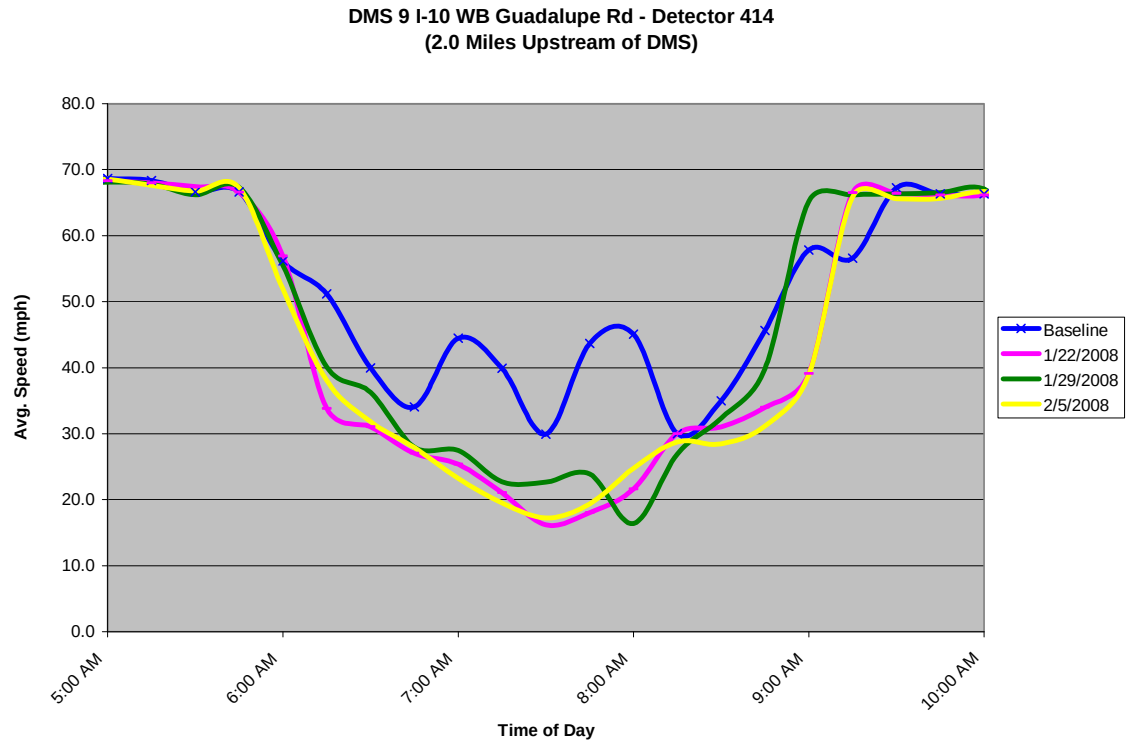




DMS 9 I-10 WB Guadalupe Rd

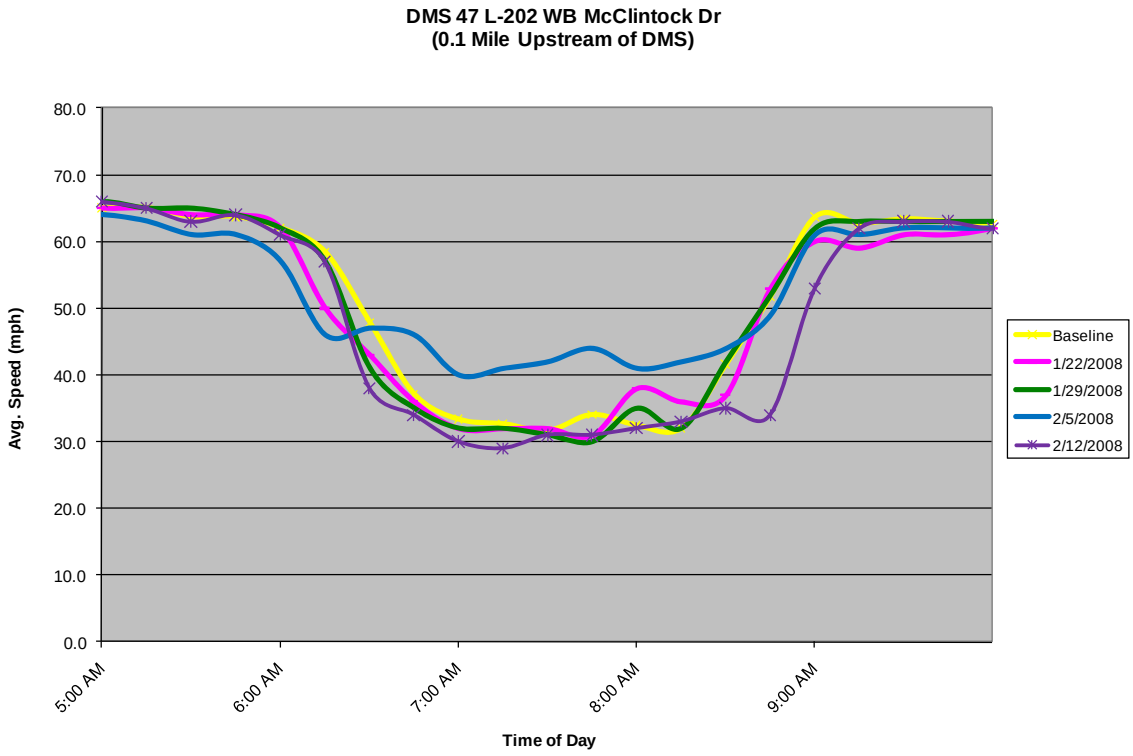






DMS 47 L-202 WB McClintock Dr

MINUTES TO
SR-143 XX
I-10 TUNNEL YY



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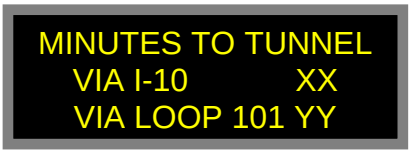
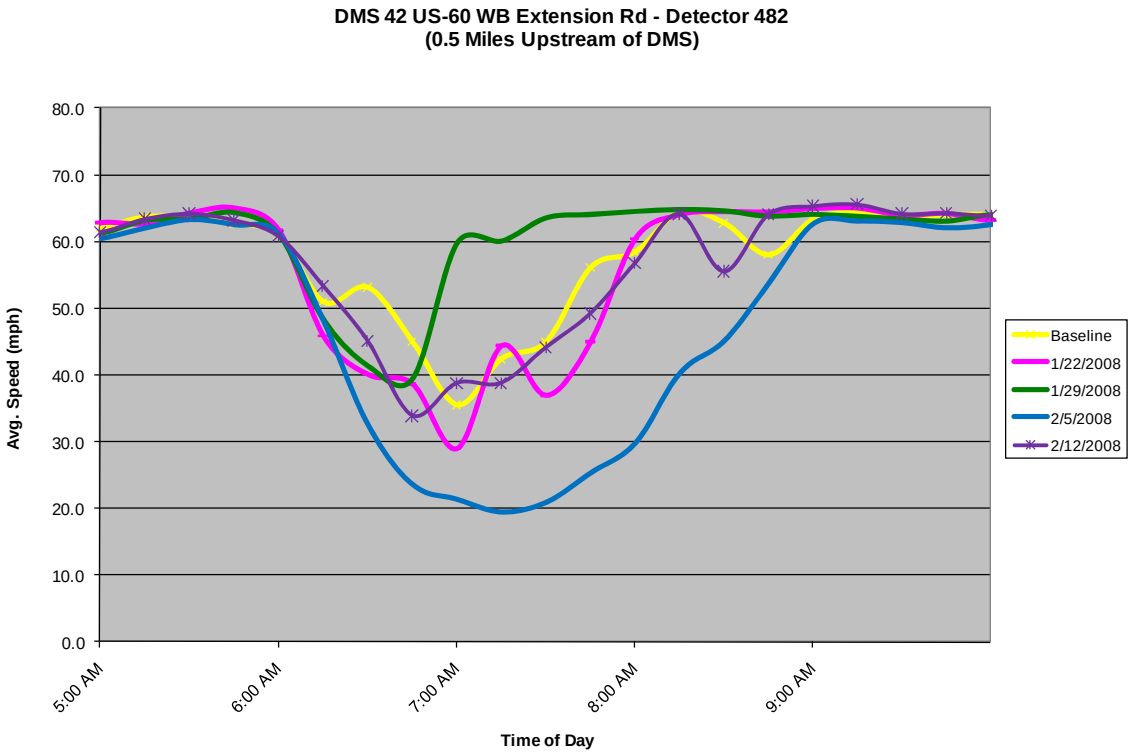
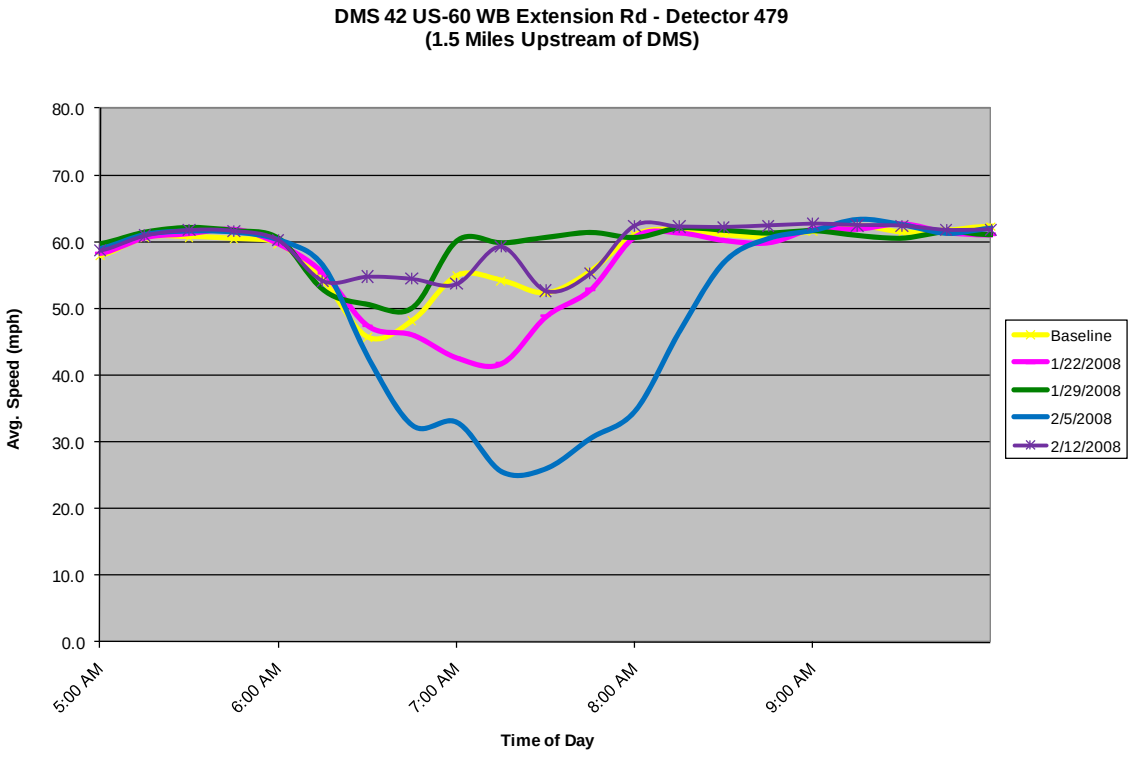
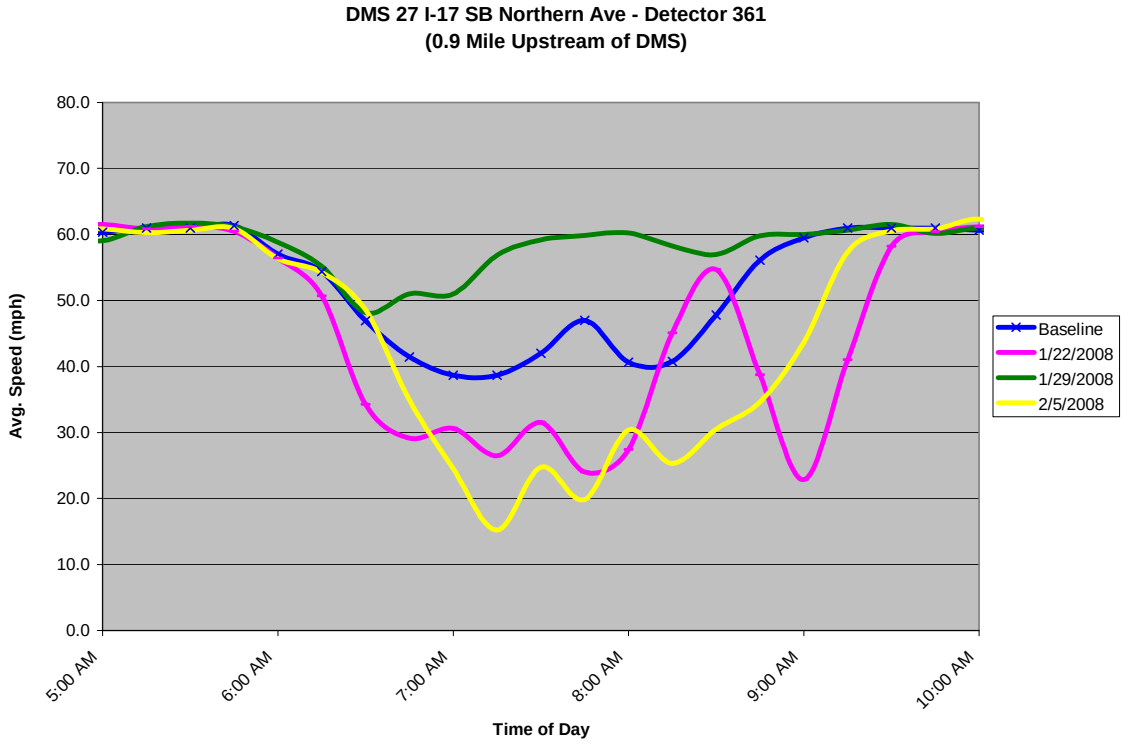


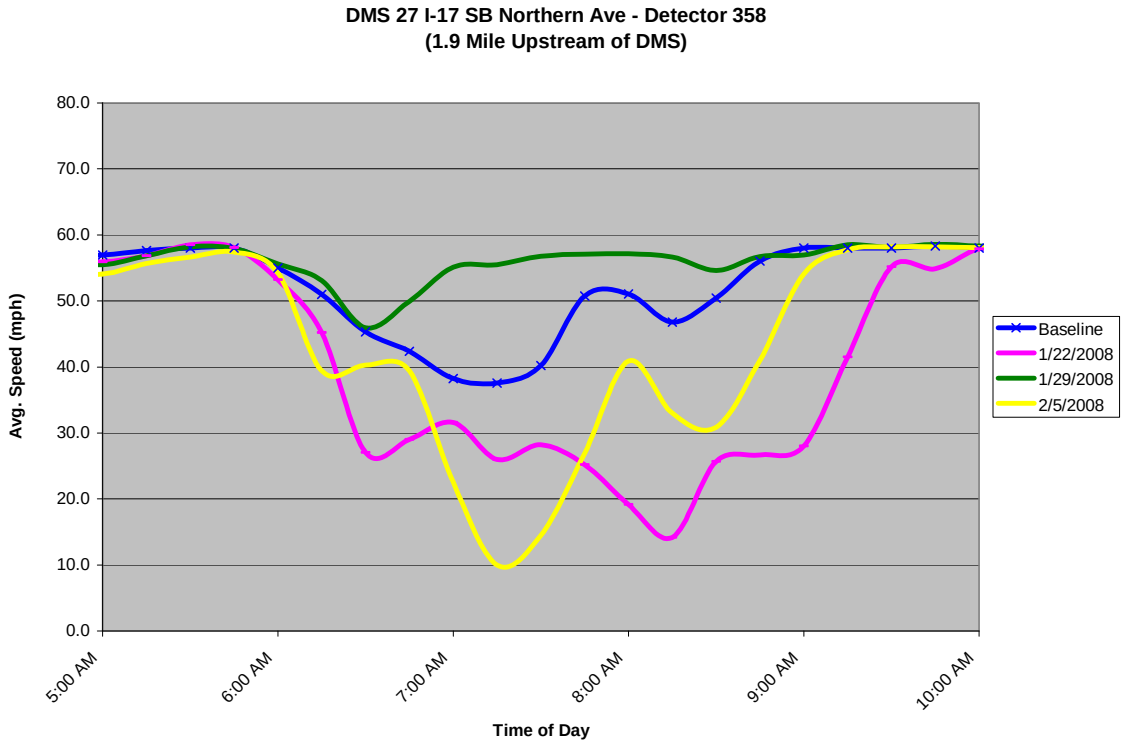




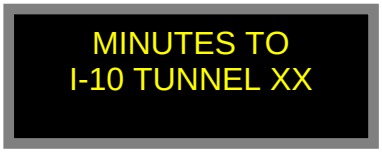
DMS 27 I-17 SB Northern Ave

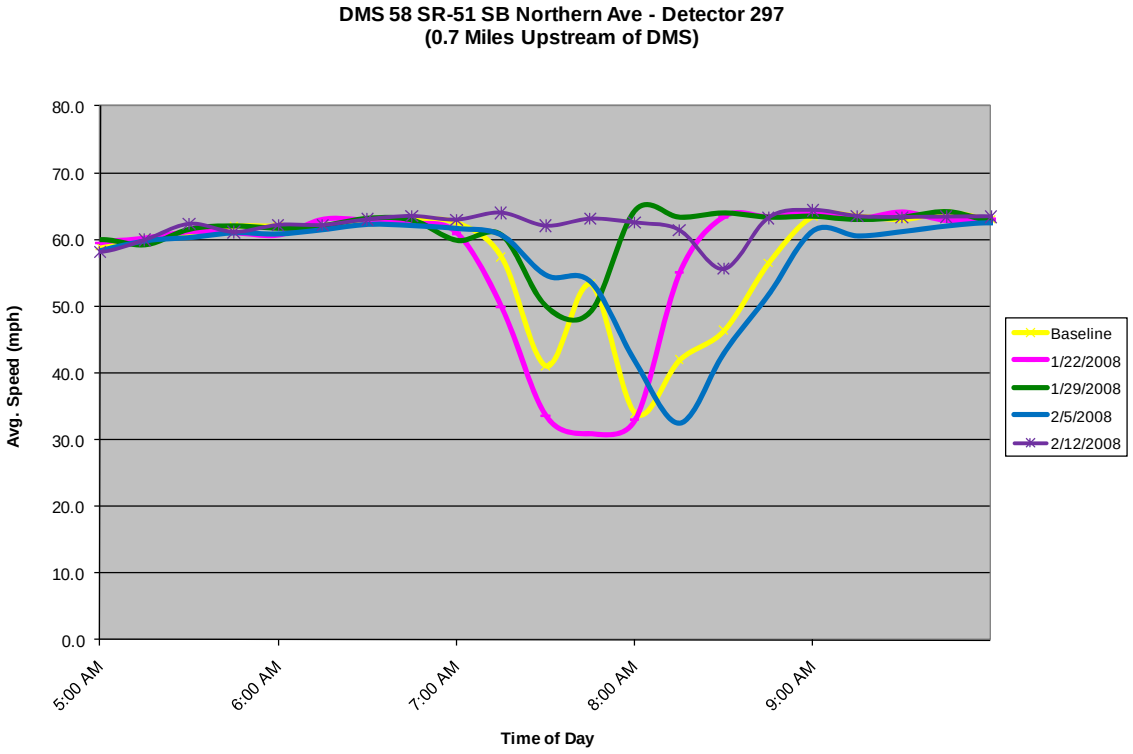
MINUTES TO
I-10 TUNNEL XX

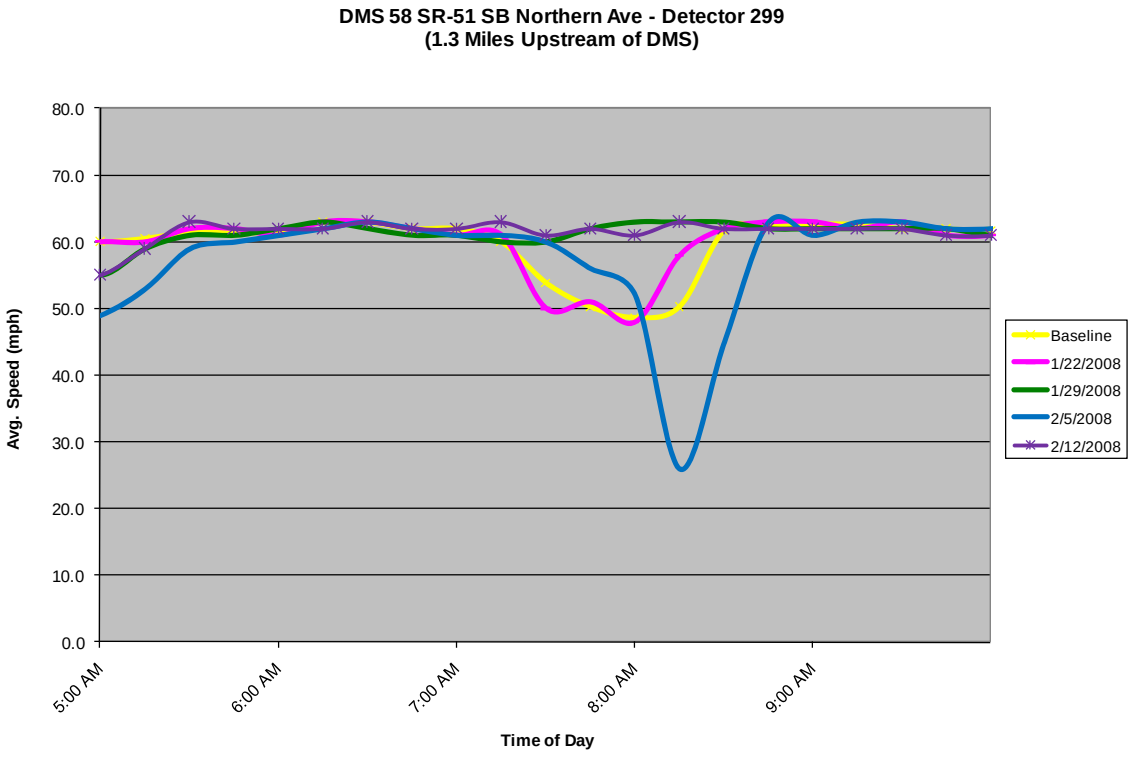




DMS 58 SR-51 SB Northern Ave

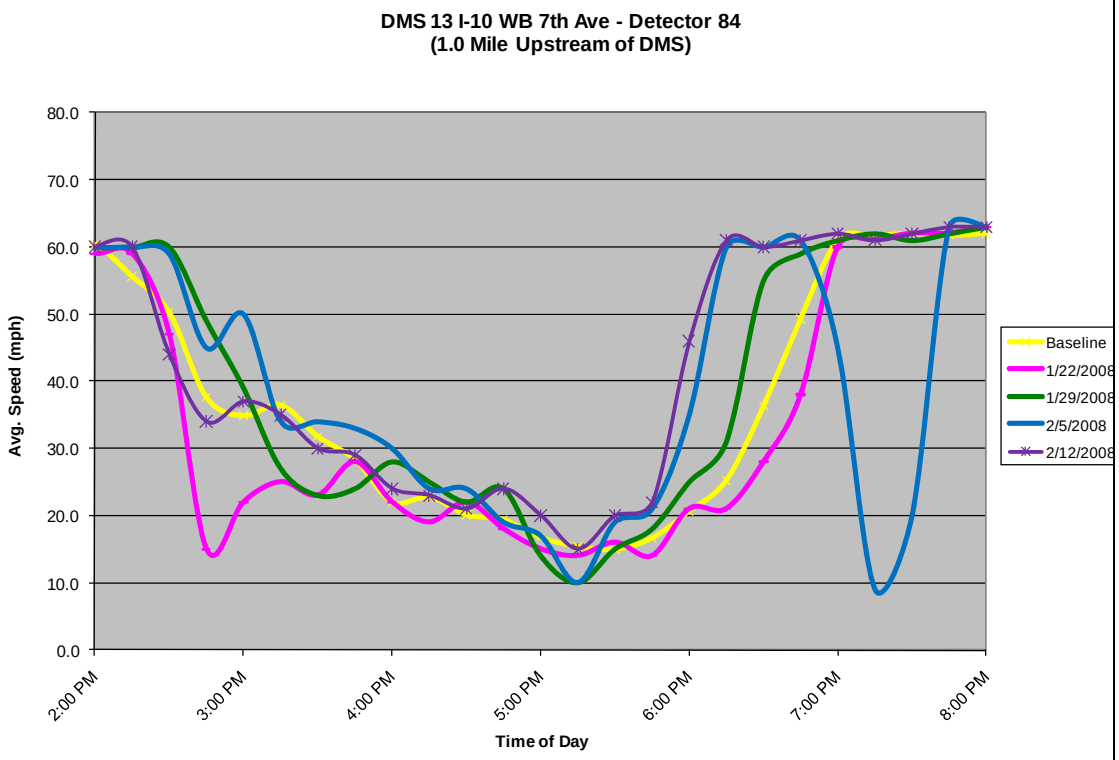


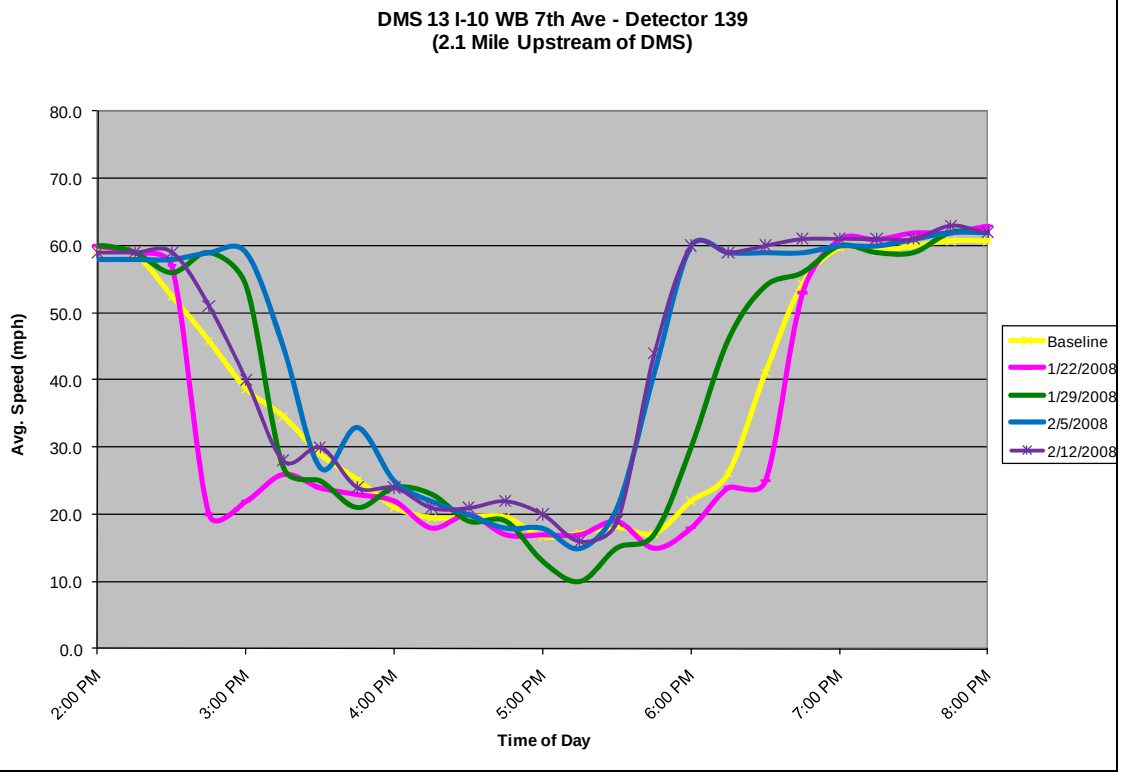




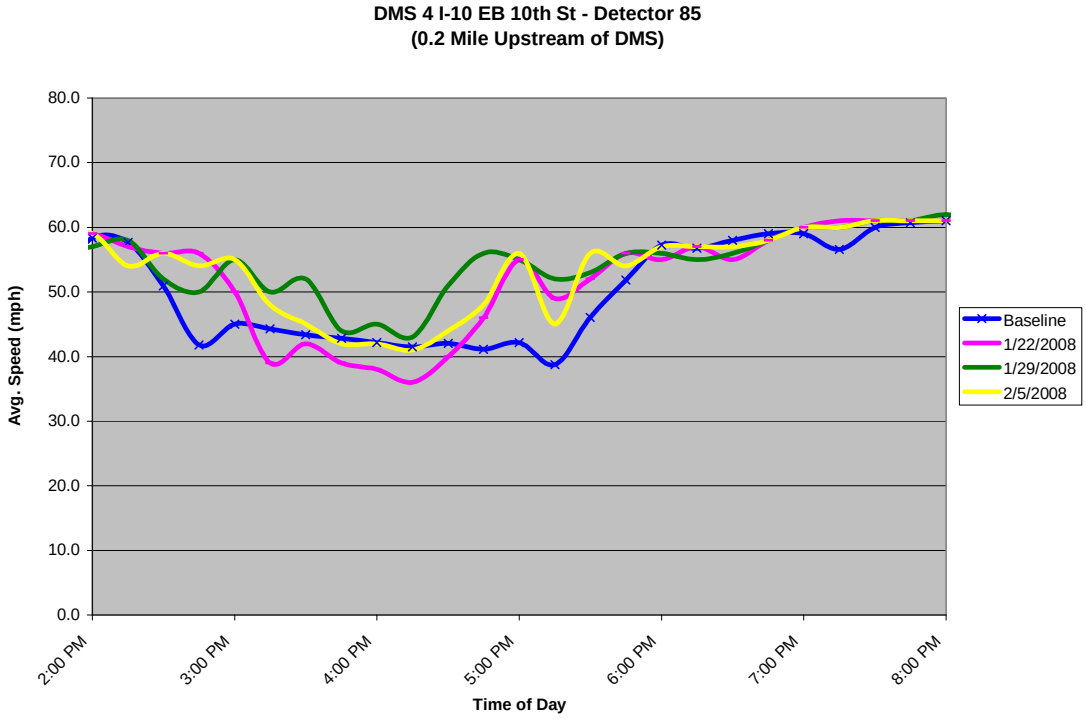
DMS 13 I-10 WB 7th Ave

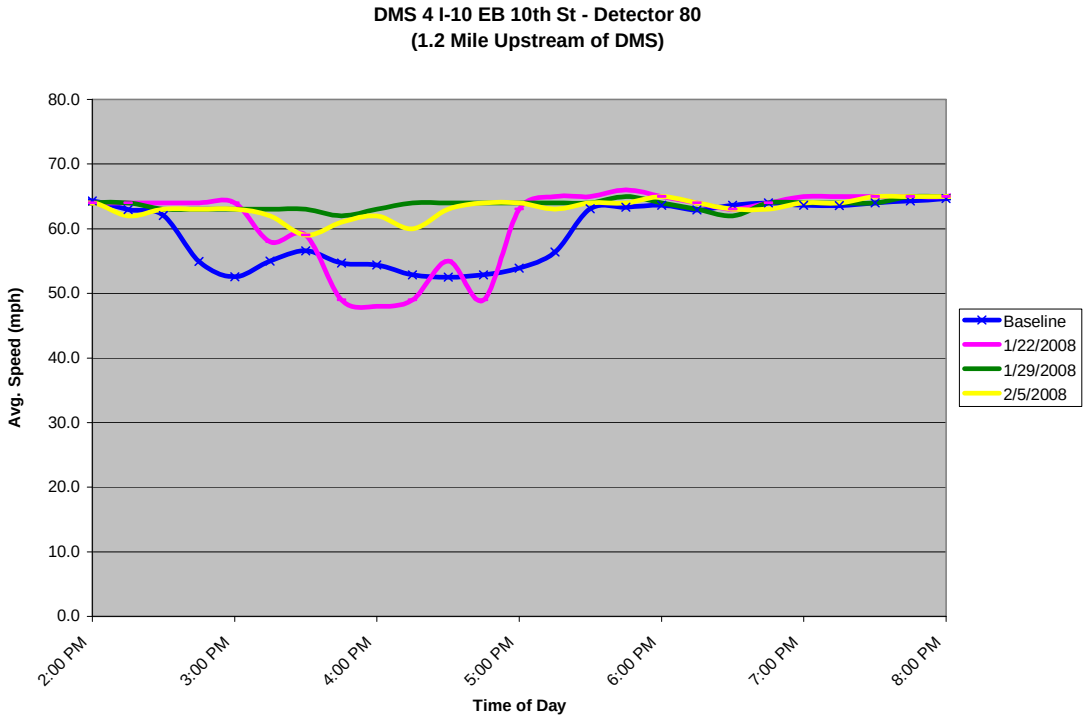
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





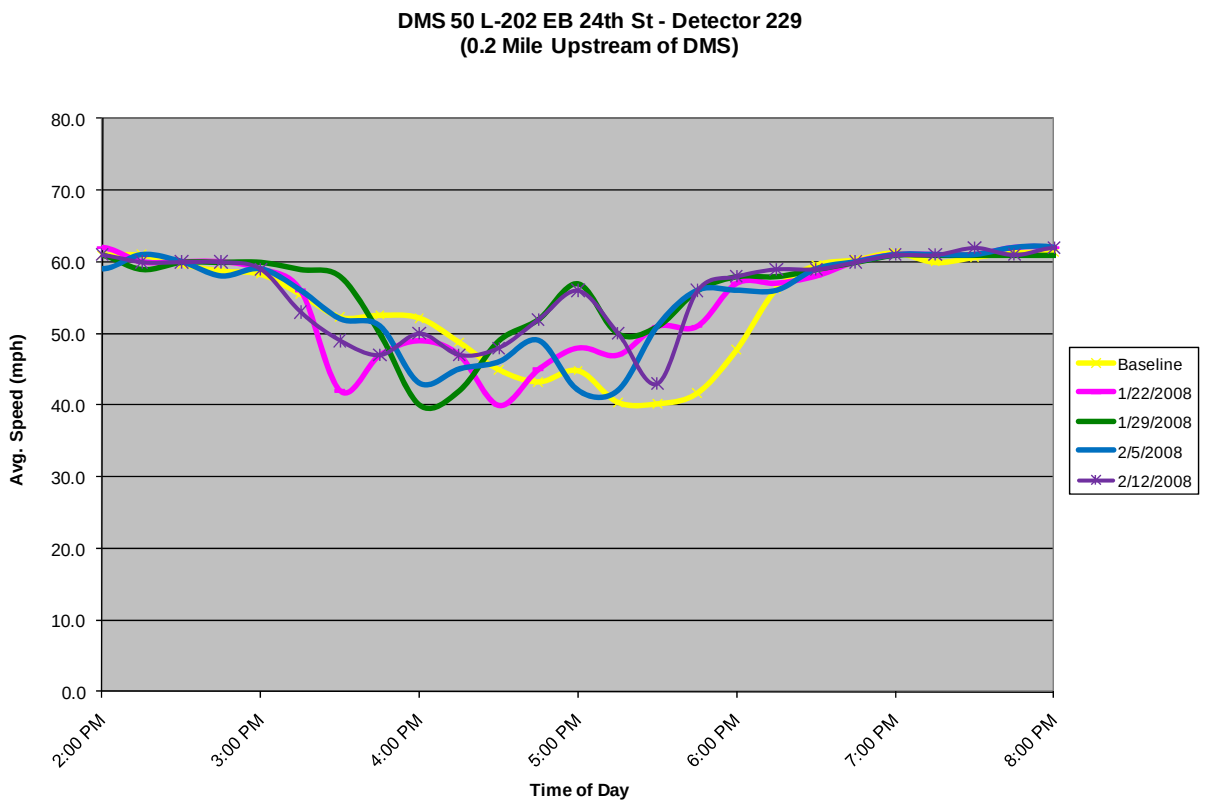
DMS 4 I-10 EB 10th St





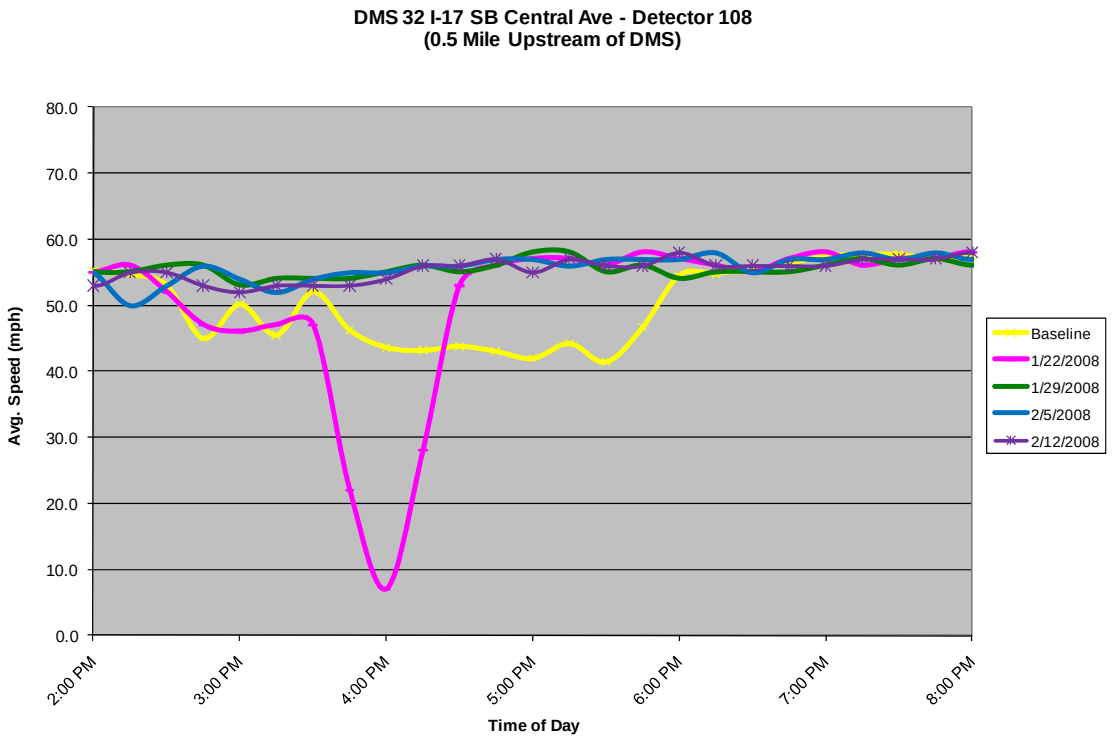
DMS 50 L-202 EB 24th ST

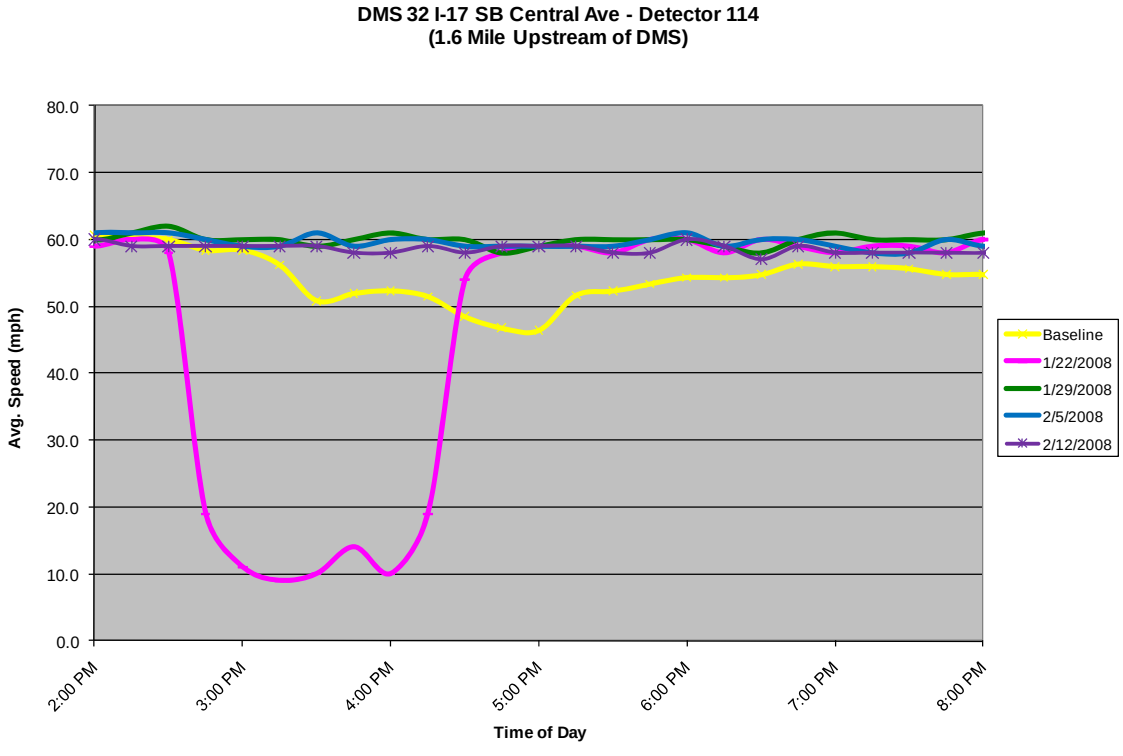
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

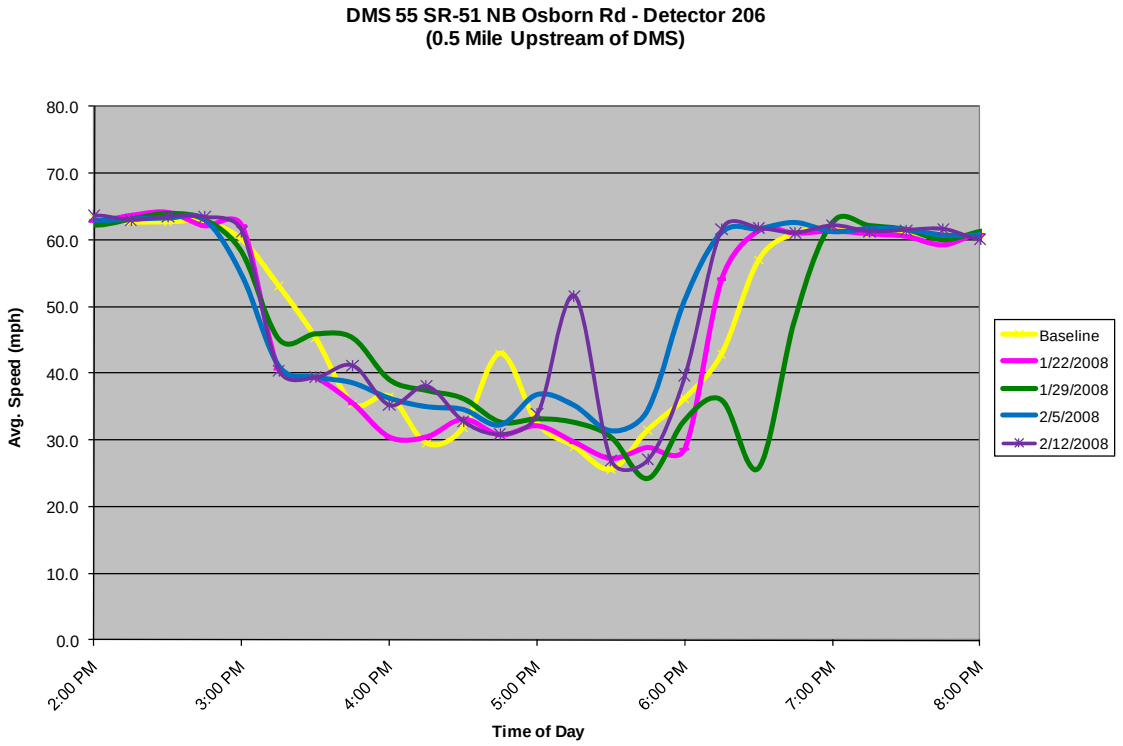


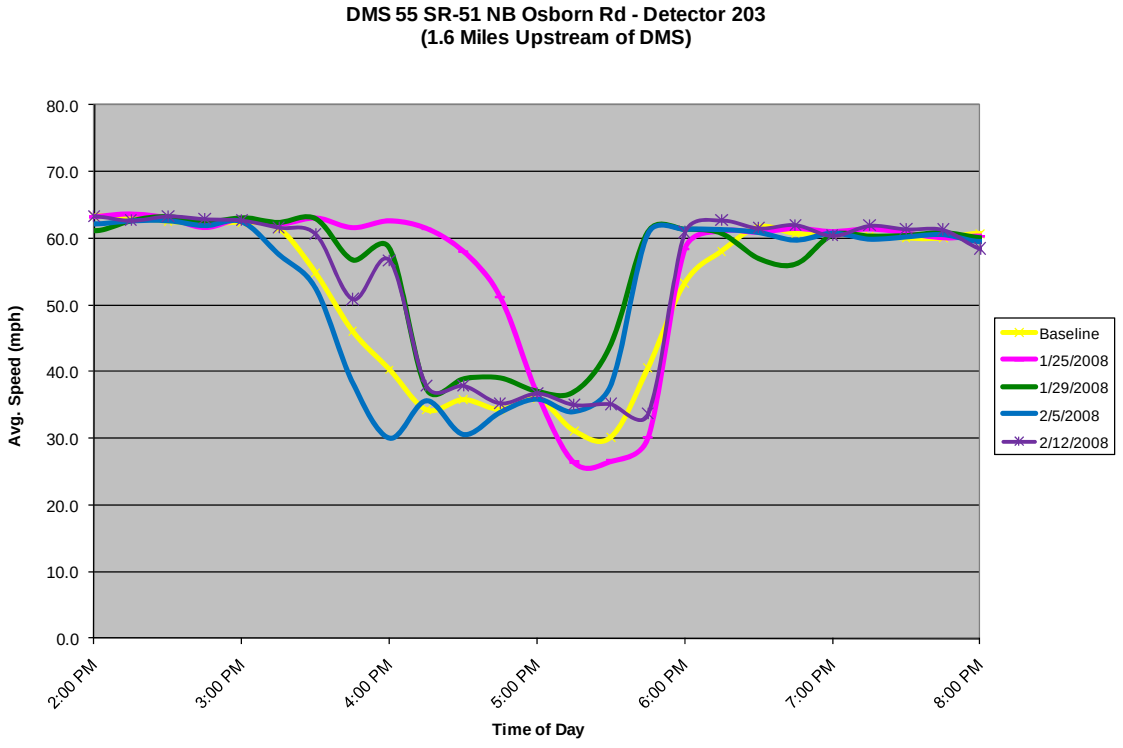


DMS 17 I-17 NB 4th Ave 
No Available Data on both Detector 104 and 98

DMS 55 SR-51 NB Osborn Rd

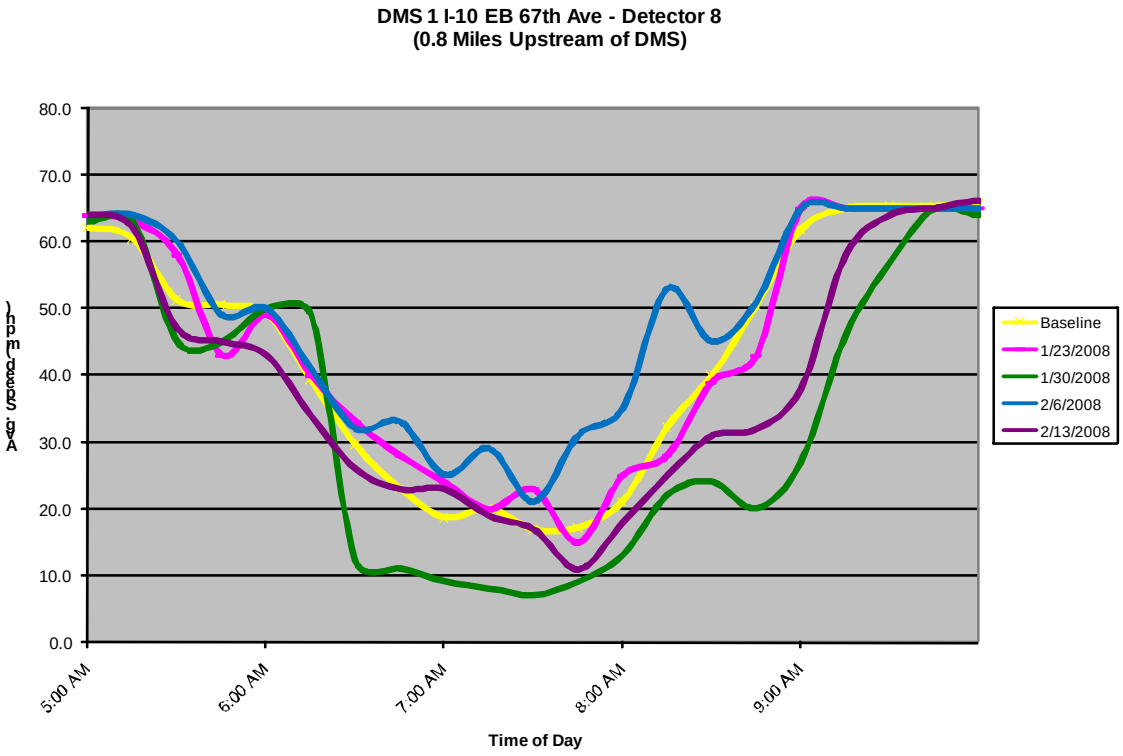
MINUTES TO
BELL RD XX

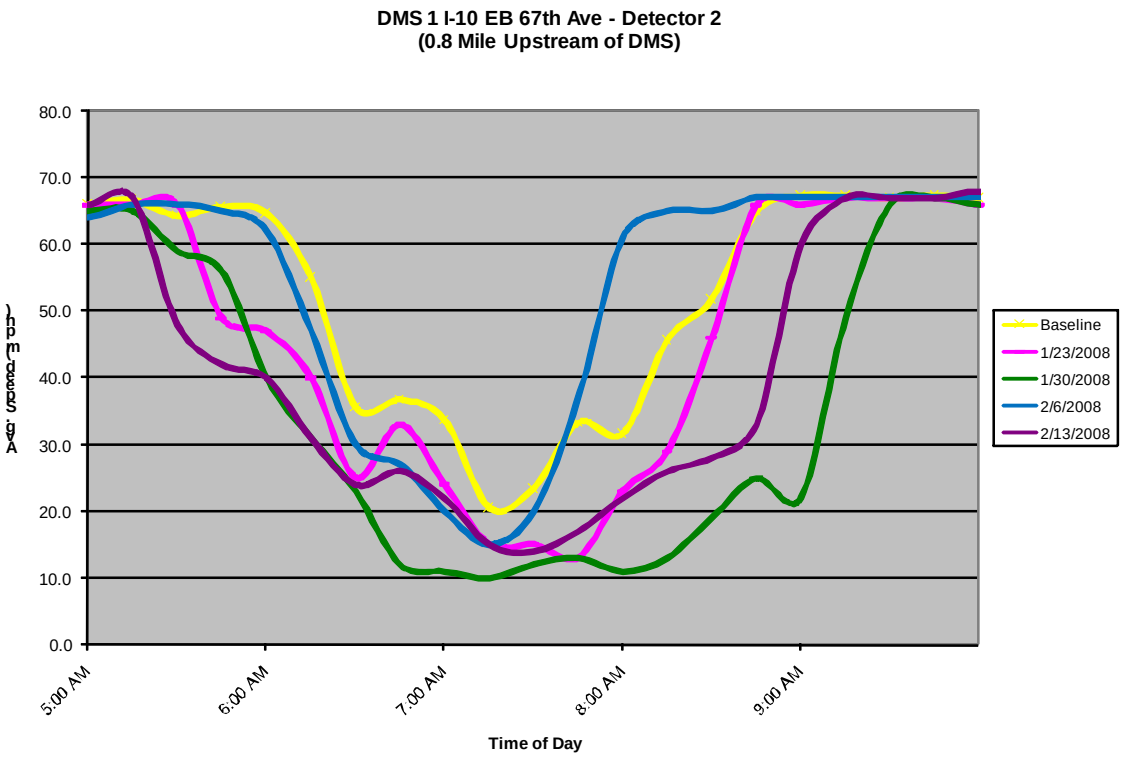




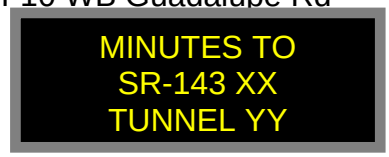
DMS 1 I-10 EB 67th Ave

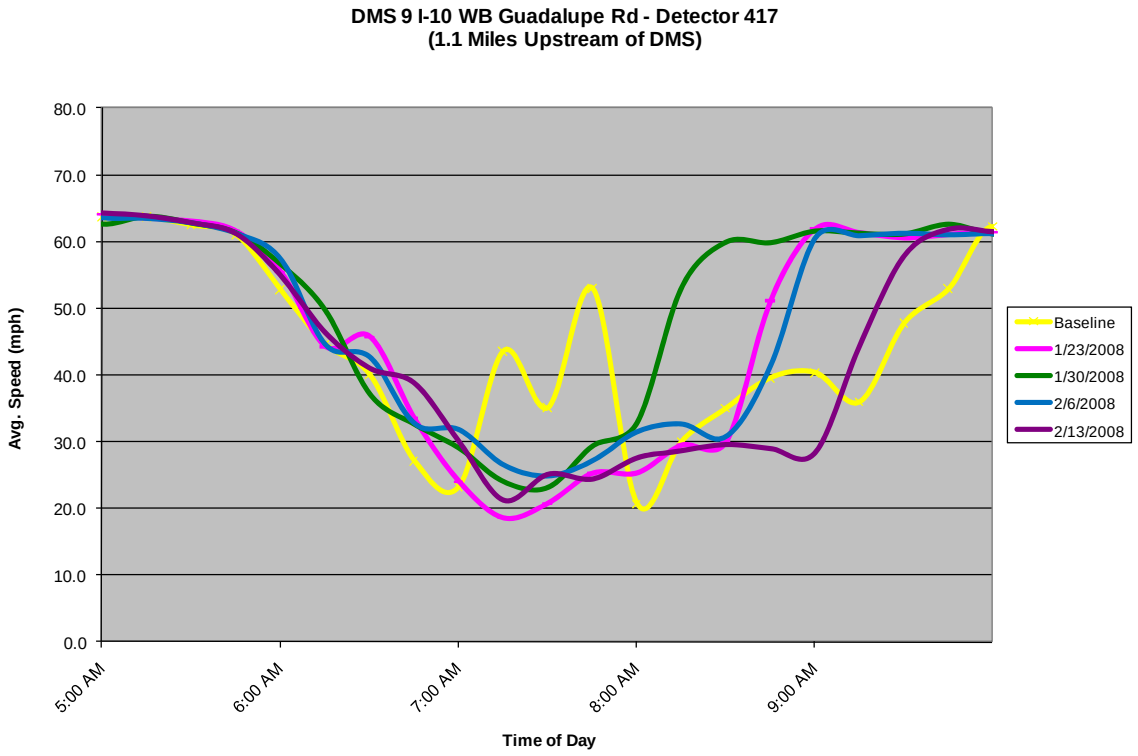
MINUTES TO
TUNNEL XX
AIRPORT YY

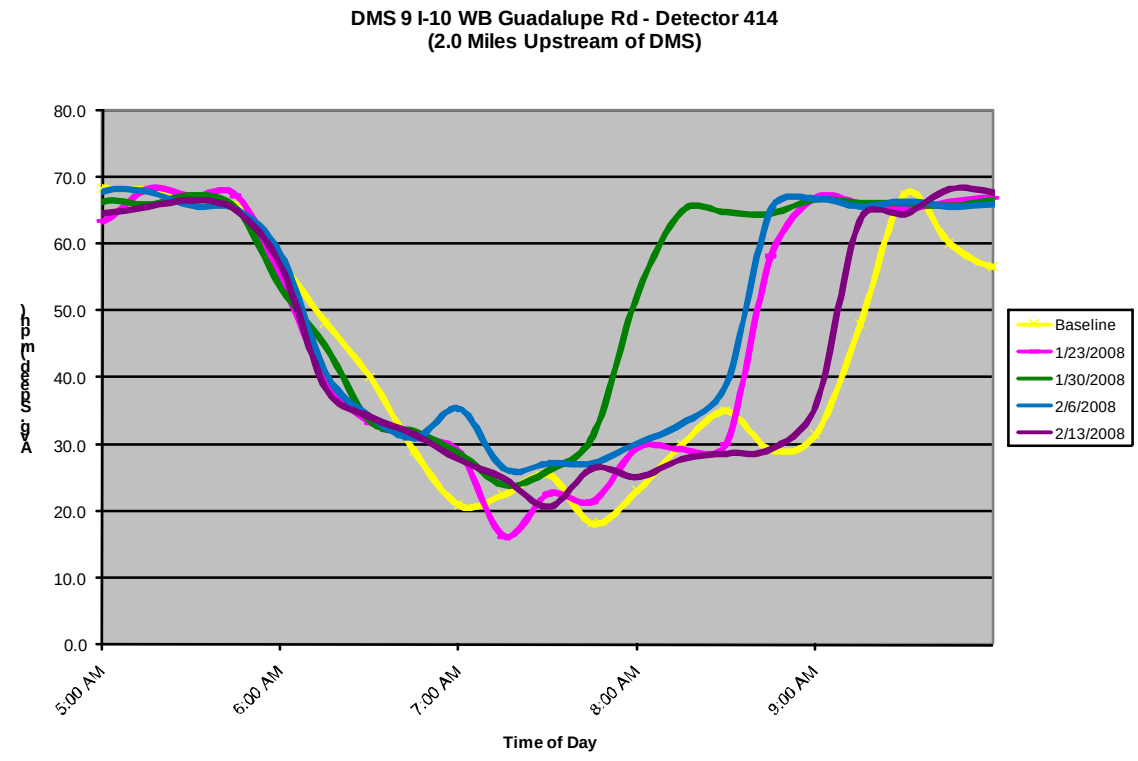




DMS 9 I-10 WB Guadalupe Rd

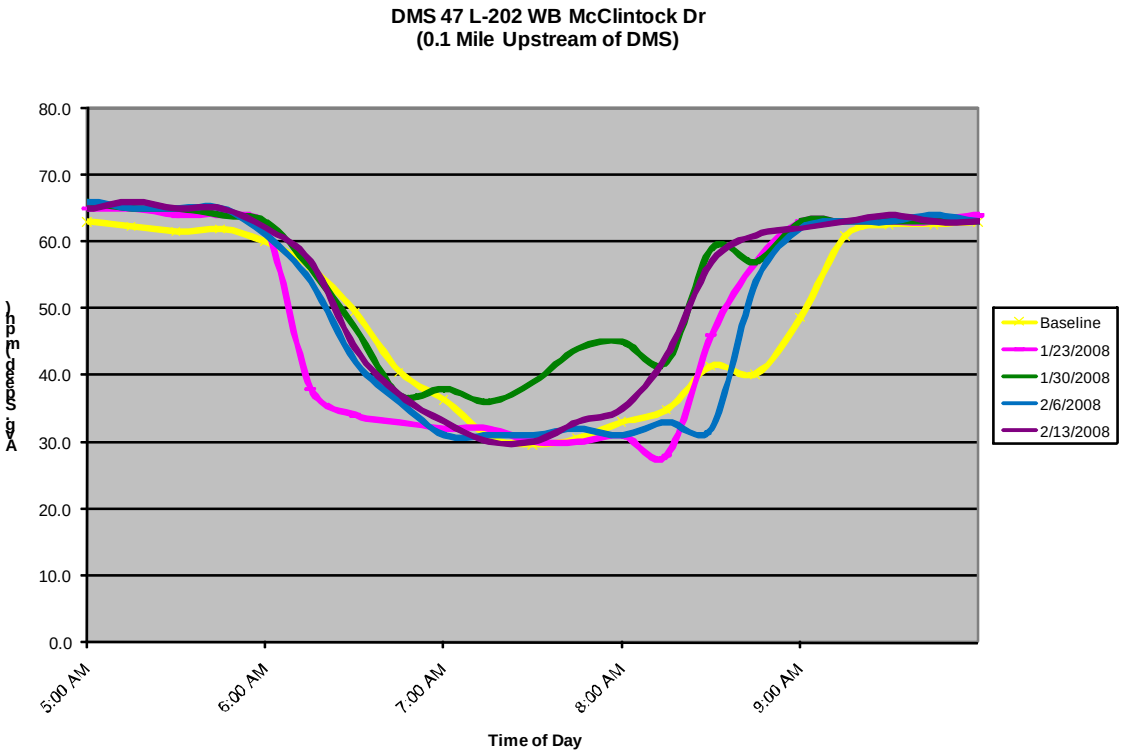




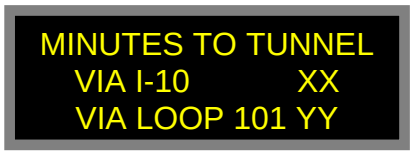


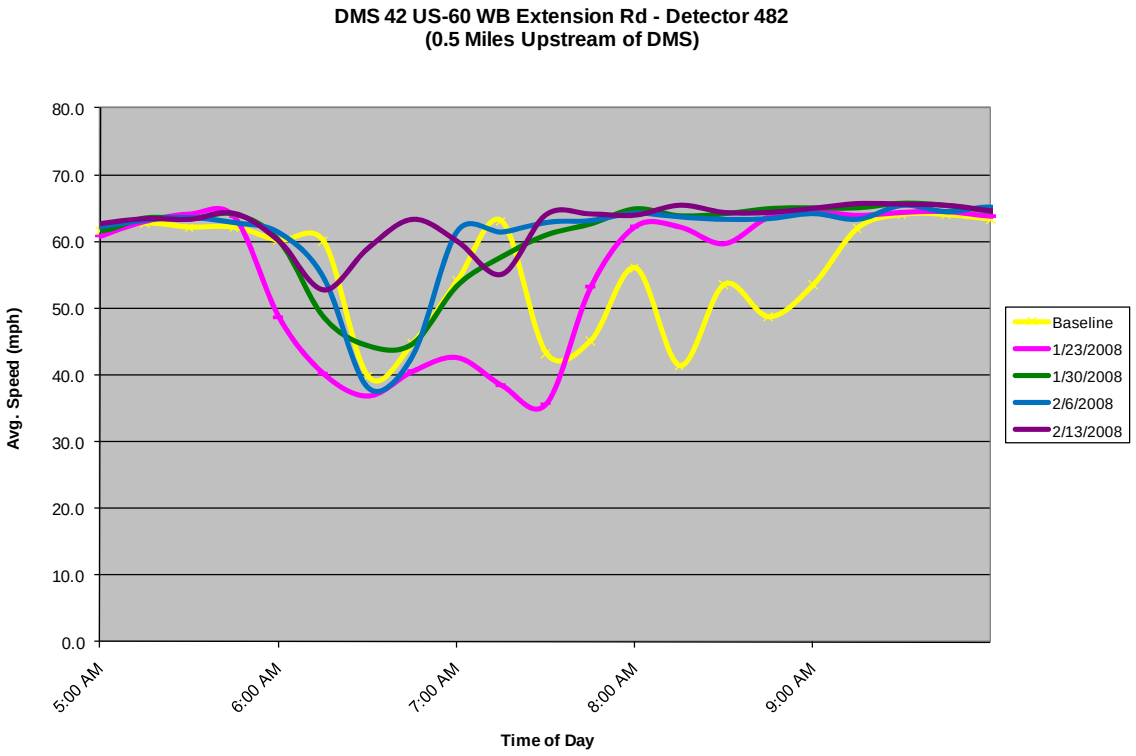
DMS 47 L-202 WB McClintock Dr

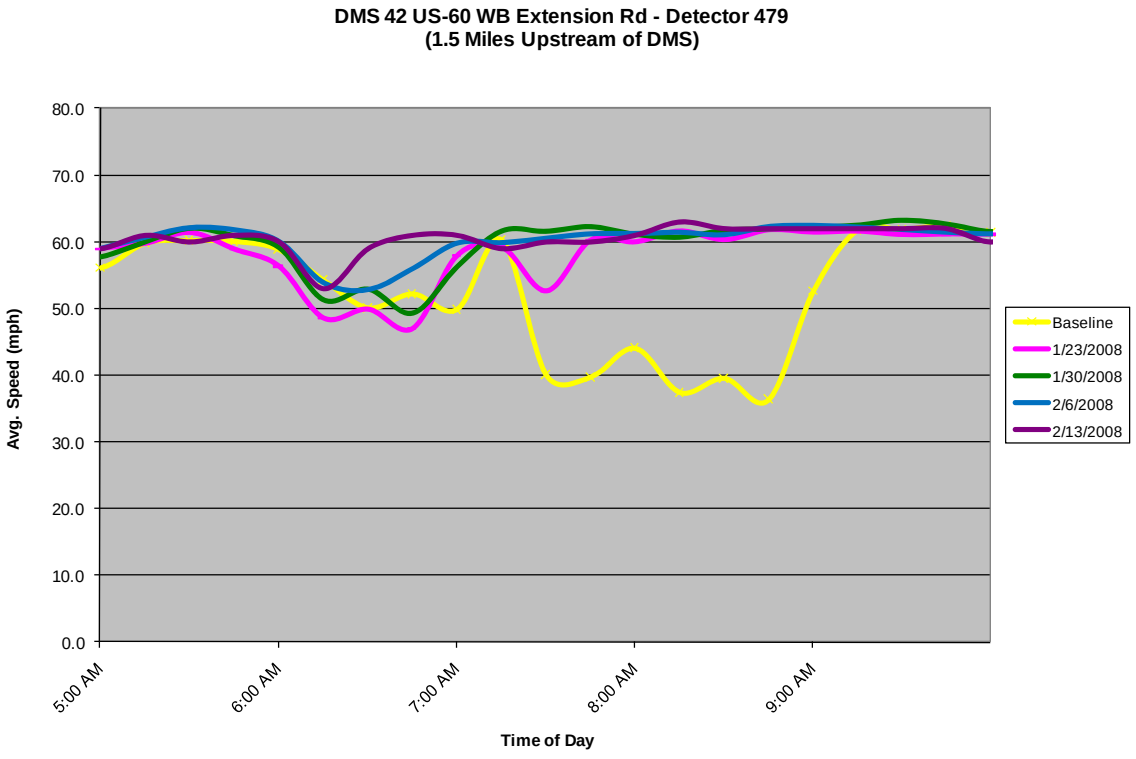
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

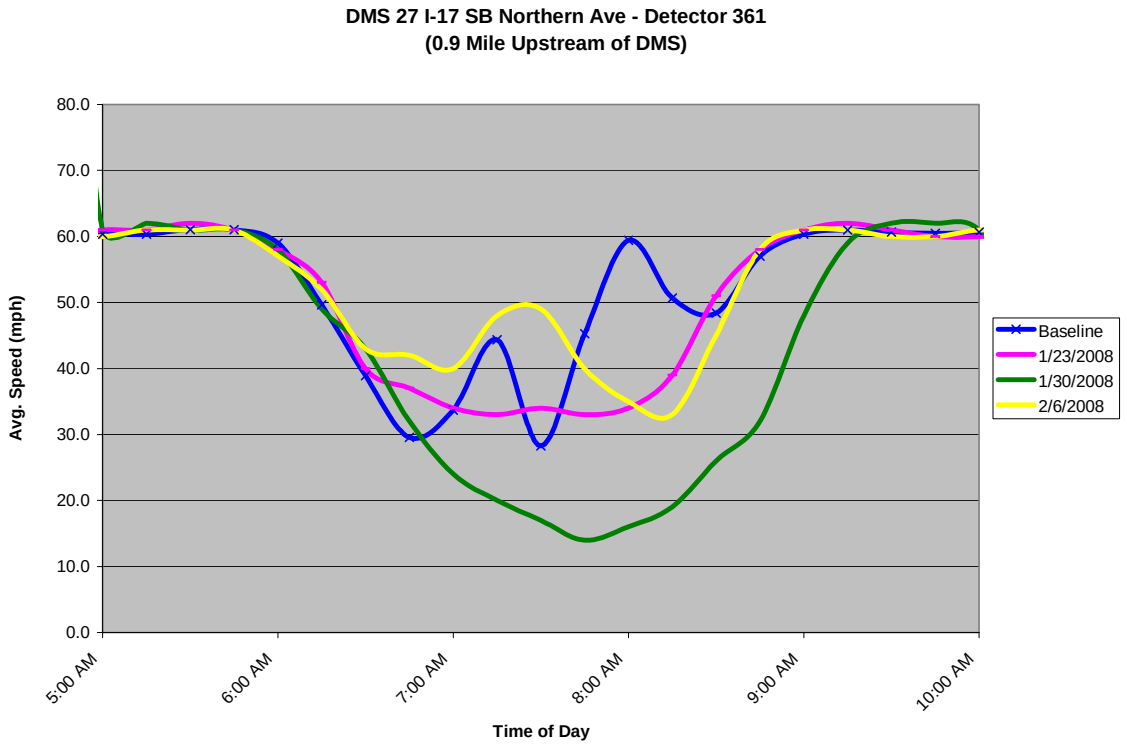


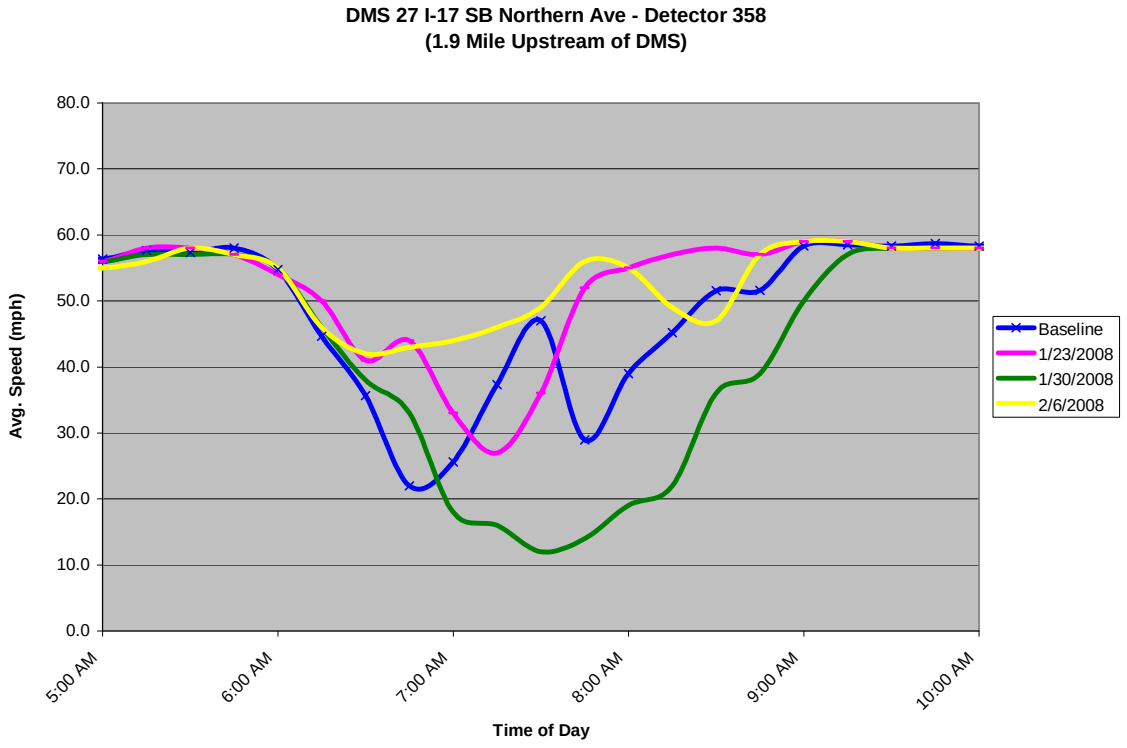




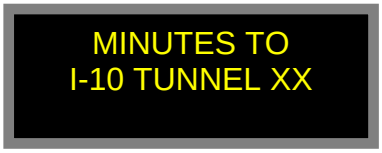
DMS 27 I-17 SB Northern Ave

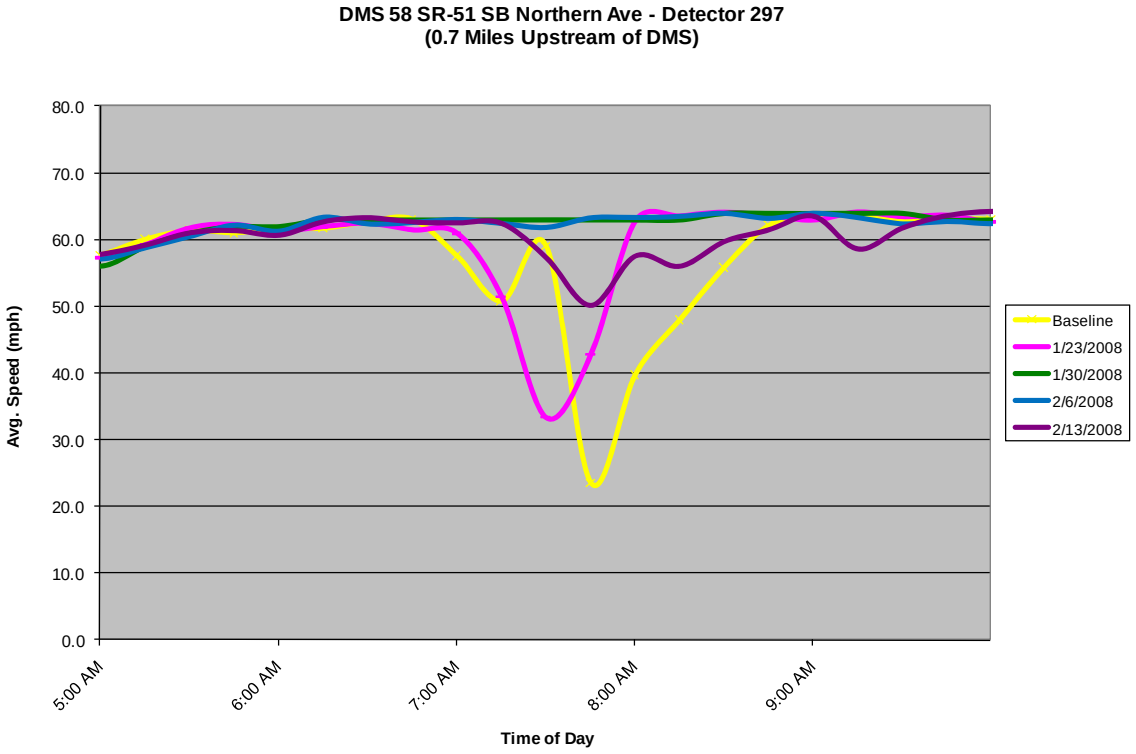
MINUTES TO
I-10 TUNNEL XX

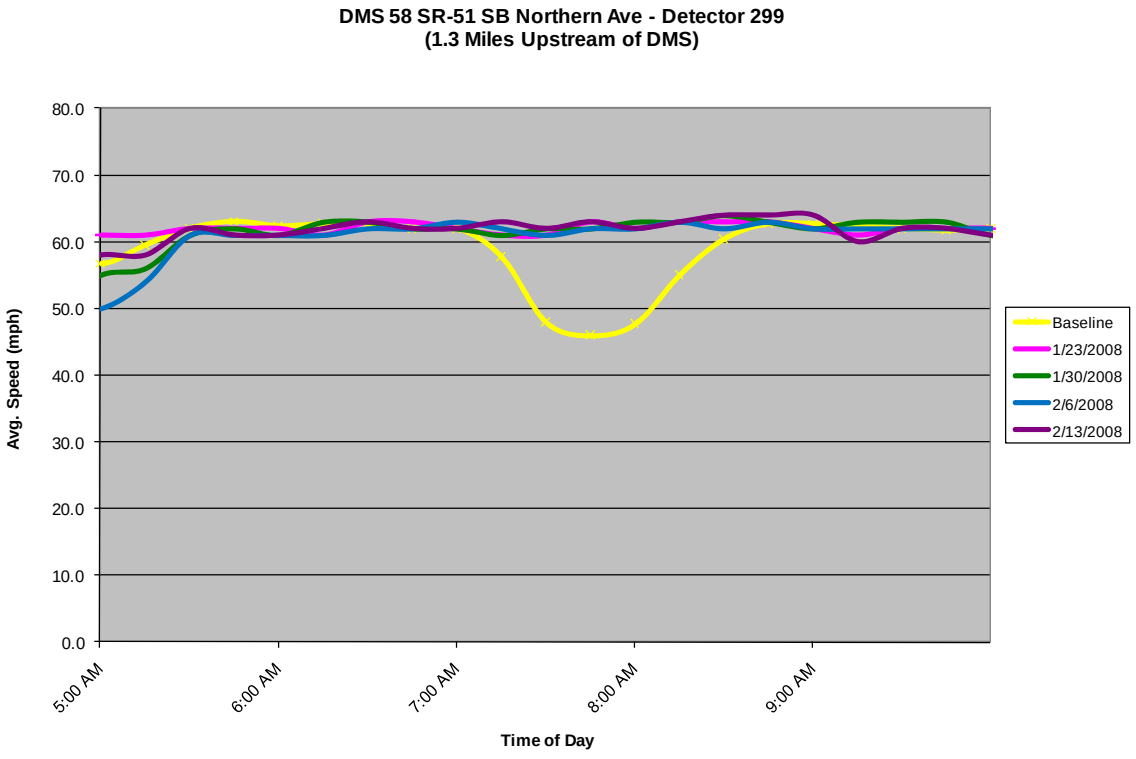




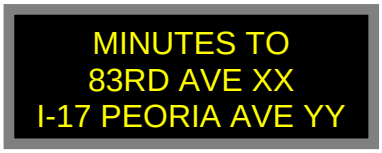
DMS 58 SR-51 SB Northern Ave

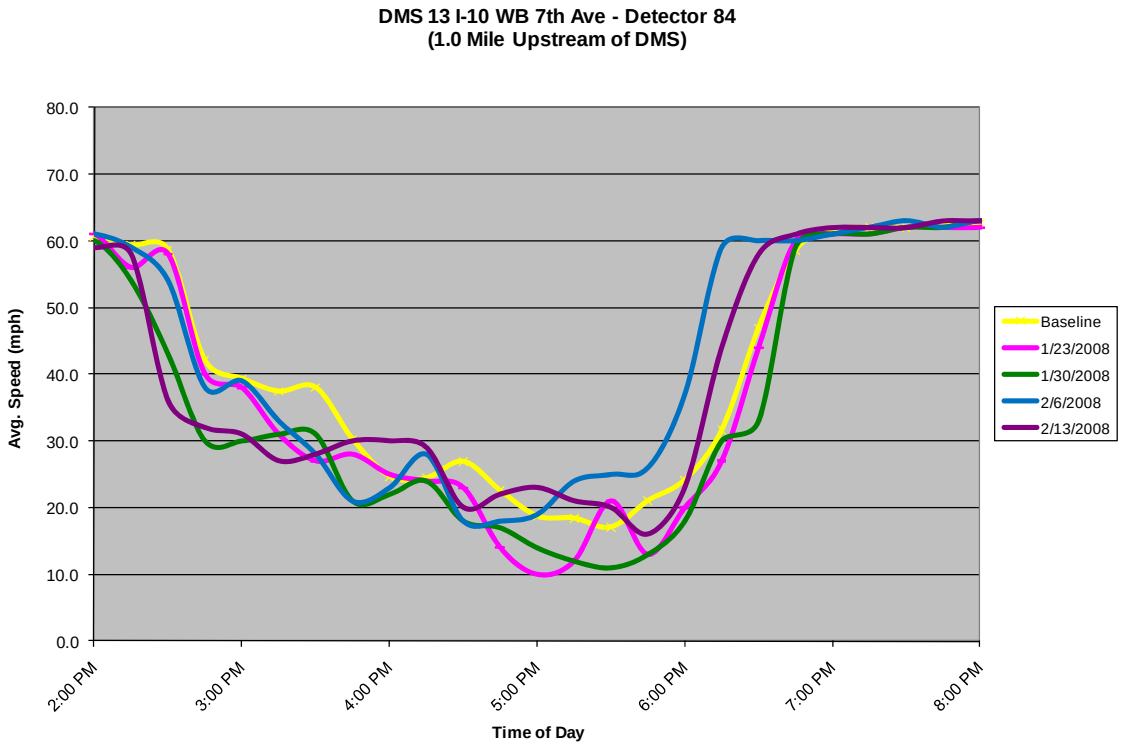


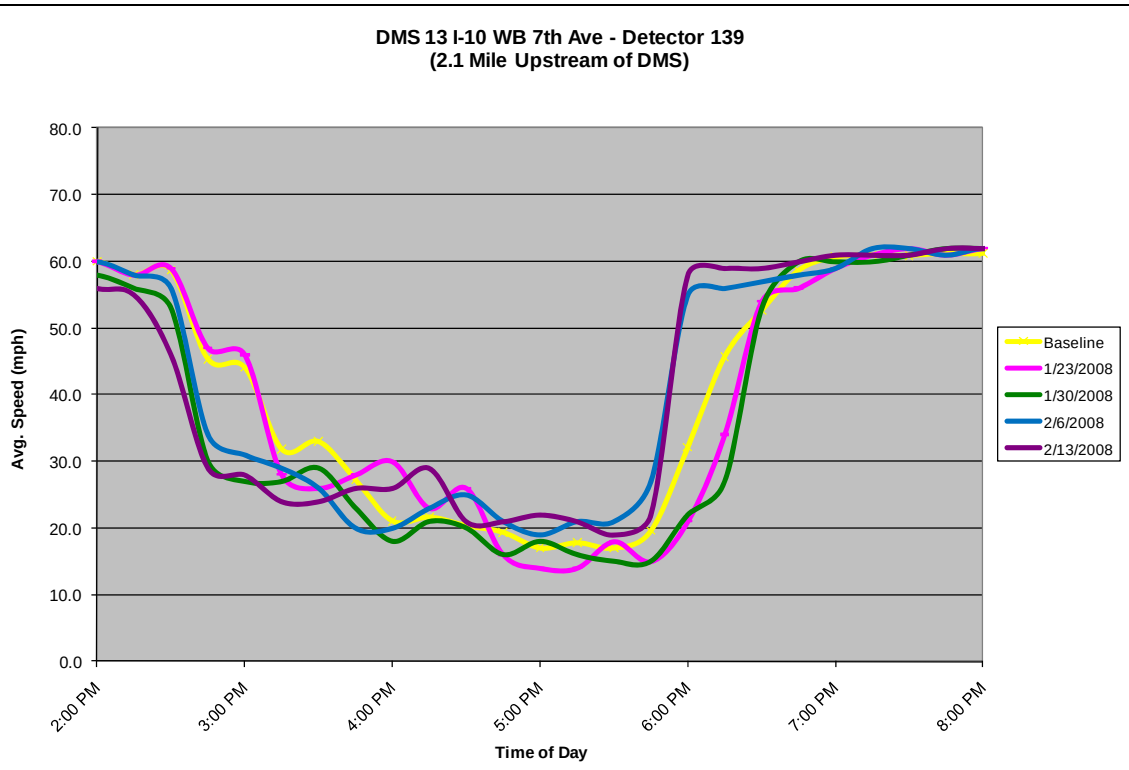




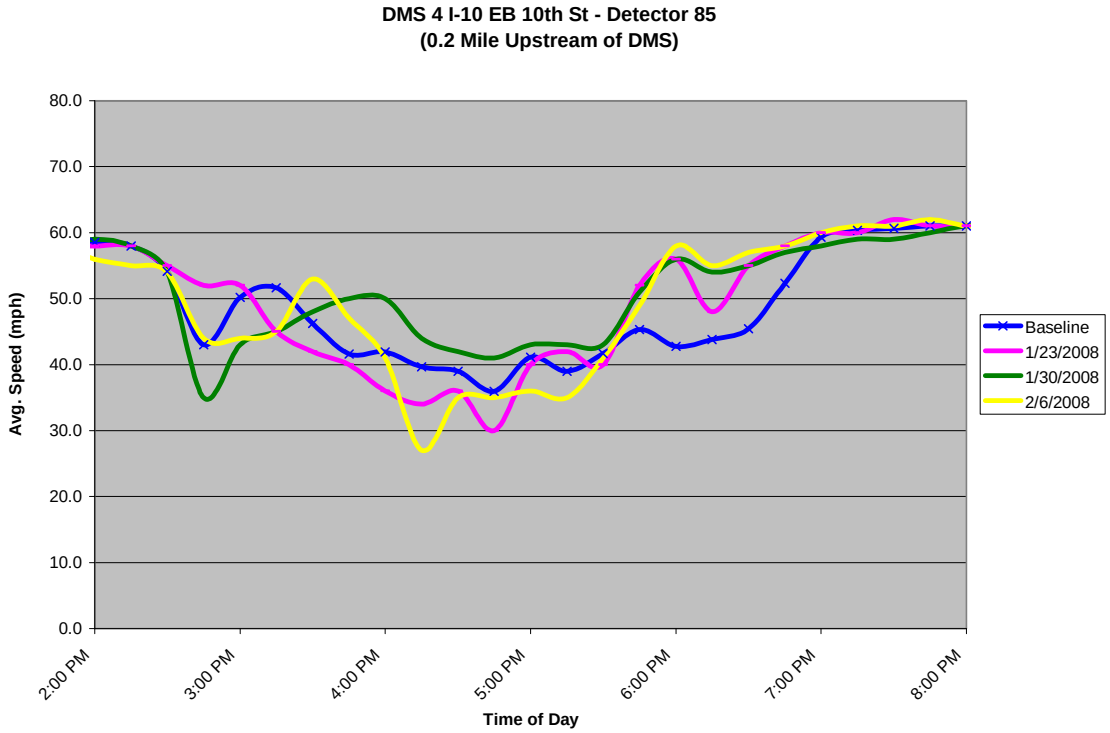
DMS 13 I-10 WB 7th Ave

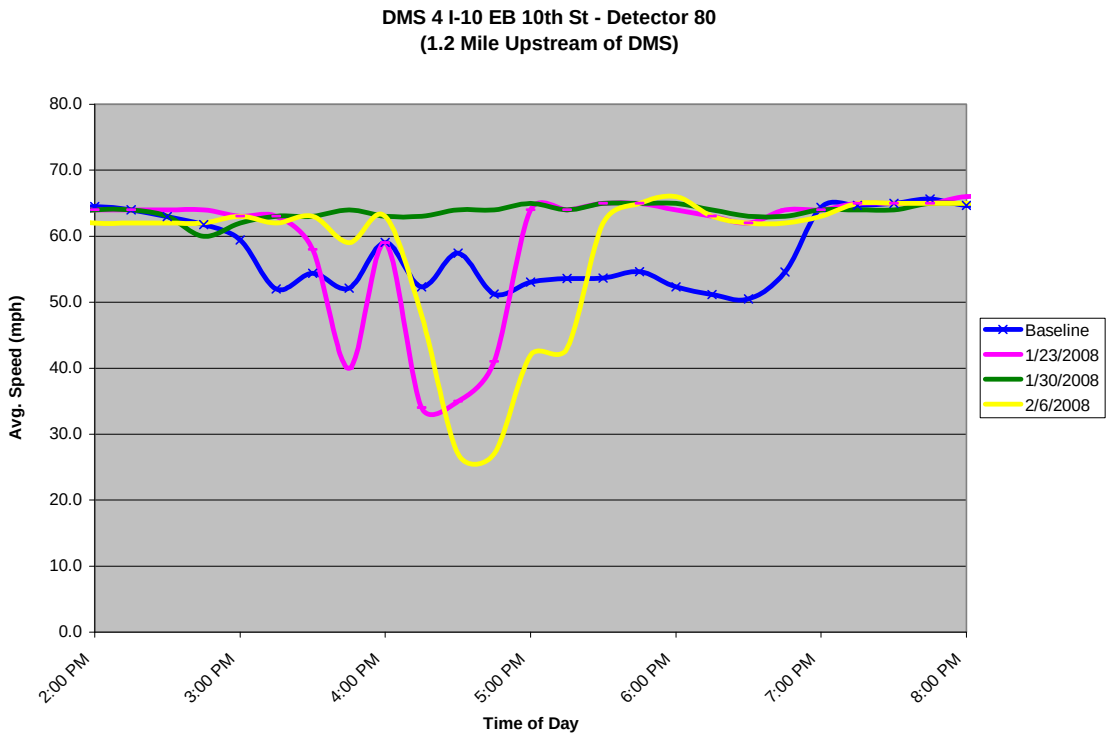






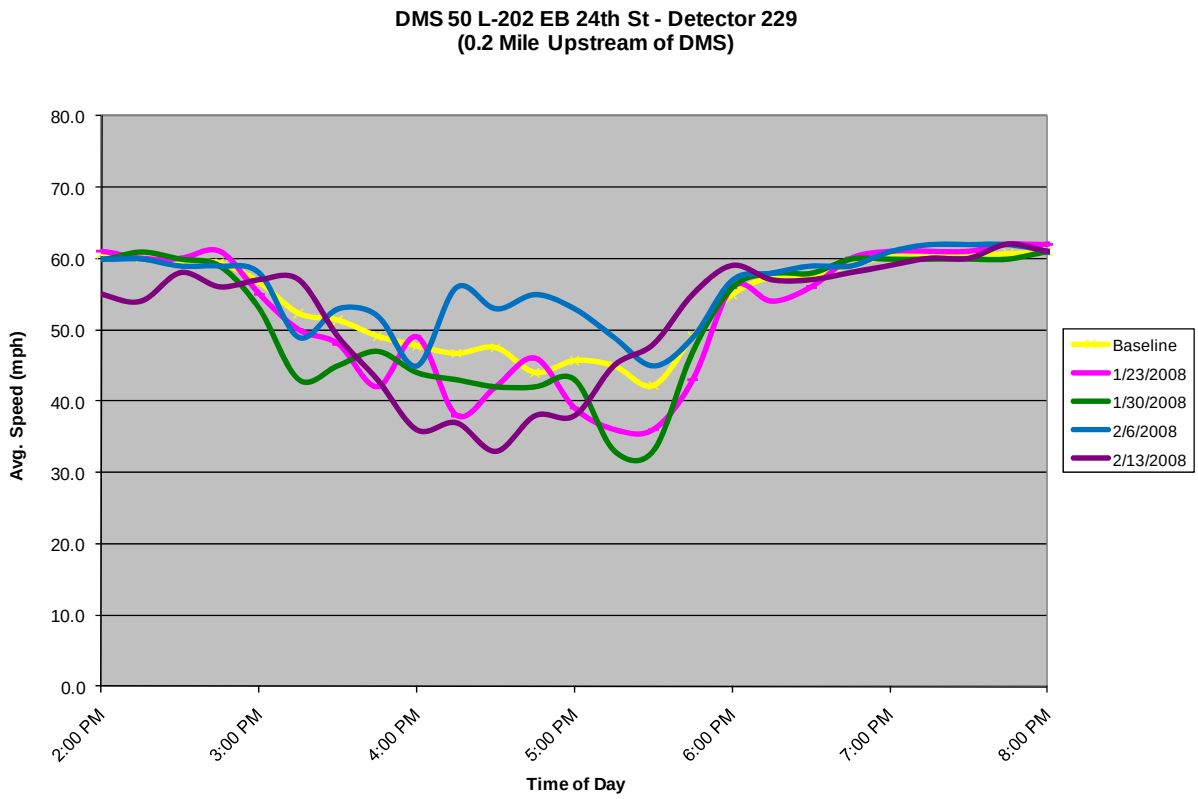
DMS 4 I-10 EB 10th St



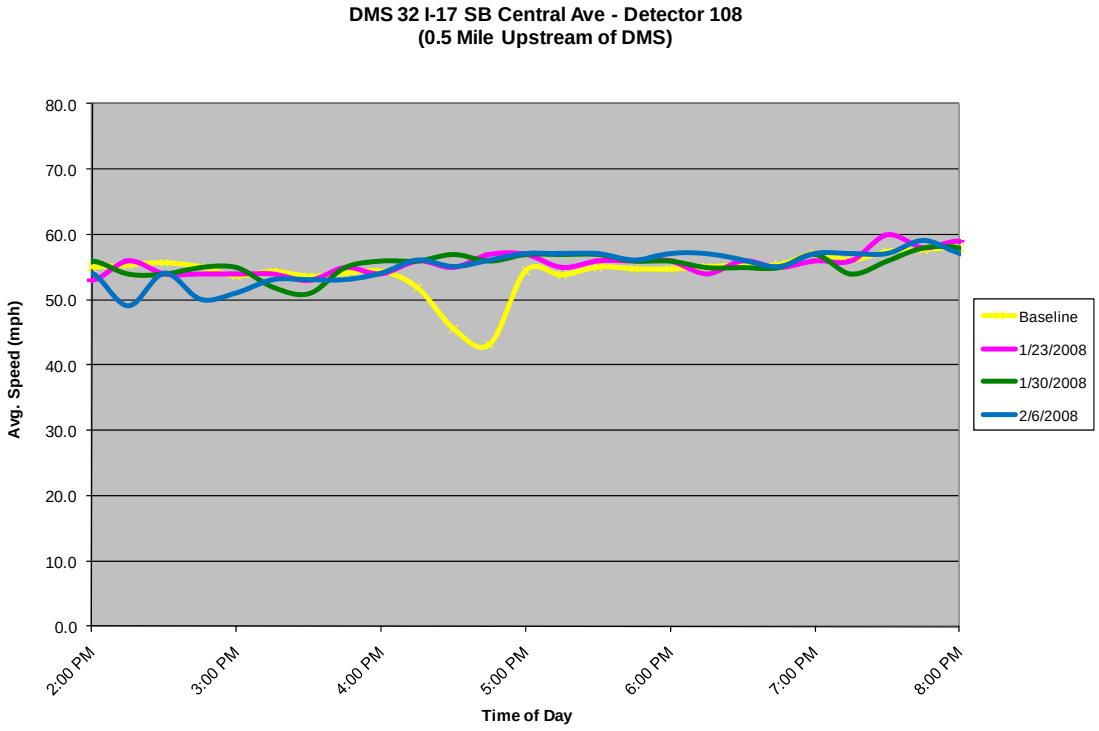


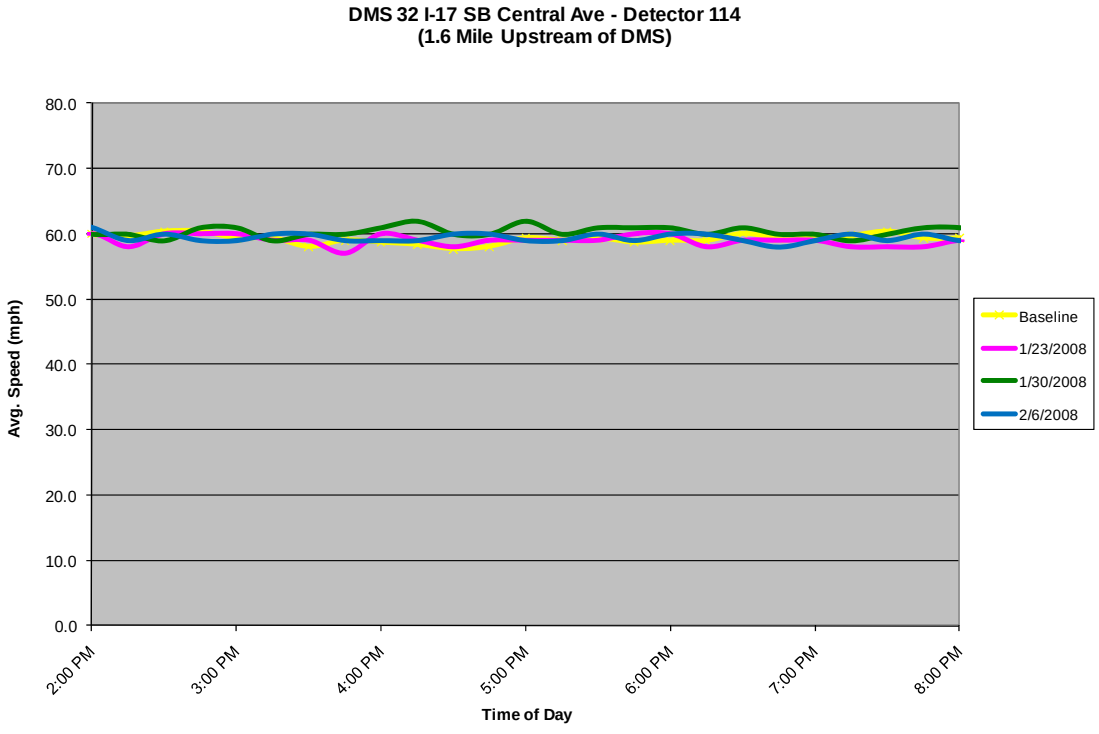
DMS 50 L-202 EB 24th ST

MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave



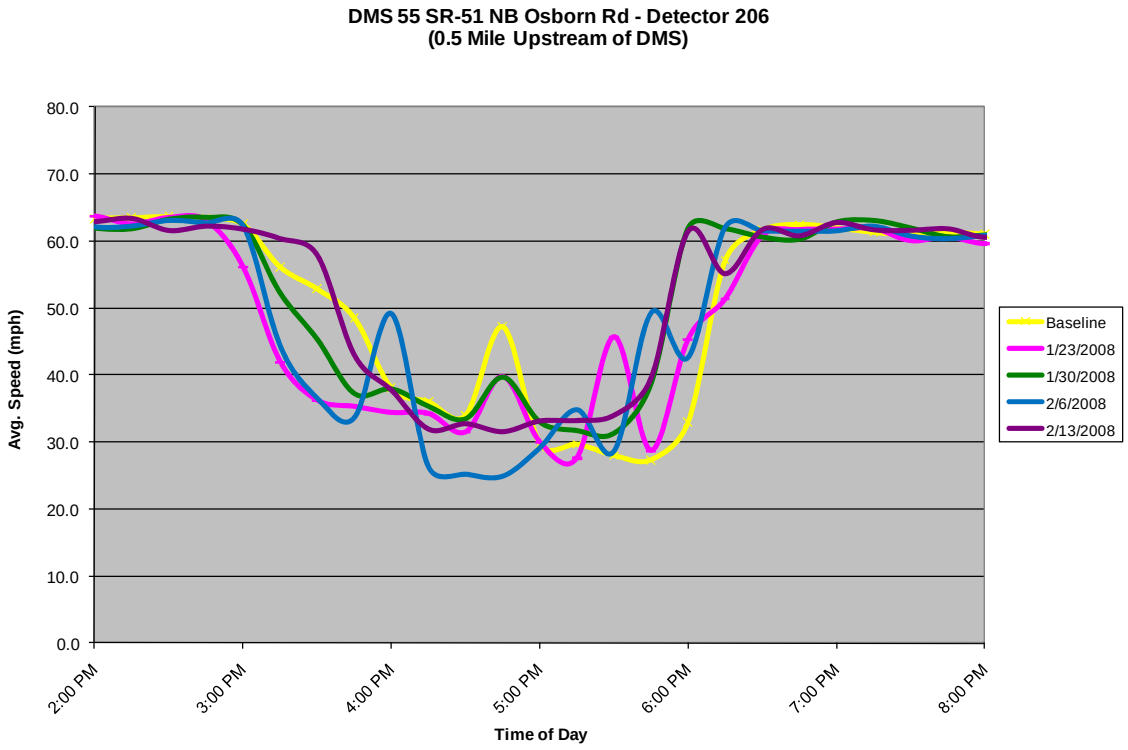


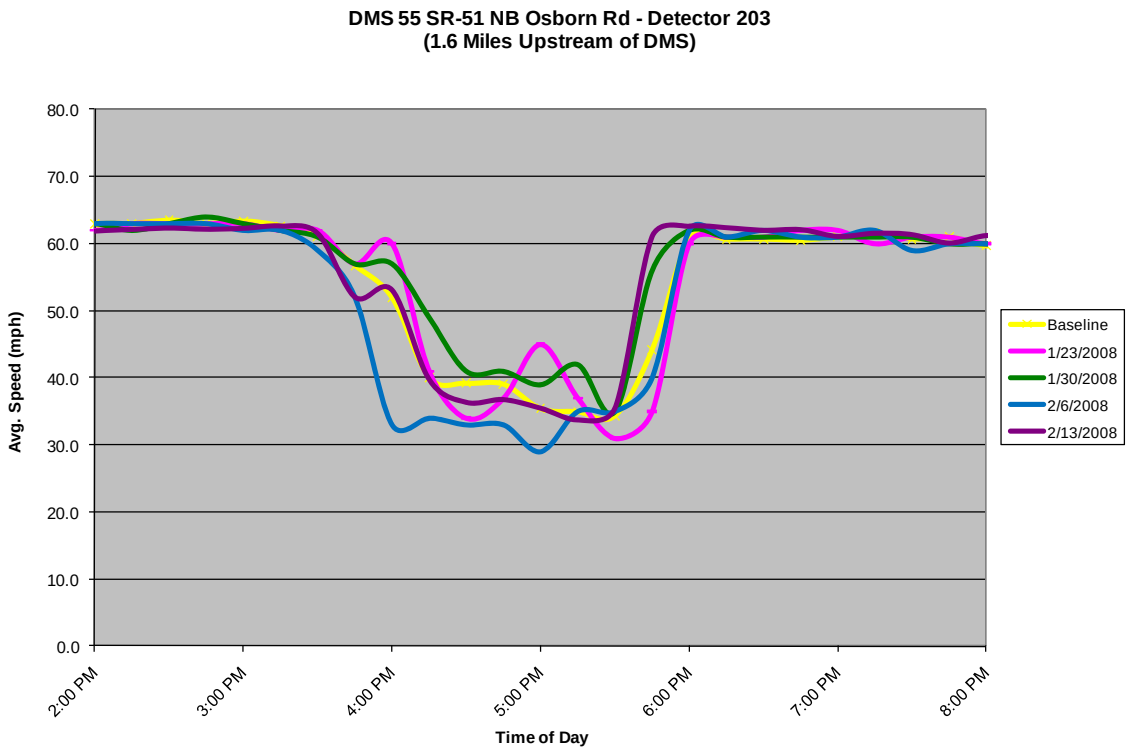
DMS 17 I-17 NB 4th Ave

No Available Data on both Detector 104 and 98

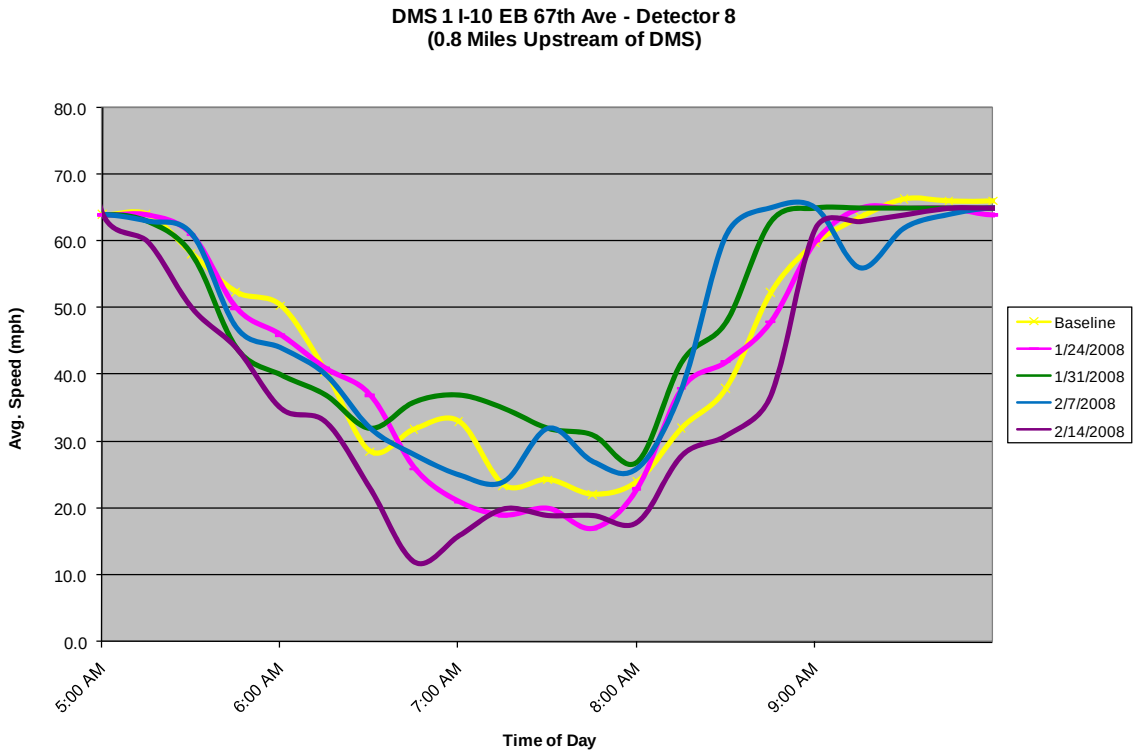
DMS 55 SR-51 NB Osborn Rd

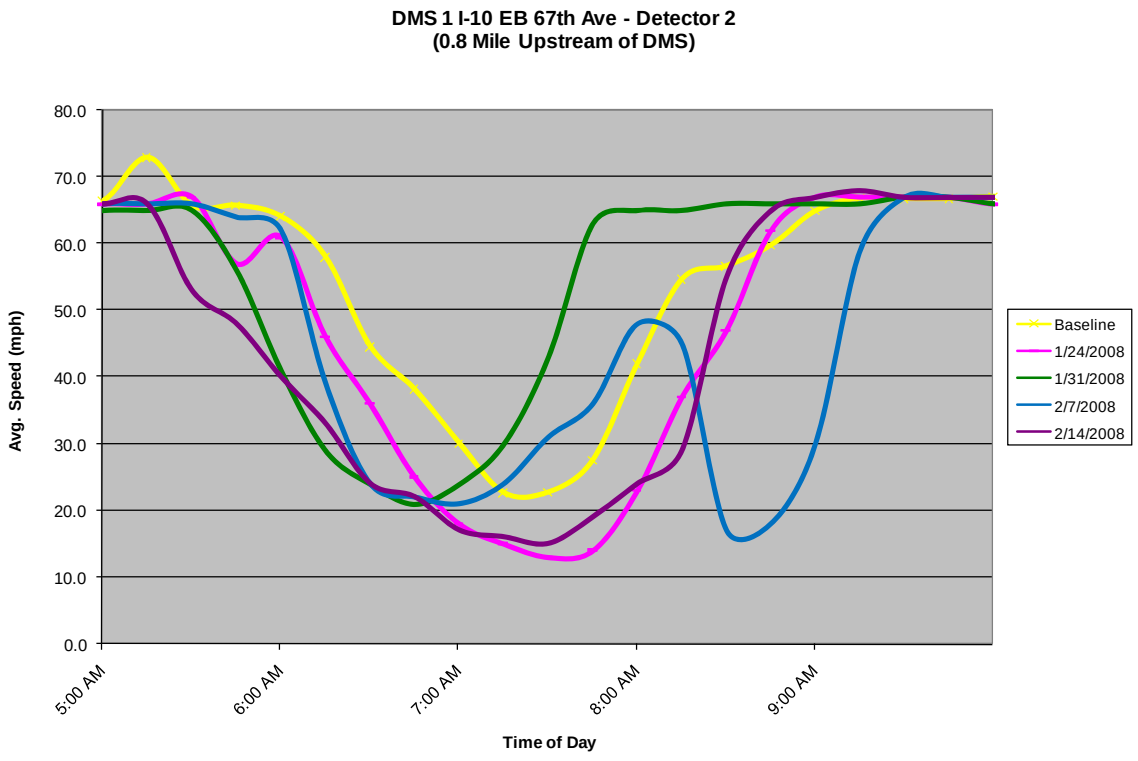
MINUTES TO
BELL RD XX





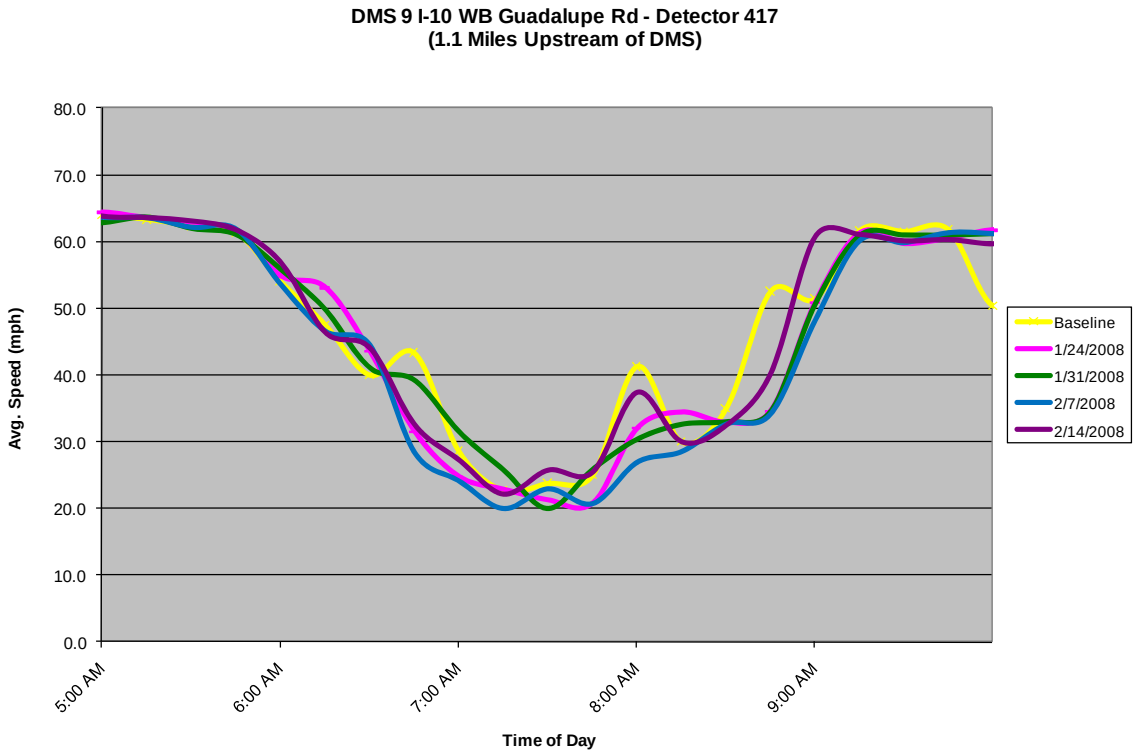
DMS 1 I-10 EB 67th Ave

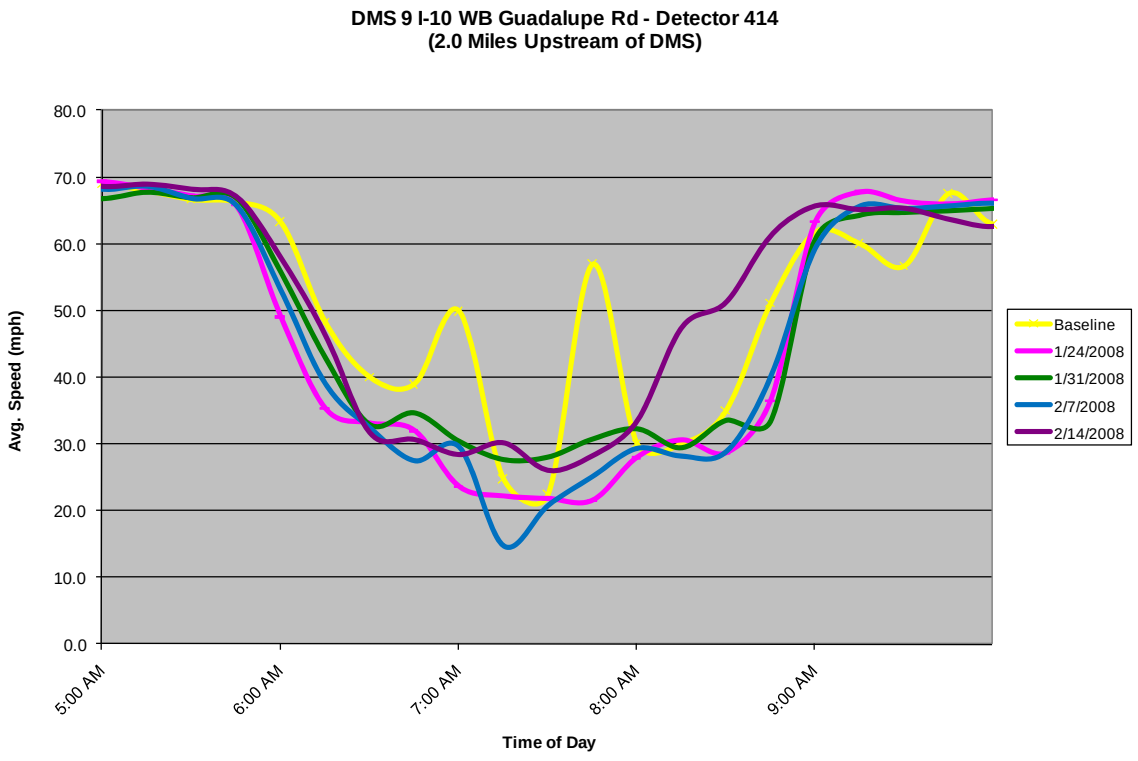




DMS 9 I-10 WB Guadalupe Rd

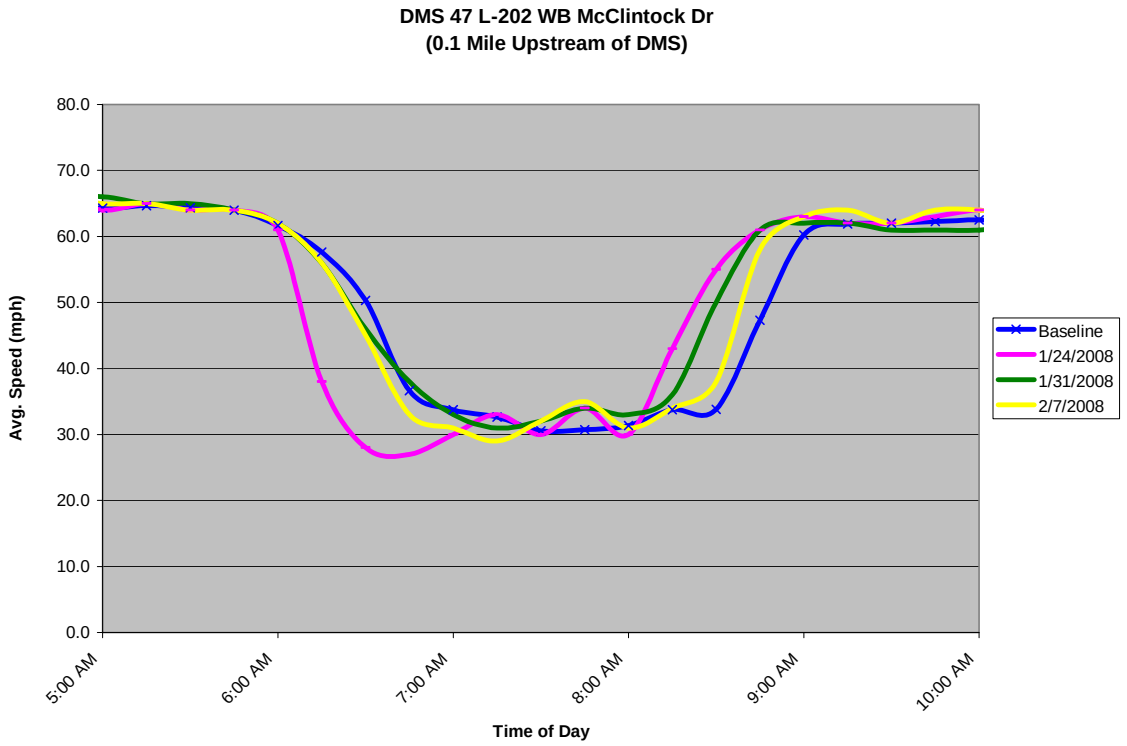
MINUTES TO
SR-143 XX
TUNNEL YY



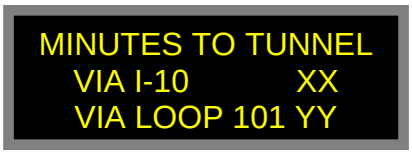


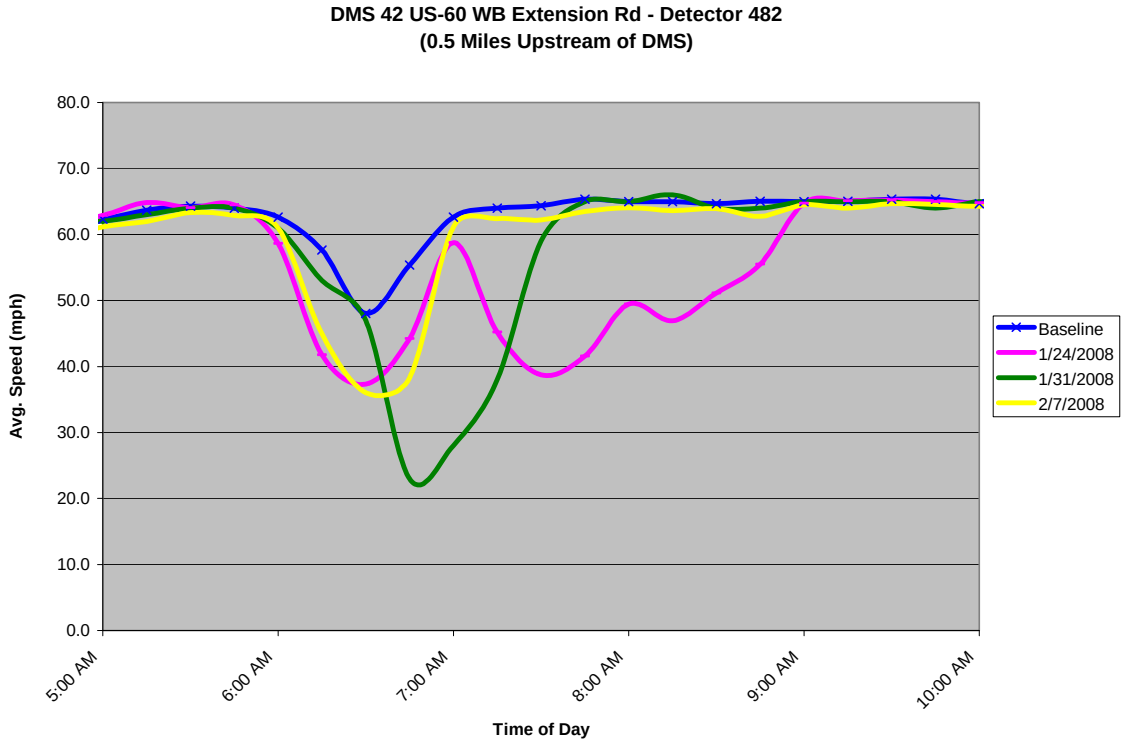
DMS 47 L-202 WB McClintock Dr

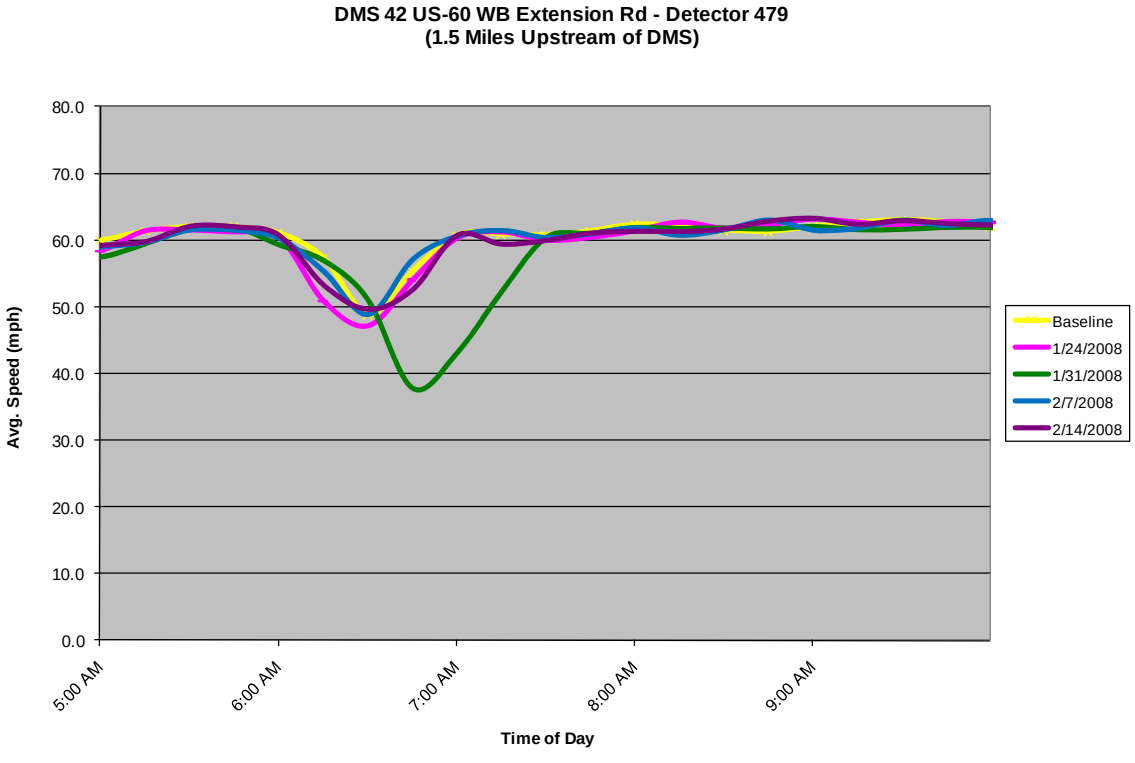
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

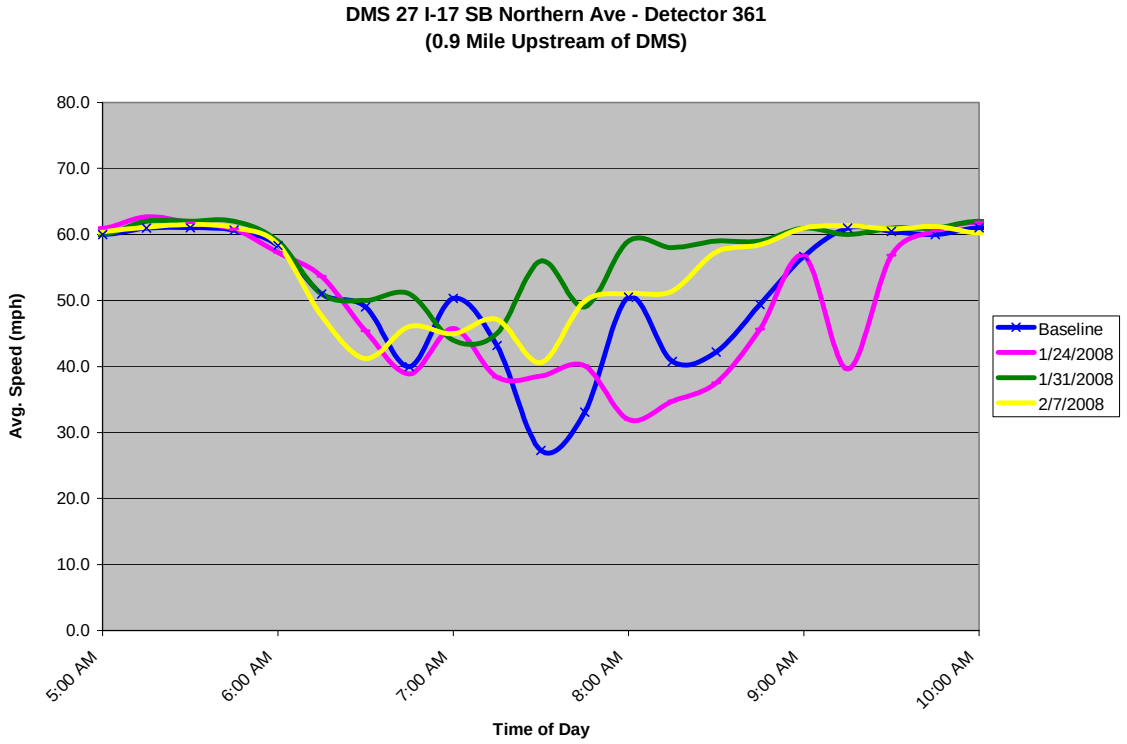


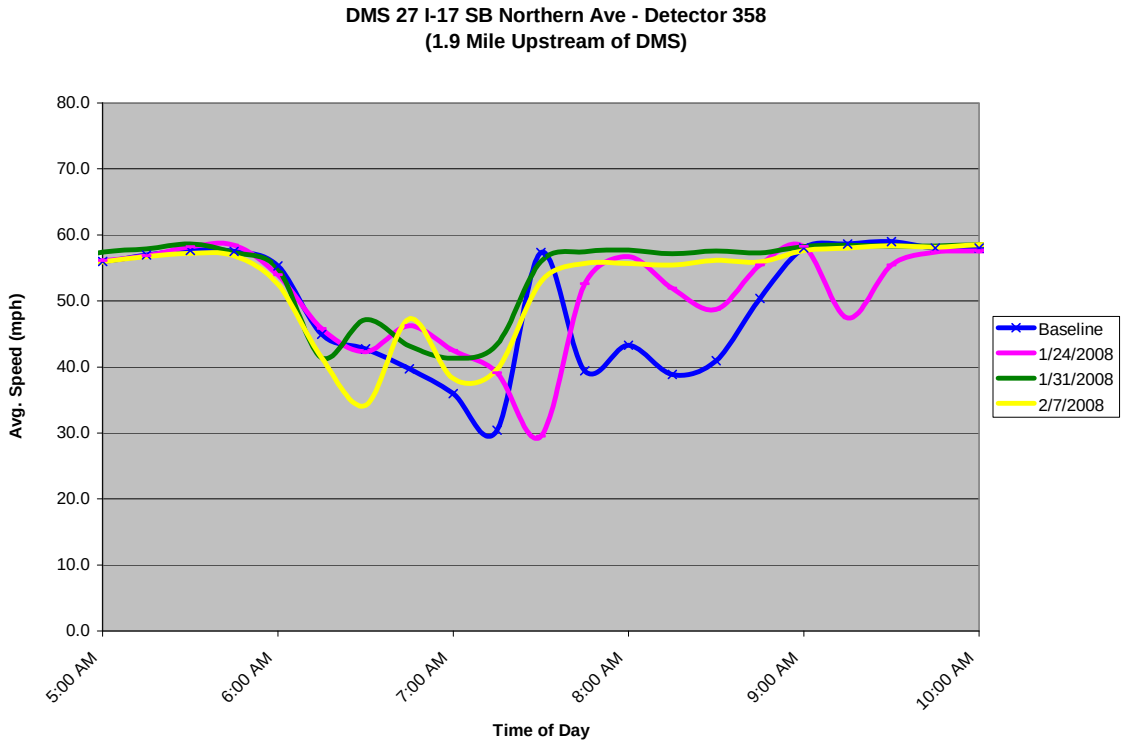




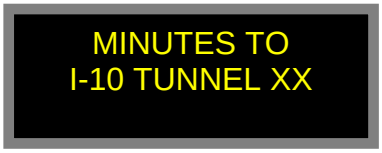
DMS 27 I-17 SB Northern Ave

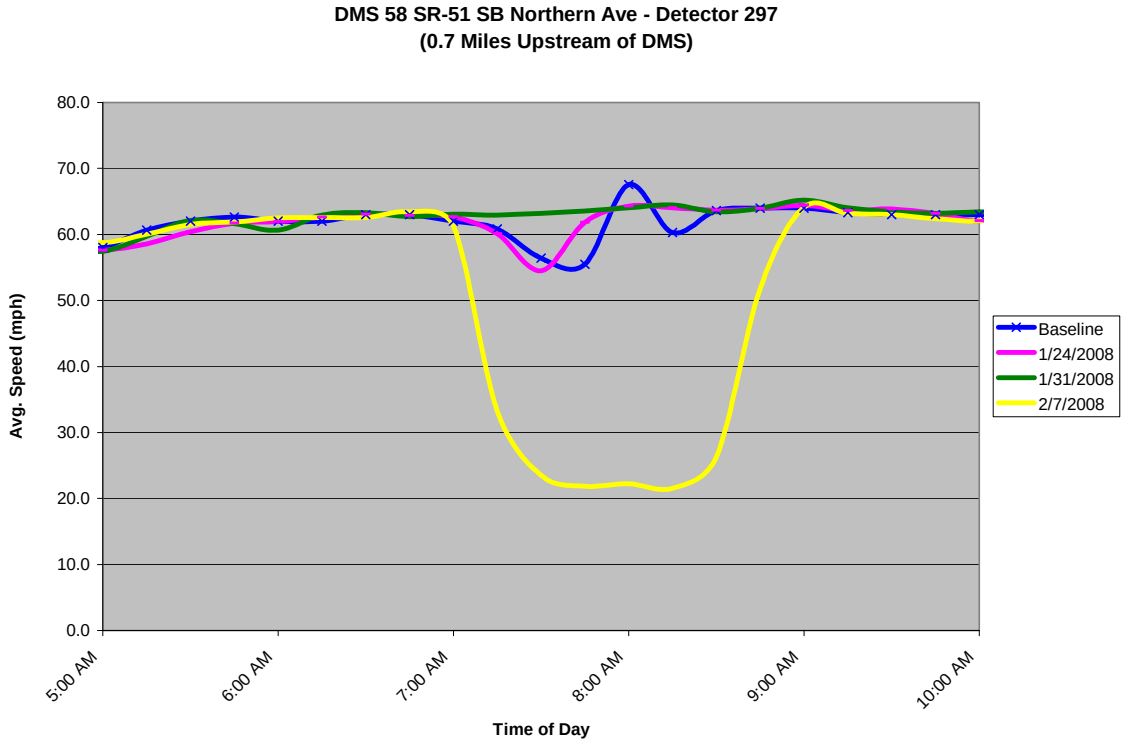
MINUTES TO
I-10 TUNNEL XX

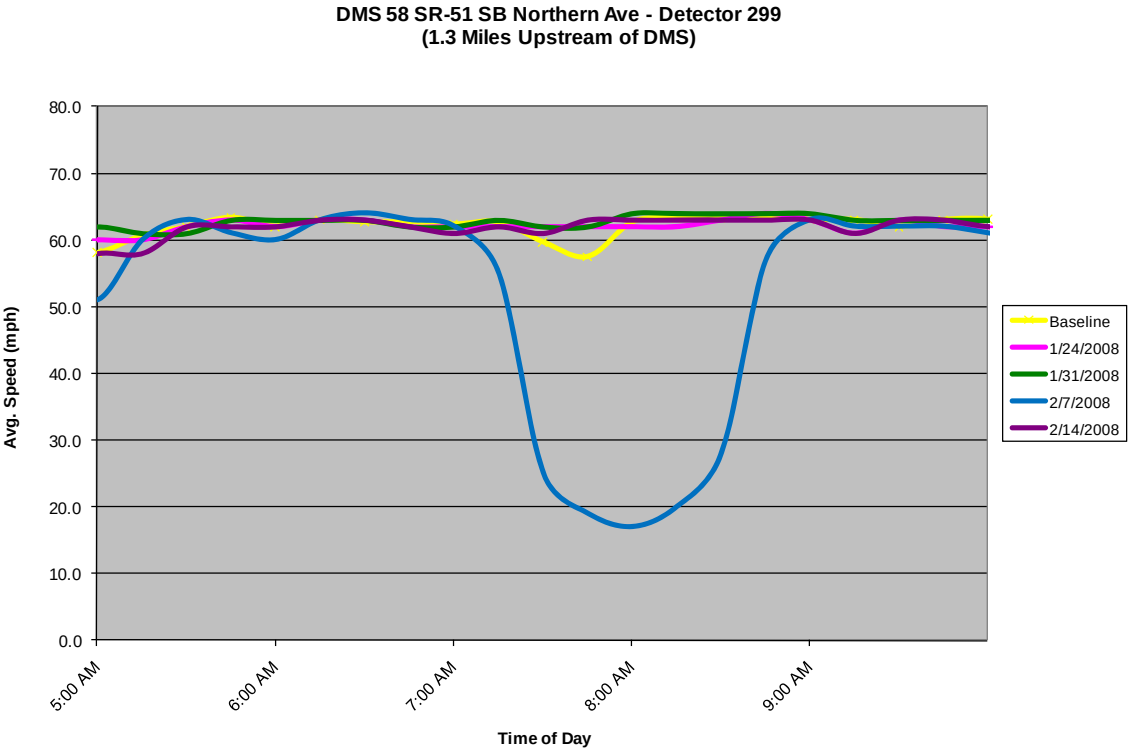




DMS 58 SR-51 SB Northern Ave

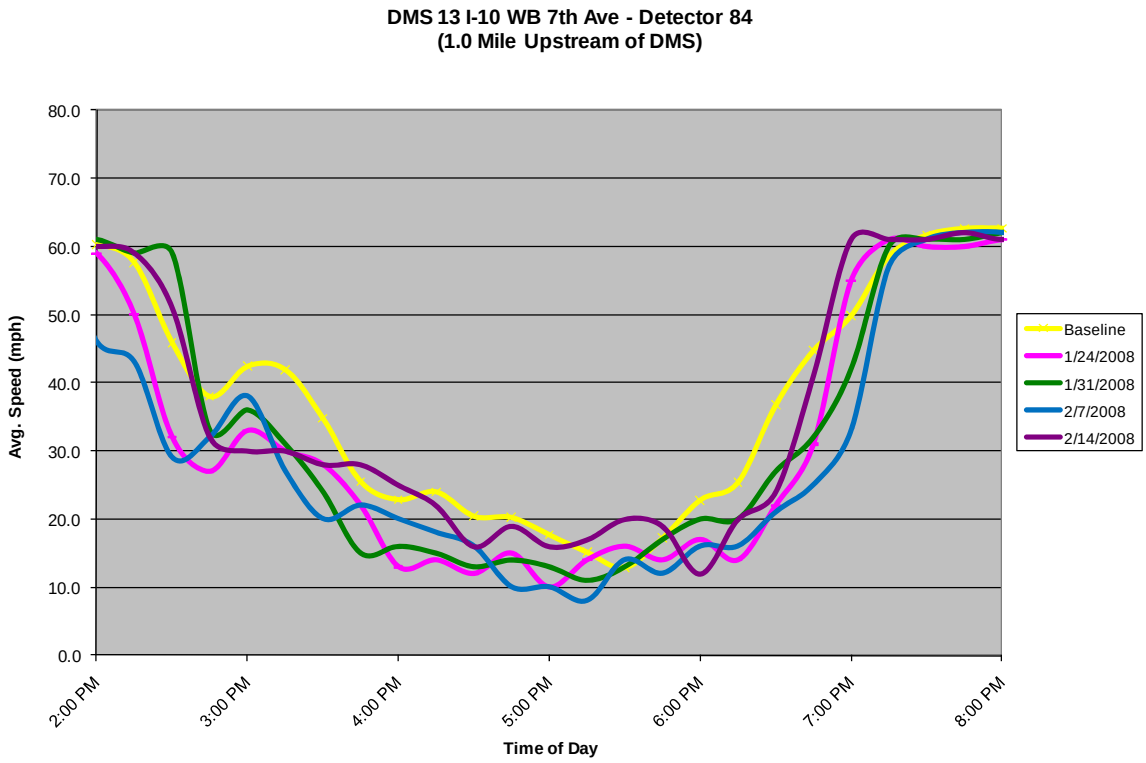


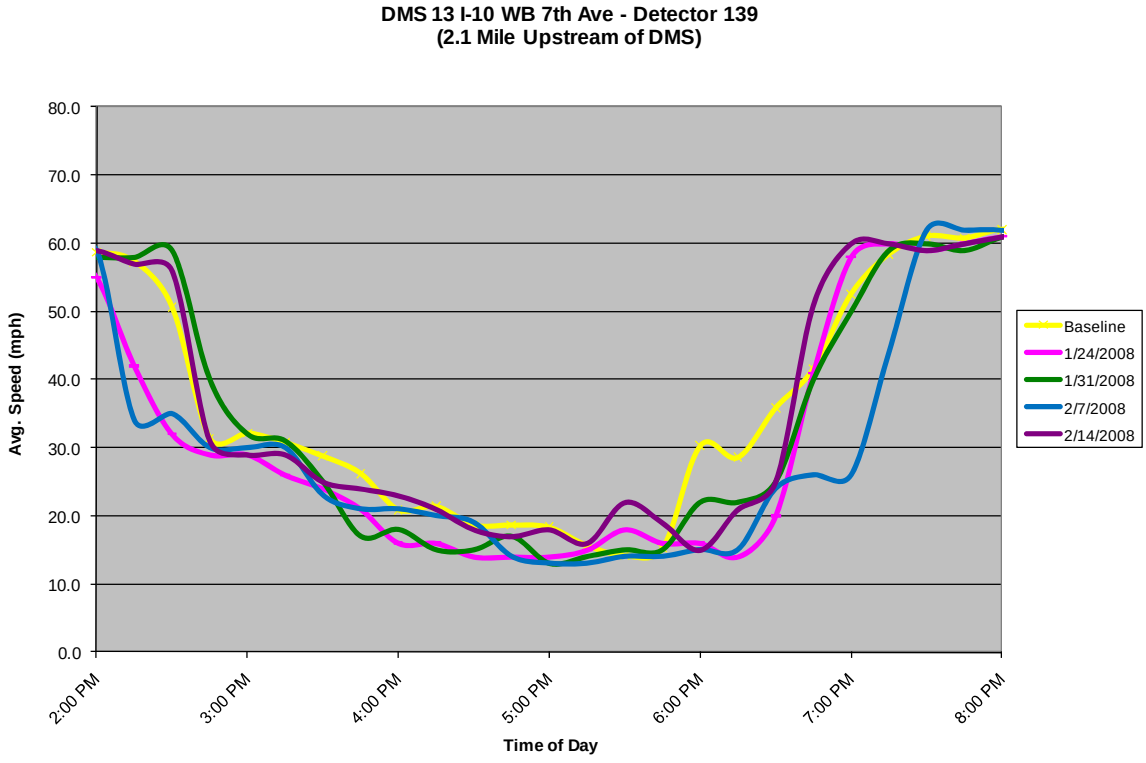




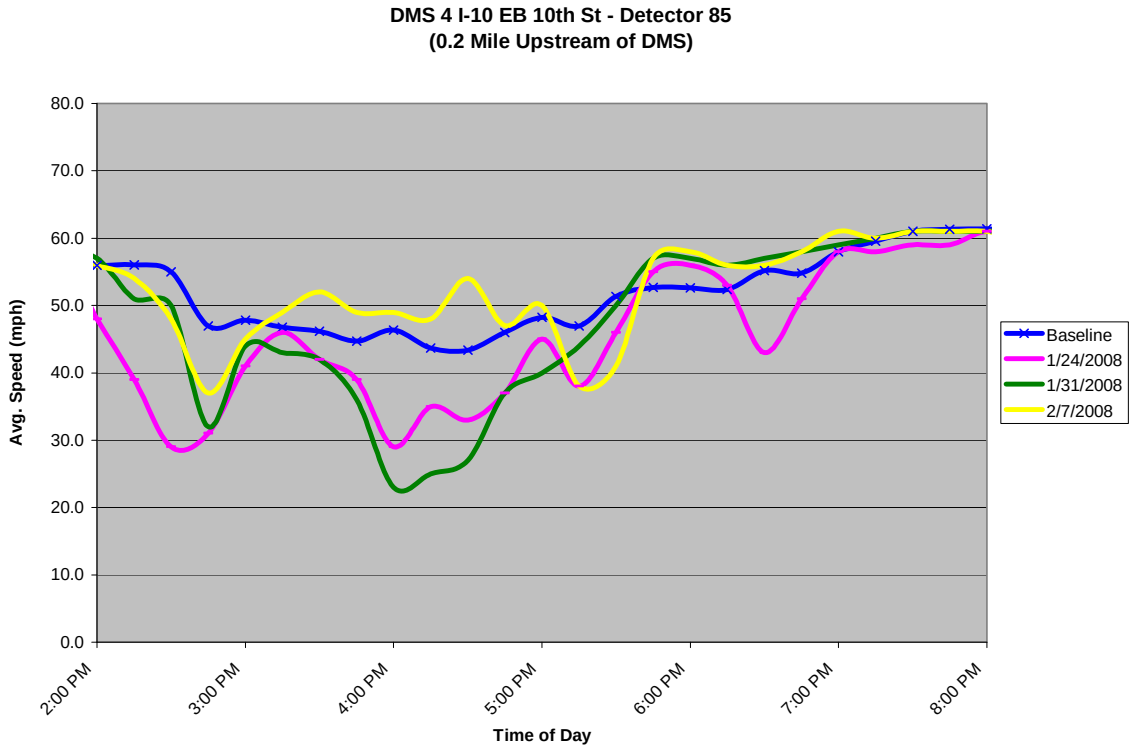
DMS 13 I-10 WB 7th Ave

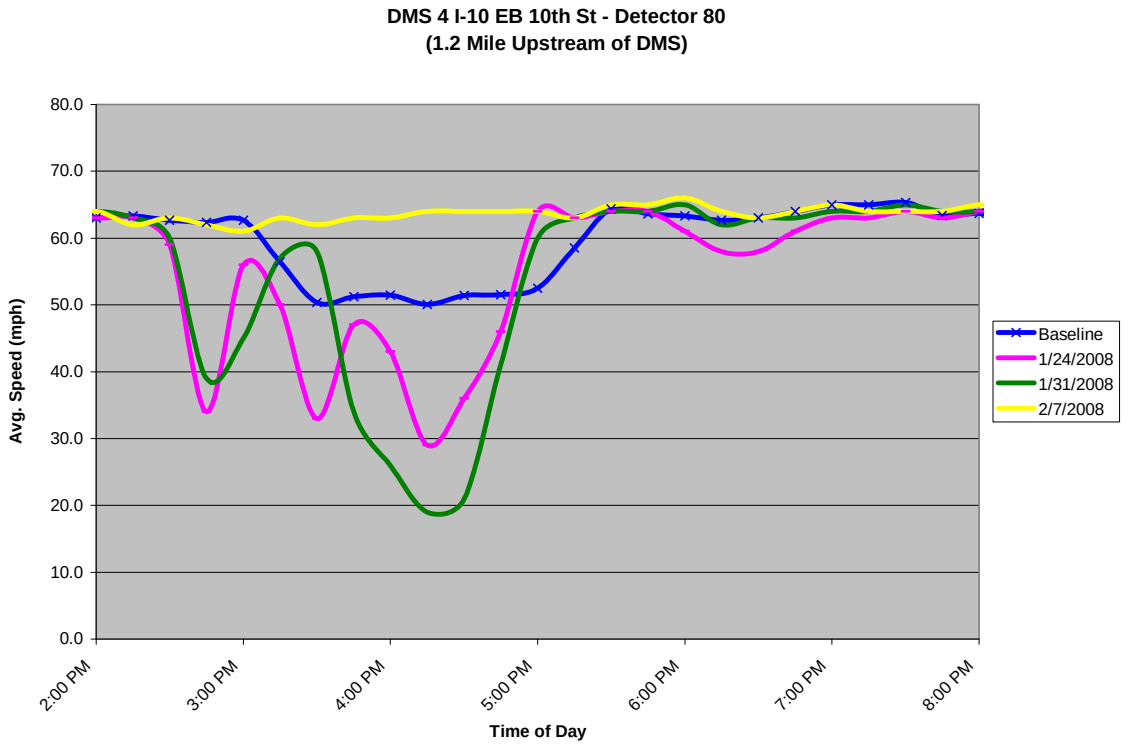
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





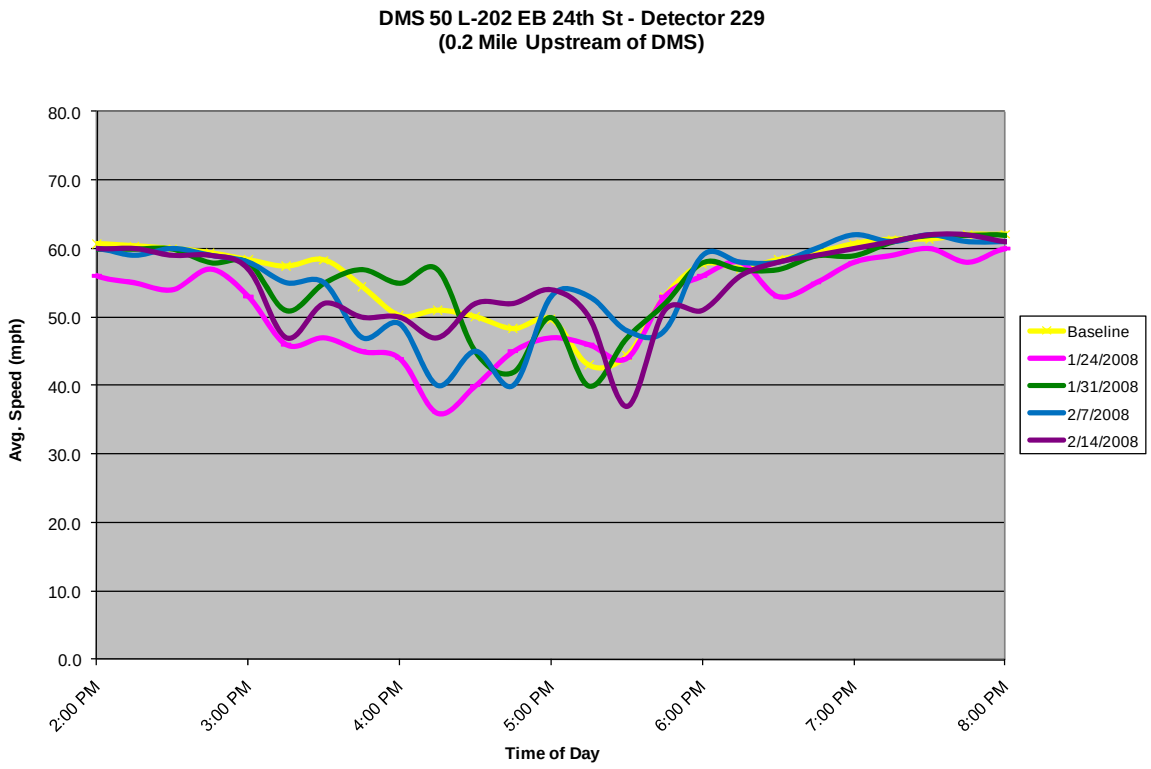
DMS 4 I-10 EB 10th St





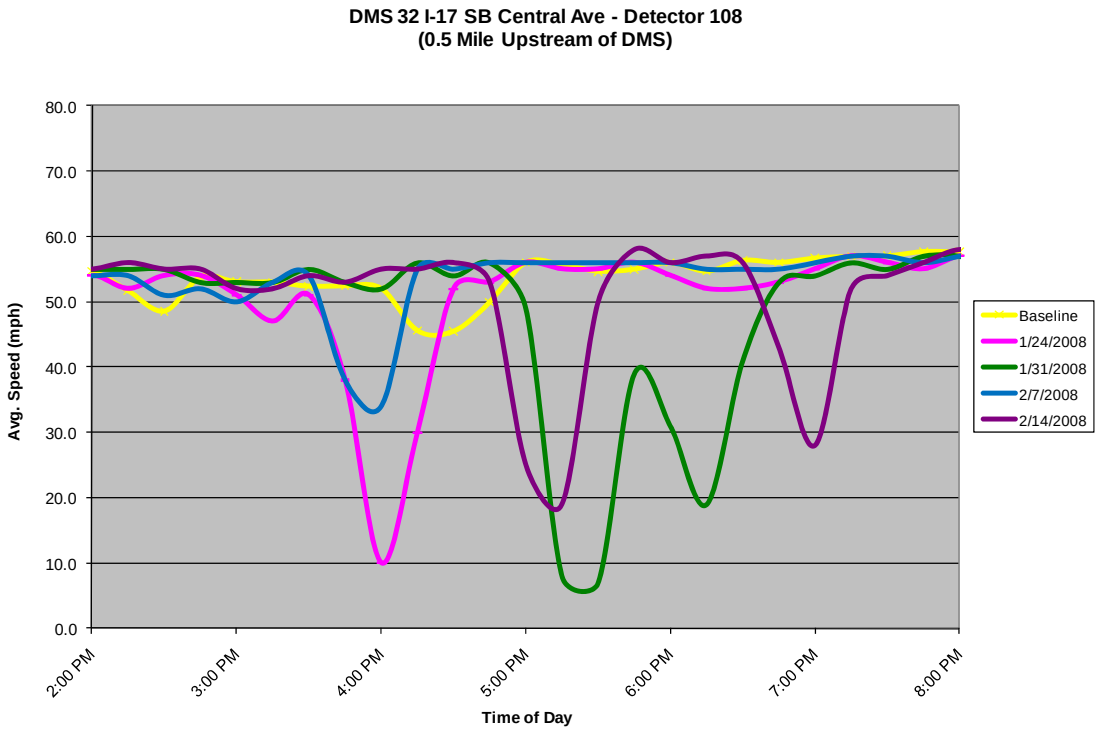
DMS 50 L-202 EB 24th ST

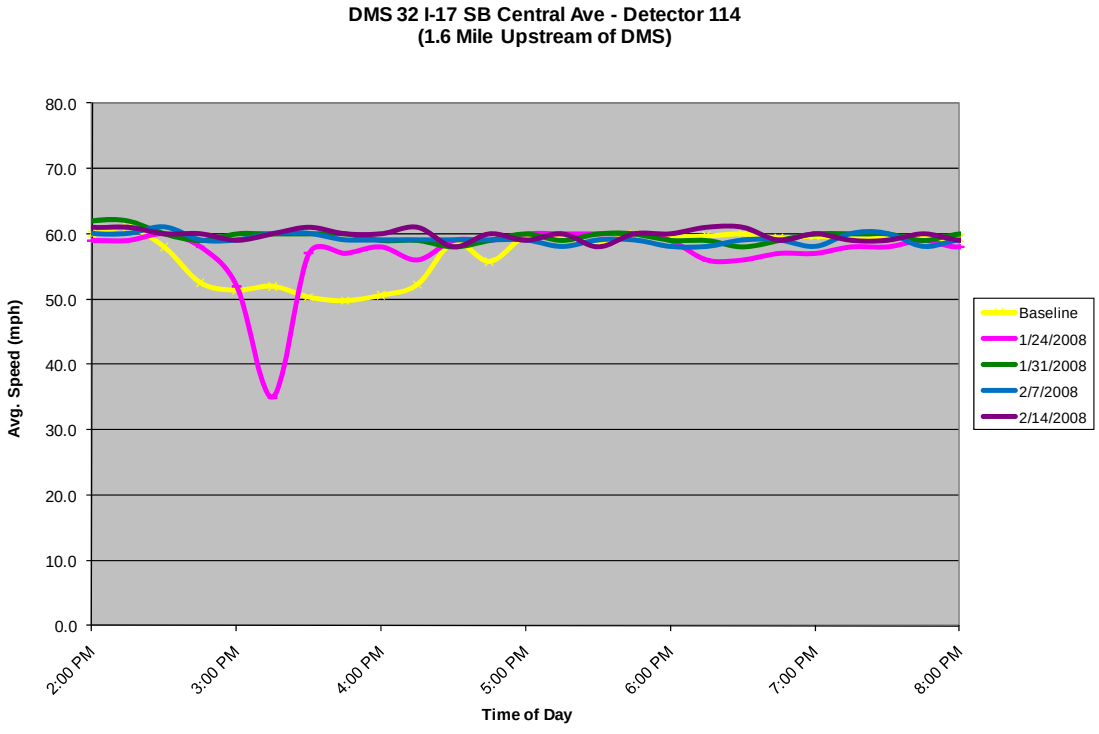
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY





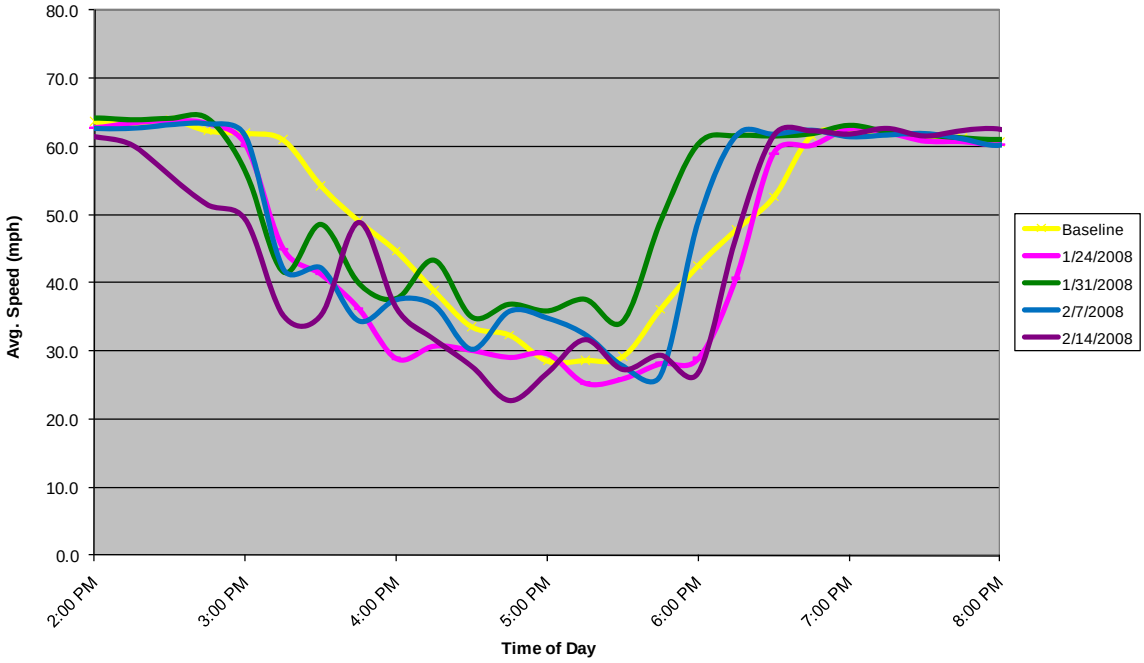
DMS 17 I-17 NB 4th Ave

No Available Data on both Detector 104 and 98

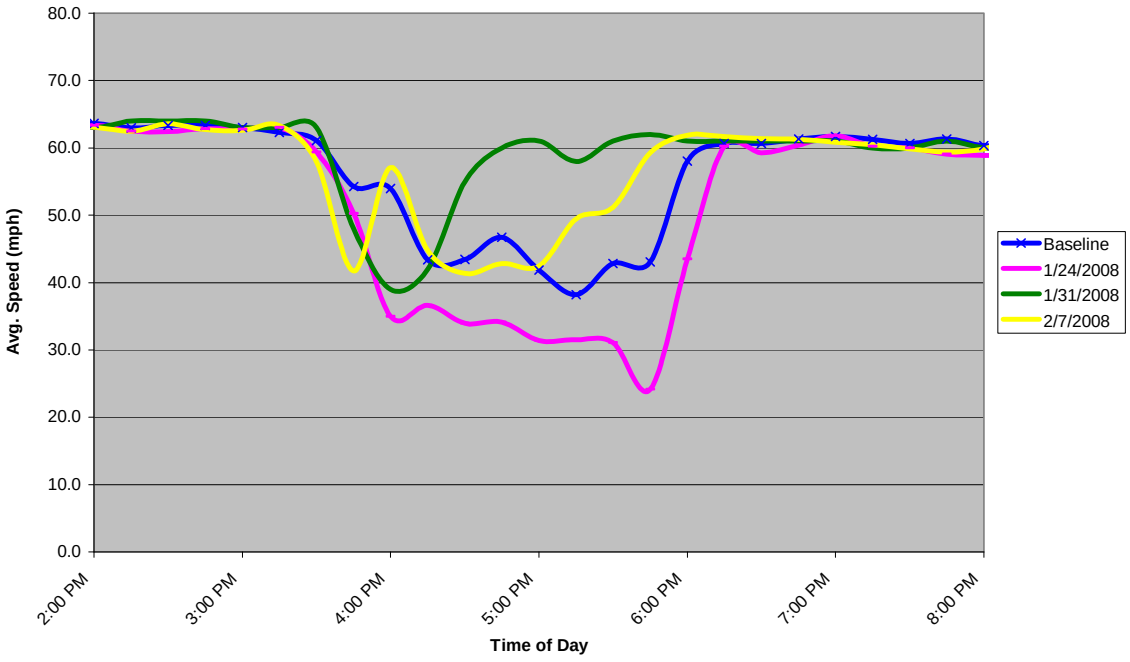
DMS 55 SR-51 NB Osborn Rd

MINUTES TO
BELL RD XX

DMS 55 SR-51 NB Osborn Rd - Detector 206
(0.5 Mile Upstream of DMS)

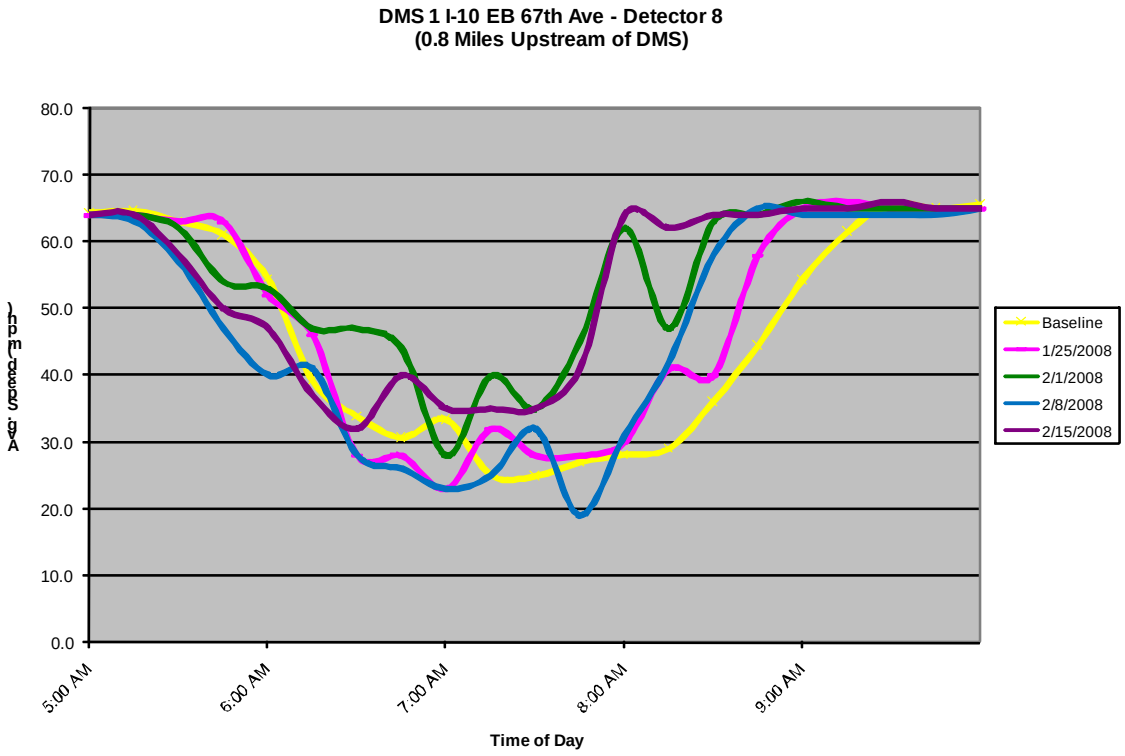


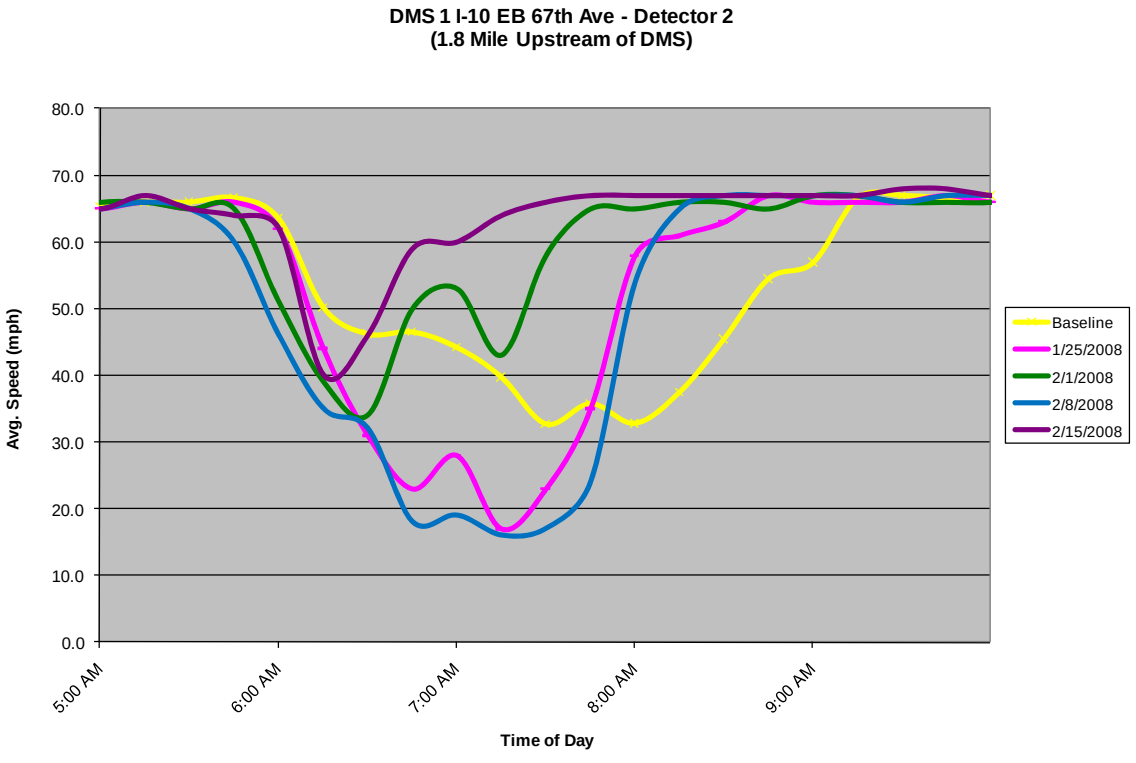
DMS 55 SR-51 NB Osborn Rd - Detector 203
(1.6 Miles Upstream of DMS)



DMS 1 I-10 EB 67th Ave

MINUTES TO
TUNNEL XX
AIRPORT YY

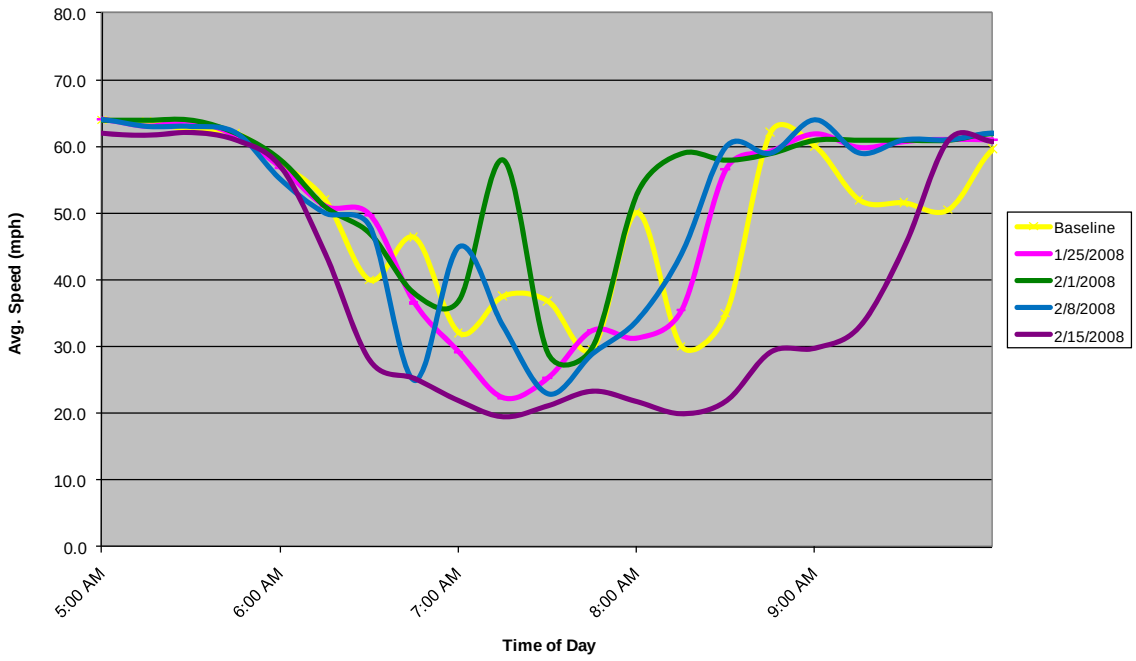




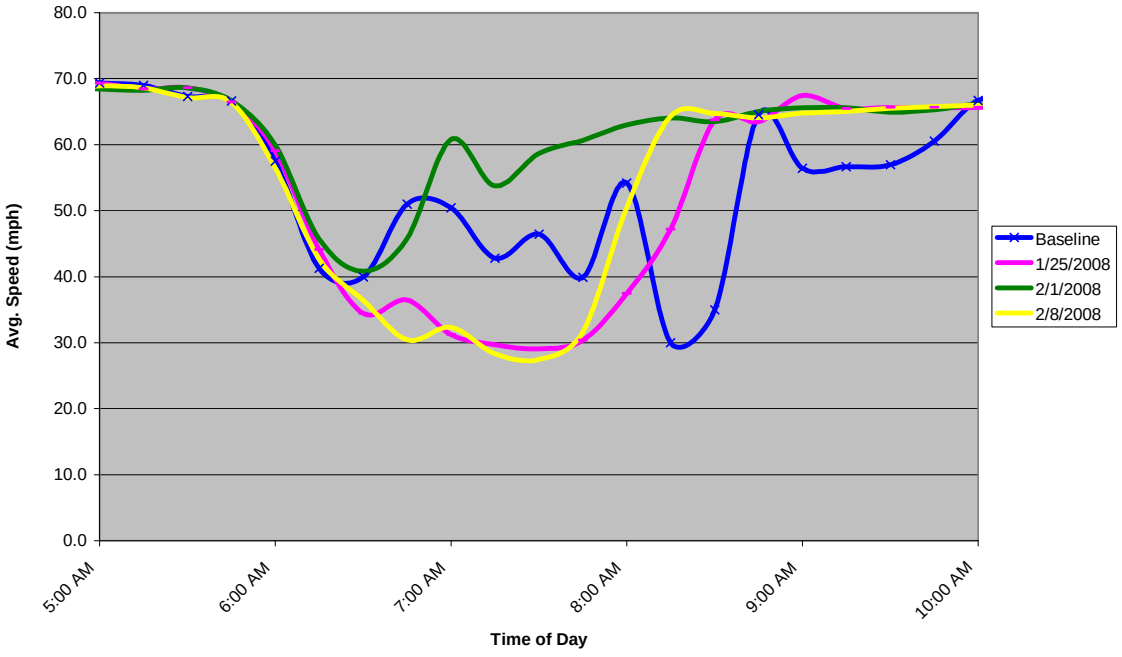
DMS 9 I-10 WB Guadalupe Rd

MINUTES TO
SR-143 XX
TUNNEL YY

DMS 9 I-10 WB Guadalupe Rd - Detector 417
(1.1 Miles Upstream of DMS)

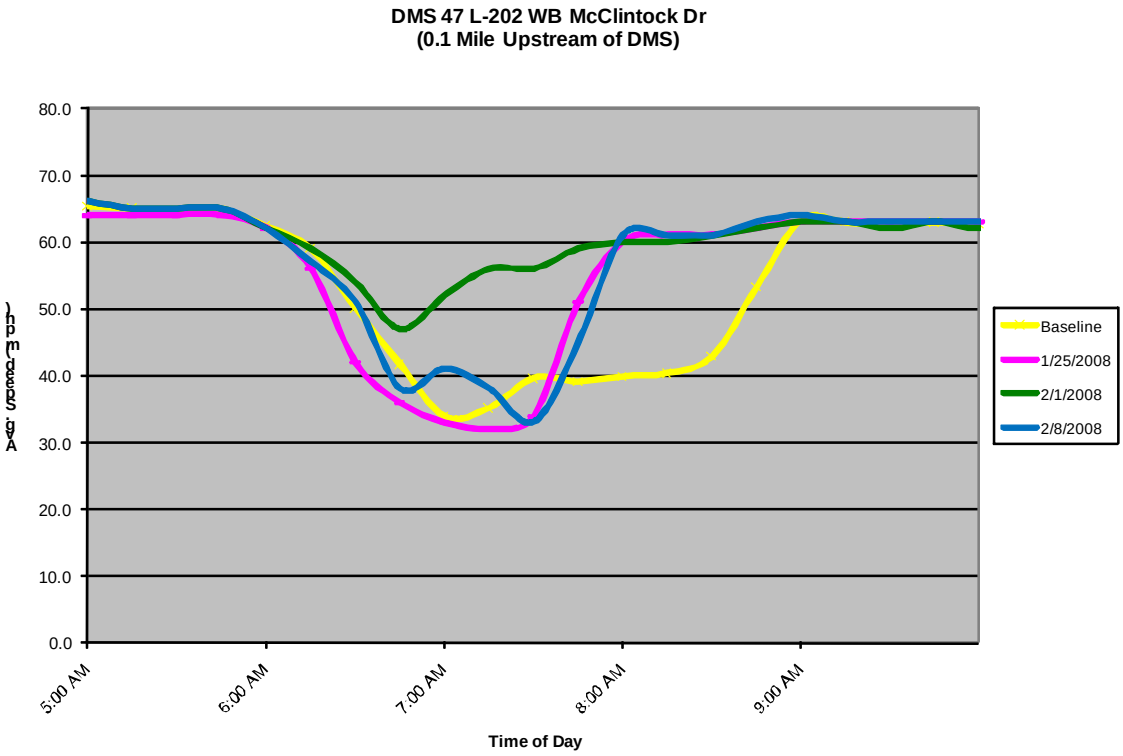


DMS 9 I-10 WB Guadalupe Rd - Detector 414
(2.0 Miles Upstream of DMS)



DMS 47 L-202 WB McClintock Dr

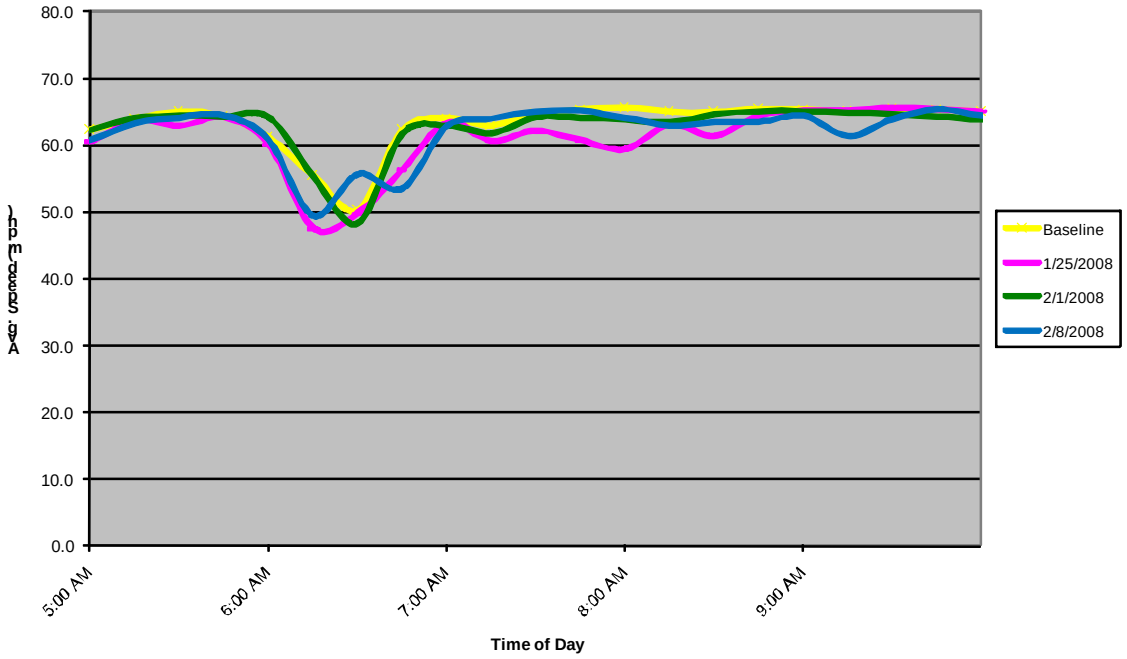
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



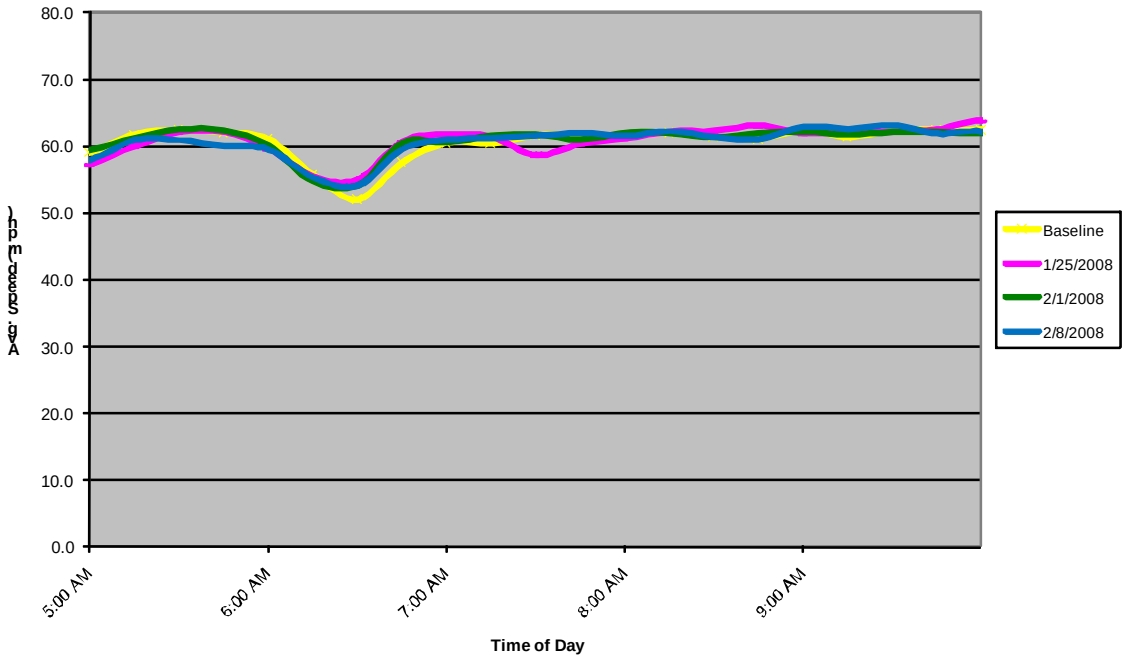
DMS 42 US-60 WB Extension Rd

MINUTES TO TUNNEL
VIA I-10 XX
VIA LOOP 101 YY

DMS 42 US-60 WB Extension Rd - Detector 482
(0.5 Miles Upstream of DMS)

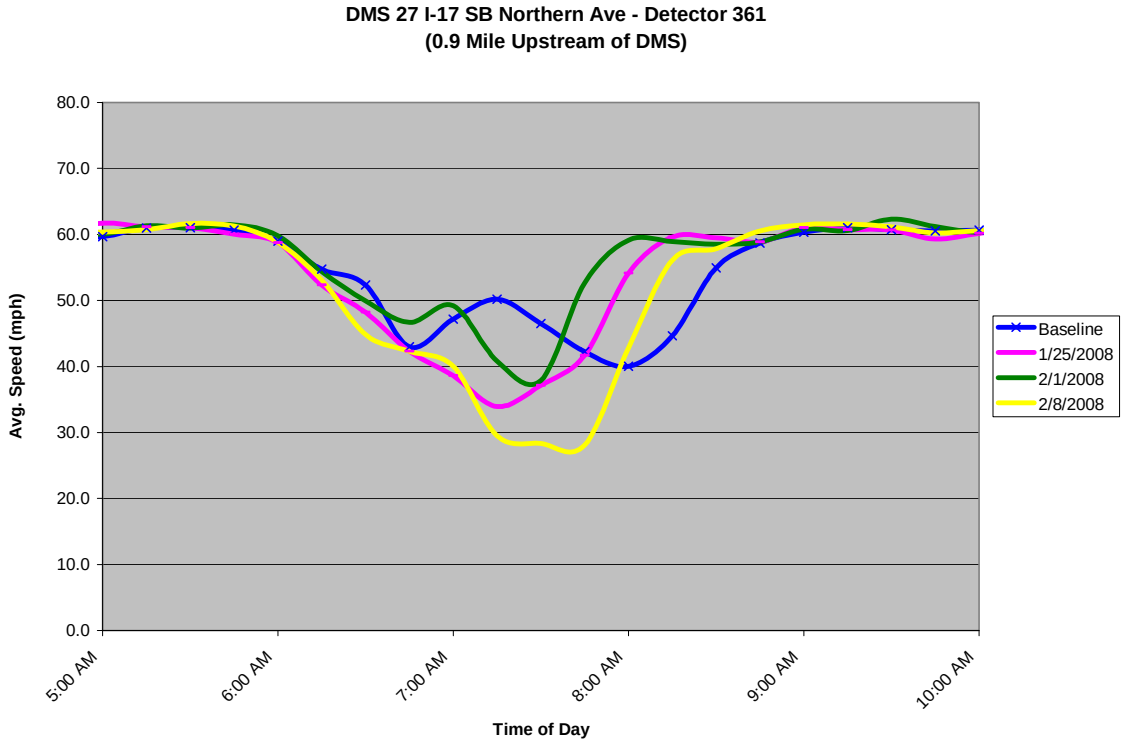


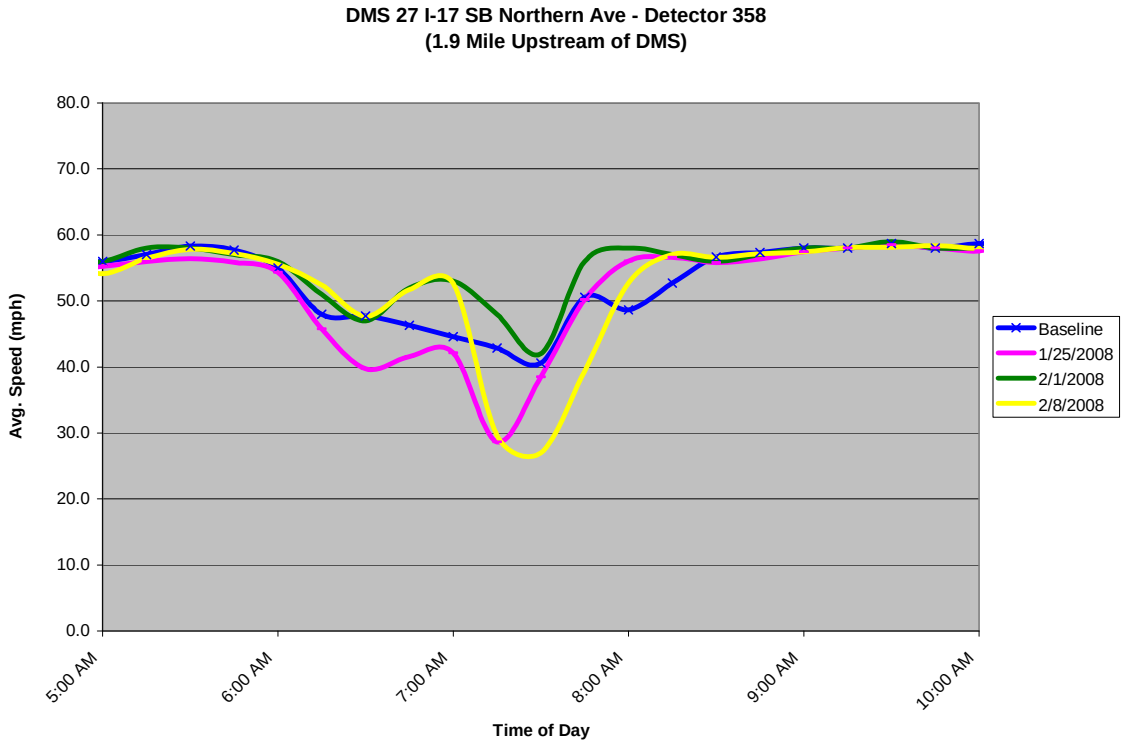
DMS 42 US-60 WB Extension Rd - Detector 479
(1.5 Miles Upstream of DMS)



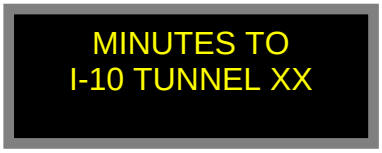
DMS 27 I-17 SB Northern Ave

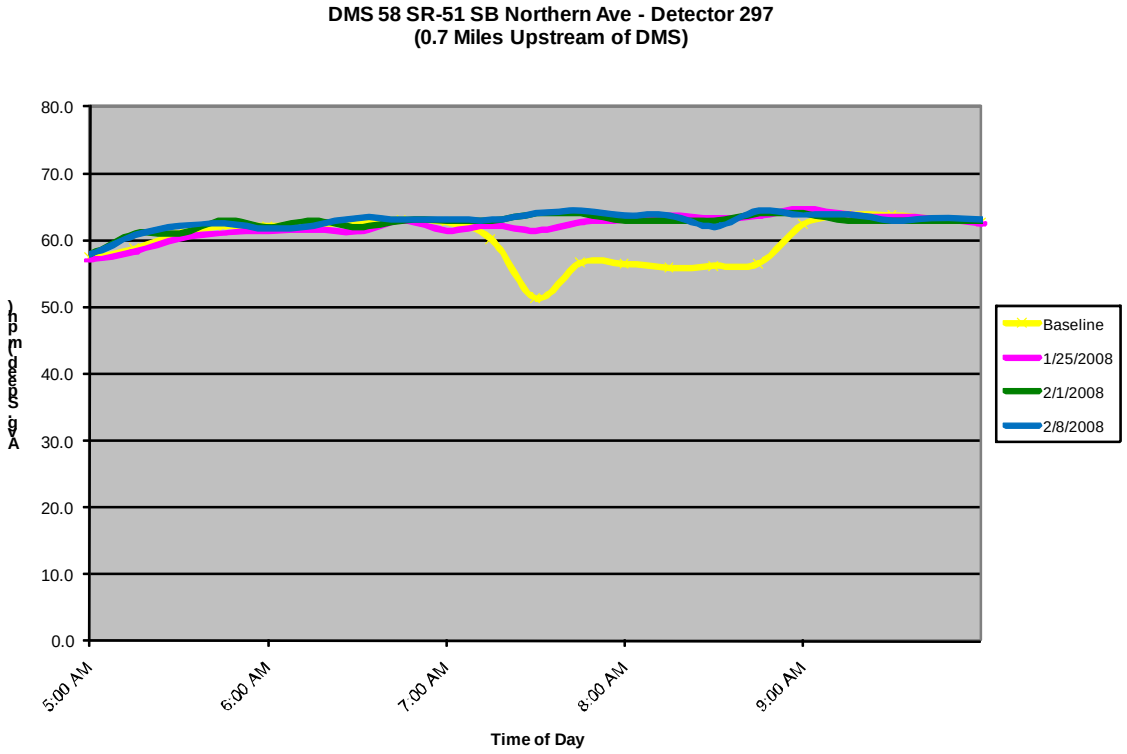
MINUTES TO
I-10 TUNNEL XX

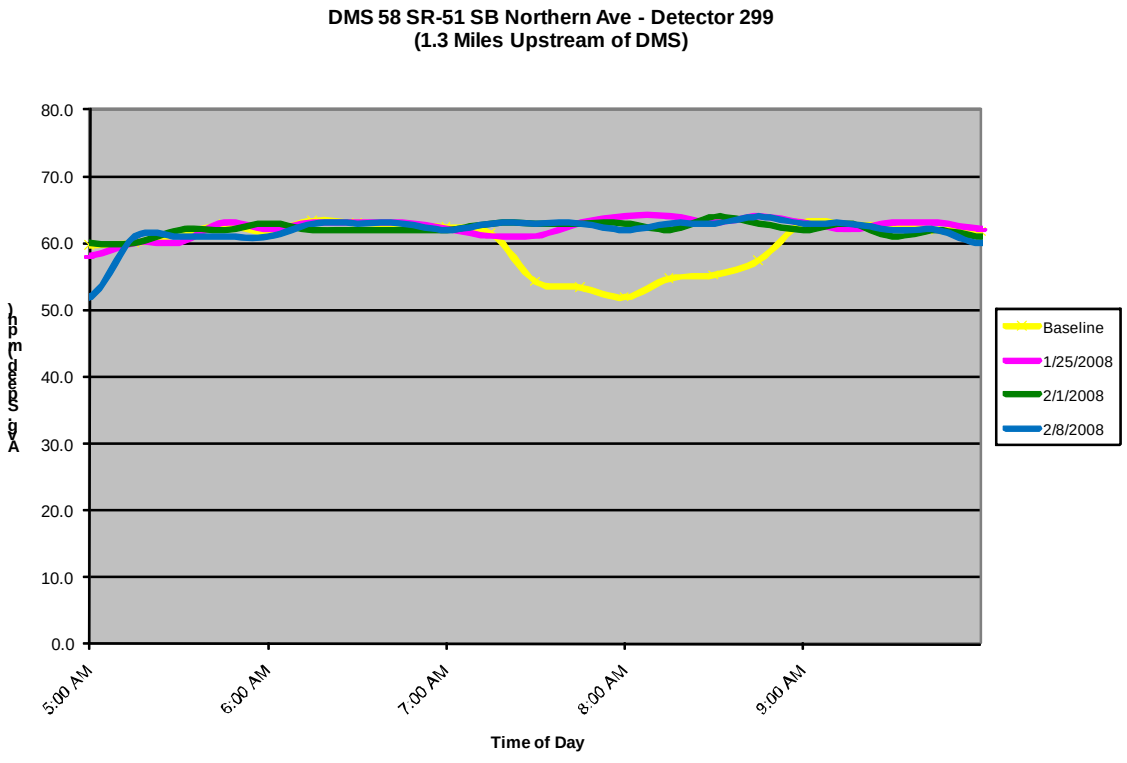




DMS 58 SR-51 SB Northern Ave

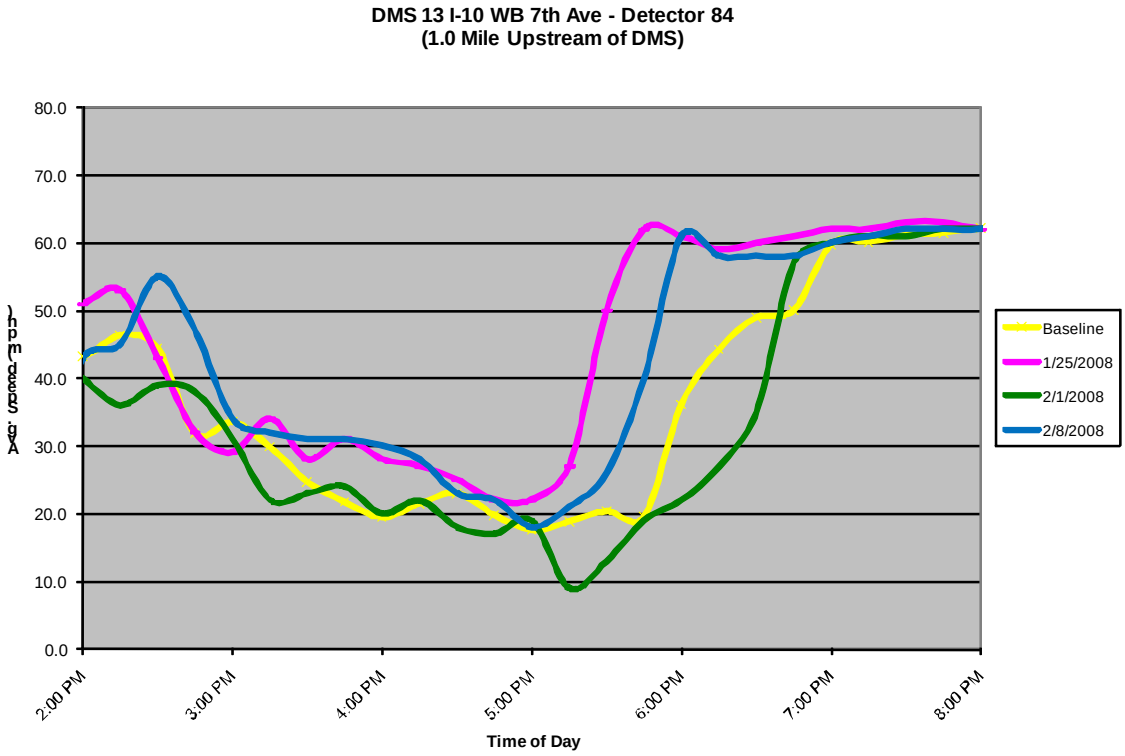


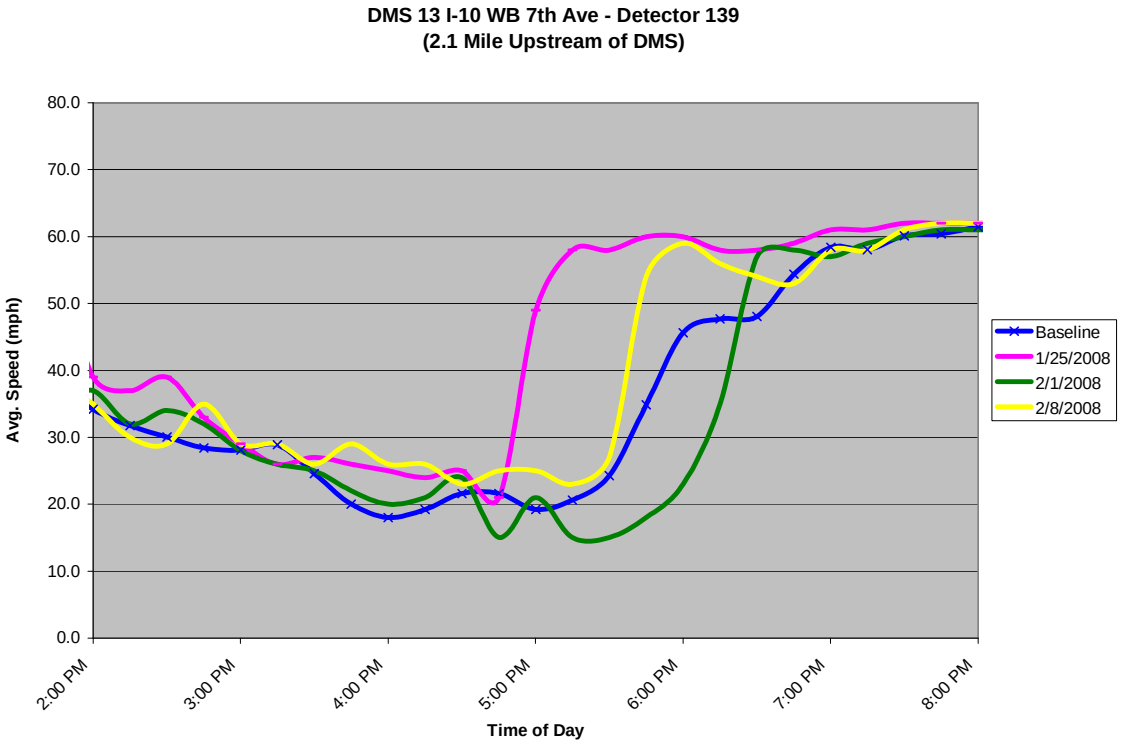




DMS 13 I-10 WB 7th Ave

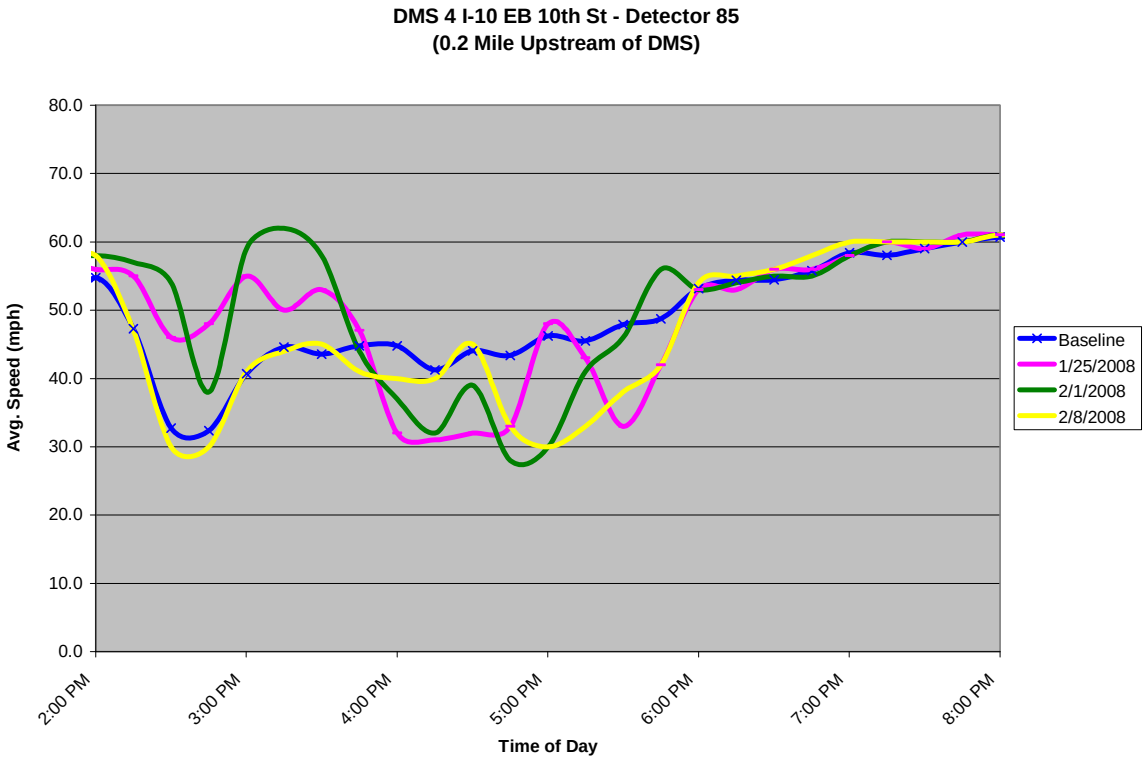
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY

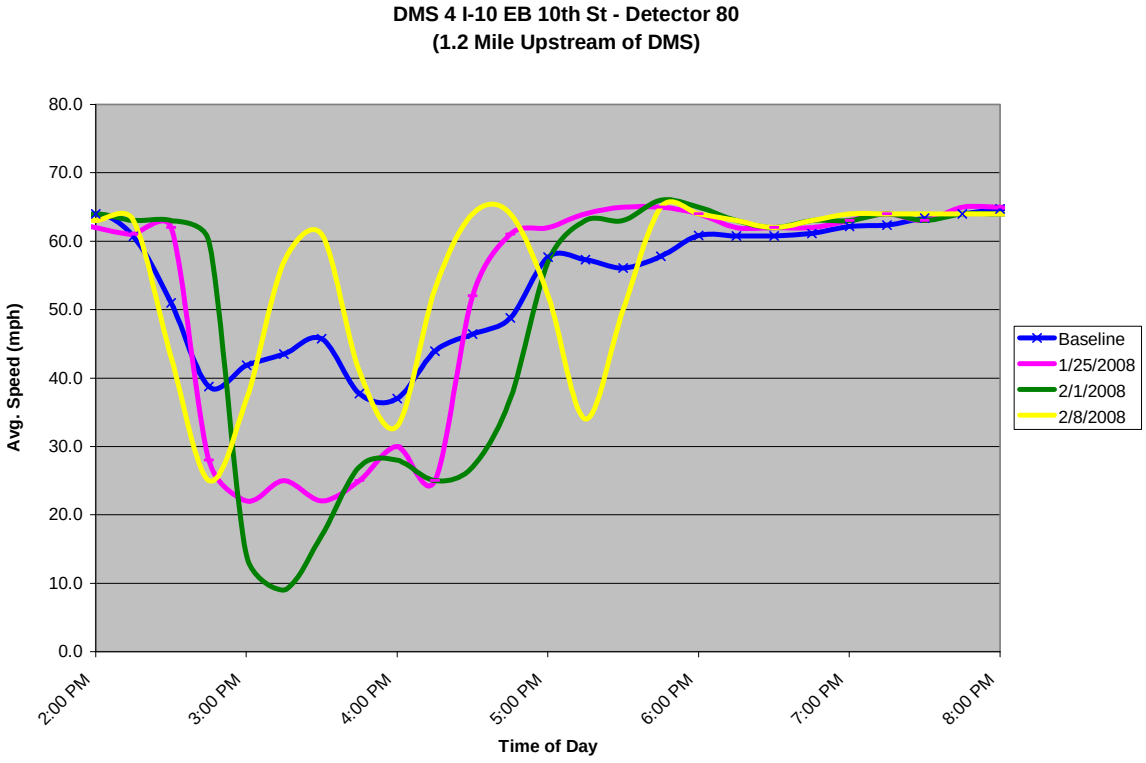




FRIDAY - JANUARY 2008

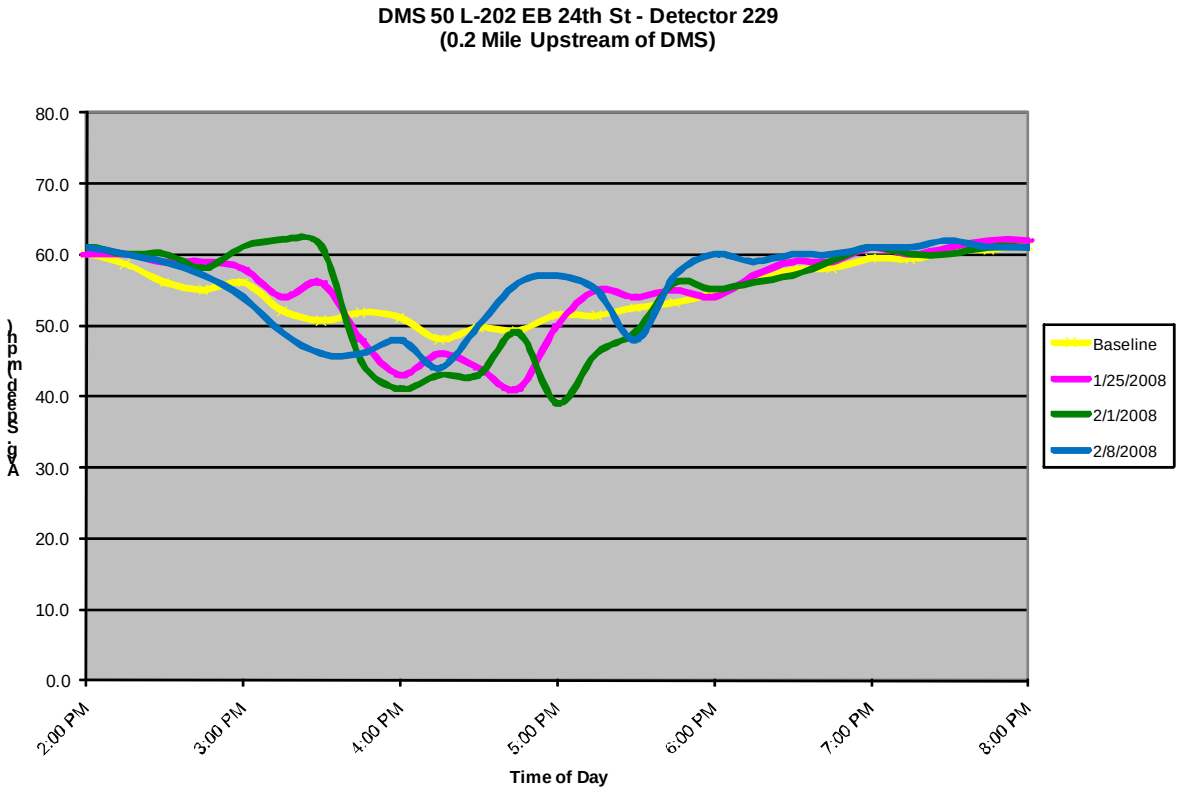
DMS 4 I-10 EB 10th St





DMS 50 L-202 EB 24th ST

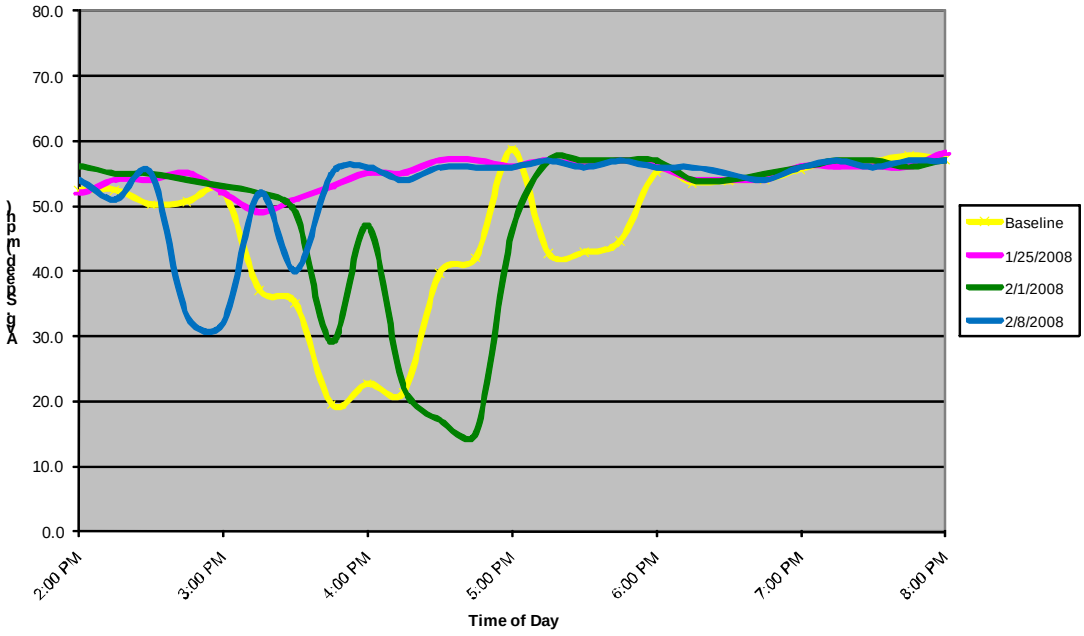
MINUTES TO
LOOP 101 XX



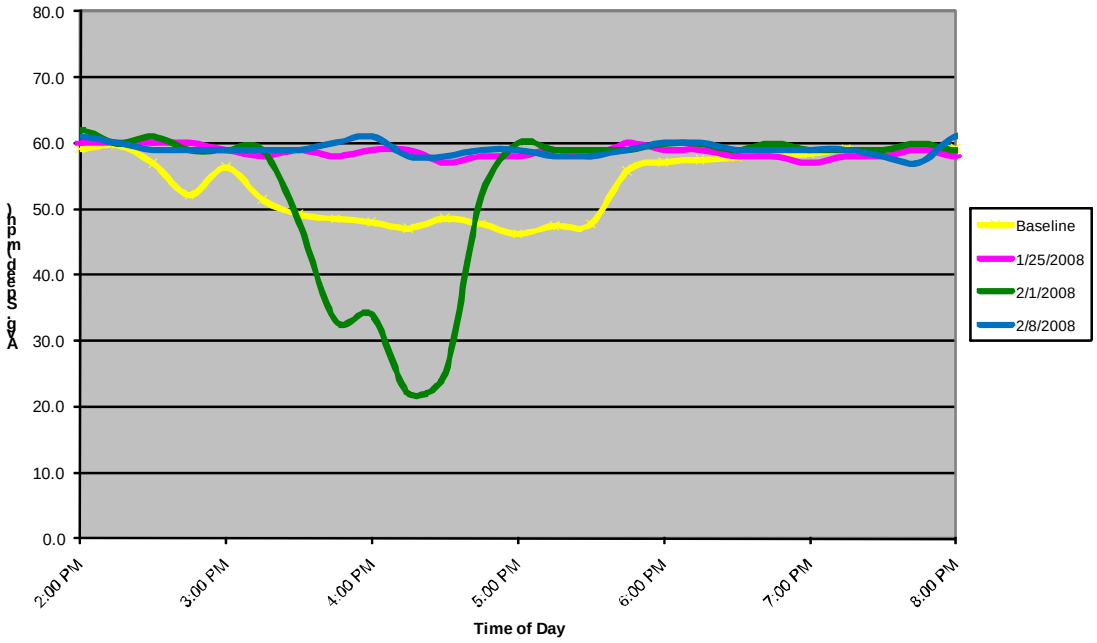
DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

DMS 32 I-17 SB Central Ave - Detector 108
(0.5 Mile Upstream of DMS)



DMS 32 I-17 SB Central Ave - Detector 114
(1.6 Mile Upstream of DMS)

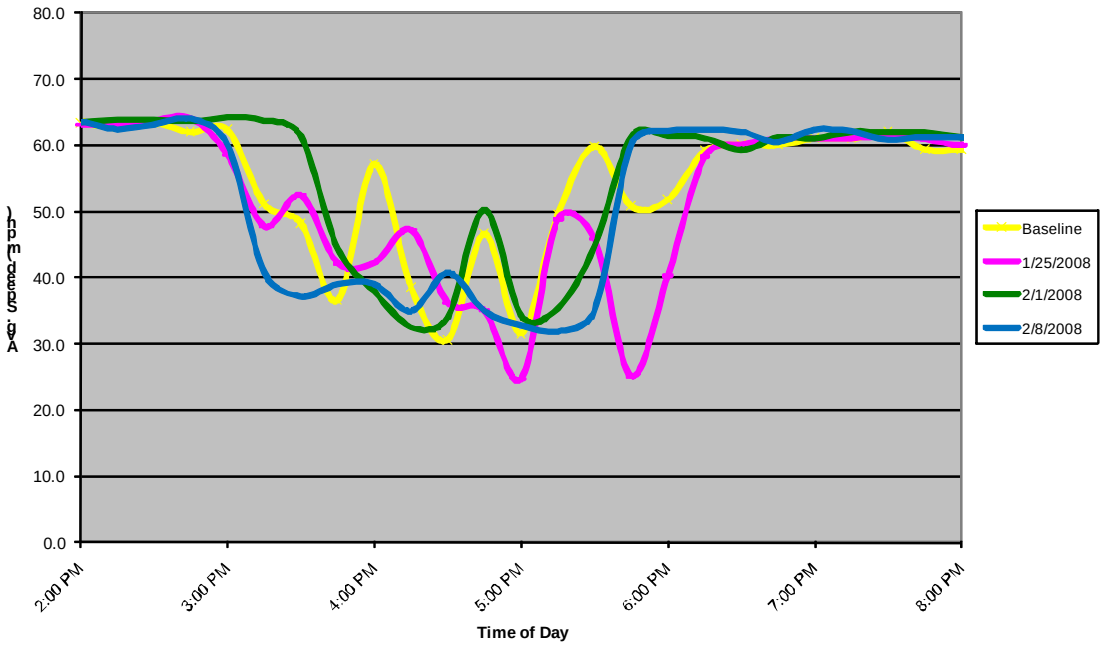


DMS 17 I-17 NB 4th Ave 
No Available Data on both Detector 104 and 98

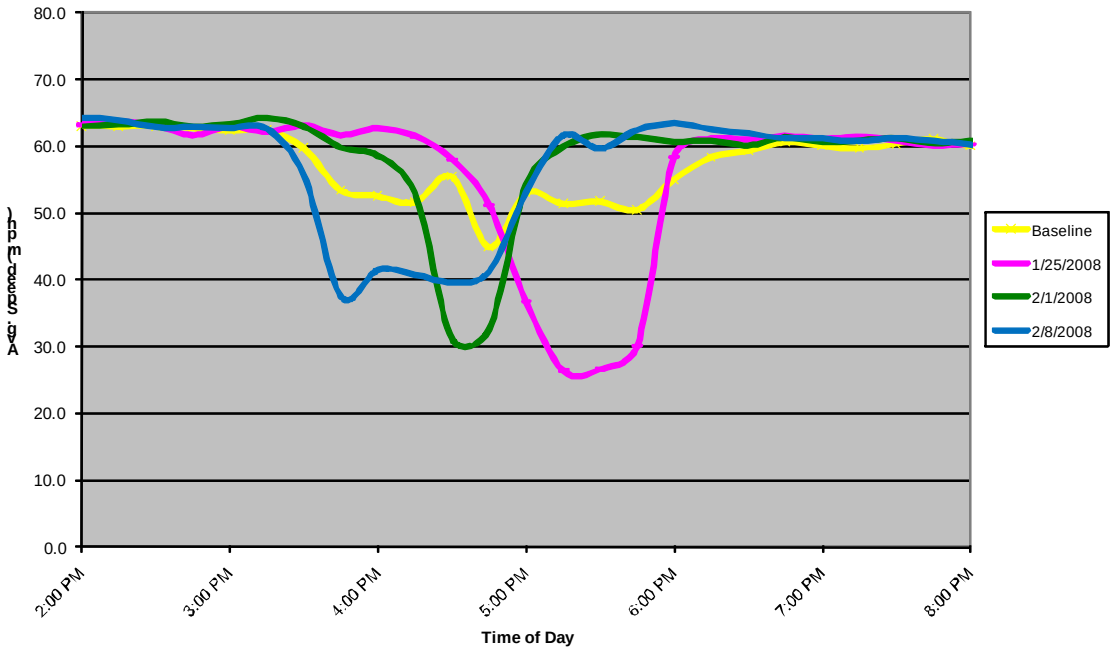
DMS 55 SR-51 NB Osborn Rd

MINUTES TO
BELL RD XX

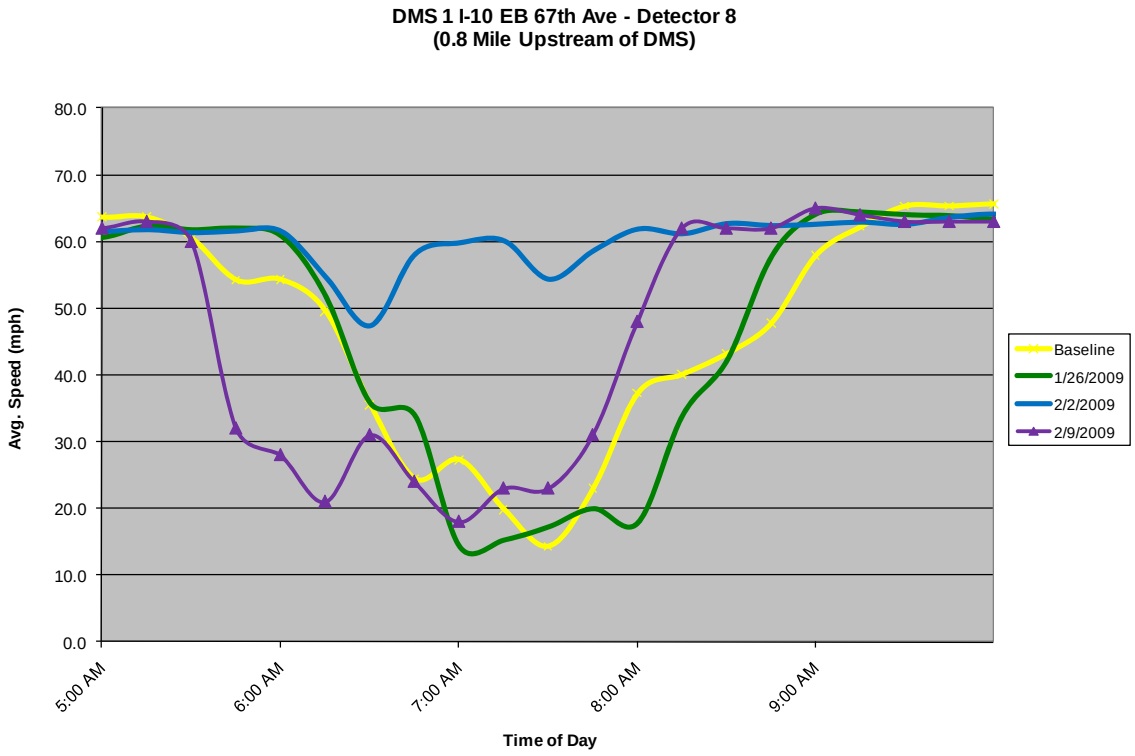
DMS 55 SR-51 NB Osborn Rd - Detector 206
(0.5 Mile Upstream of DMS)

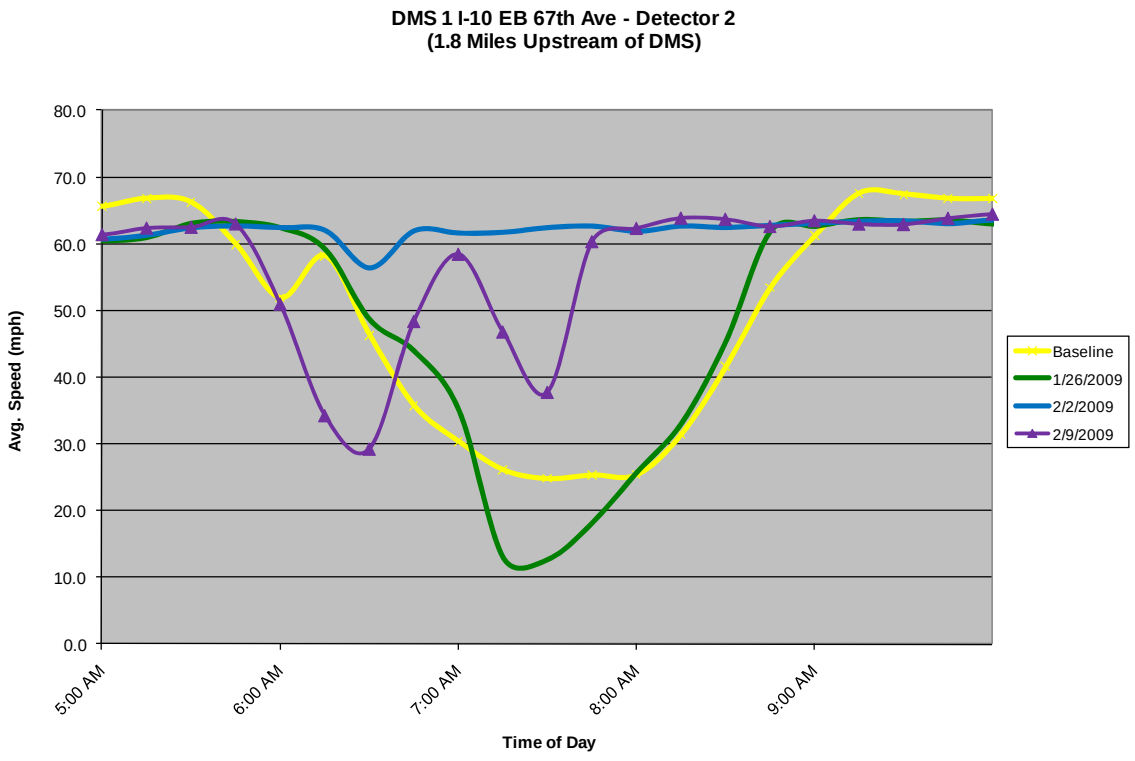


DMS 55 SR-51 NB Osborn Rd - Detector 203
(1.6 Miles Upstream of DMS)



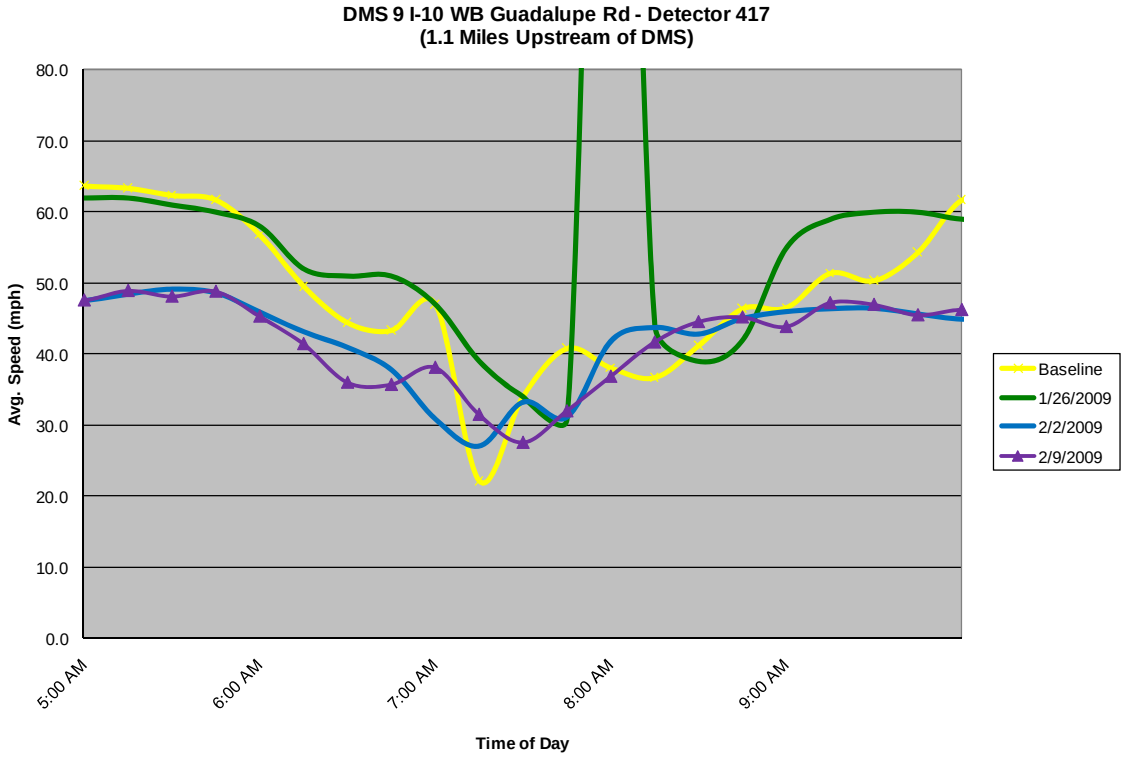
DMS 1 I-10 EB 67th Ave

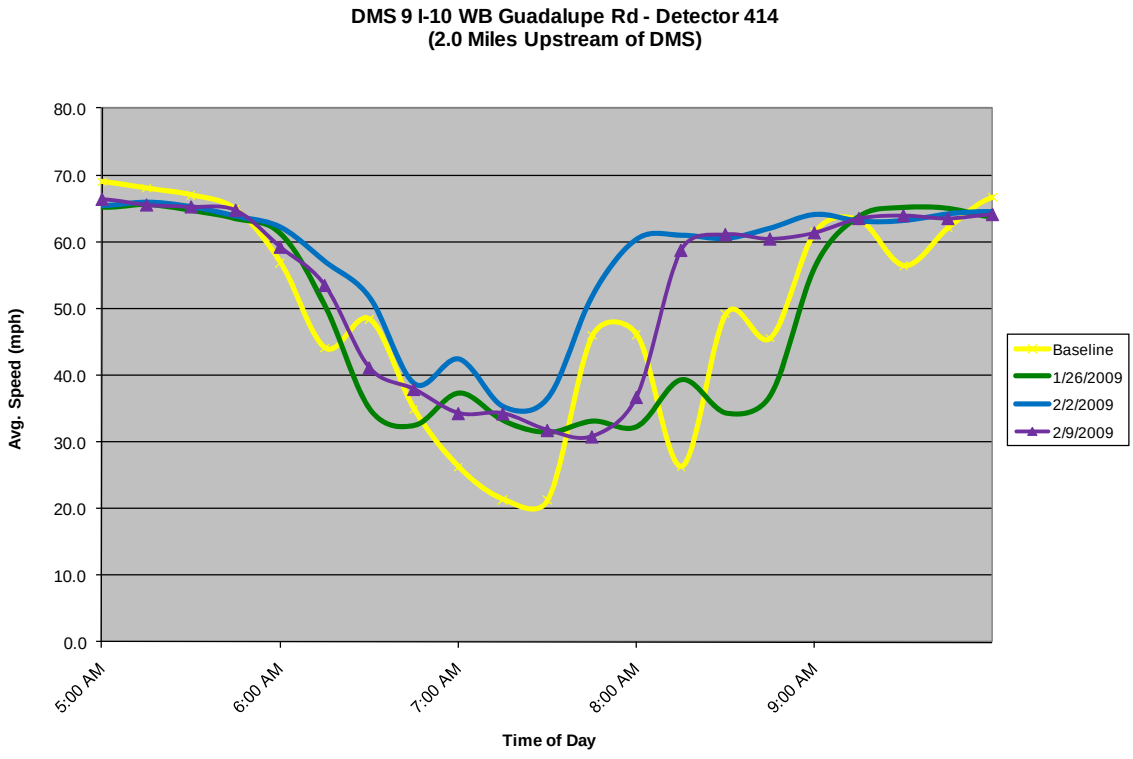




DMS 9 I-10 WB Guadalupe Rd

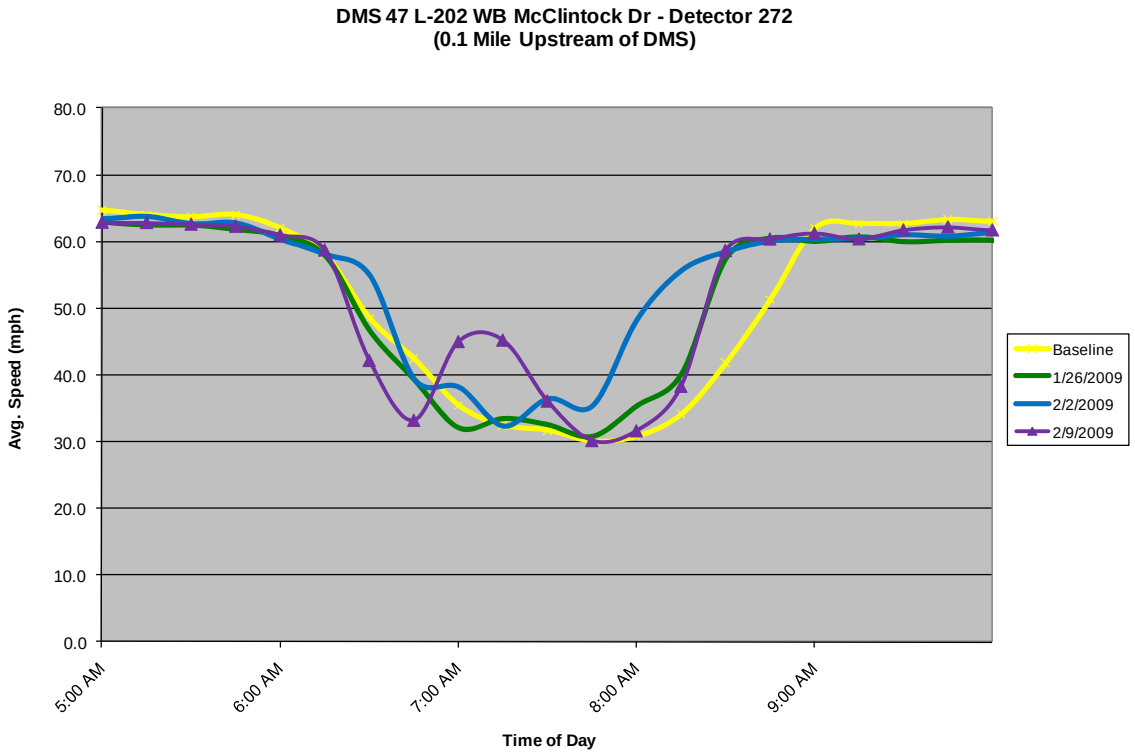
MINUTES TO
SR-143 XX
TUNNEL YY



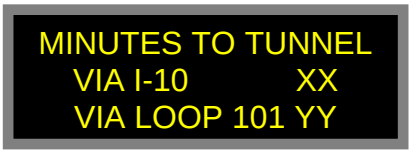


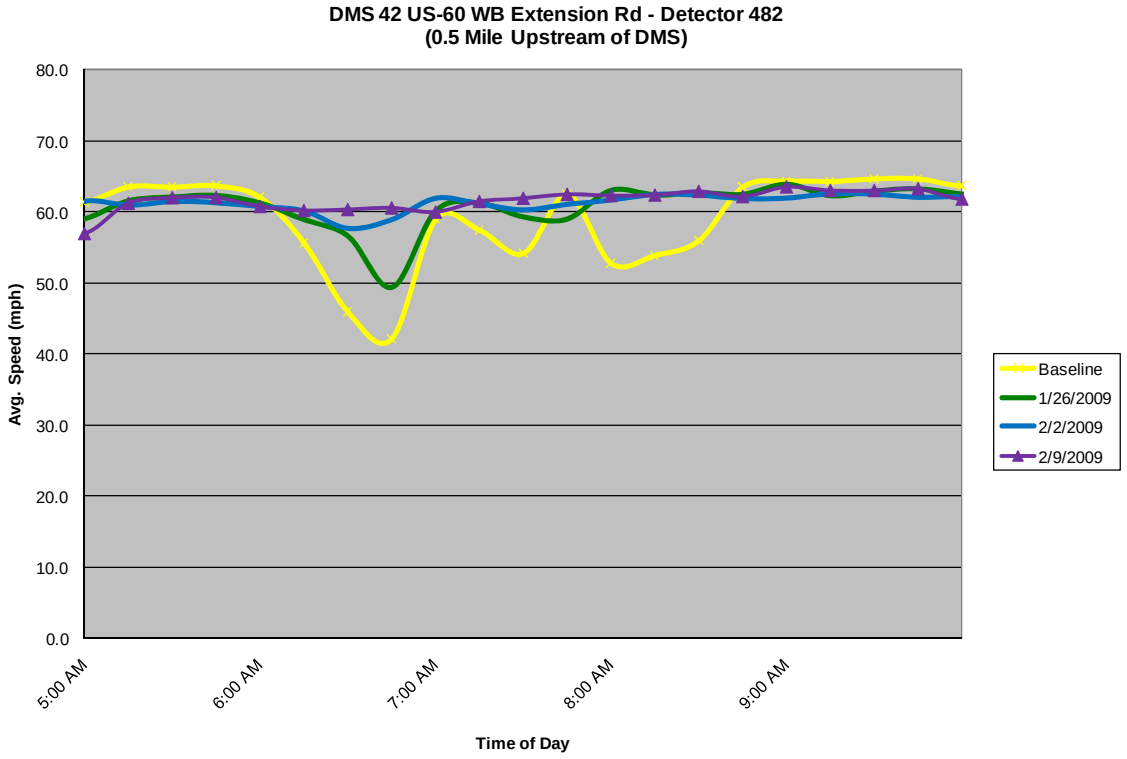
DMS 47 L-202 WB McClintock Dr

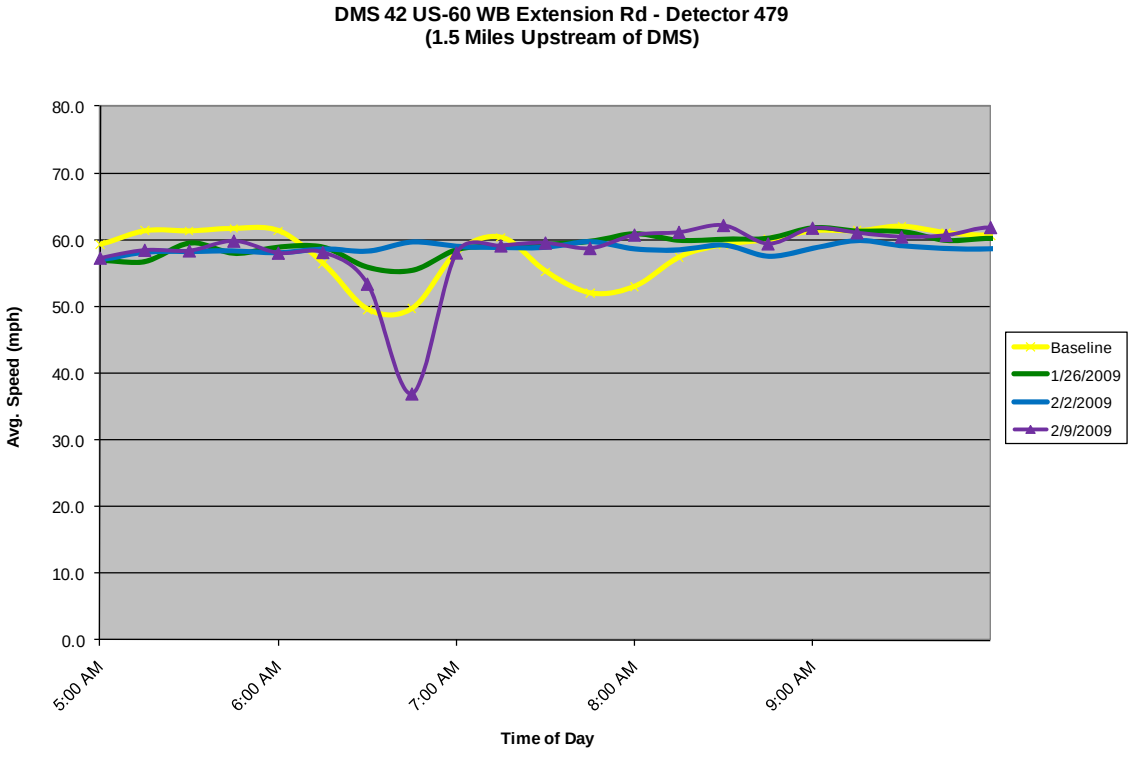
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

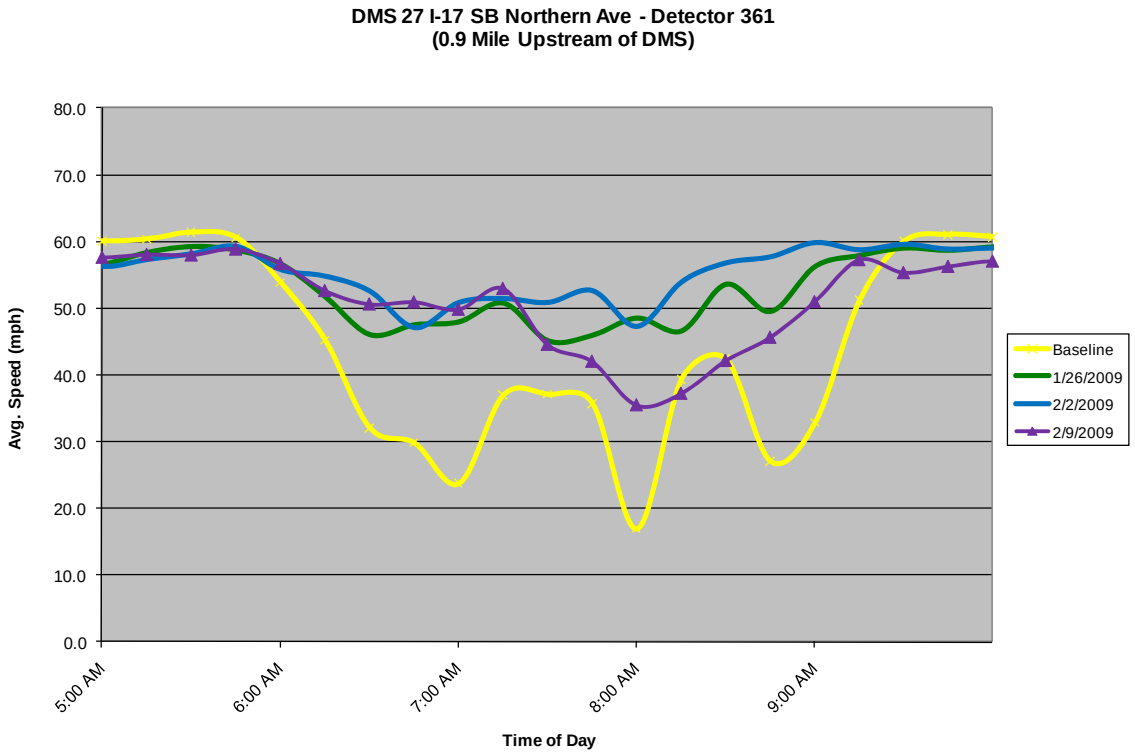


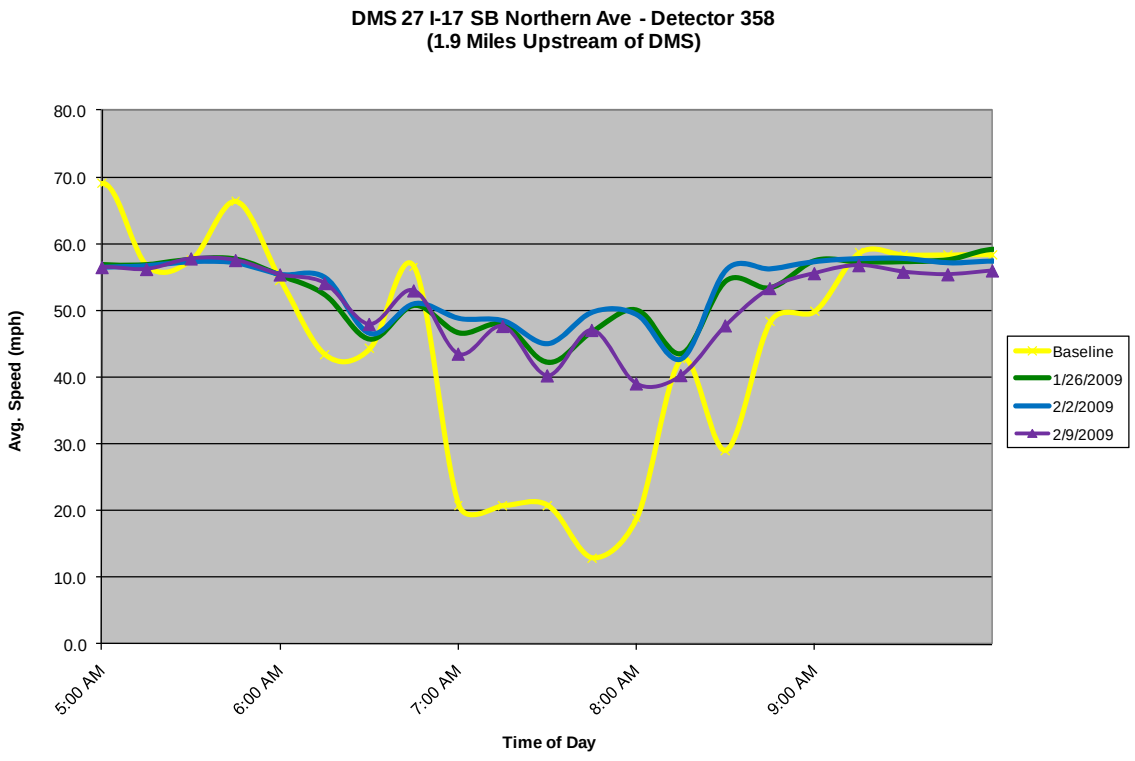




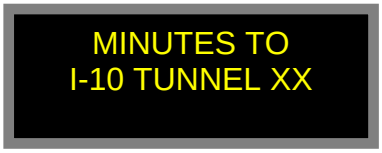
DMS 27 I-17 SB Northern Ave

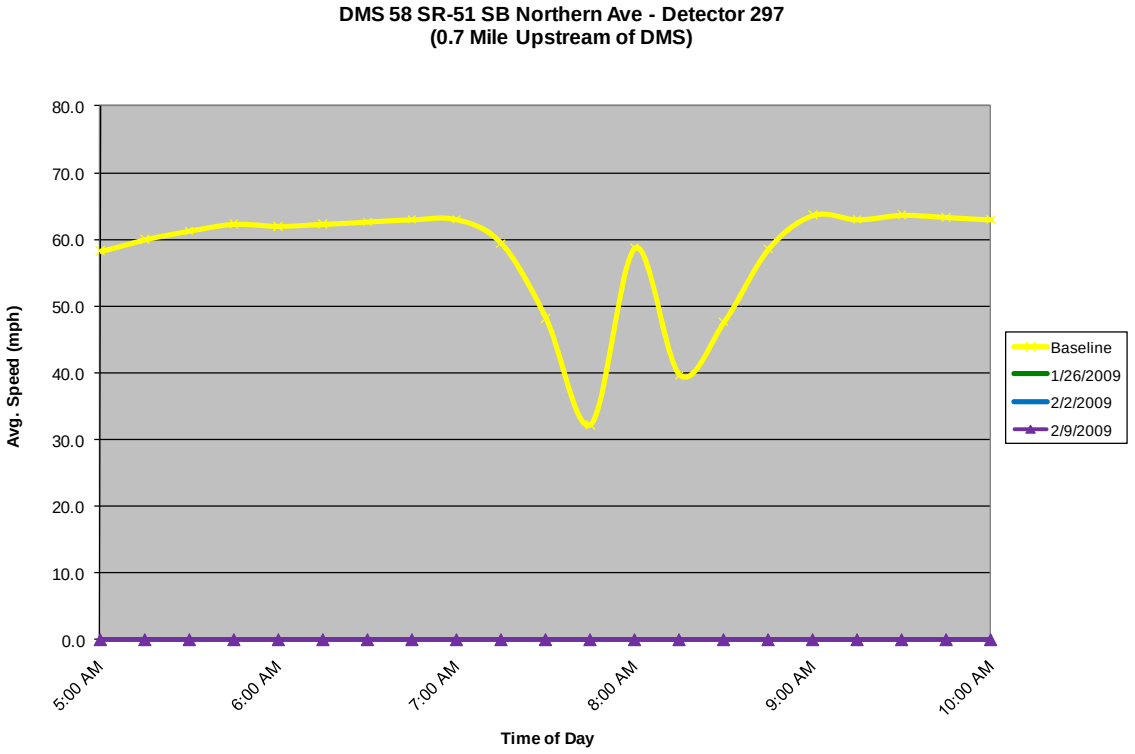
MINUTES TO
I-10 TUNNEL XX

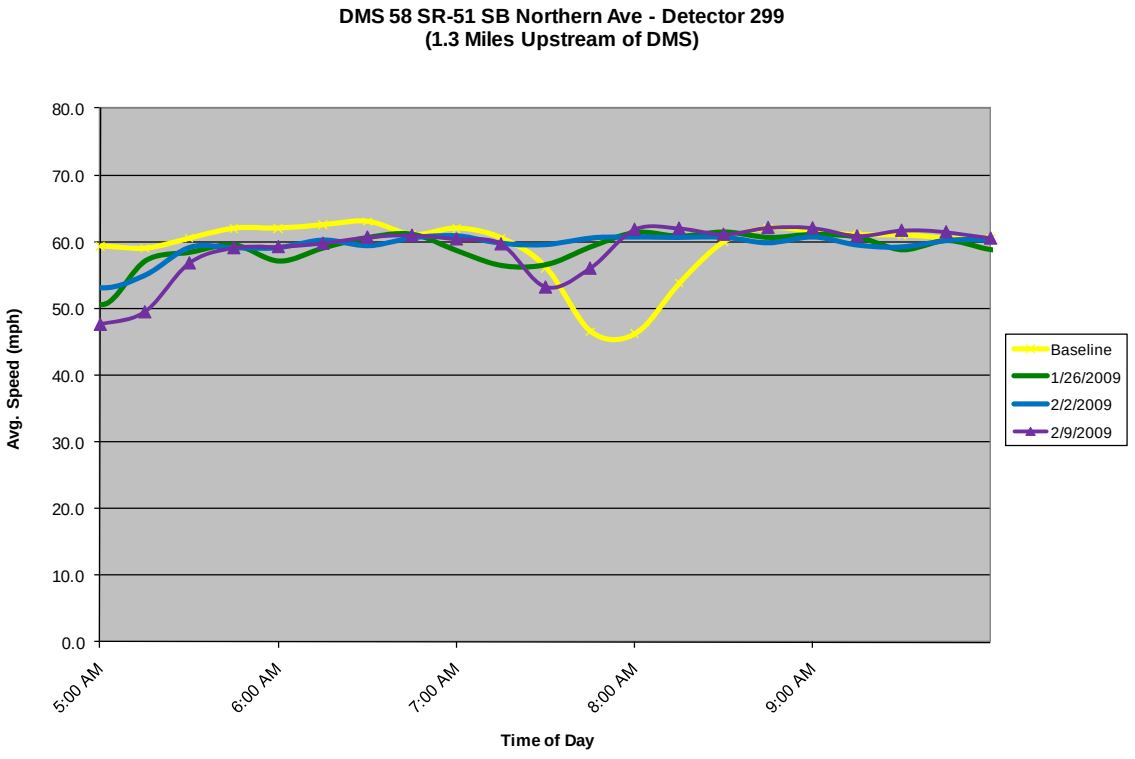




DMS 58 SR-51 SB Northern Ave

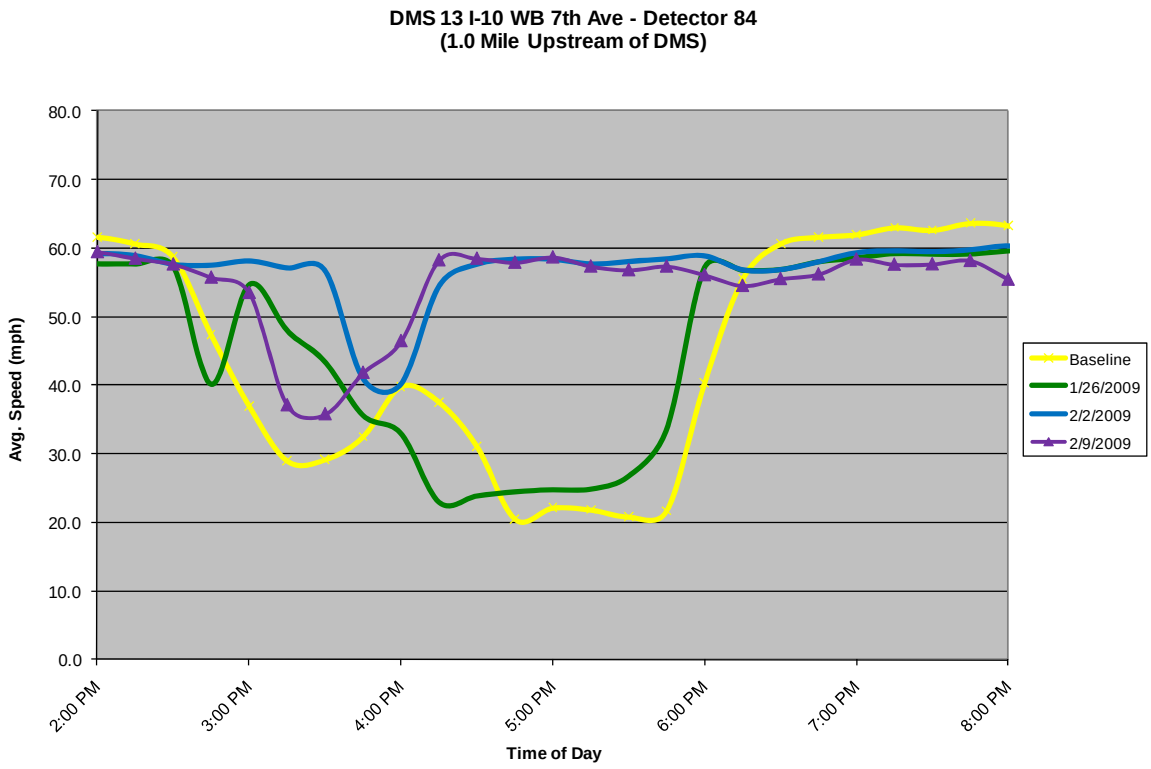


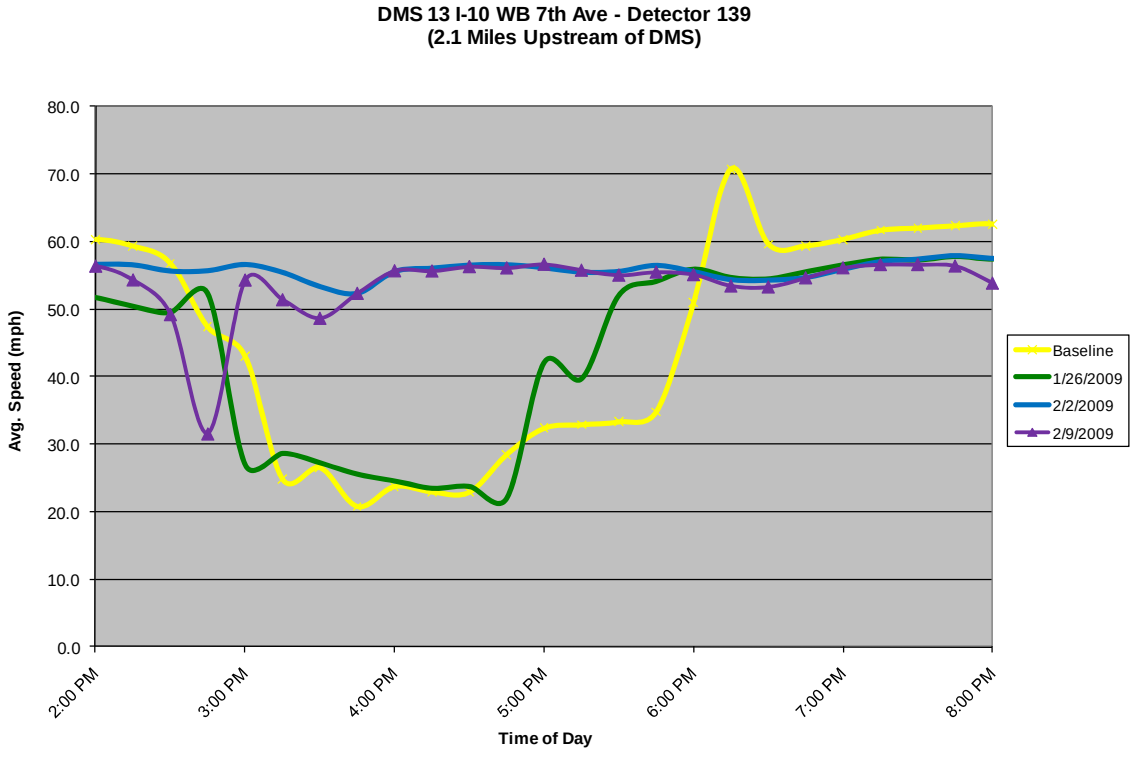




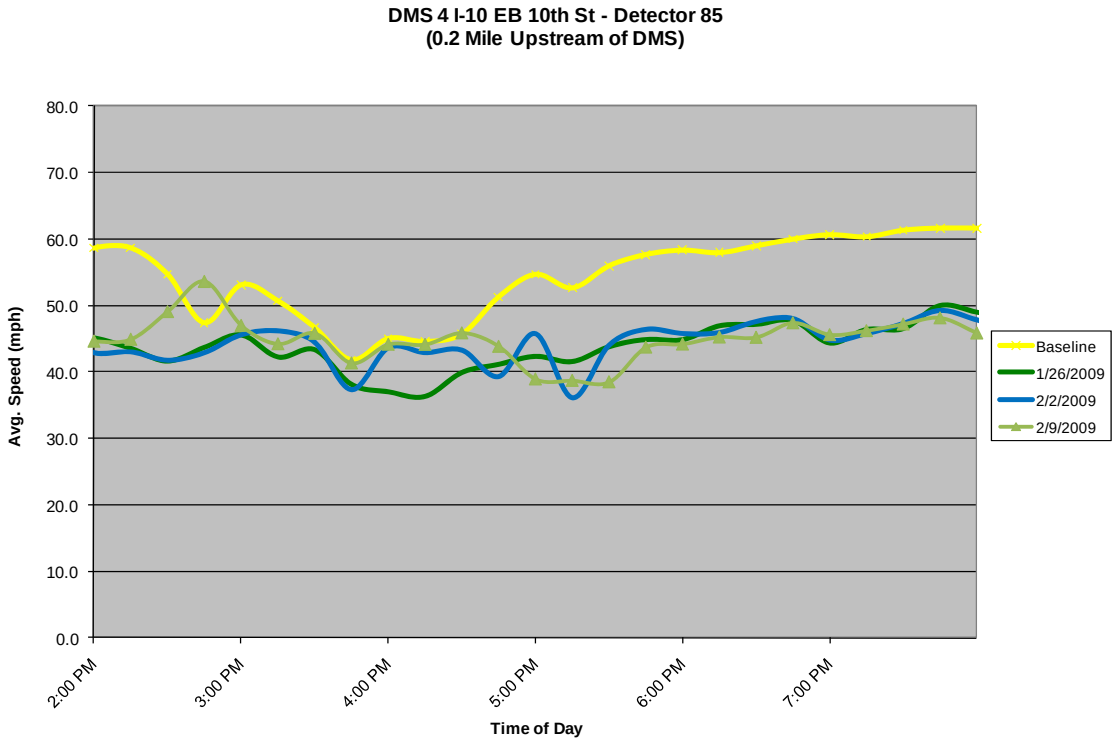
DMS 13 I-10 WB 7th Ave

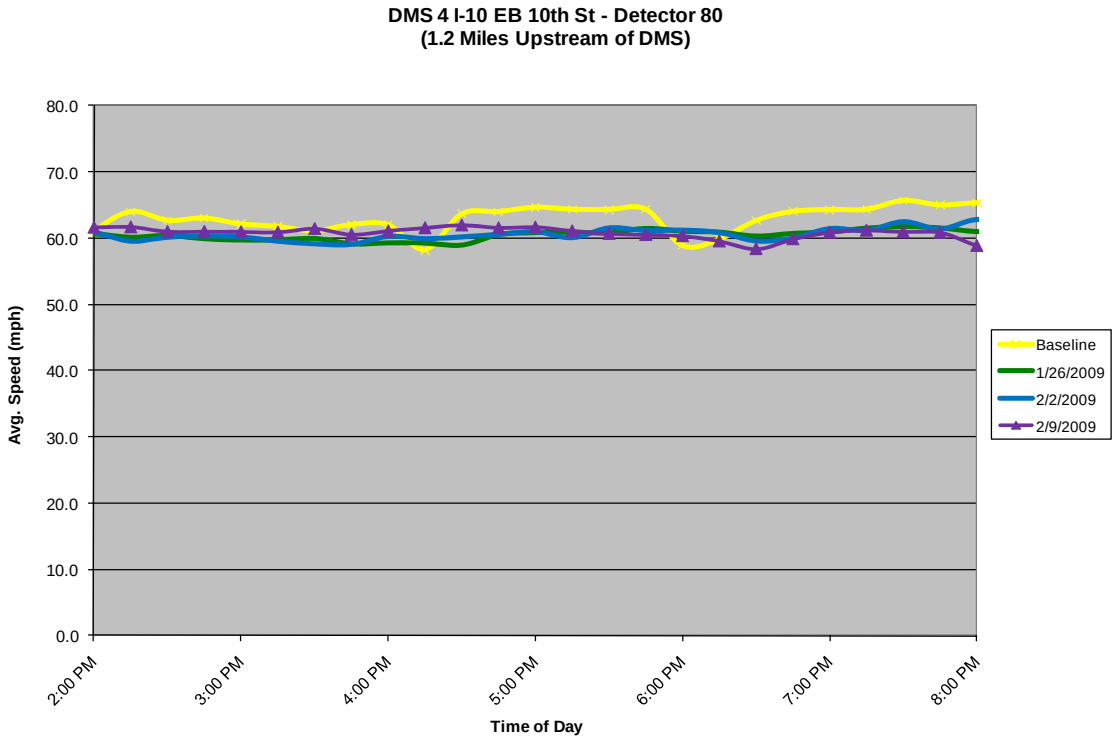
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





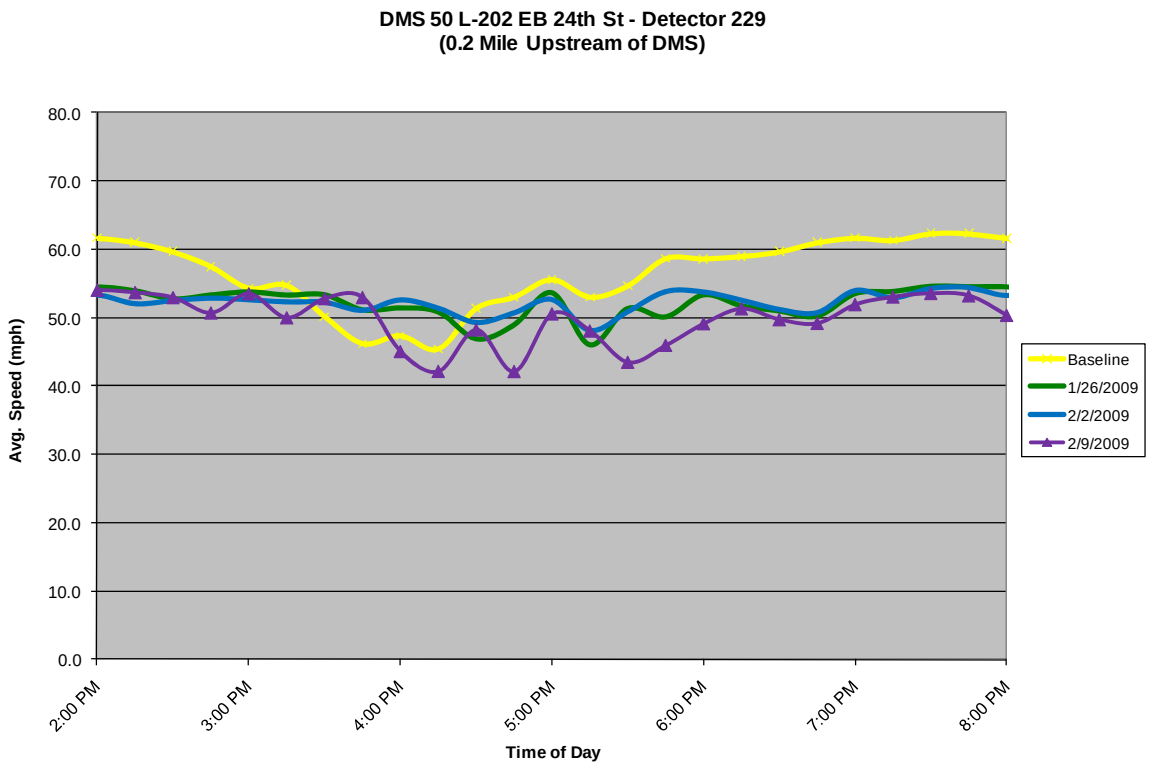
DMS 4 I-10 EB 10th St



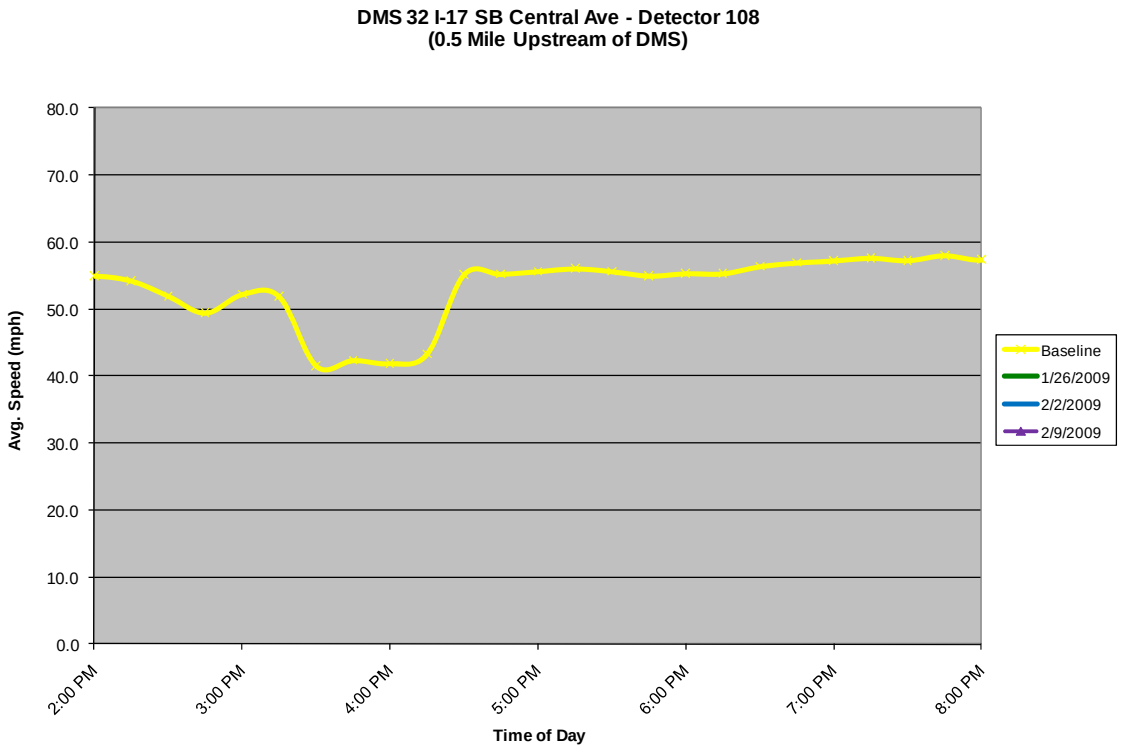


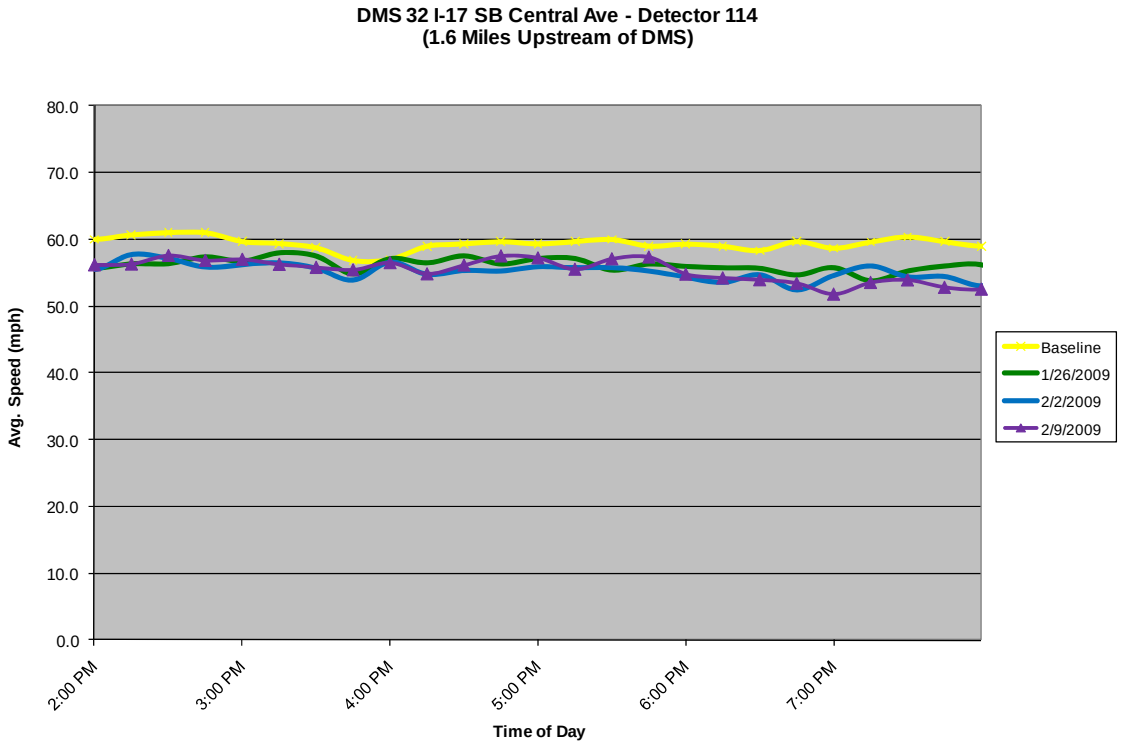
DMS 50 L-202 EB 24th ST

MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

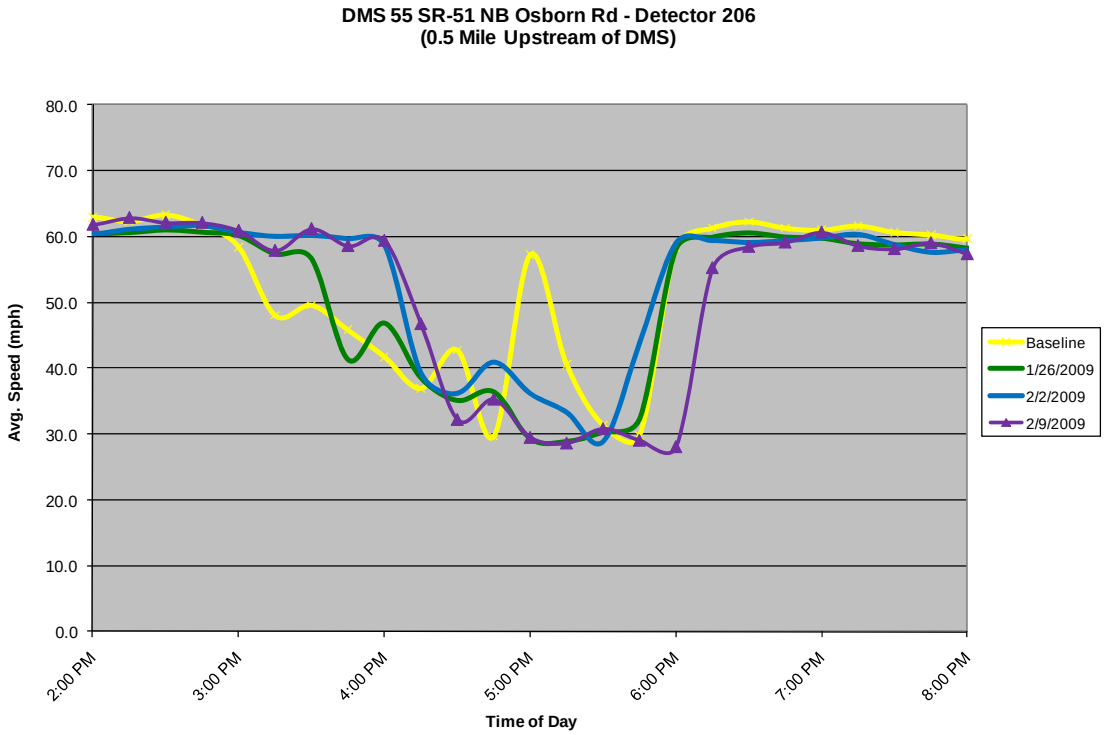


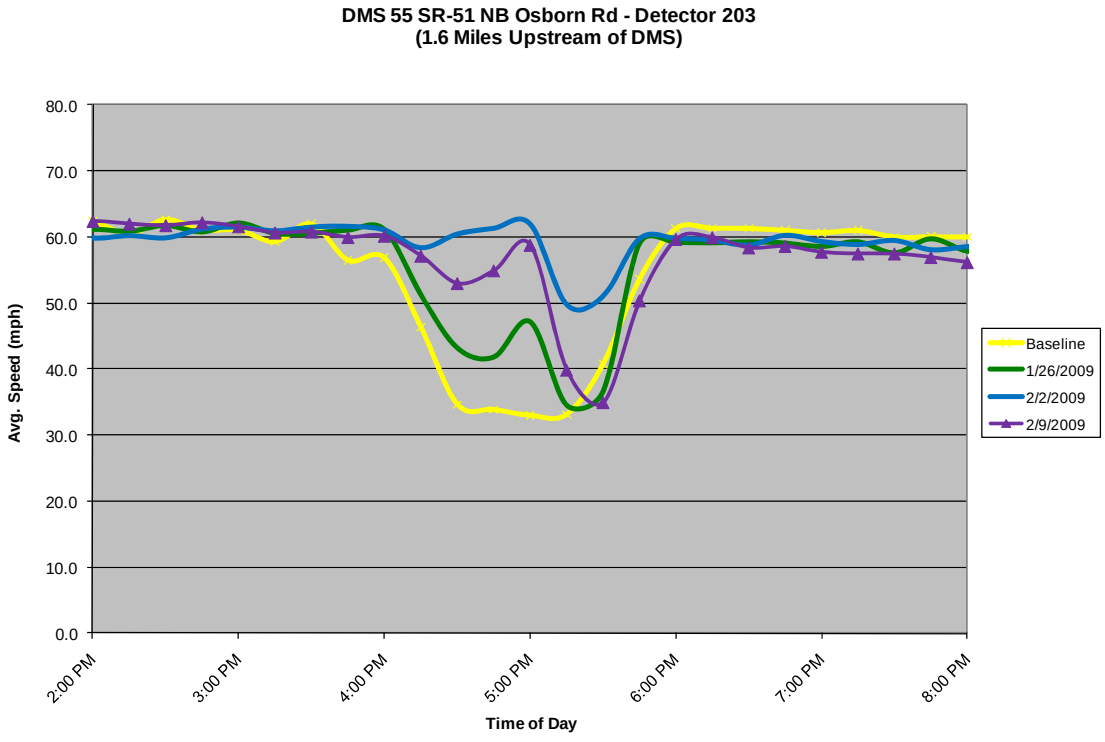


DMS 17 I-17 NB 4th Ave 
No Available Data on both Detector 104 and 98

DMS 55 SR-51 NB Osborn Rd

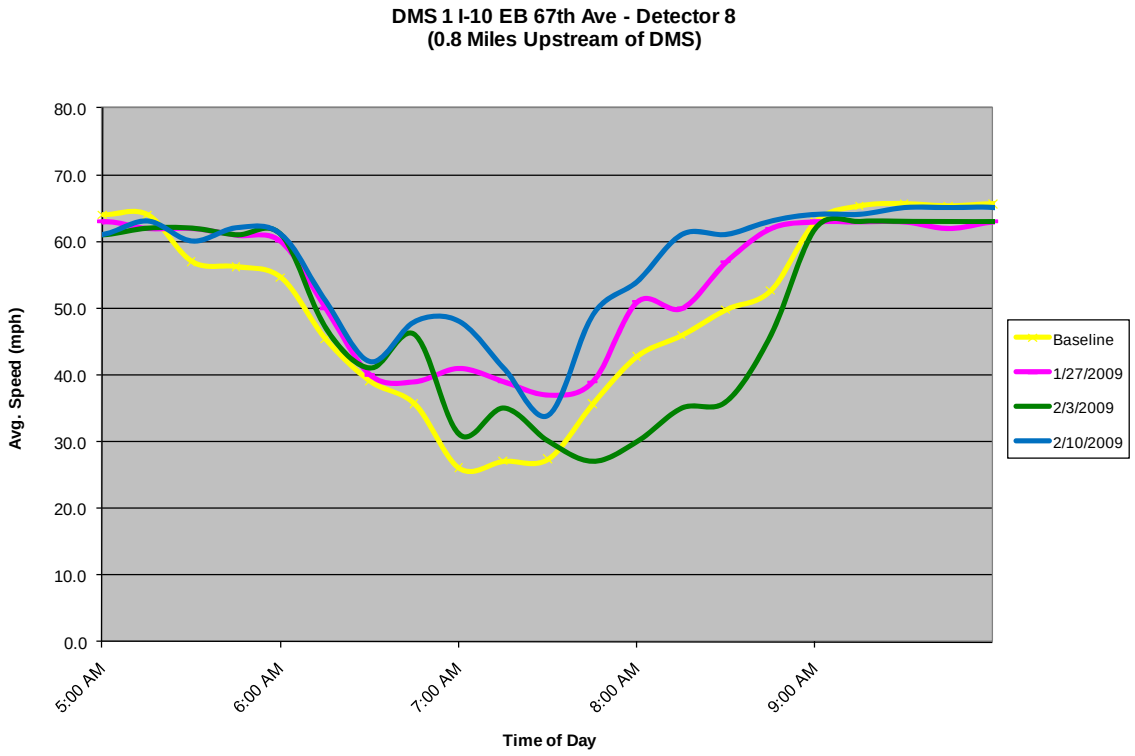
MINUTES TO
BELL RD XX

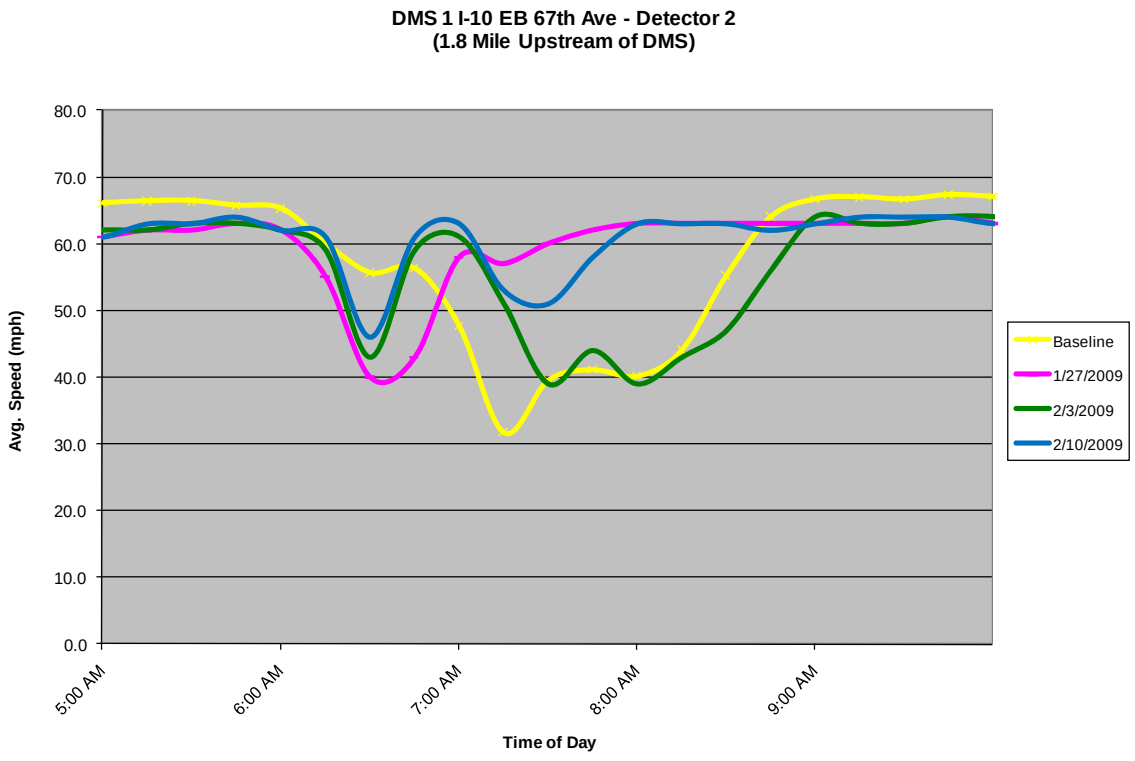




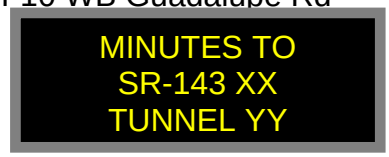
DMS 1 I-10 EB 67th Ave

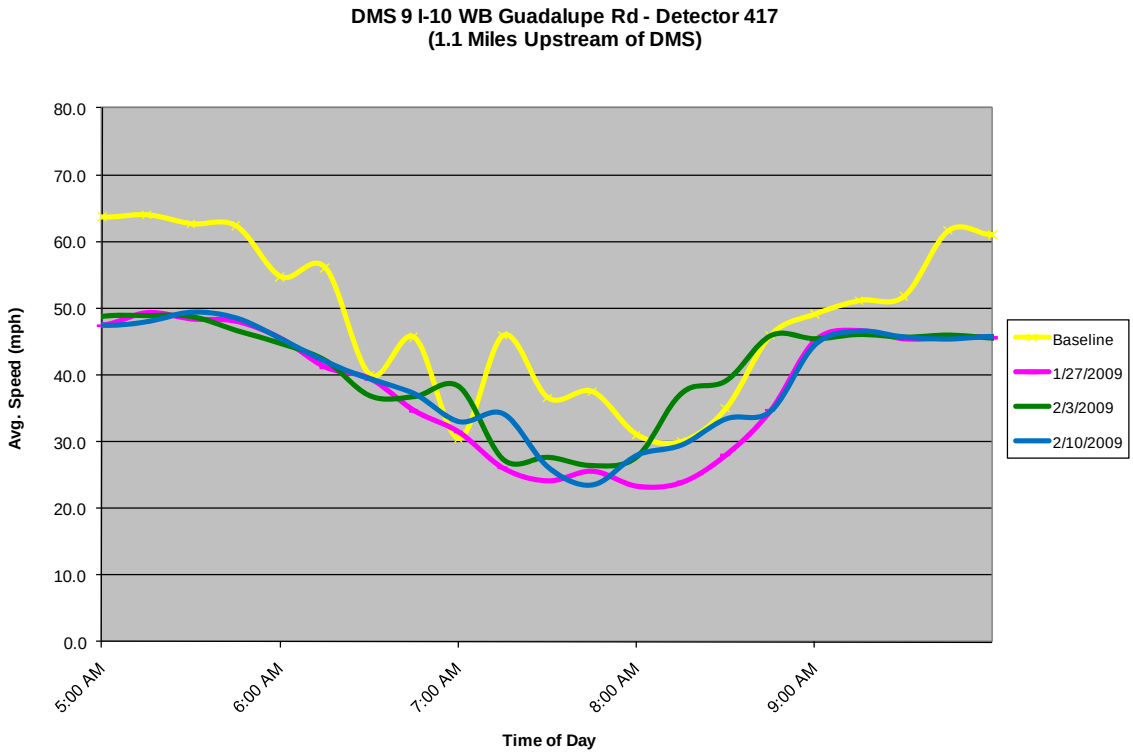
MINUTES TO
TUNNEL XX
AIRPORT YY

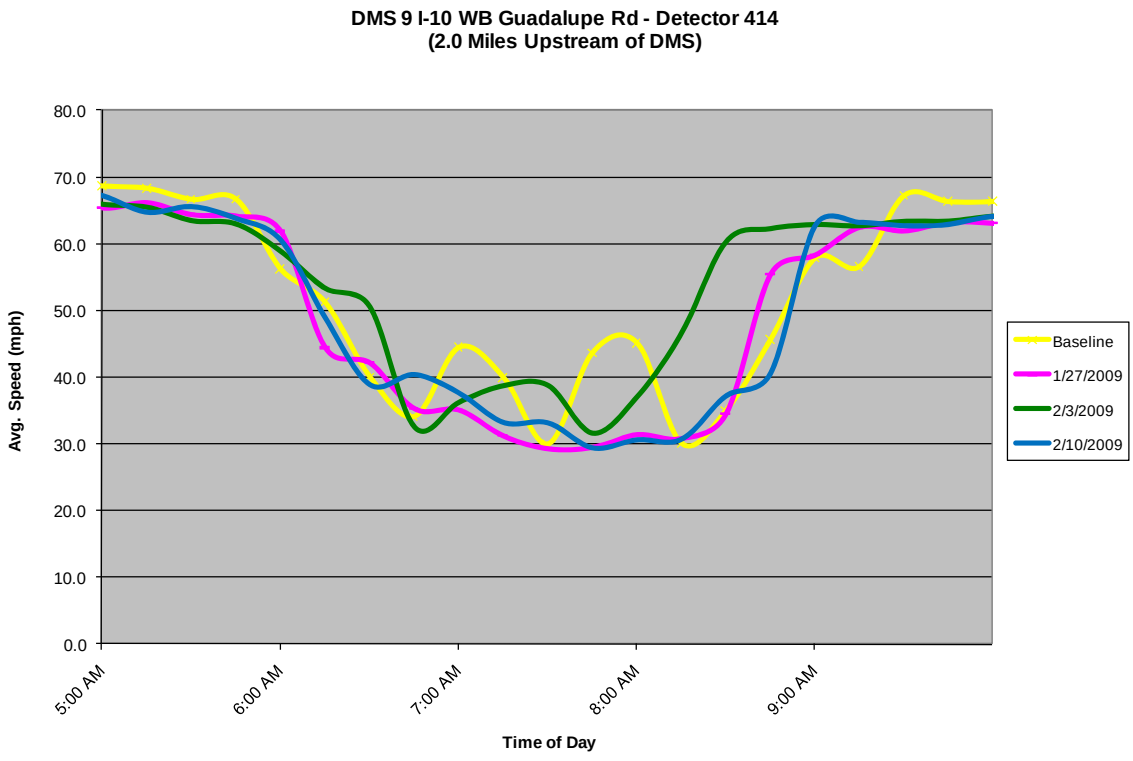




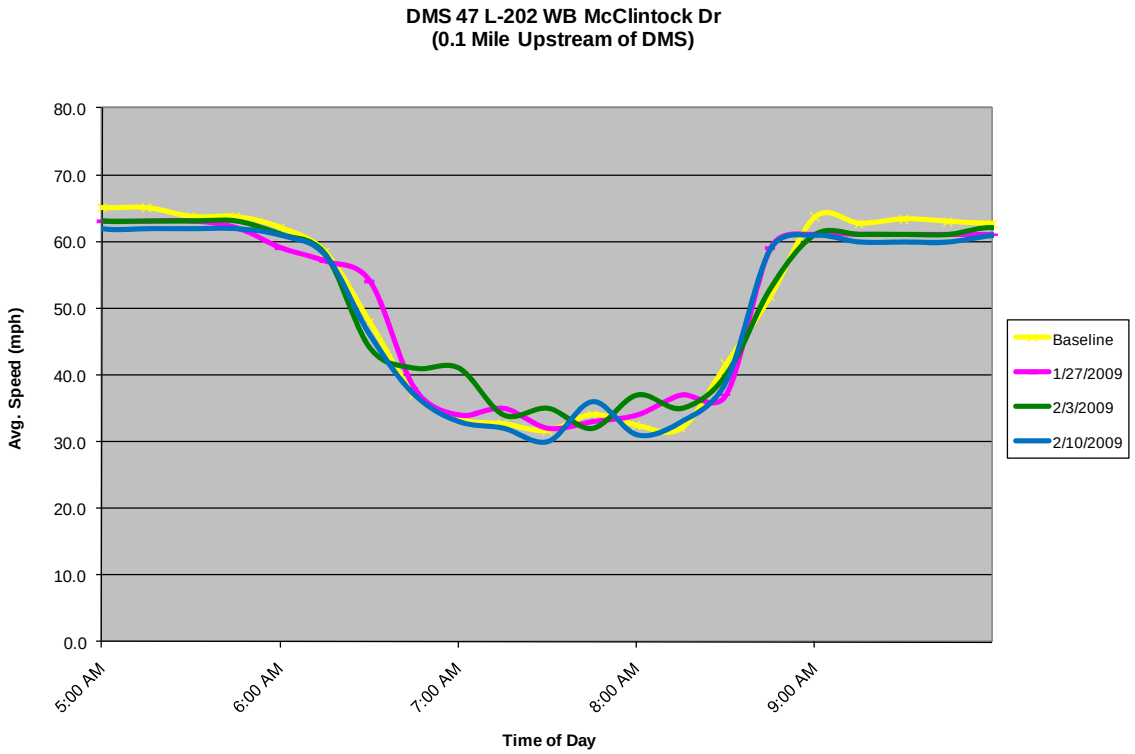
DMS 9 I-10 WB Guadalupe Rd



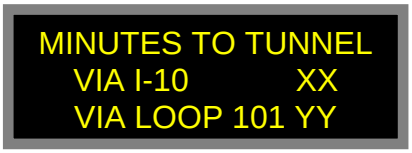


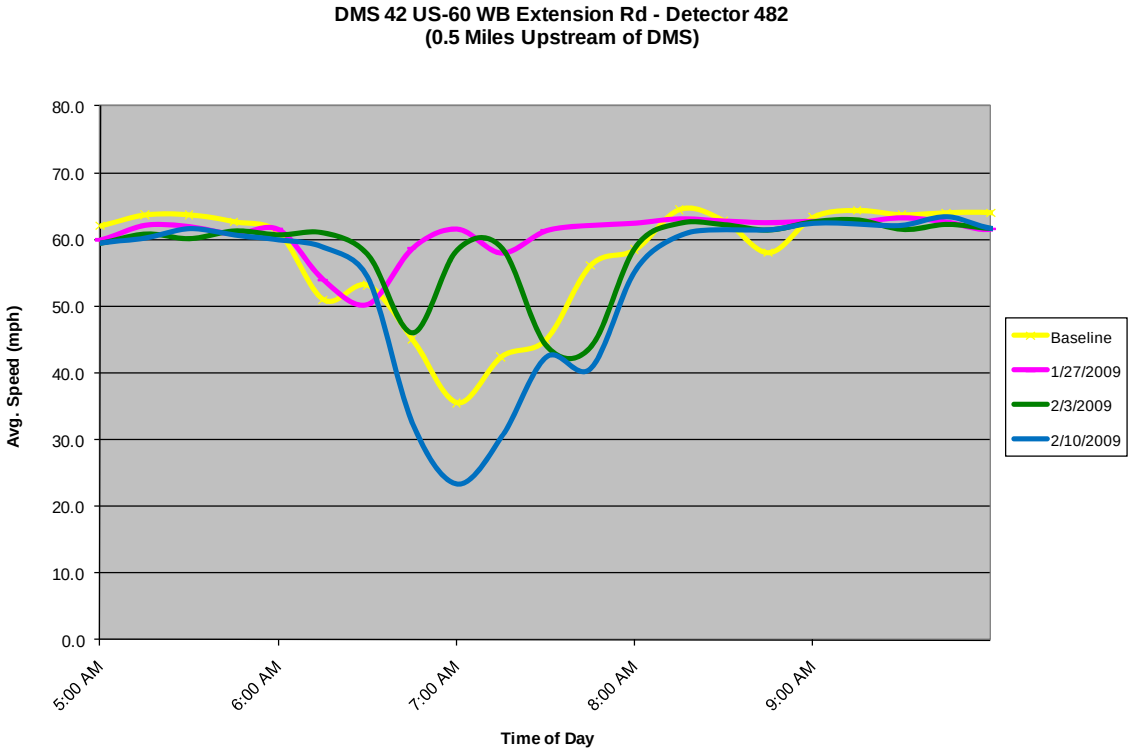


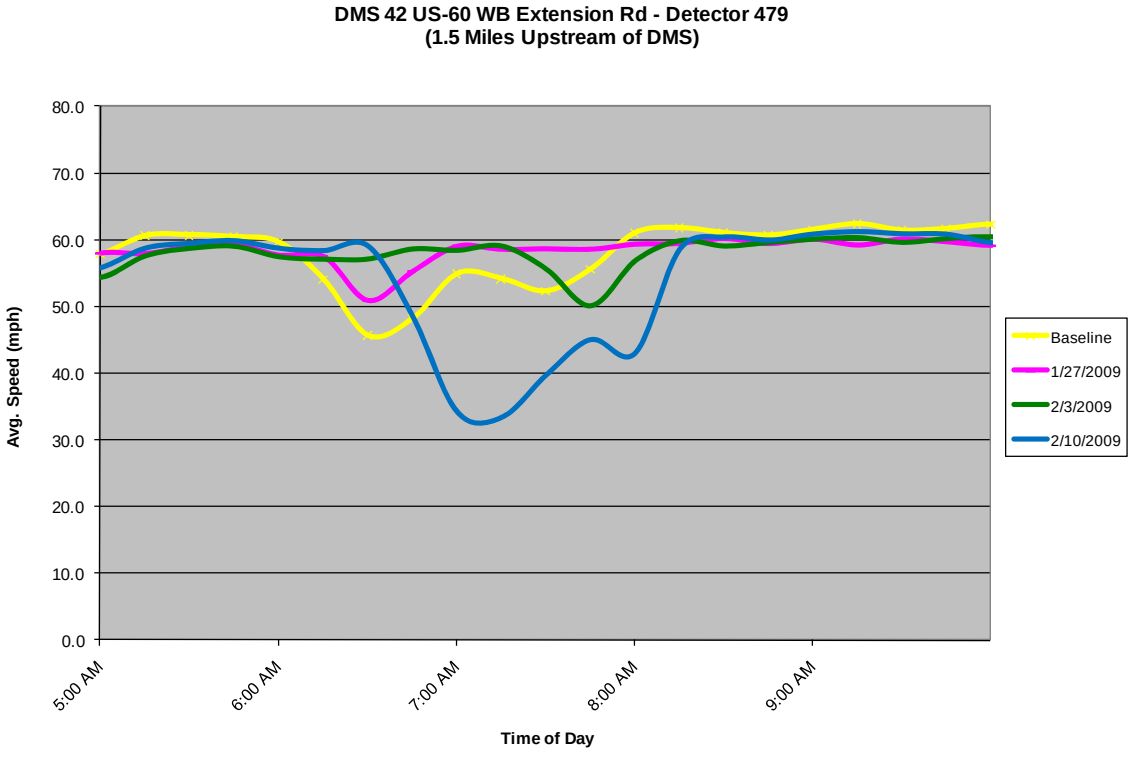
DMS 47 L-202 WB McClintock Dr



DMS 42 US-60 WB Extension Rd

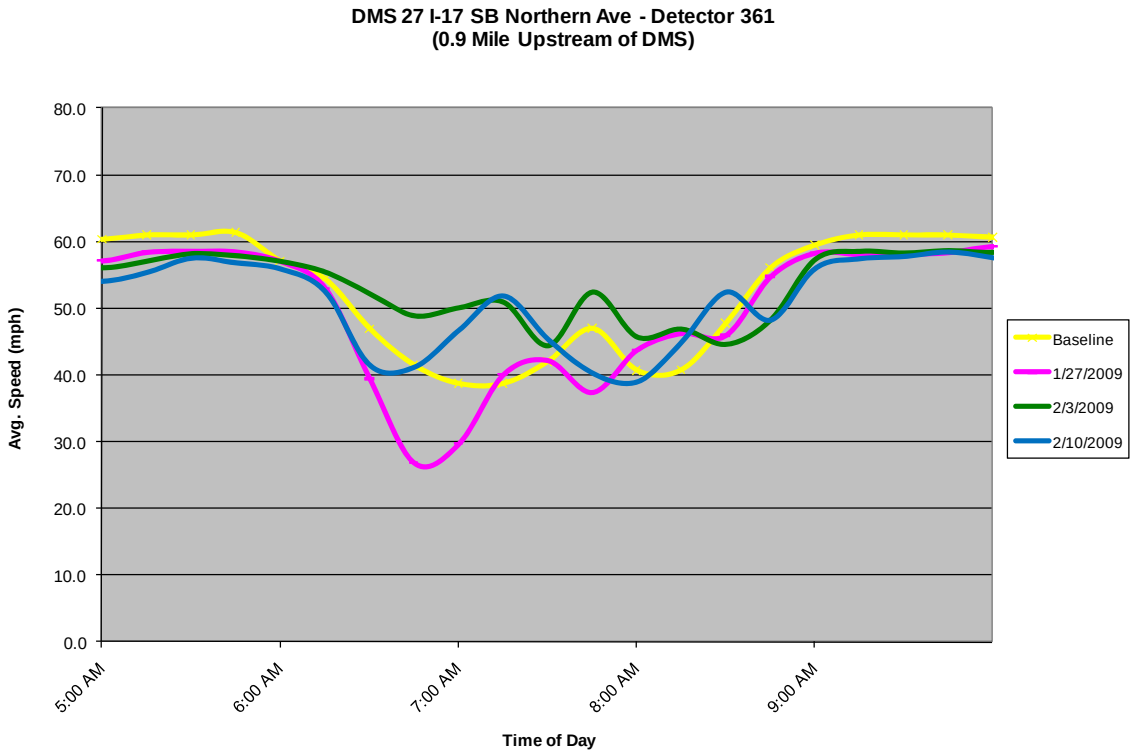


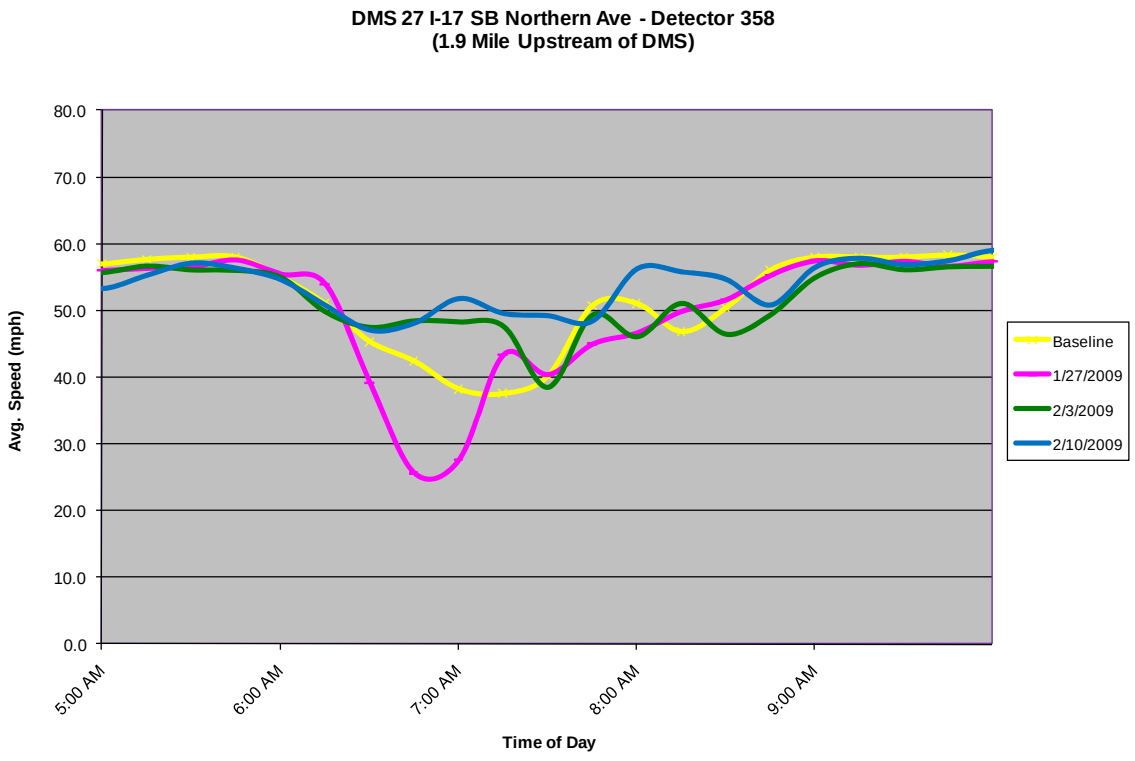




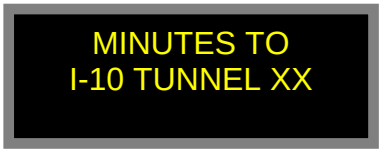
DMS 27 I-17 SB Northern Ave

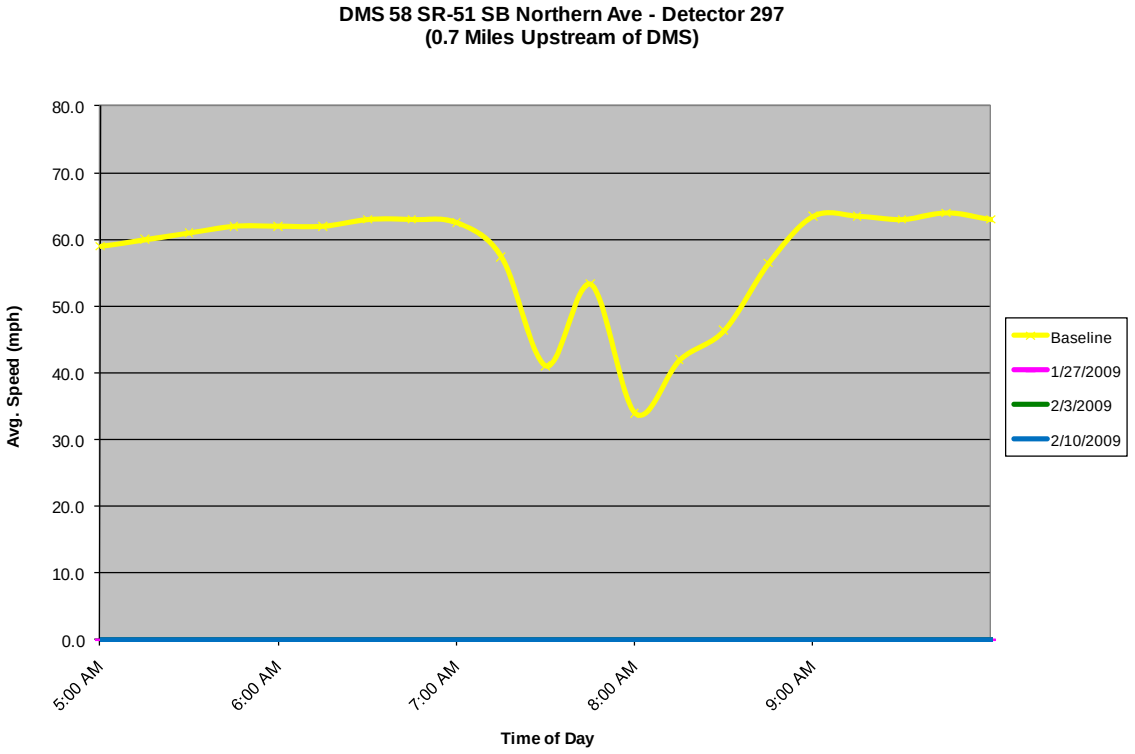
MINUTES TO
I-10 TUNNEL XX

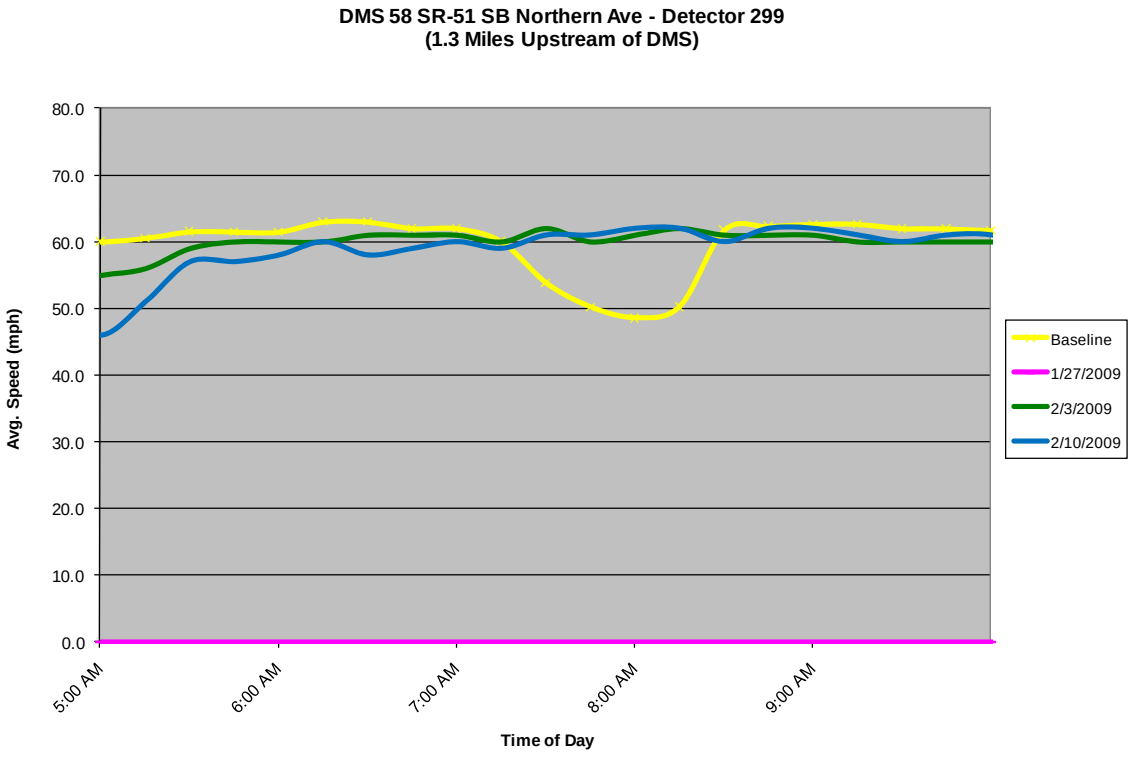




DMS 58 SR-51 SB Northern Ave

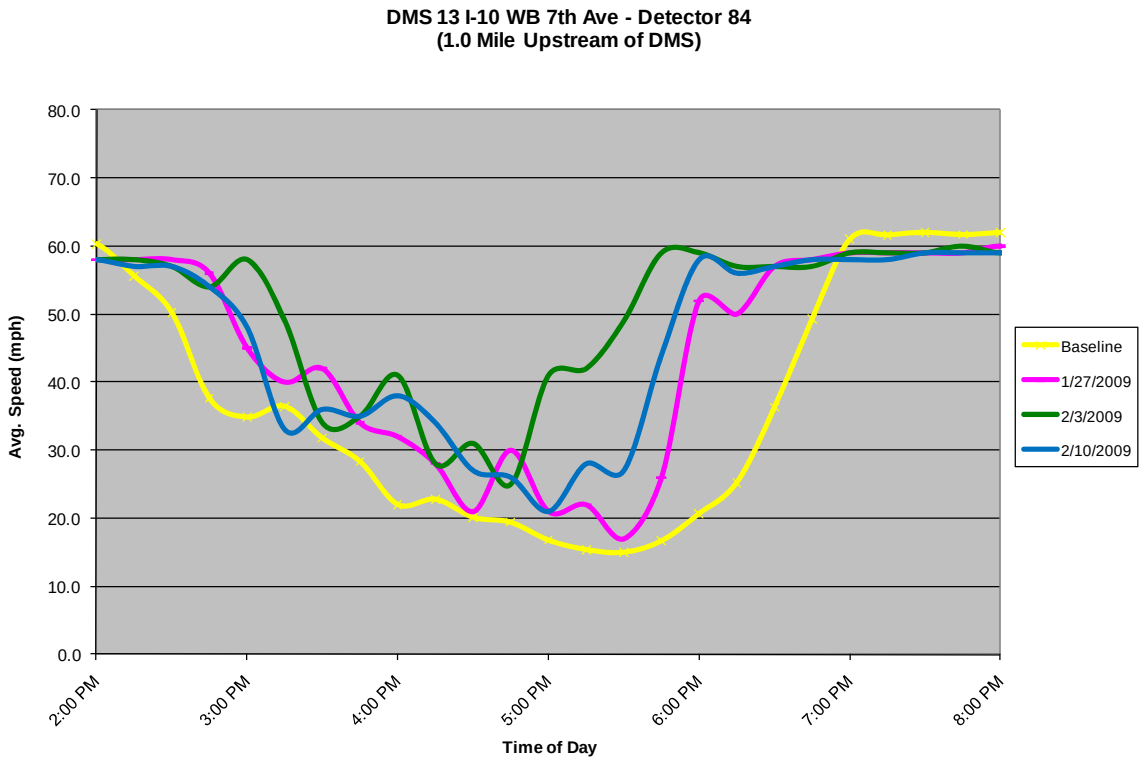


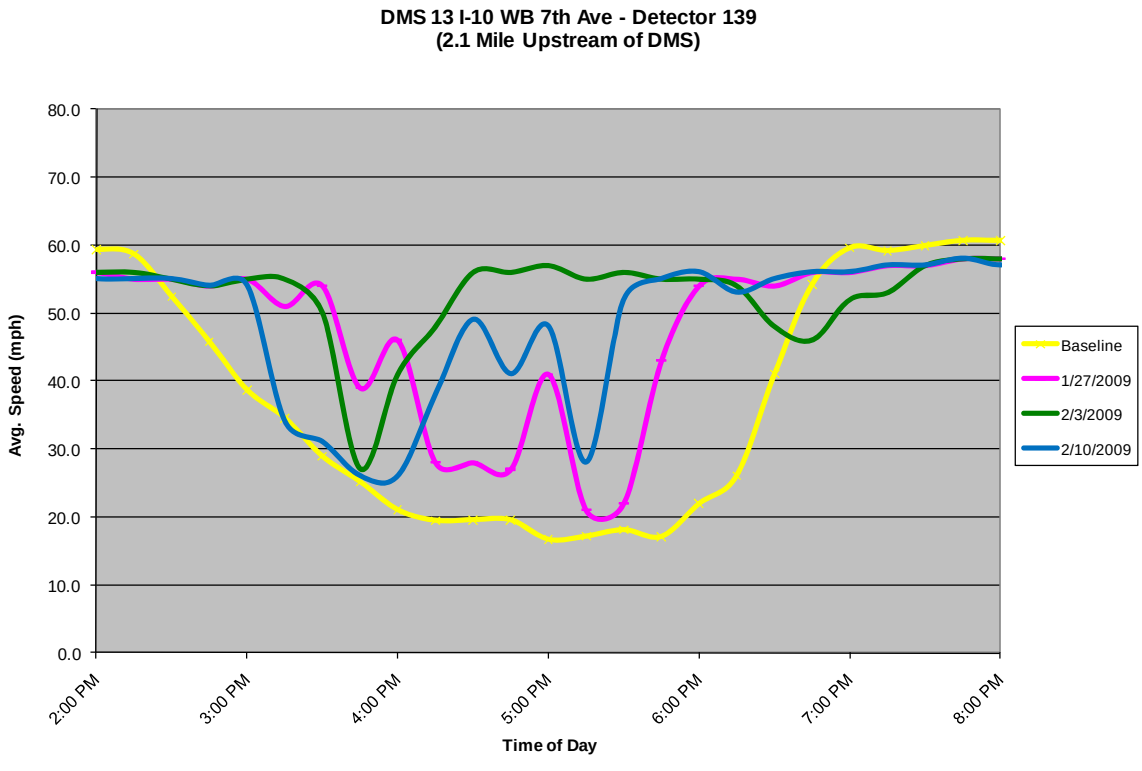




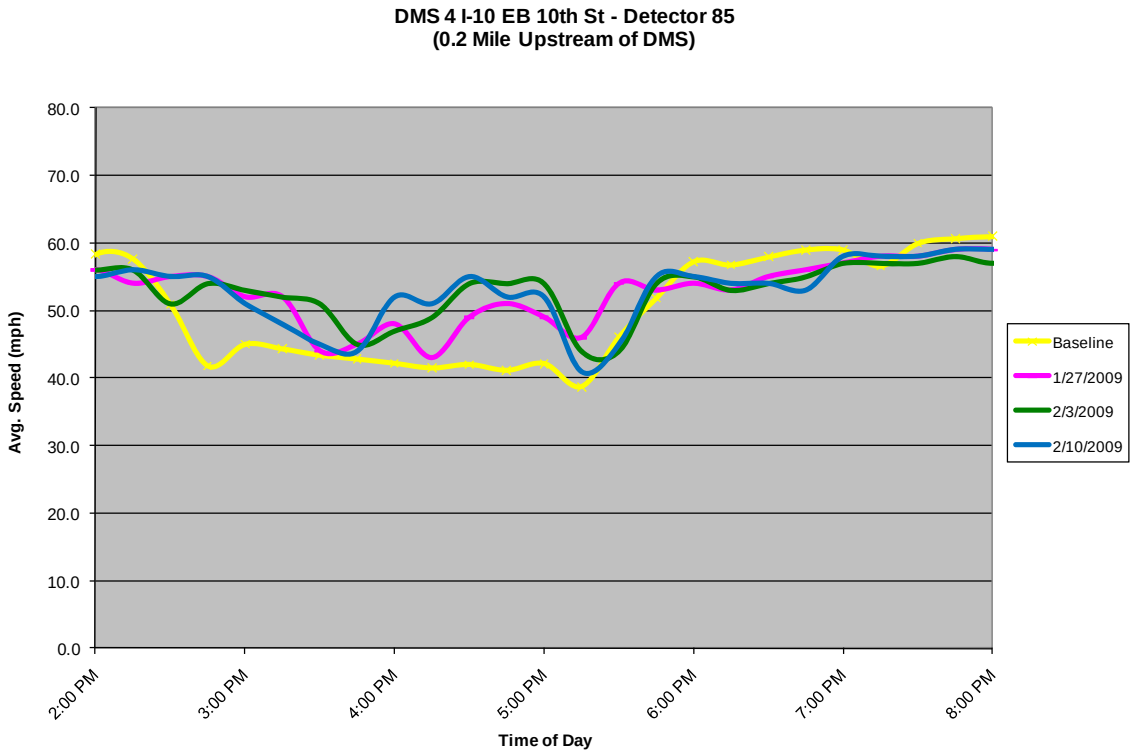
DMS 13 I-10 WB 7th Ave

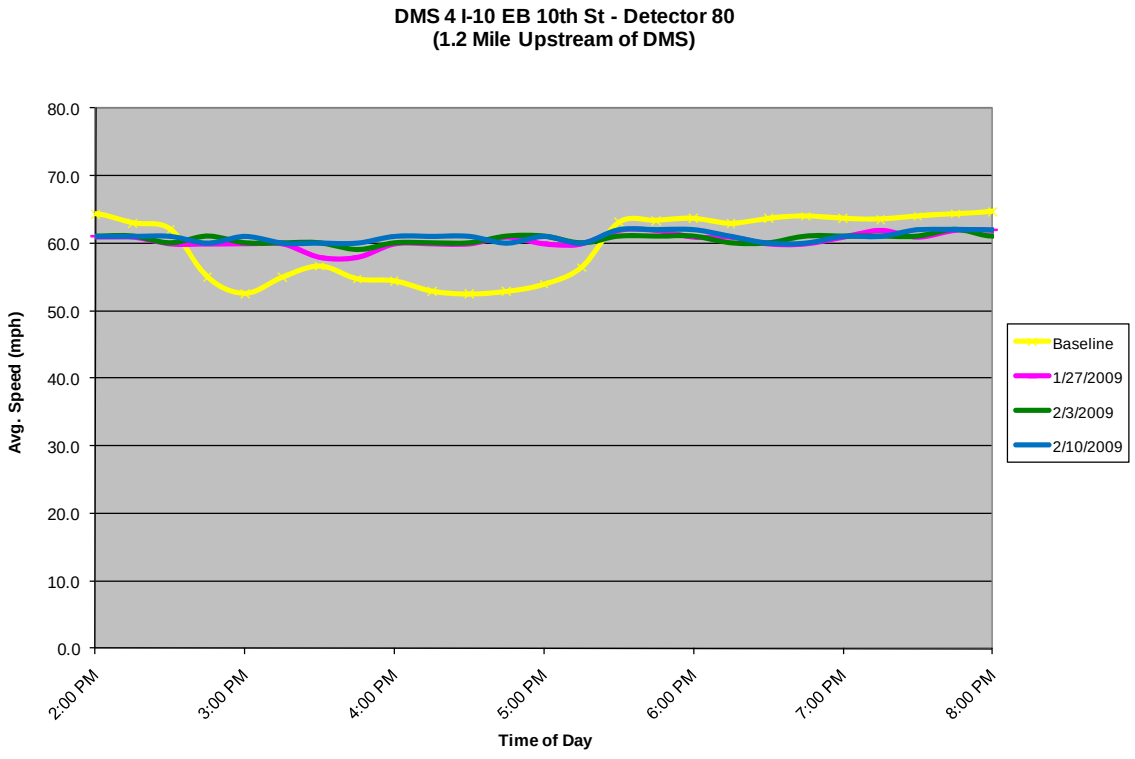
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





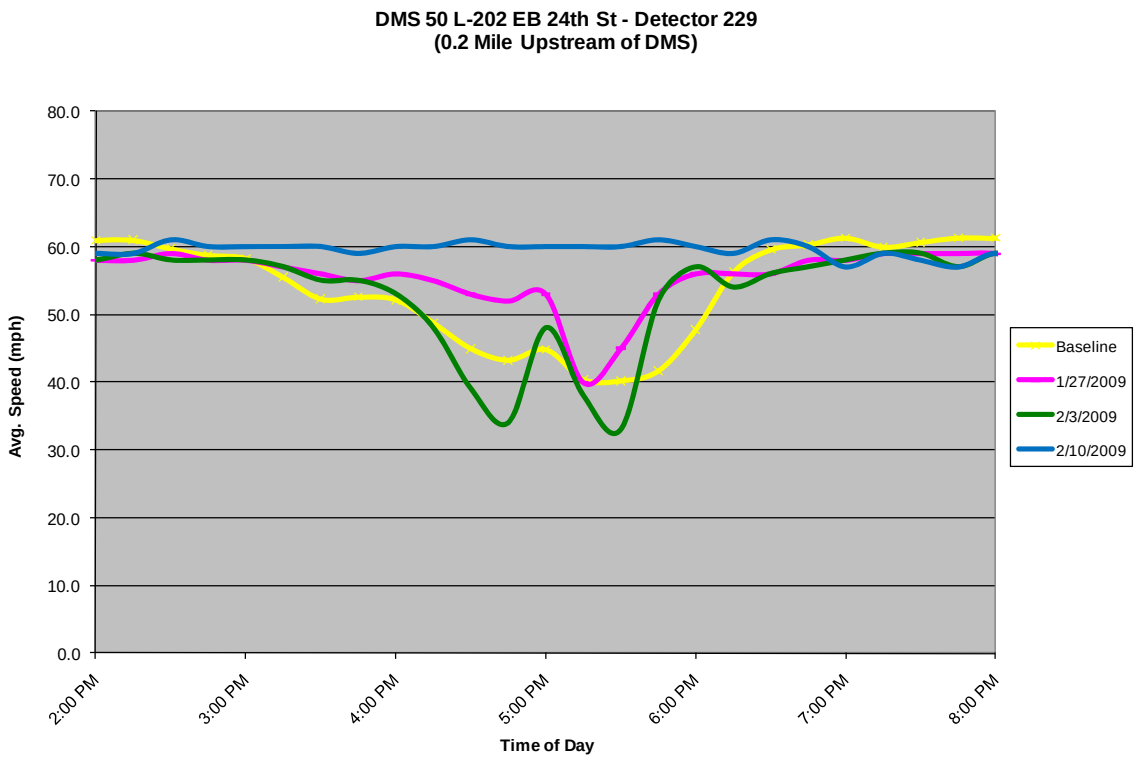
DMS 4 I-10 EB 10th St





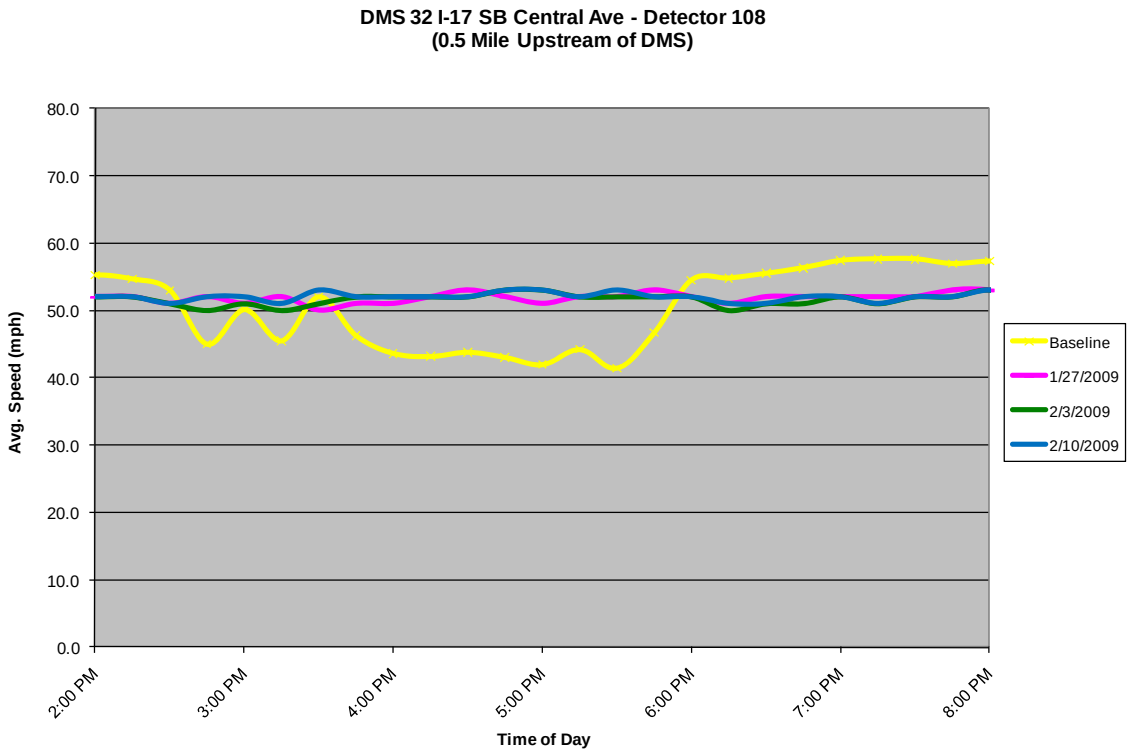
DMS 50 L-202 EB 24th ST

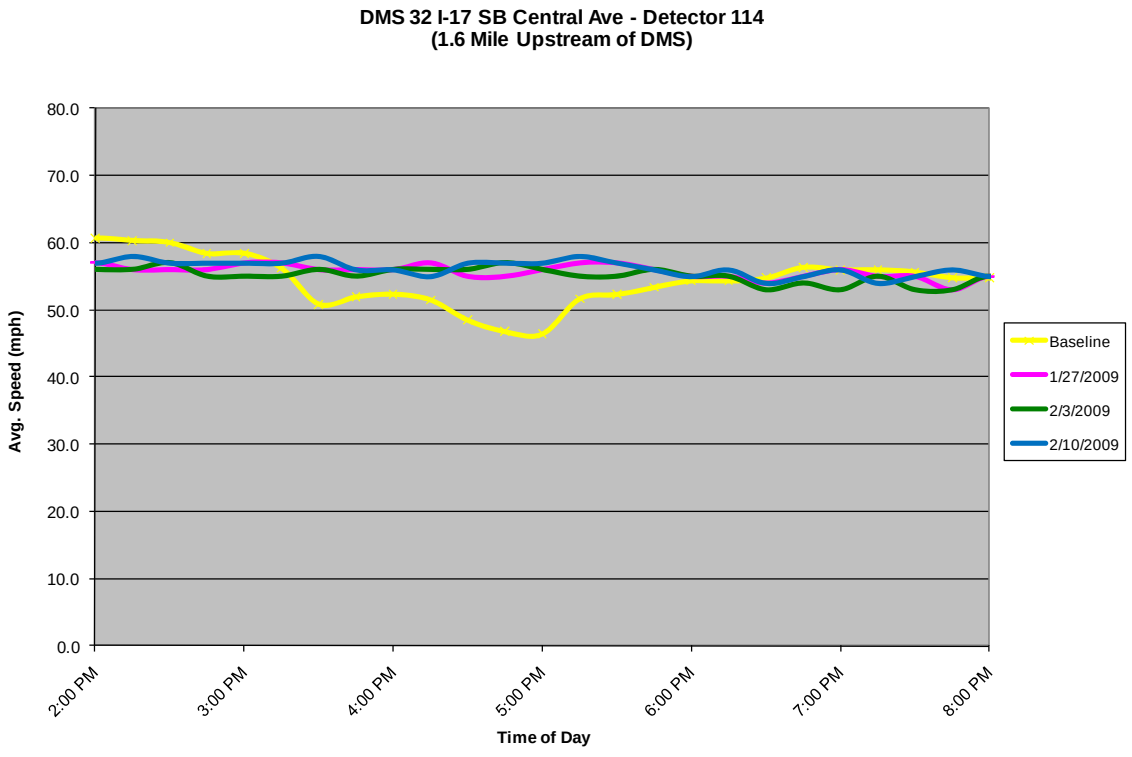
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

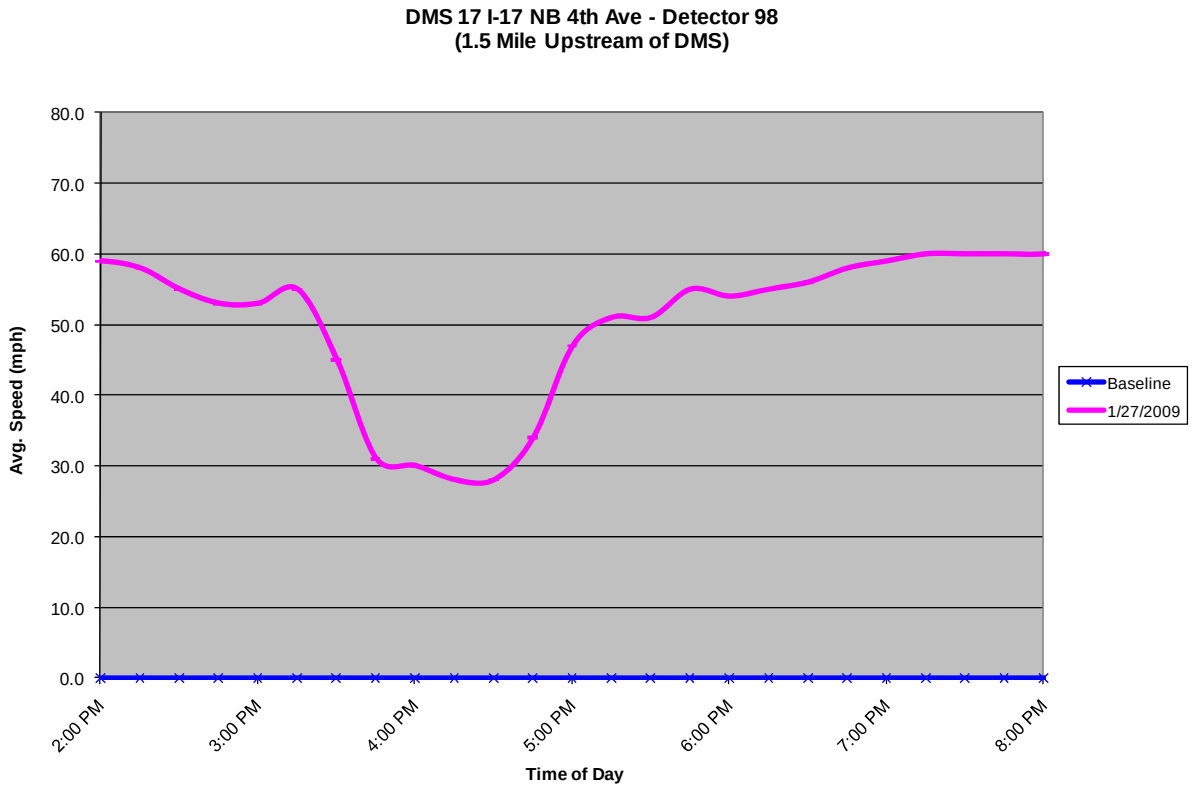




DMS 17 I-17 NB 4th Ave

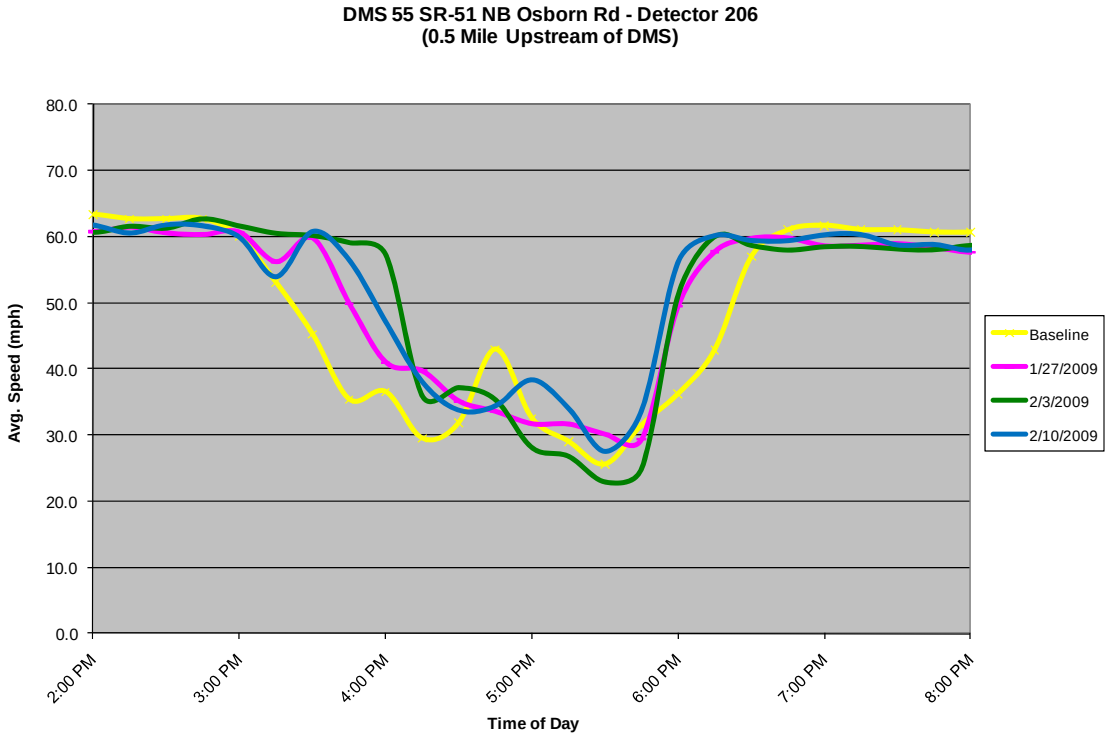
MINUTES TO
PEORIA AVE XX
I-10 83RD AVE YY

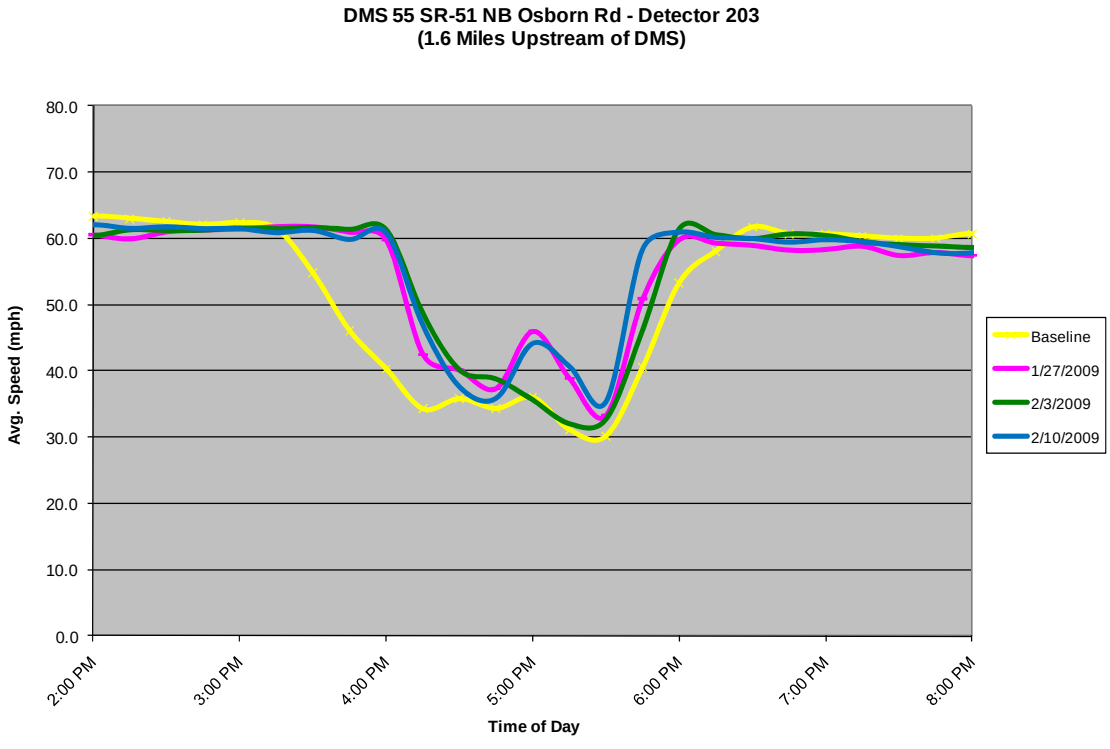
No Available Data on Detector 104



DMS 55 SR-51 NB Osborn Rd

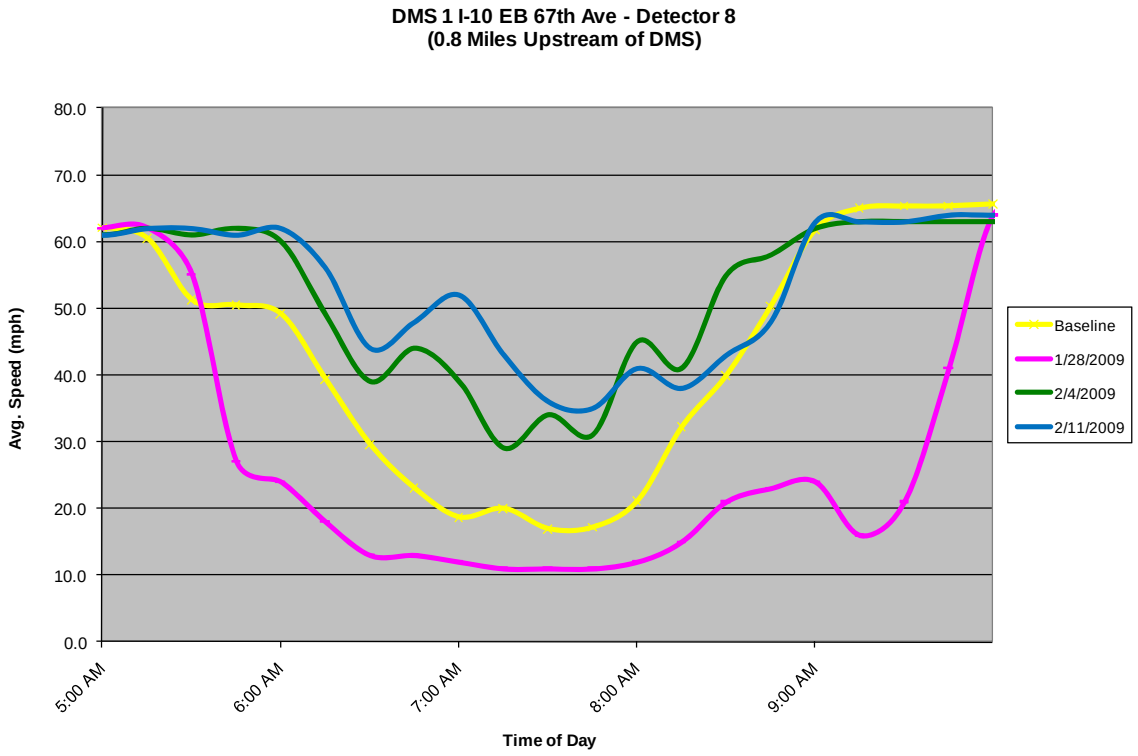
MINUTES TO
BELL RD XX

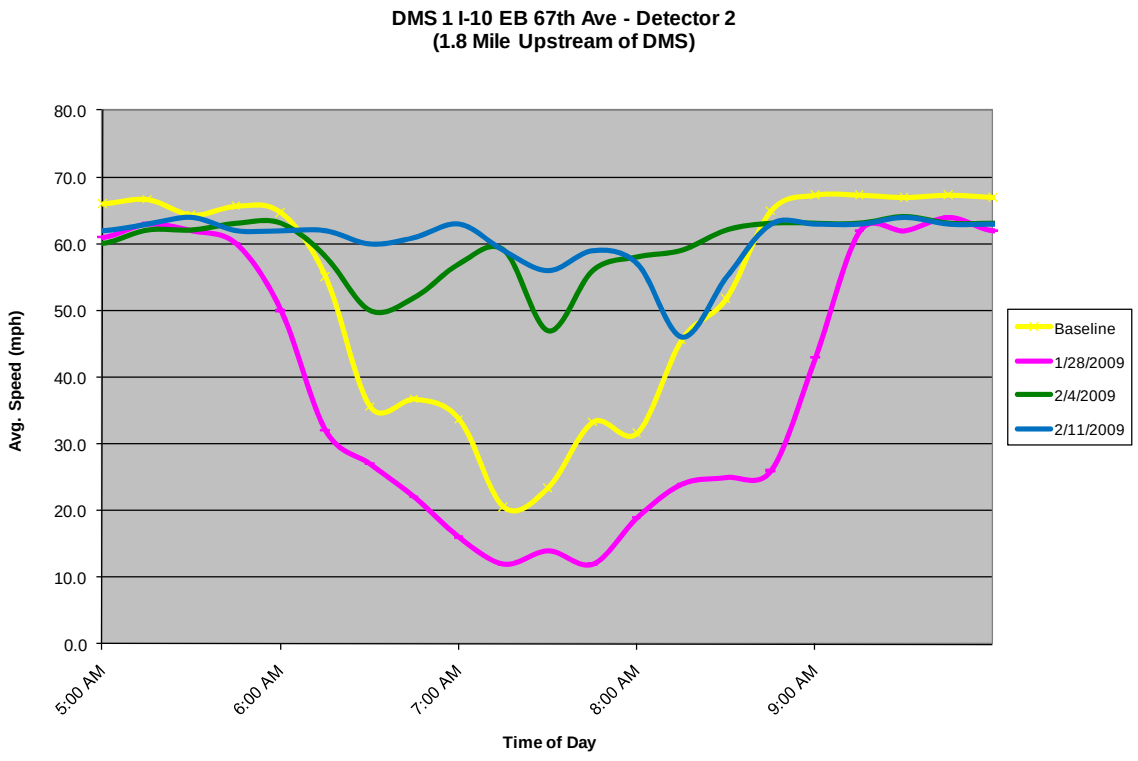




DMS 1 I-10 EB 67th Ave

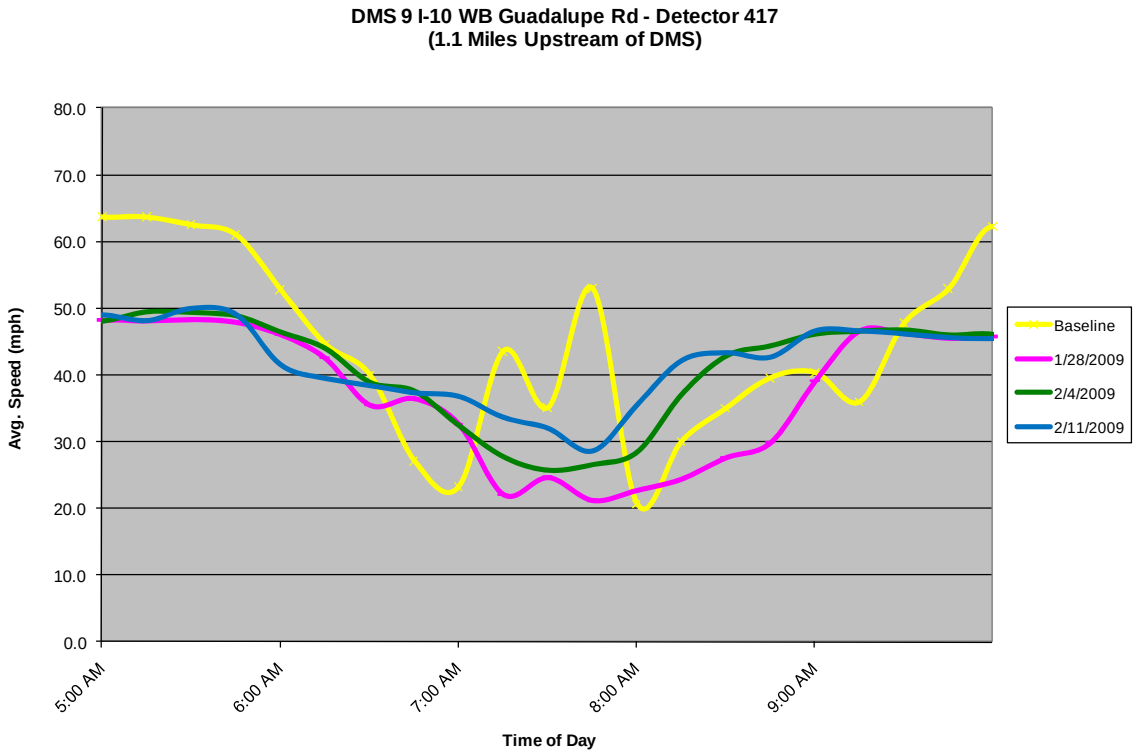
MINUTES TO
TUNNEL XX
AIRPORT YY

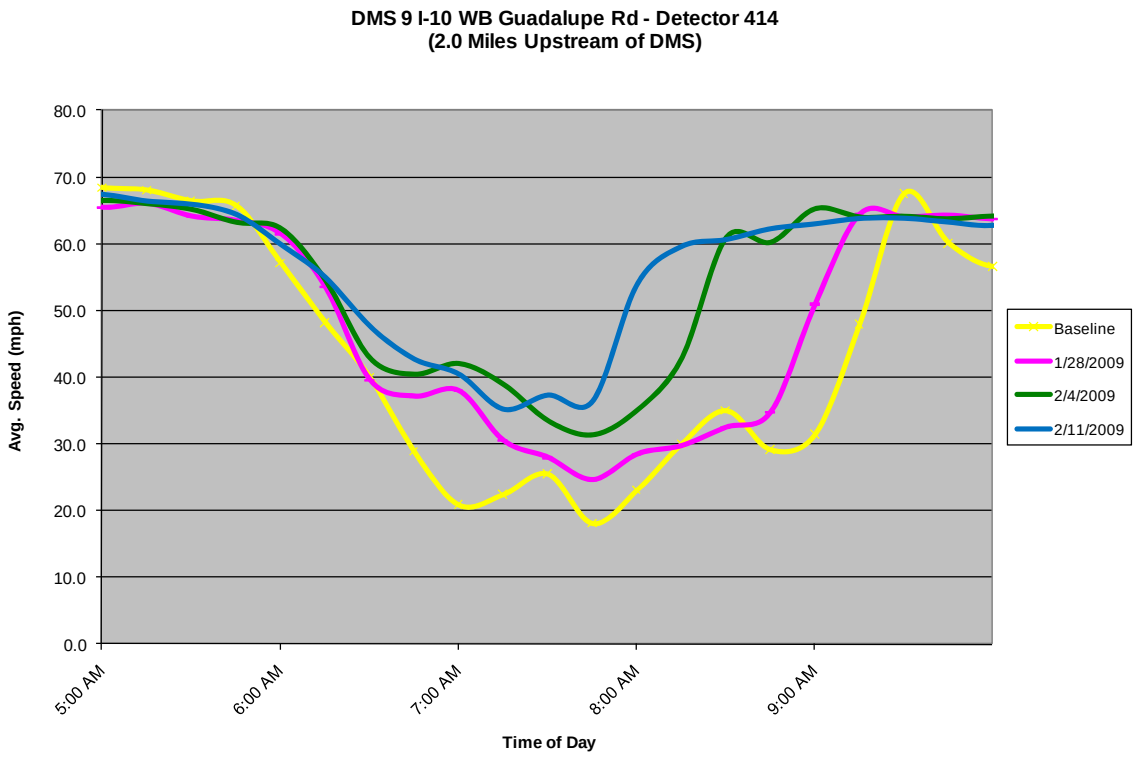




DMS 9 I-10 WB Guadalupe Rd

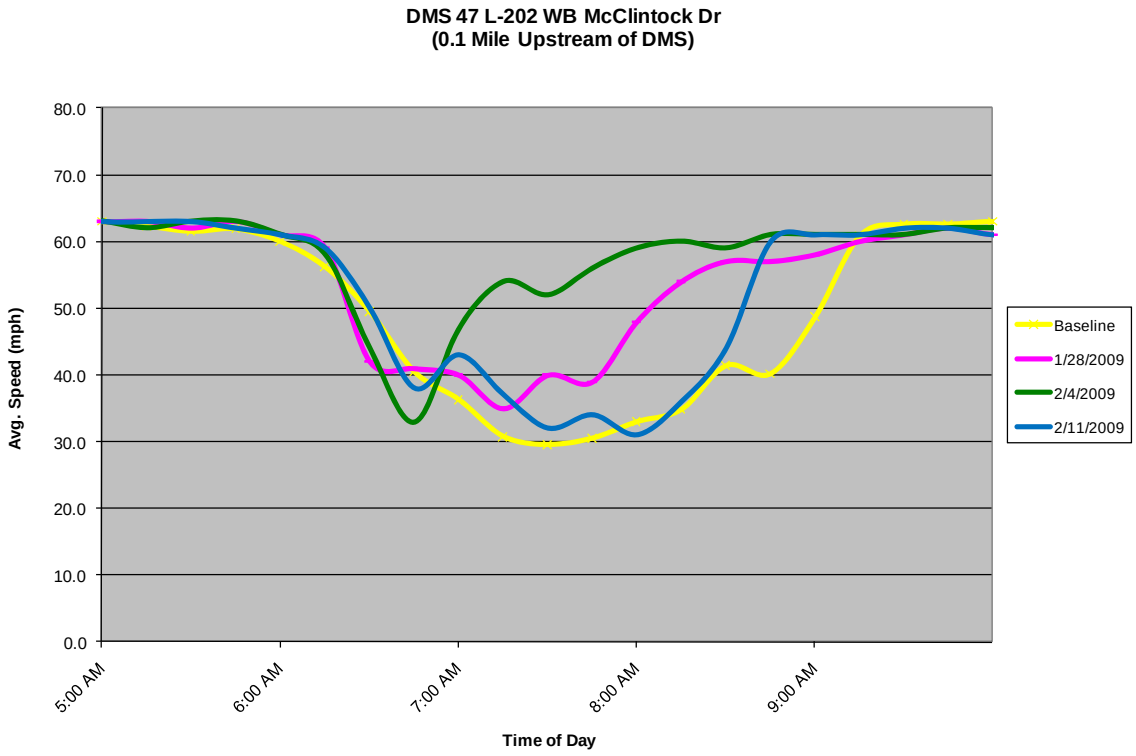
MINUTES TO
SR-143 XX
TUNNEL YY





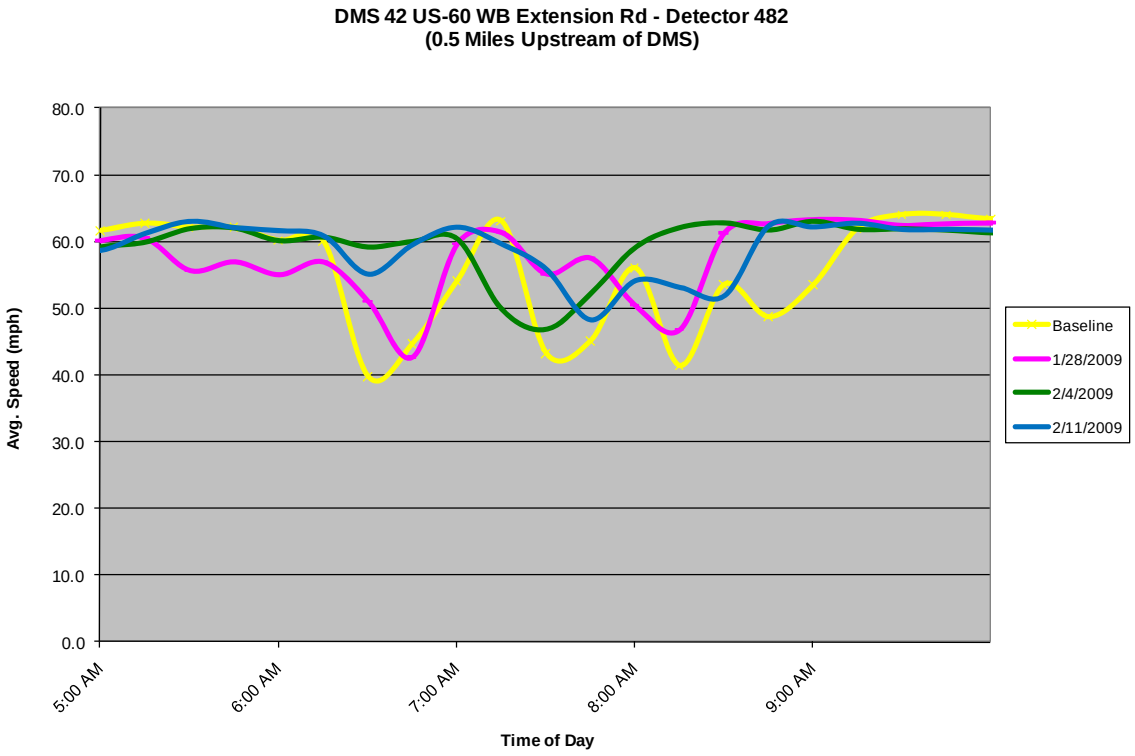
DMS 47 L-202 WB McClintock Dr

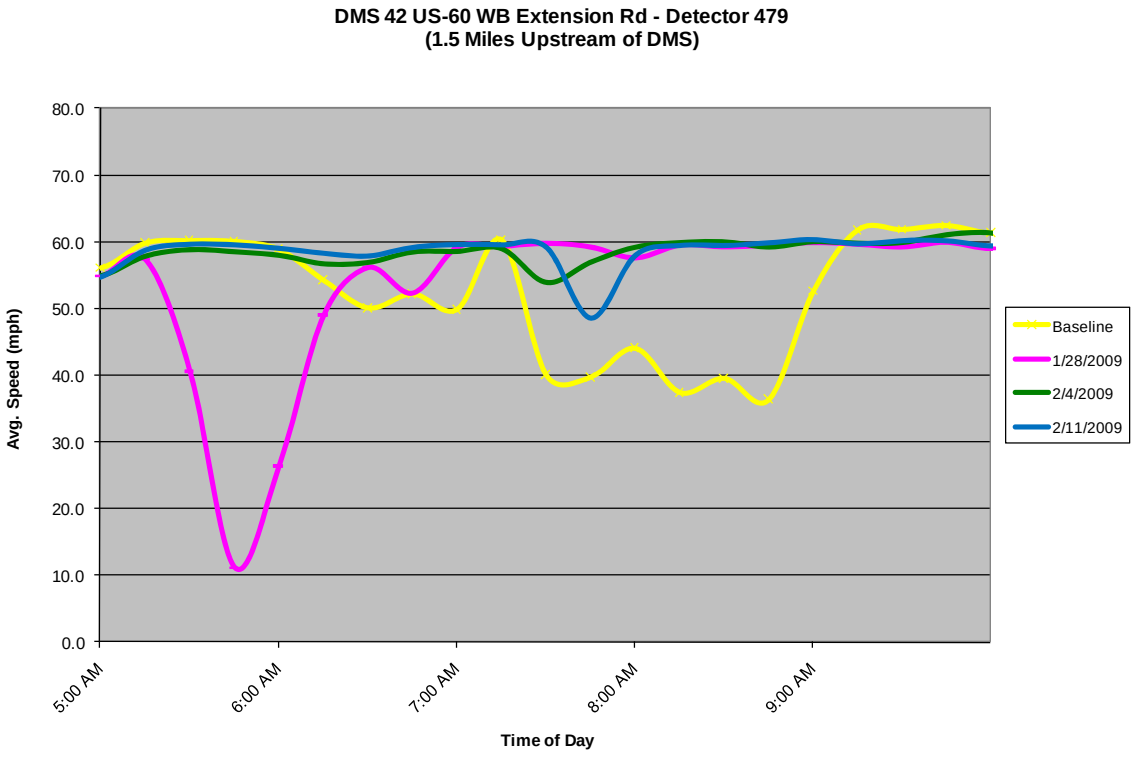
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

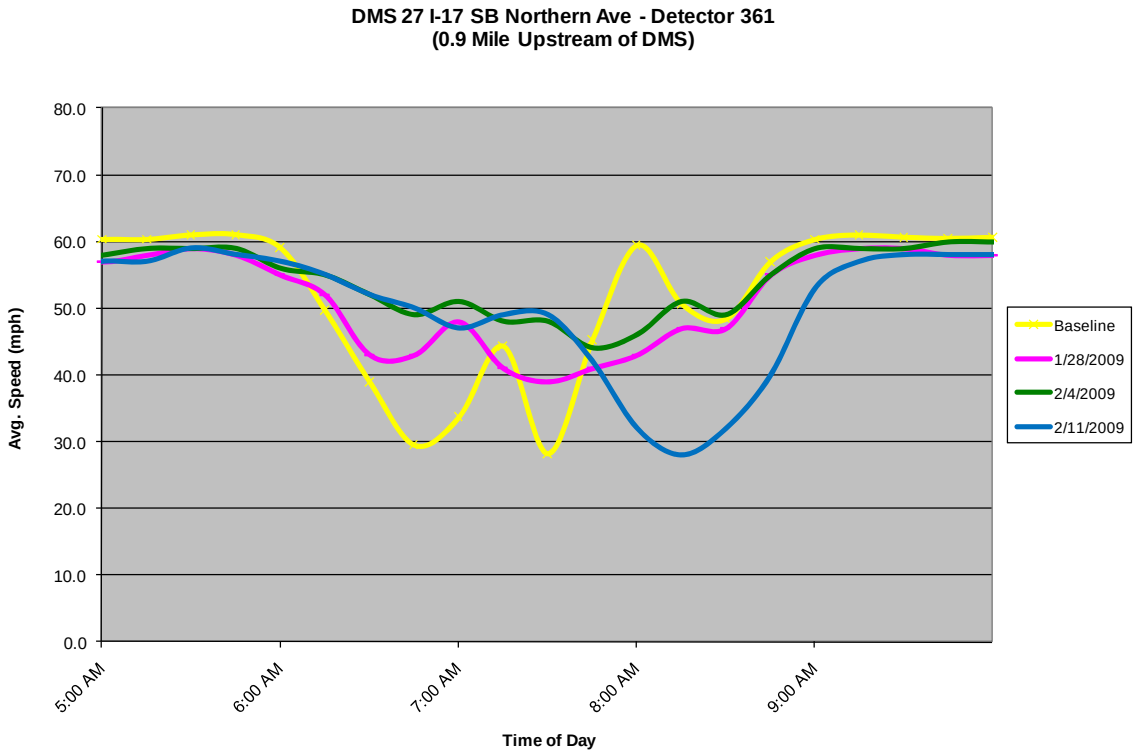
MINUTES TO TUNNEL
VIA I-10 XX
VIA LOOP 101 YY

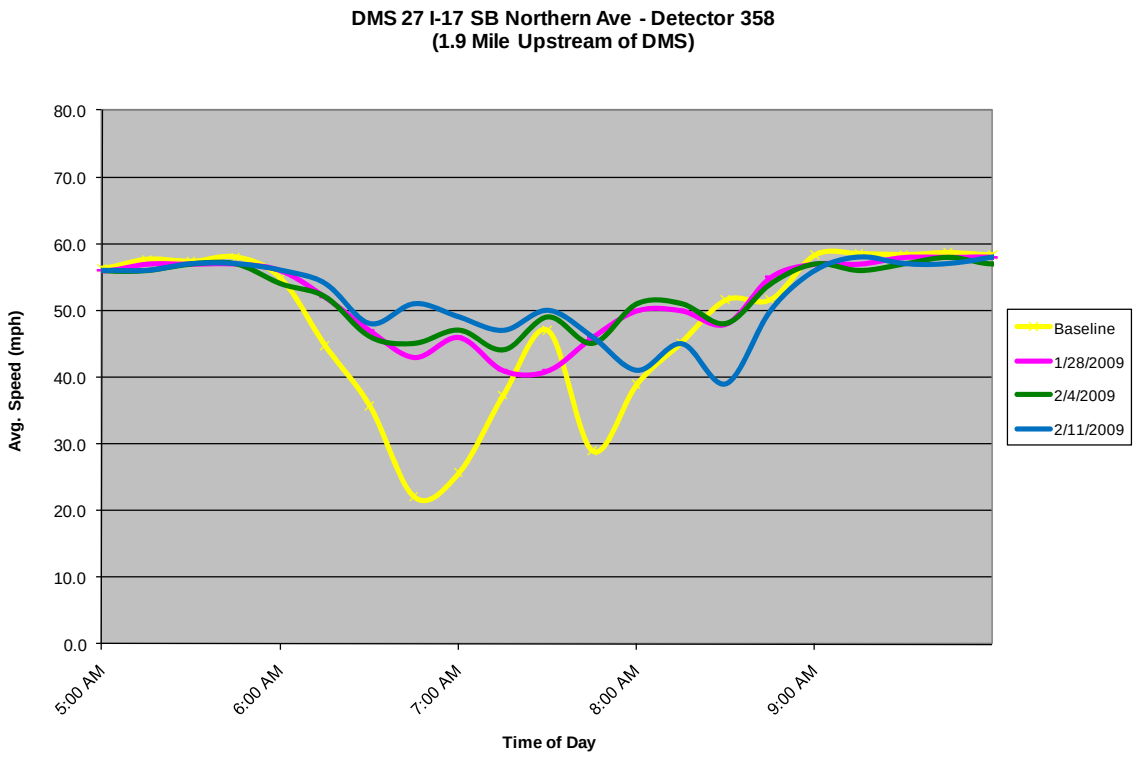




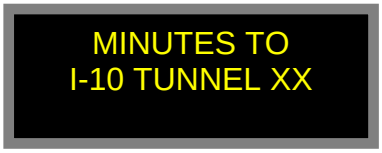
DMS 27 I-17 SB Northern Ave

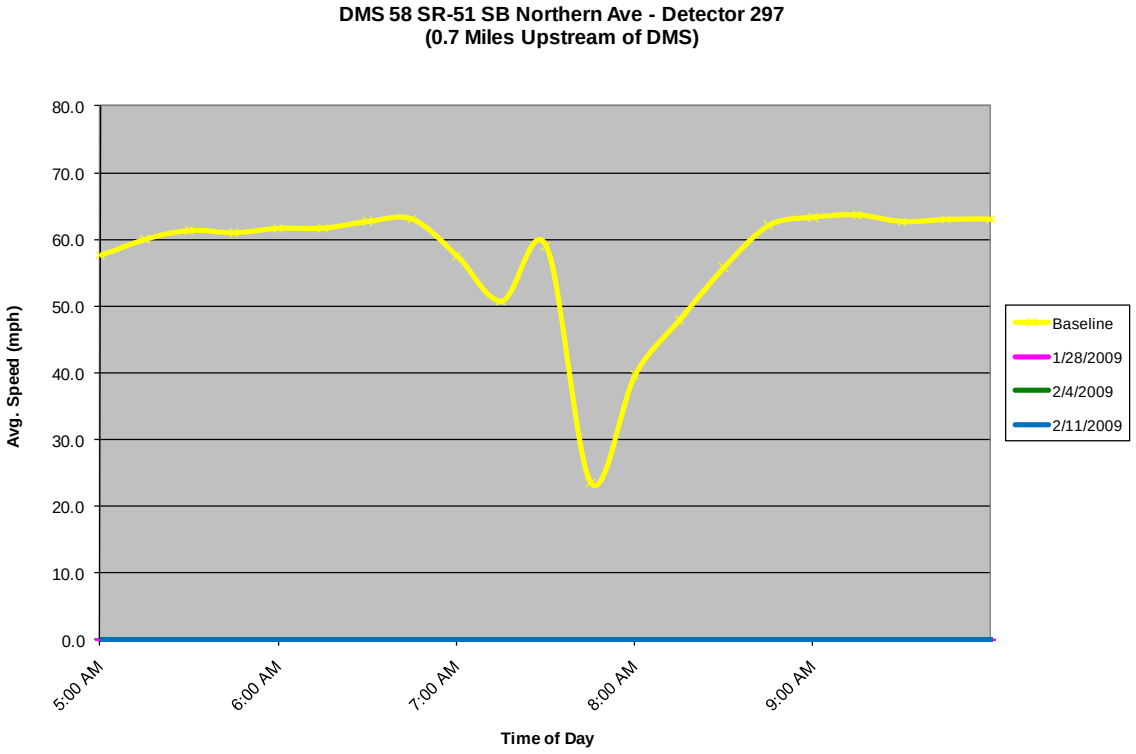
MINUTES TO
I-10 TUNNEL XX

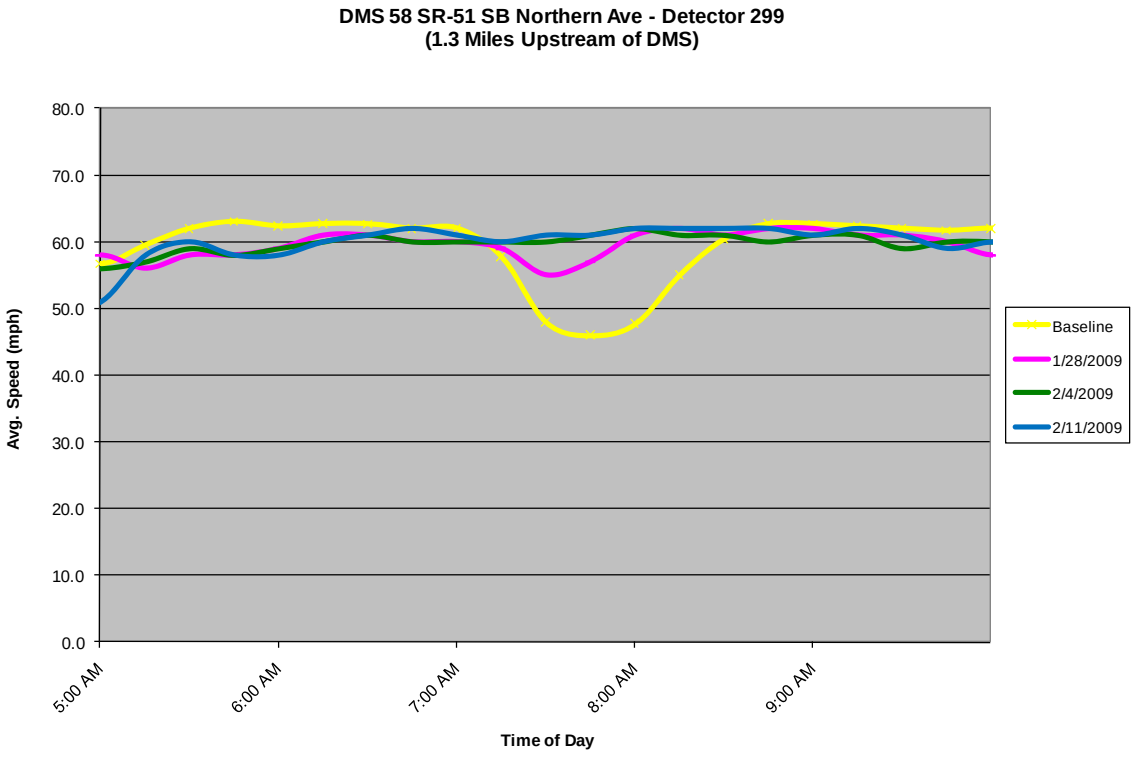




DMS 58 SR-51 SB Northern Ave

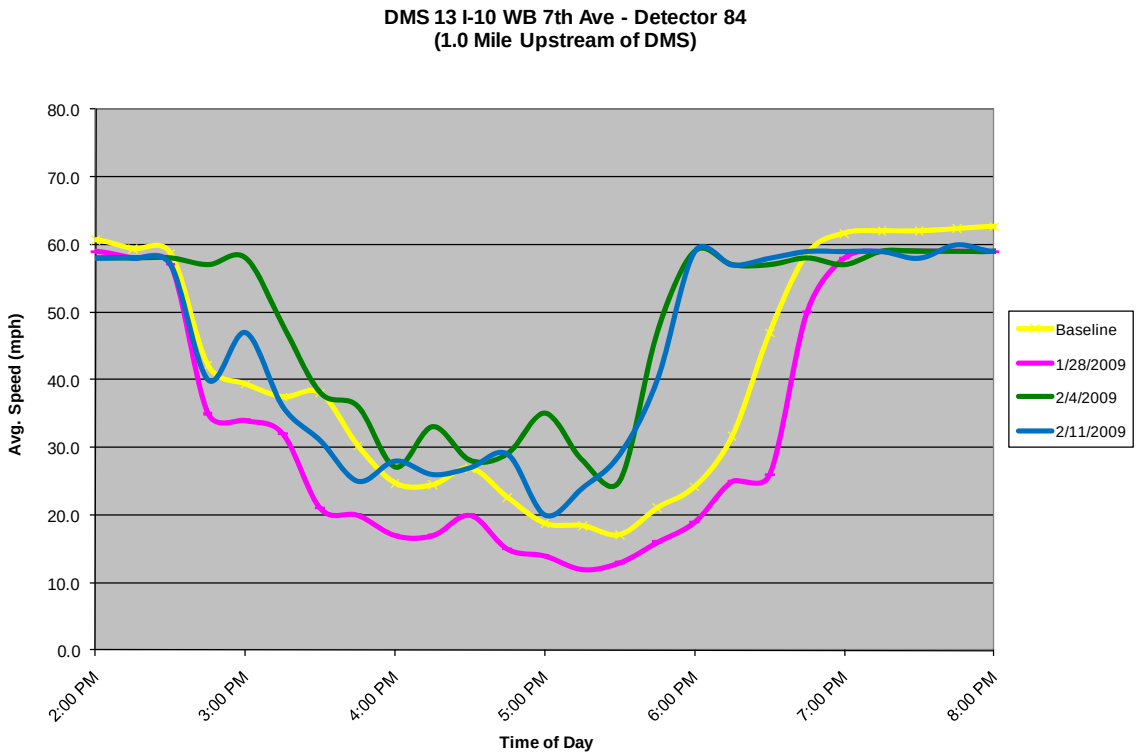


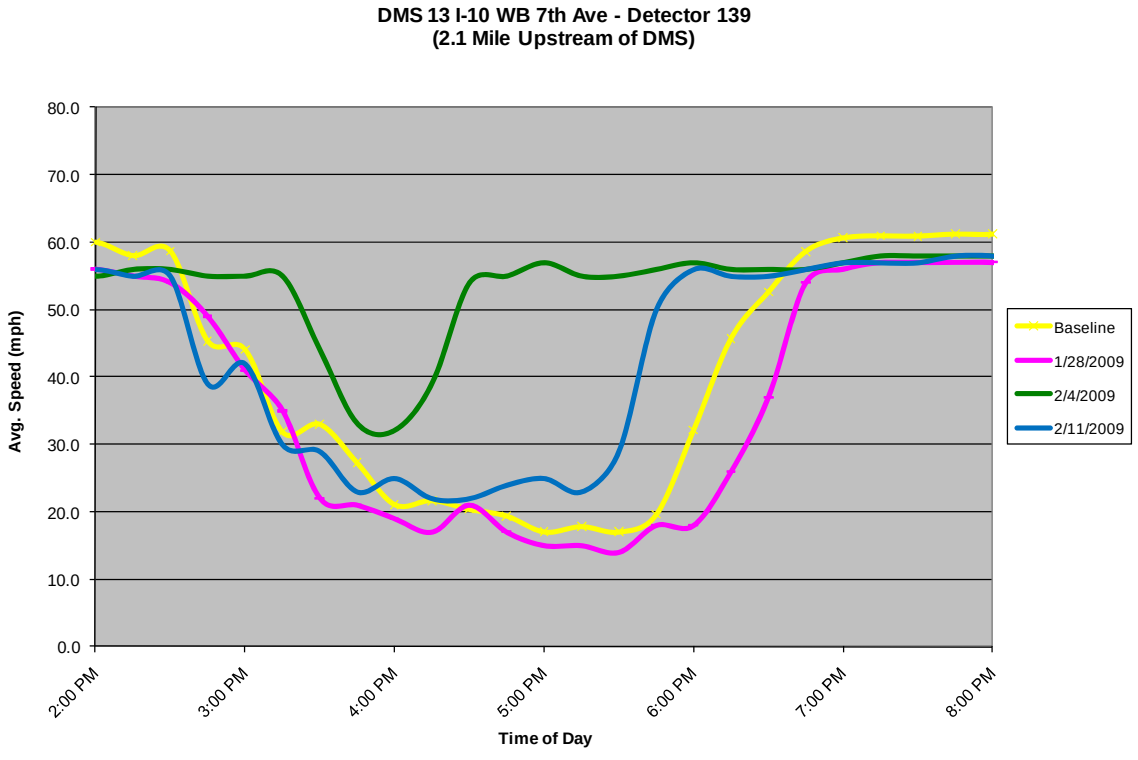




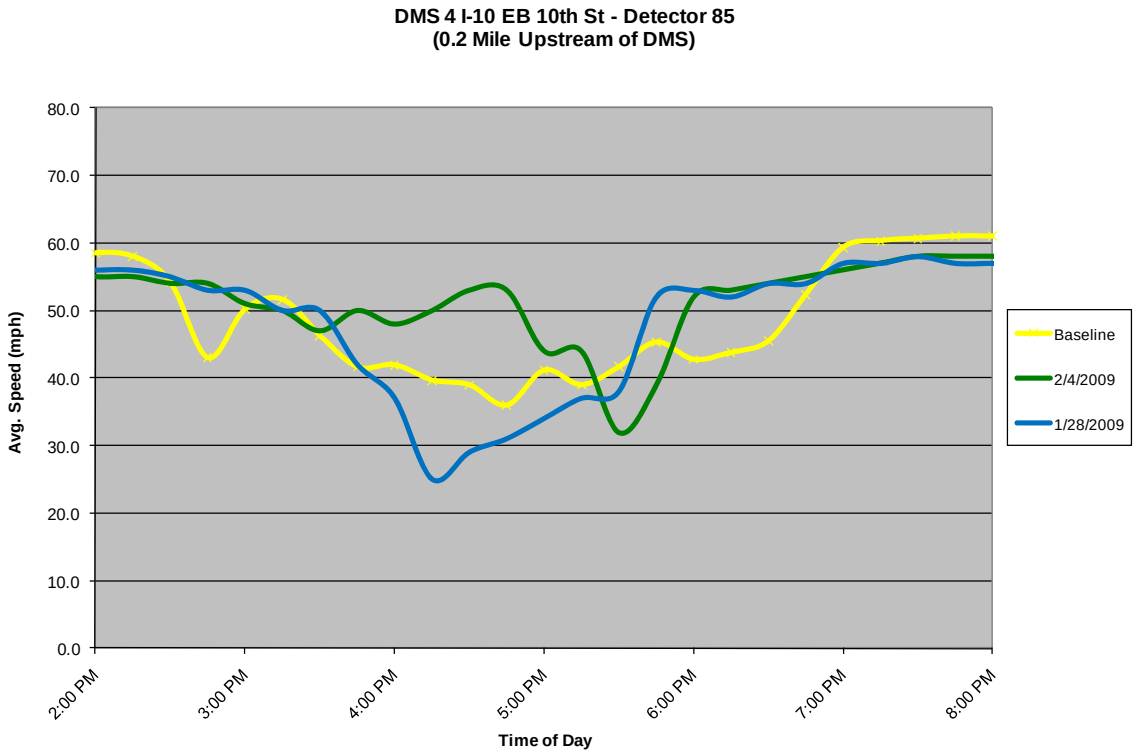
DMS 13 I-10 WB 7th Ave

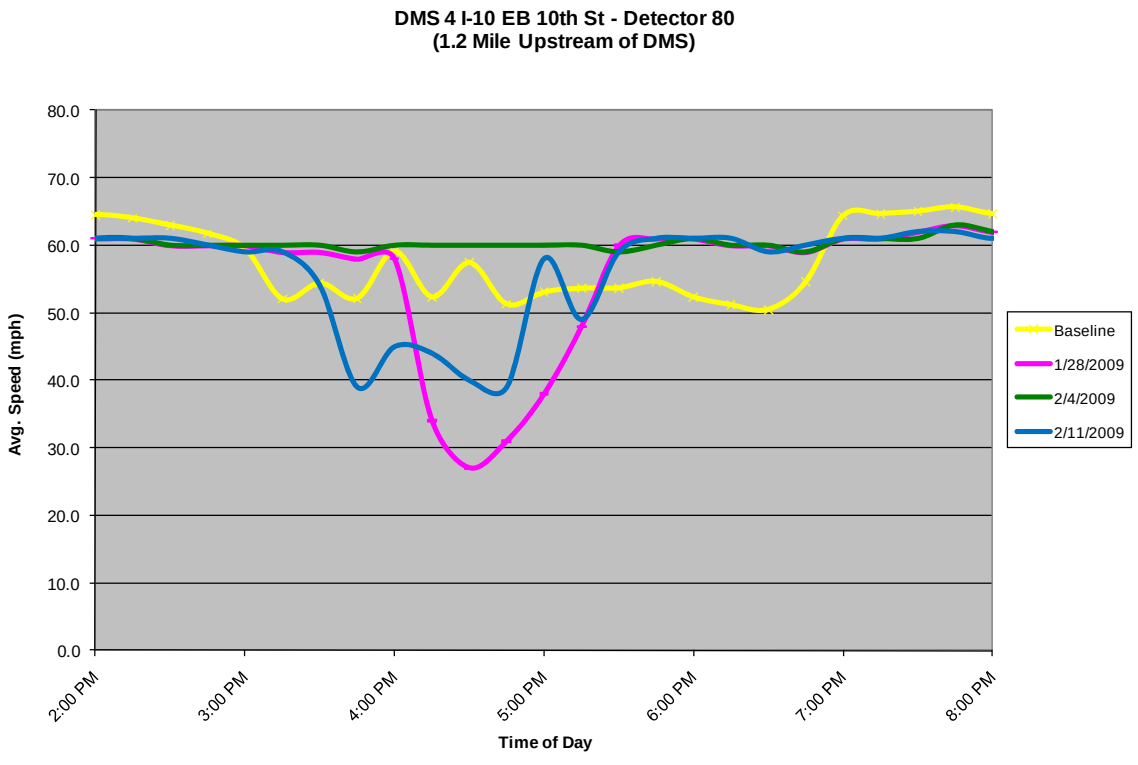
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





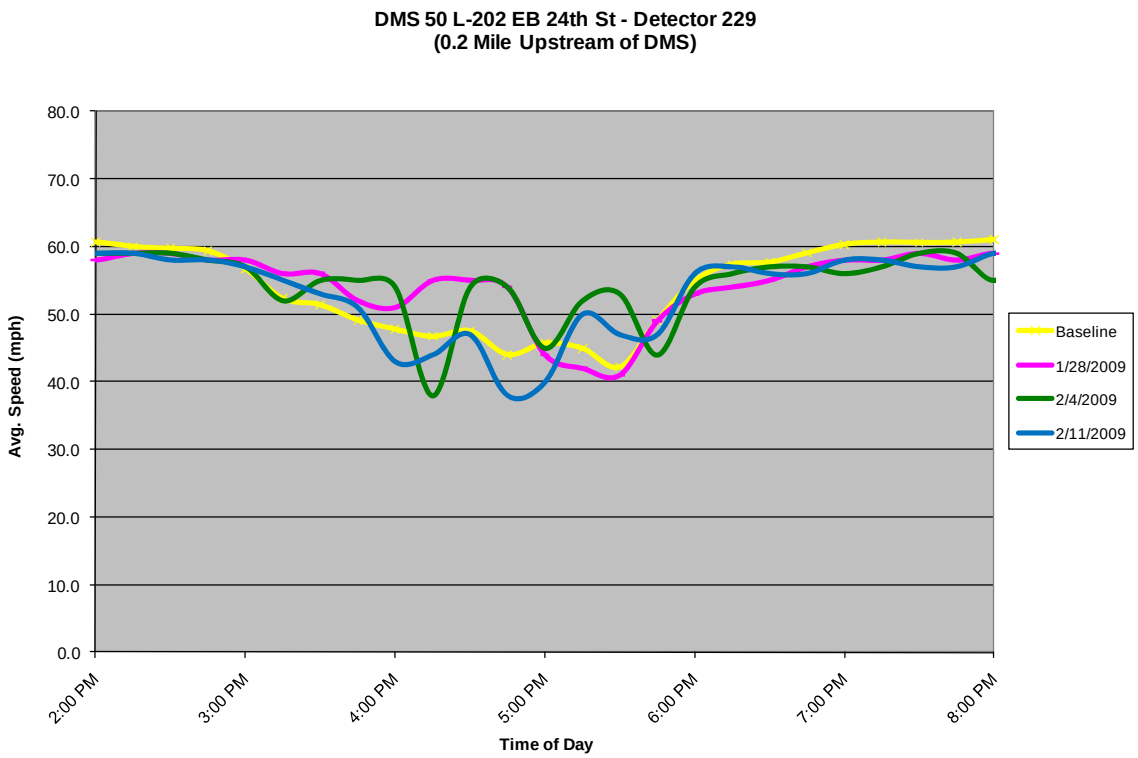
DMS 4 I-10 EB 10th St





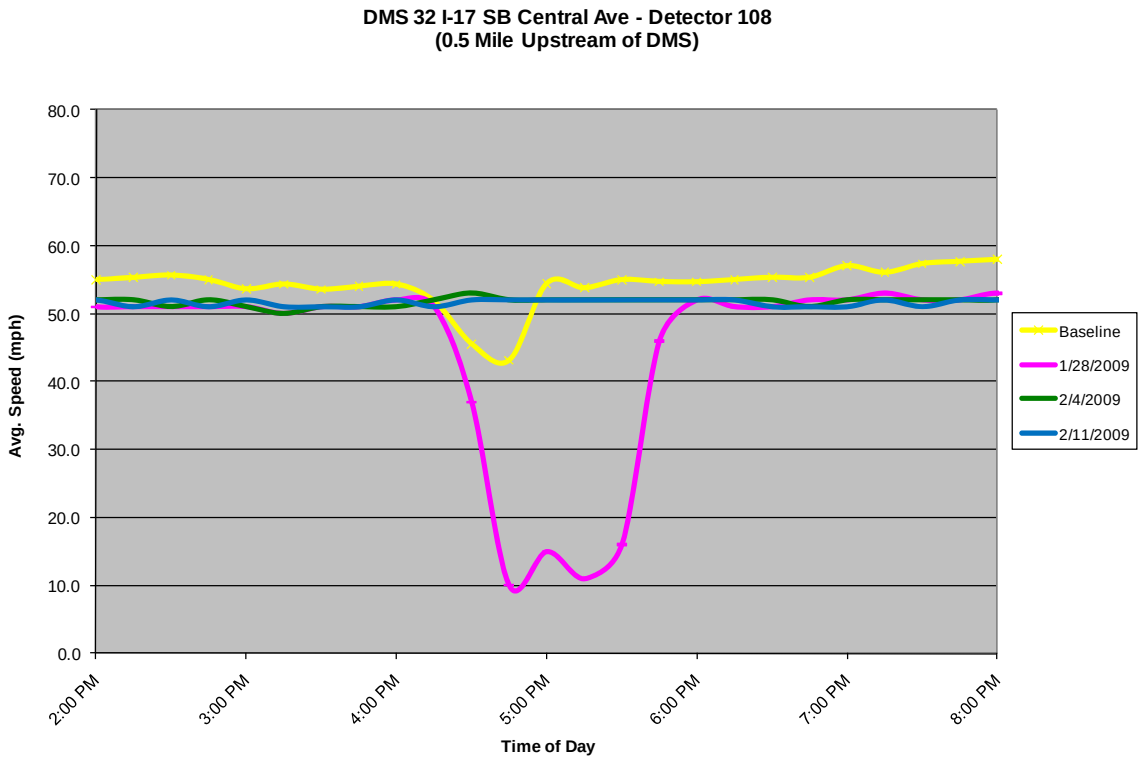
DMS 50 L-202 EB 24th ST

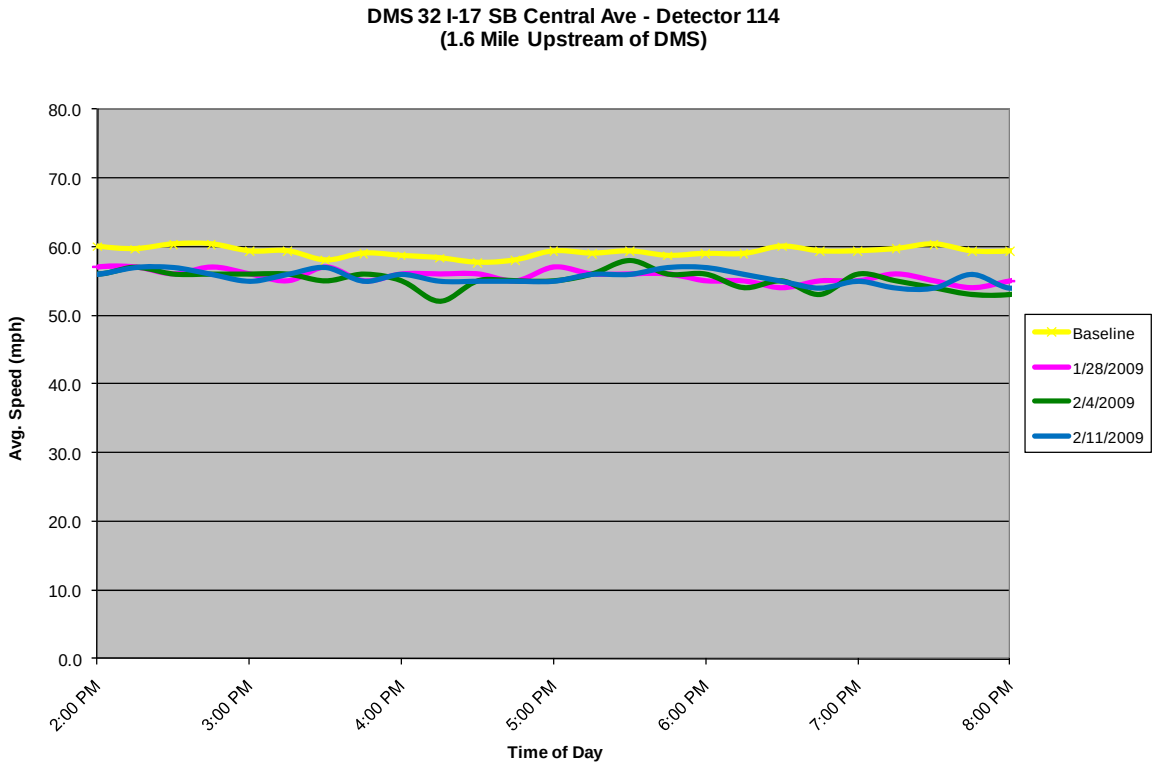
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

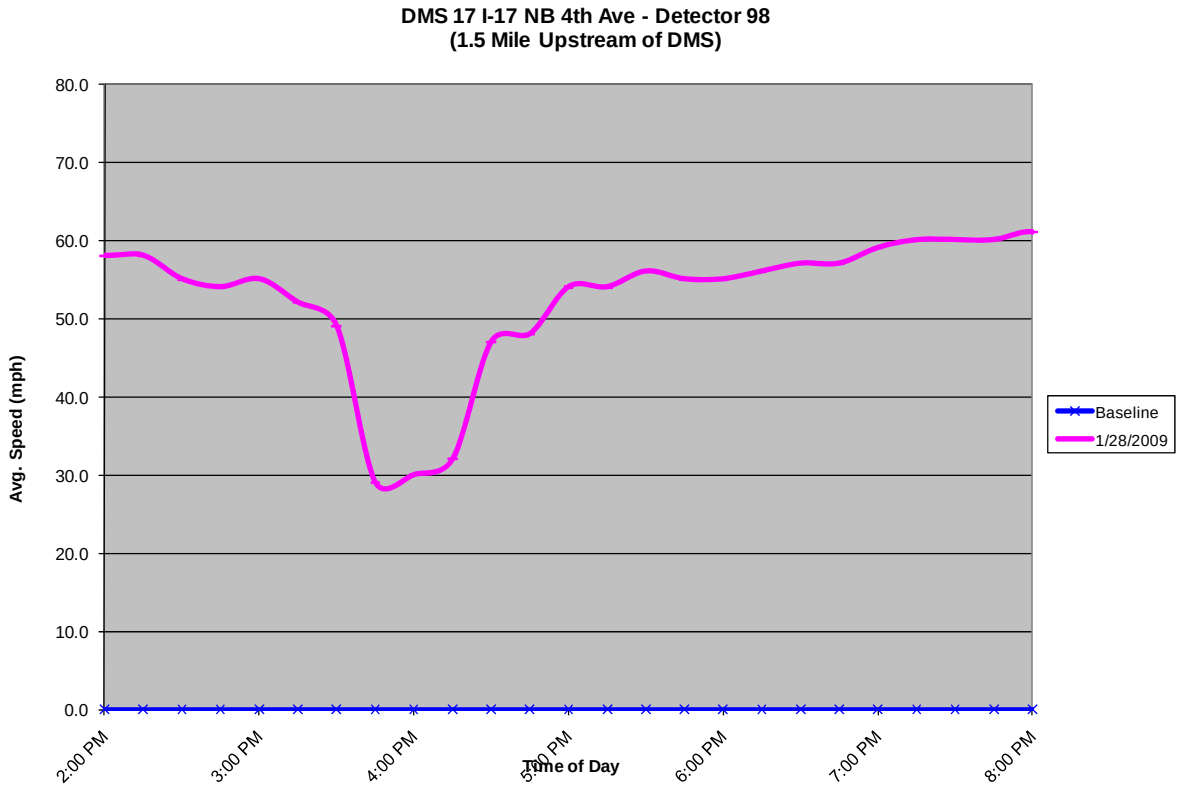




DMS 17 I-17 NB 4th Ave

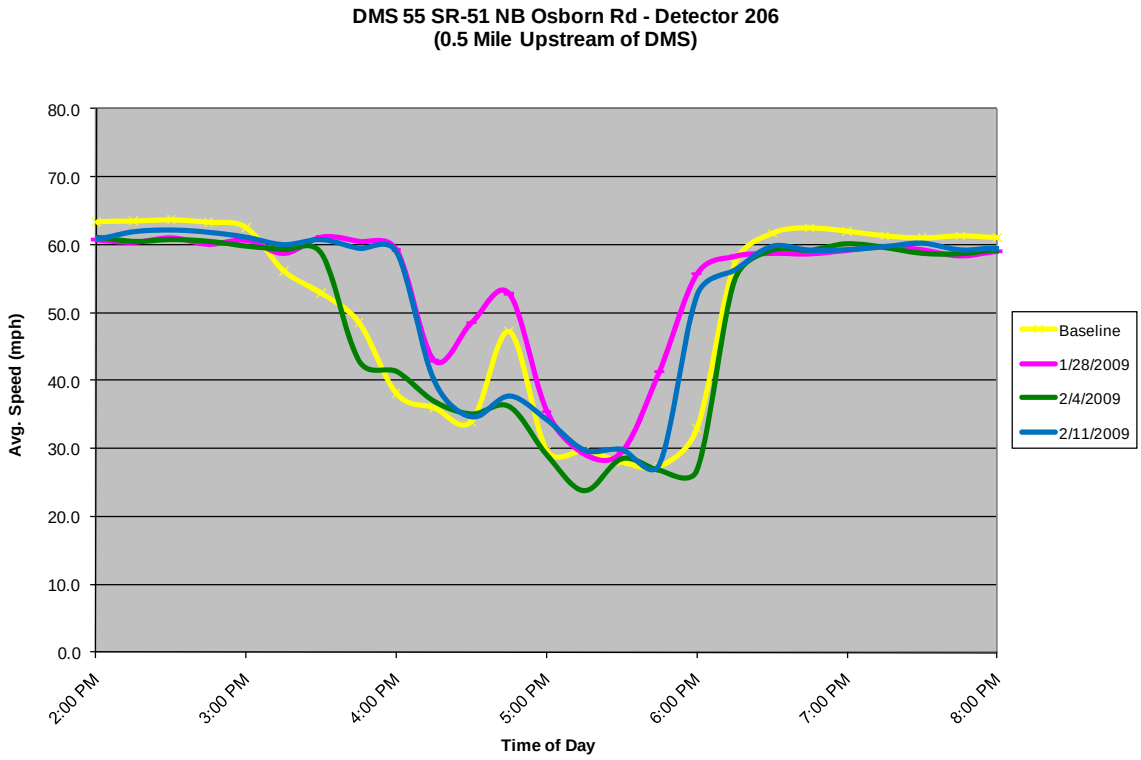
MINUTES TO
PEORIA AVE XX
I-10 83RD AVE YY

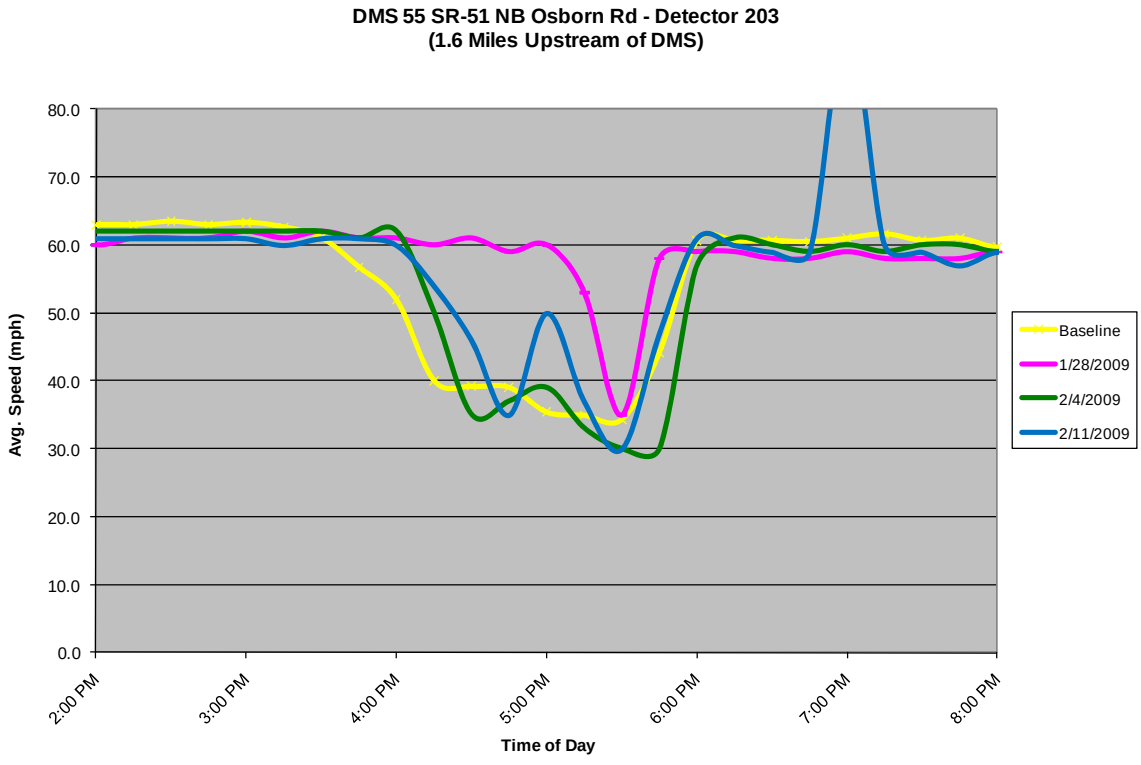
No Available Data on Detector 104



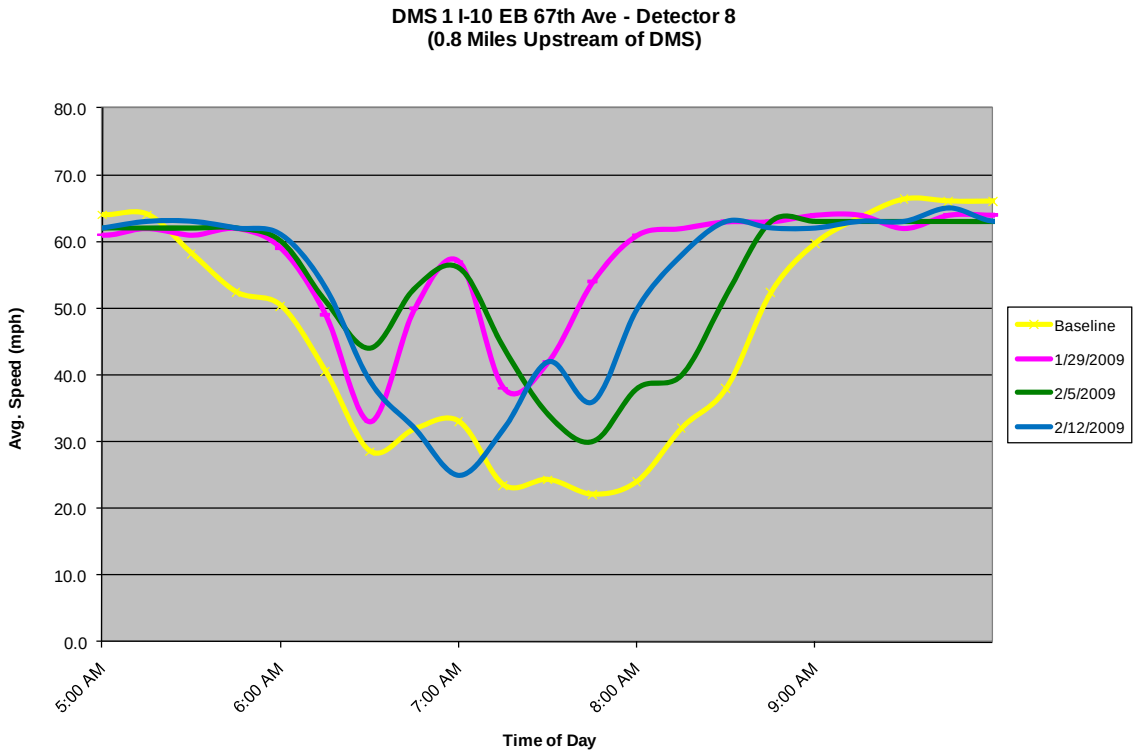
DMS 55 SR-51 NB Osborn Rd

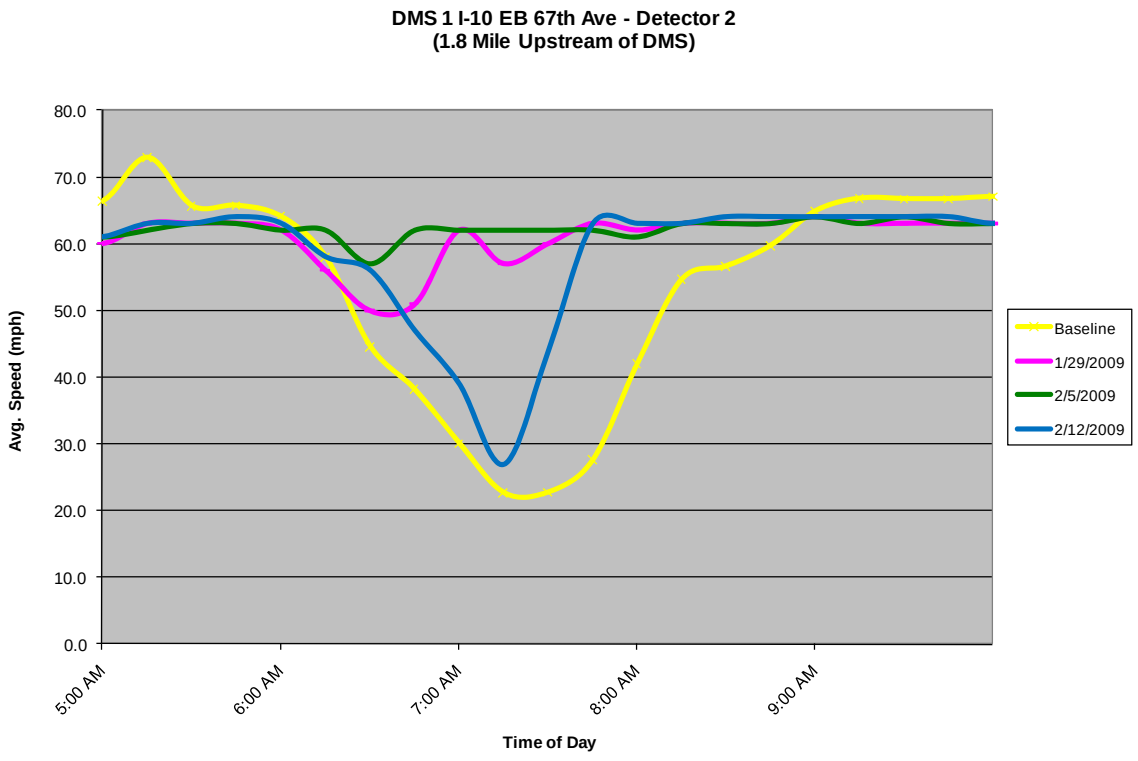
MINUTES TO
BELL RD XX





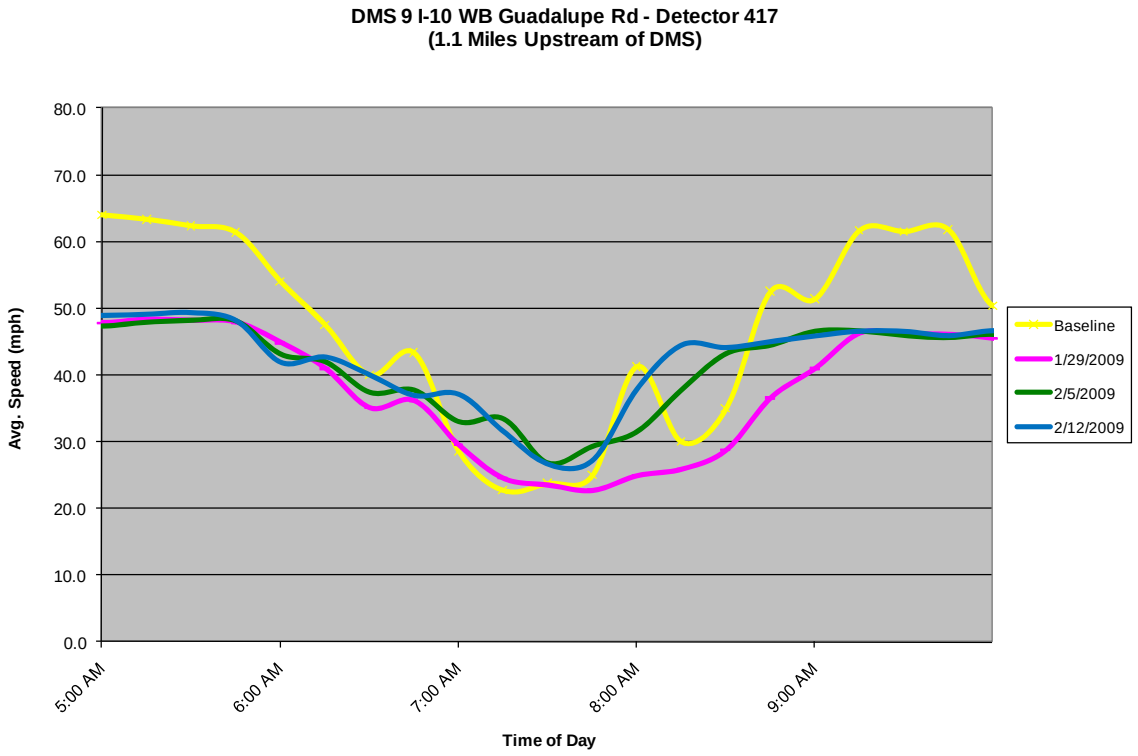
DMS 1 I-10 EB 67th Ave

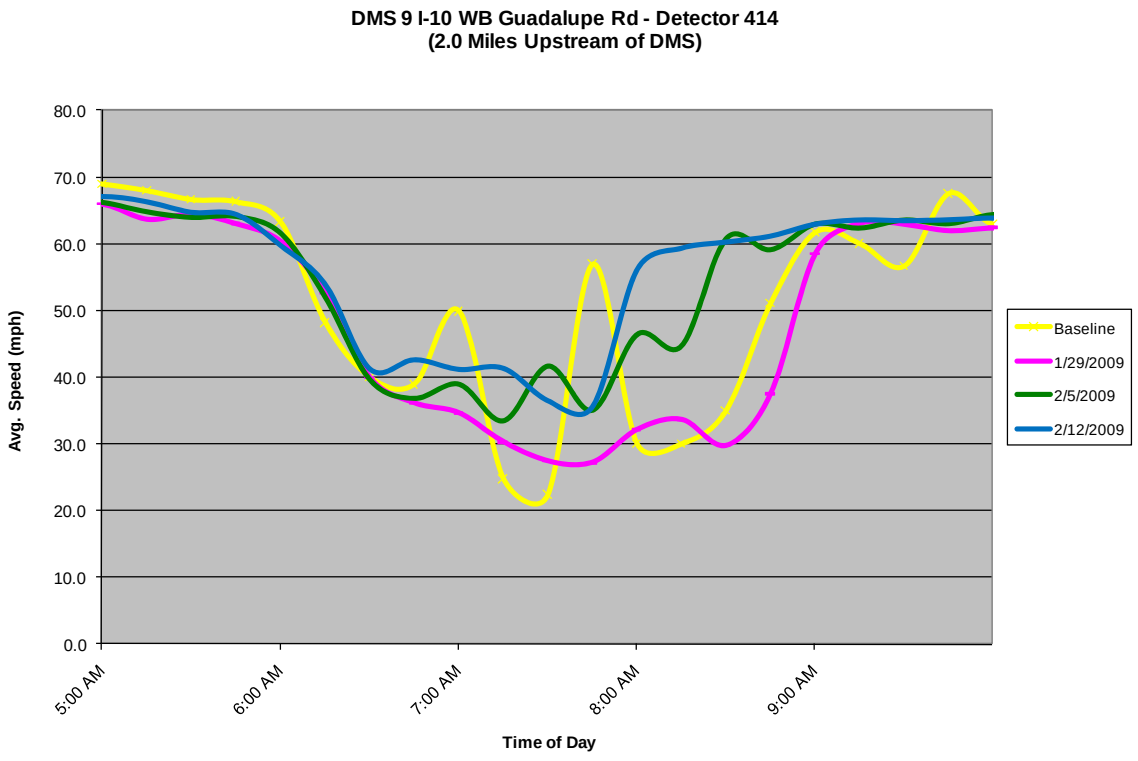




DMS 9 I-10 WB Guadalupe Rd

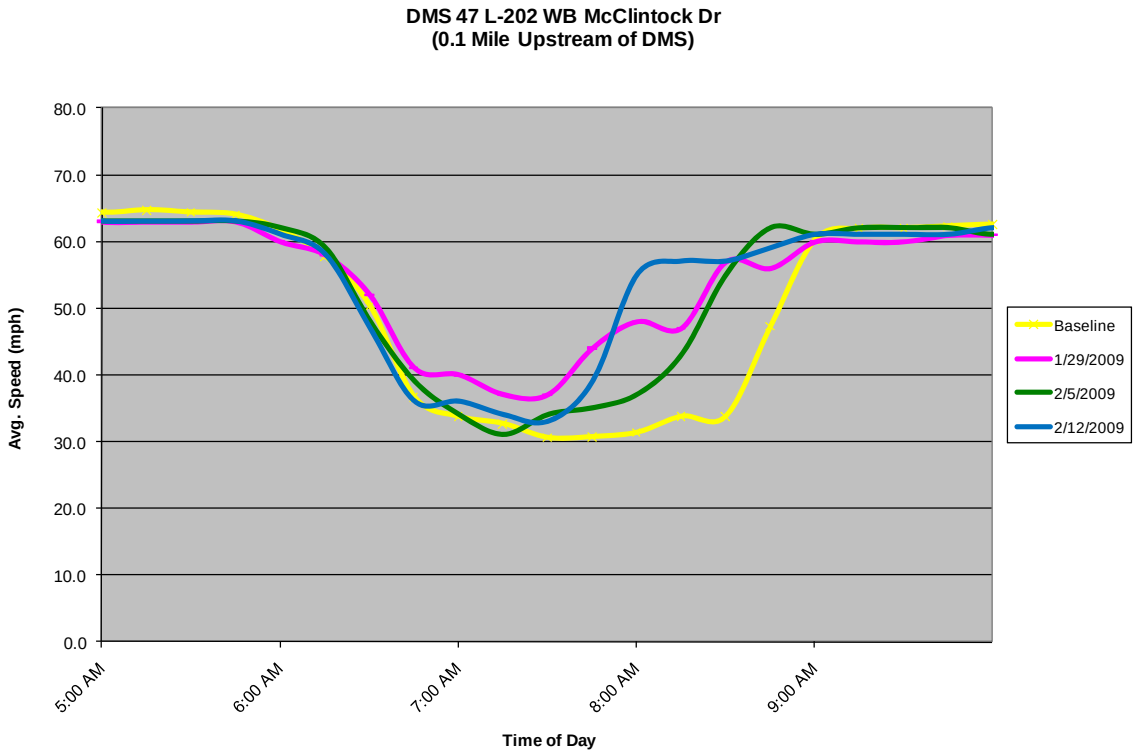
MINUTES TO
SR-143 XX
TUNNEL YY



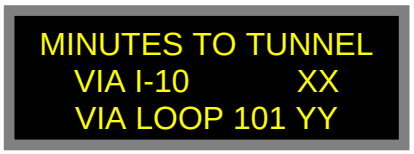


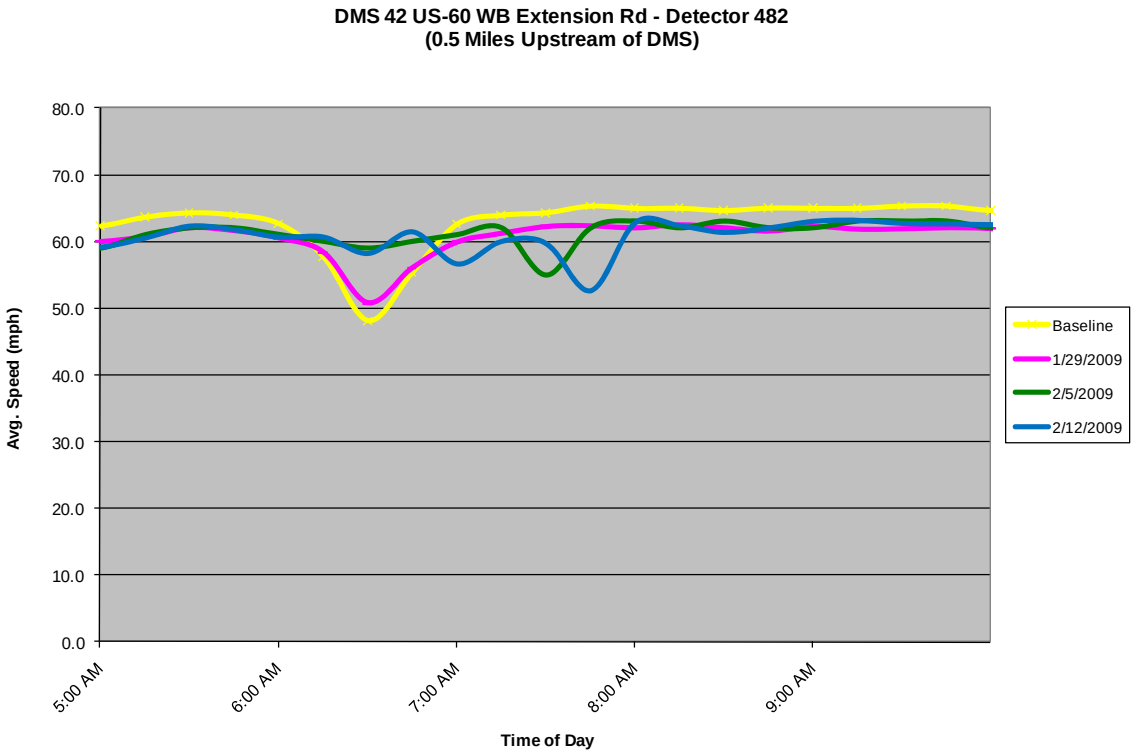
DMS 47 L-202 WB McClintock Dr

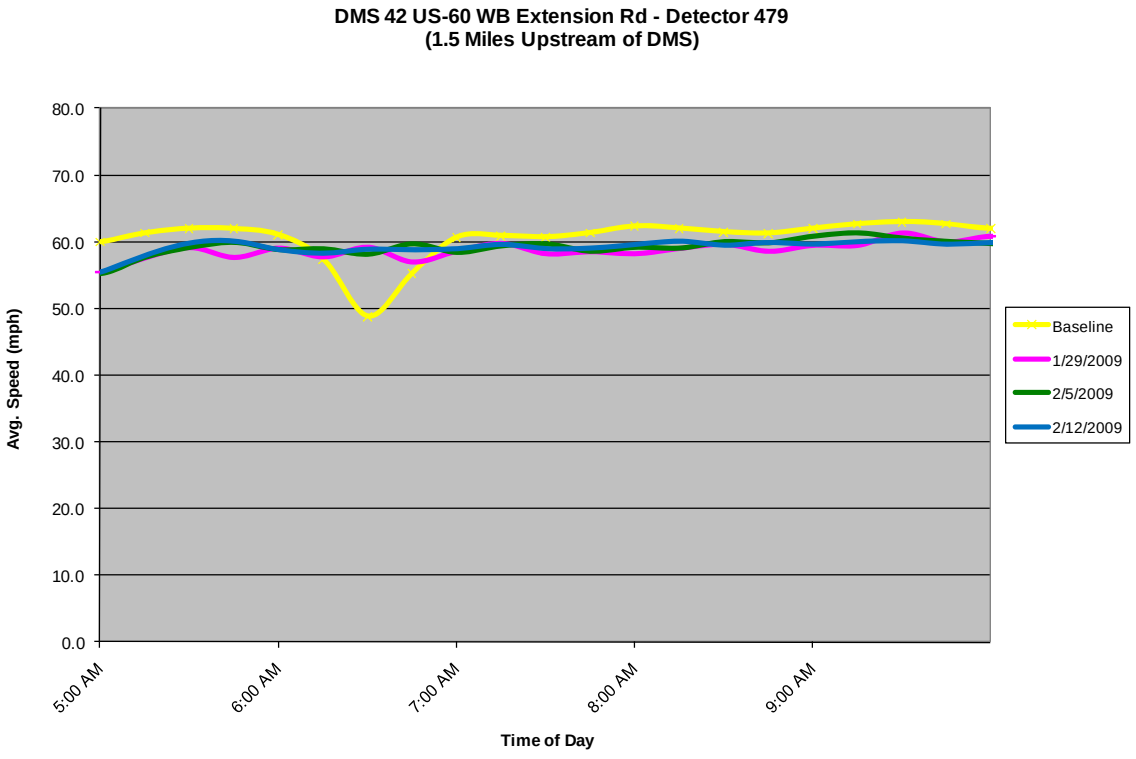
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

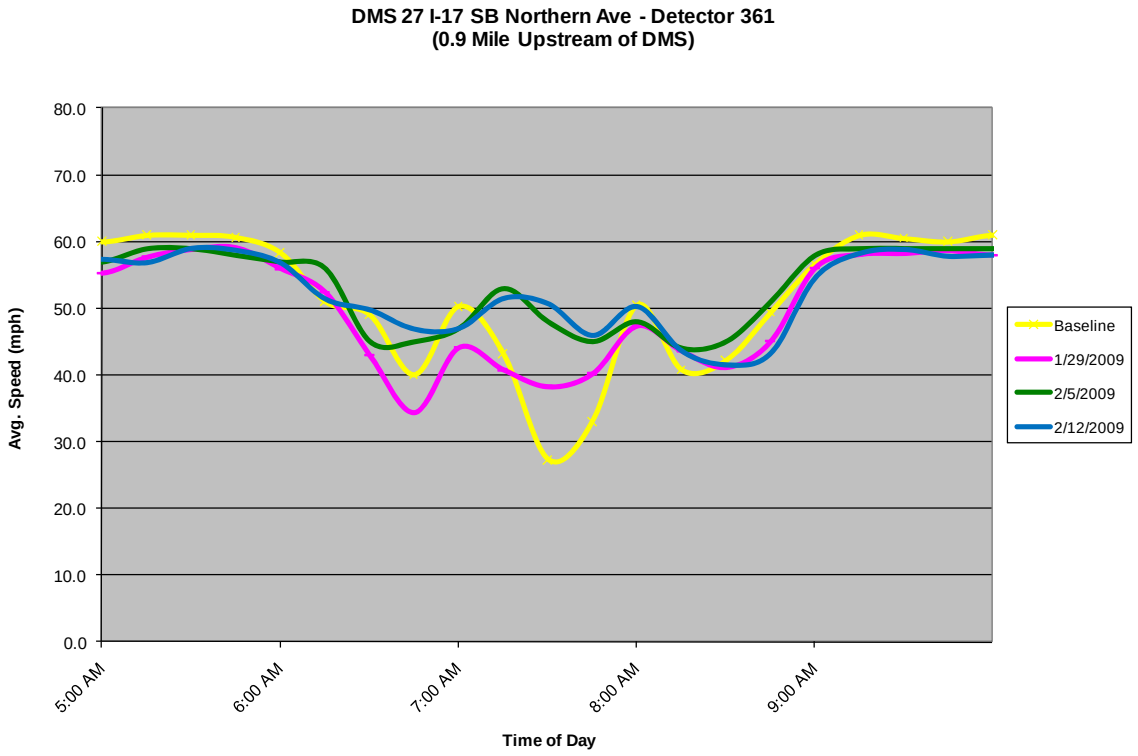


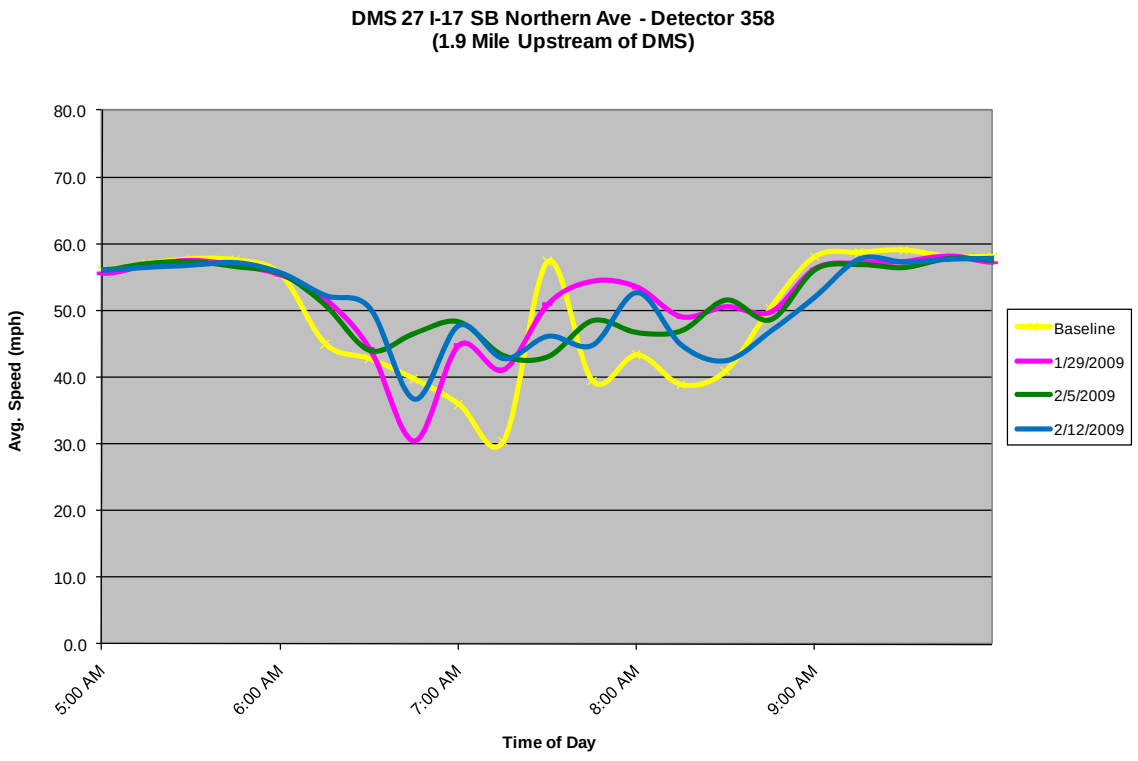




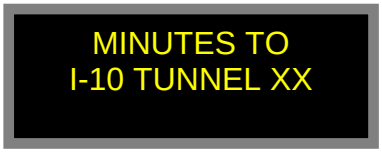
DMS 27 I-17 SB Northern Ave

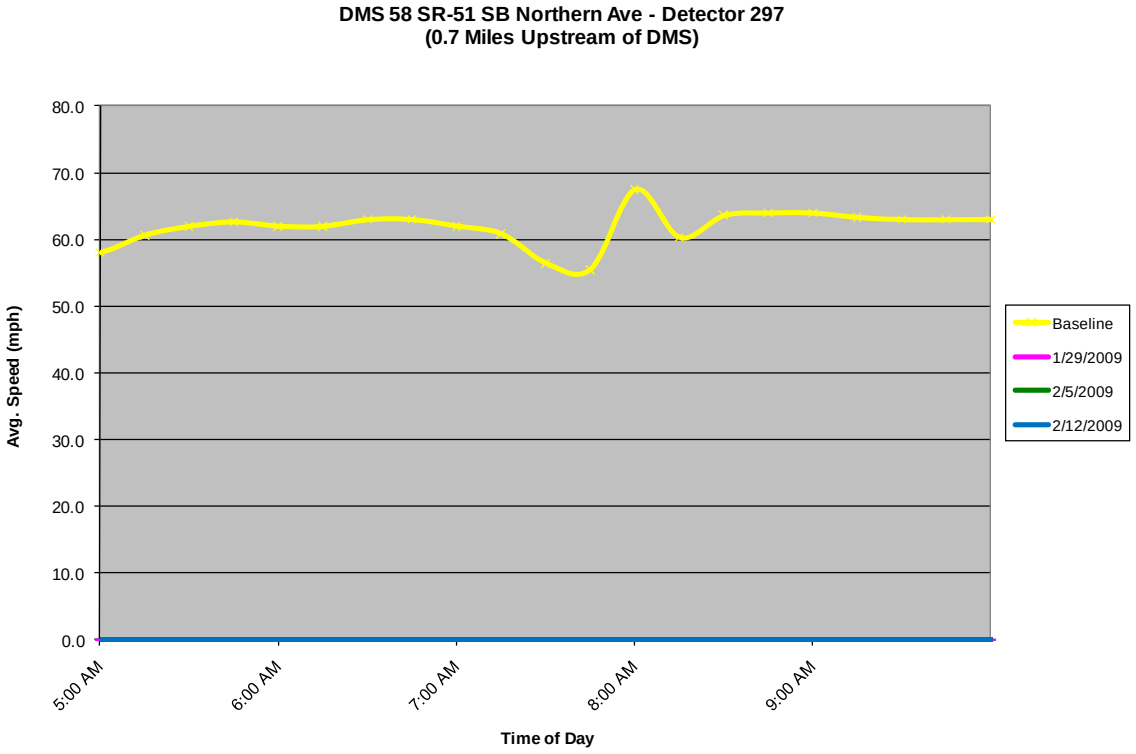
MINUTES TO
I-10 TUNNEL XX

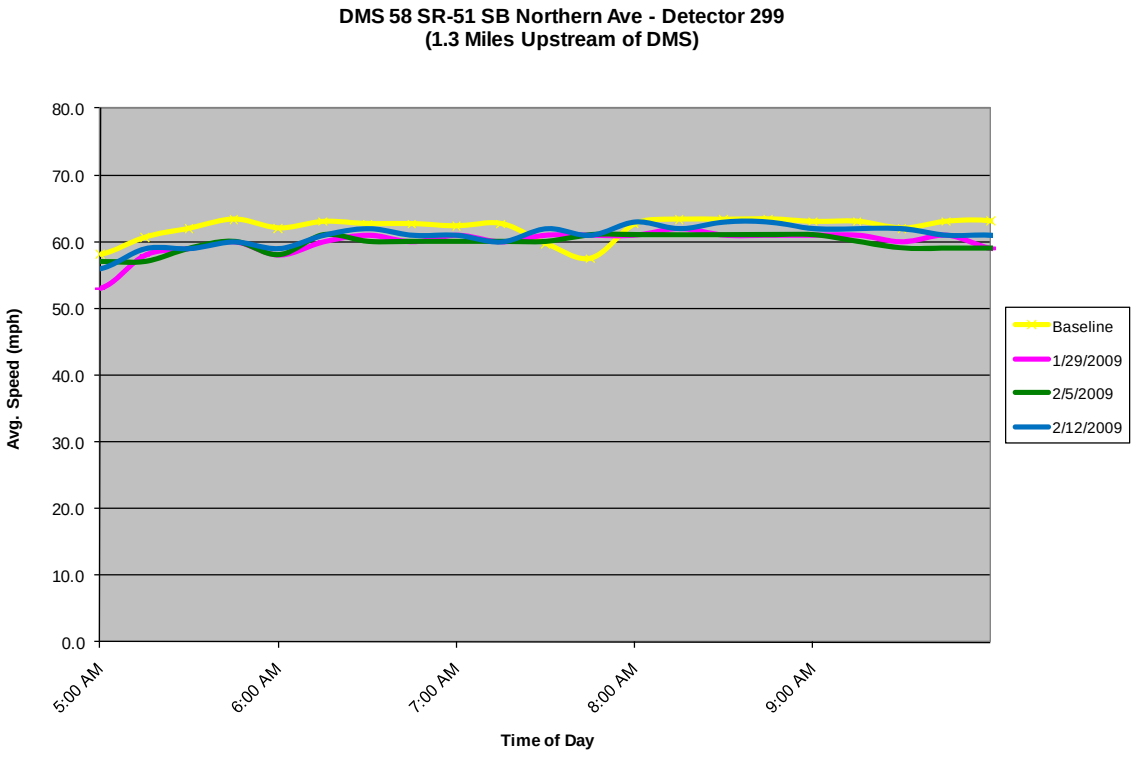




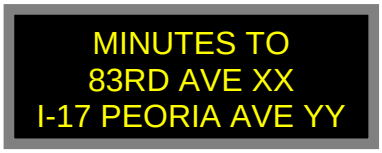
DMS 58 SR-51 SB Northern Ave

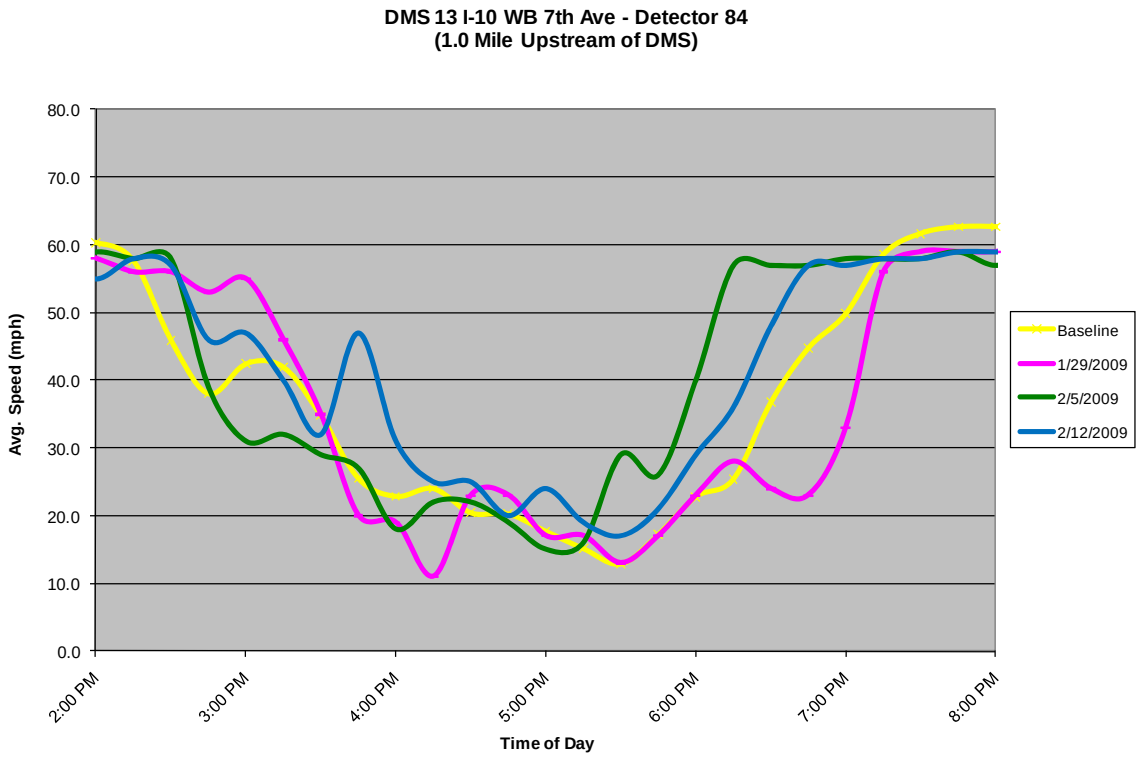


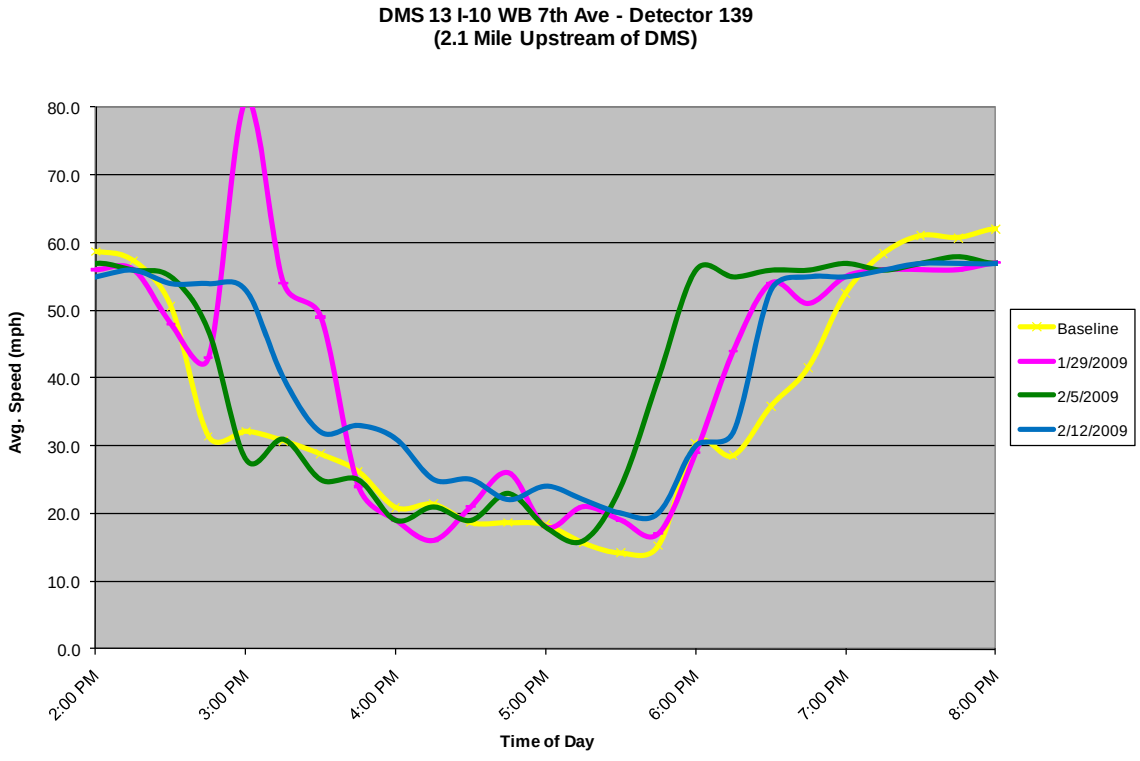




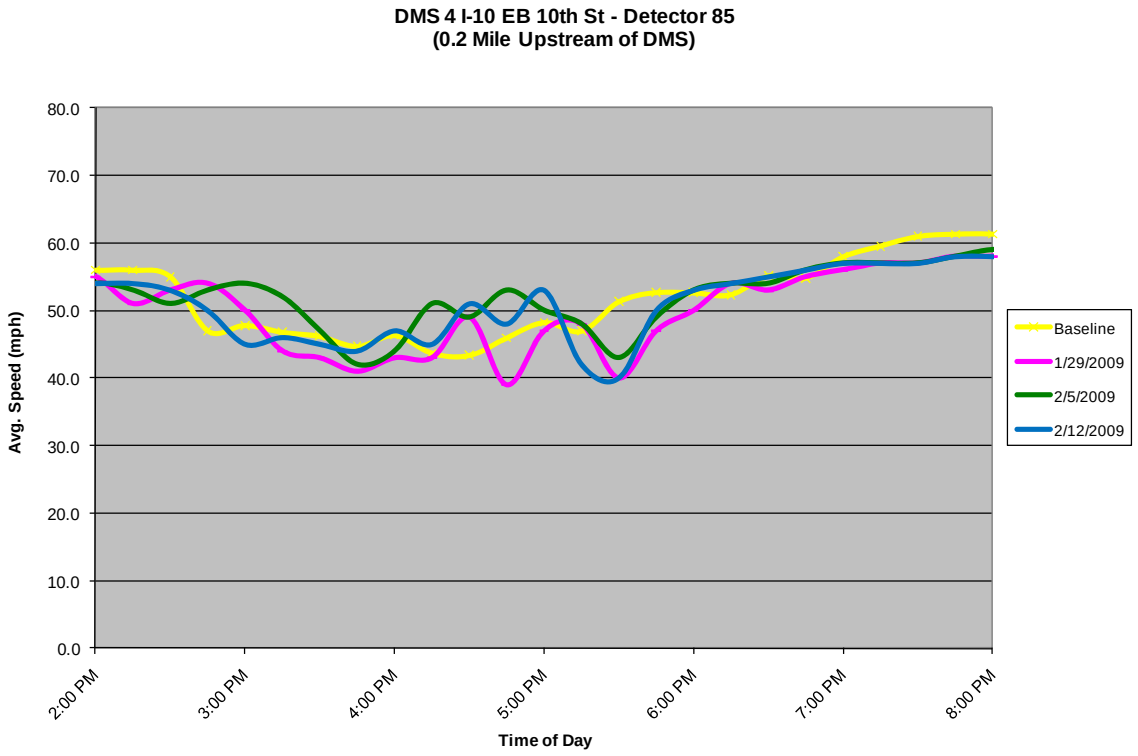
DMS 13 I-10 WB 7th Ave

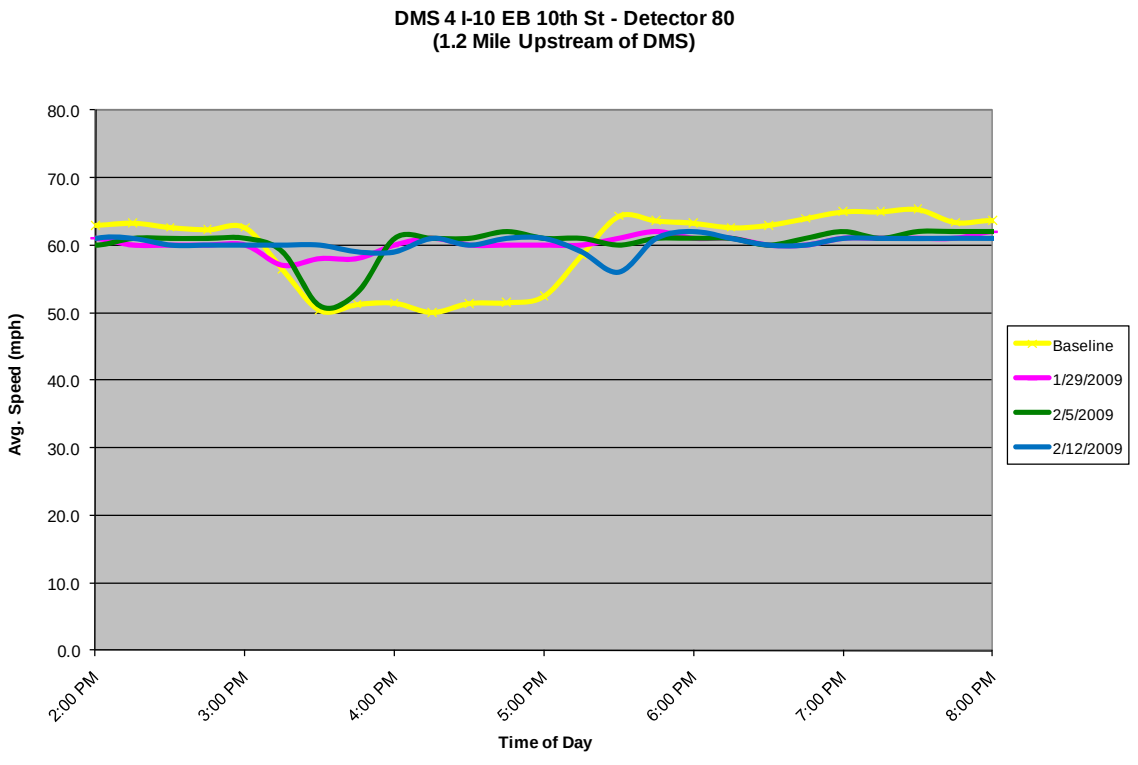






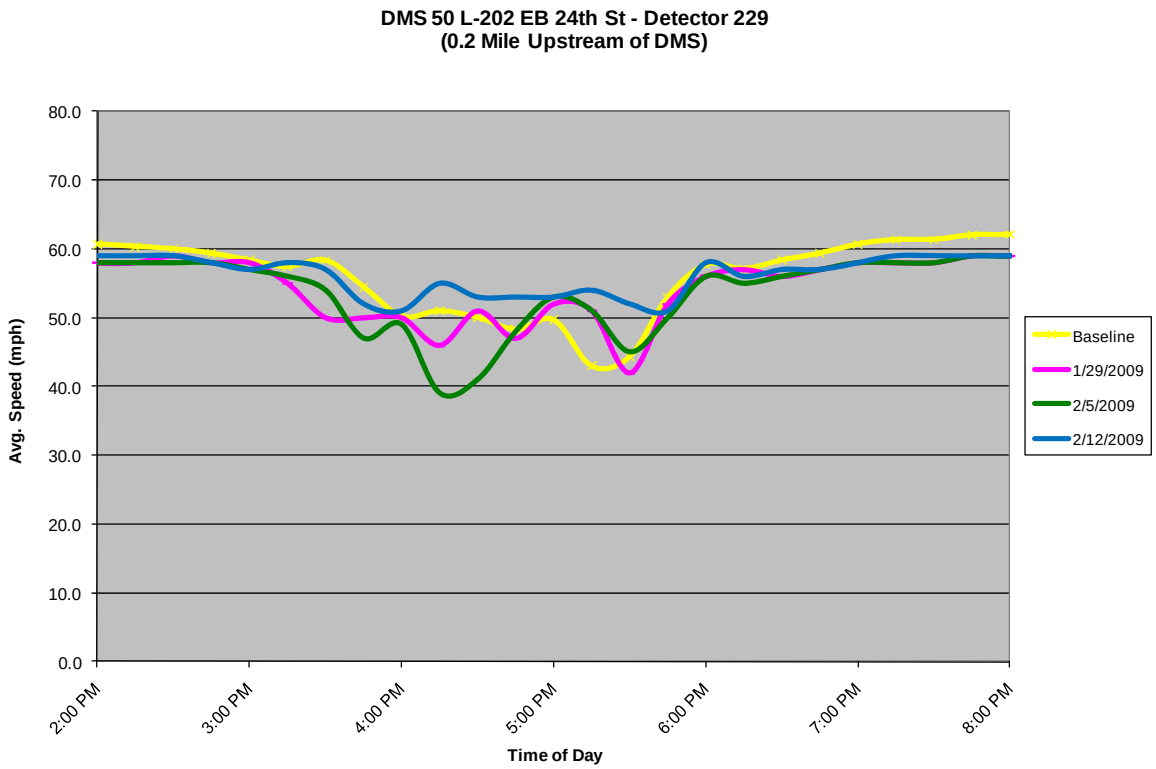
DMS 4 I-10 EB 10th St





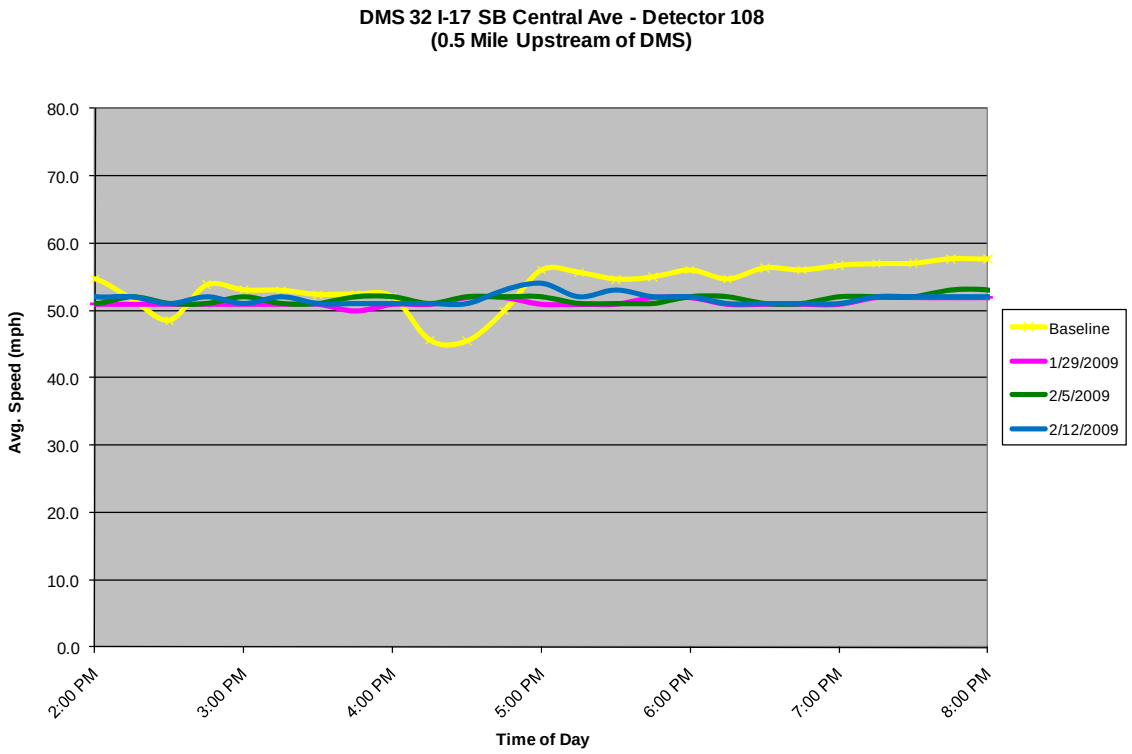
DMS 50 L-202 EB 24th ST

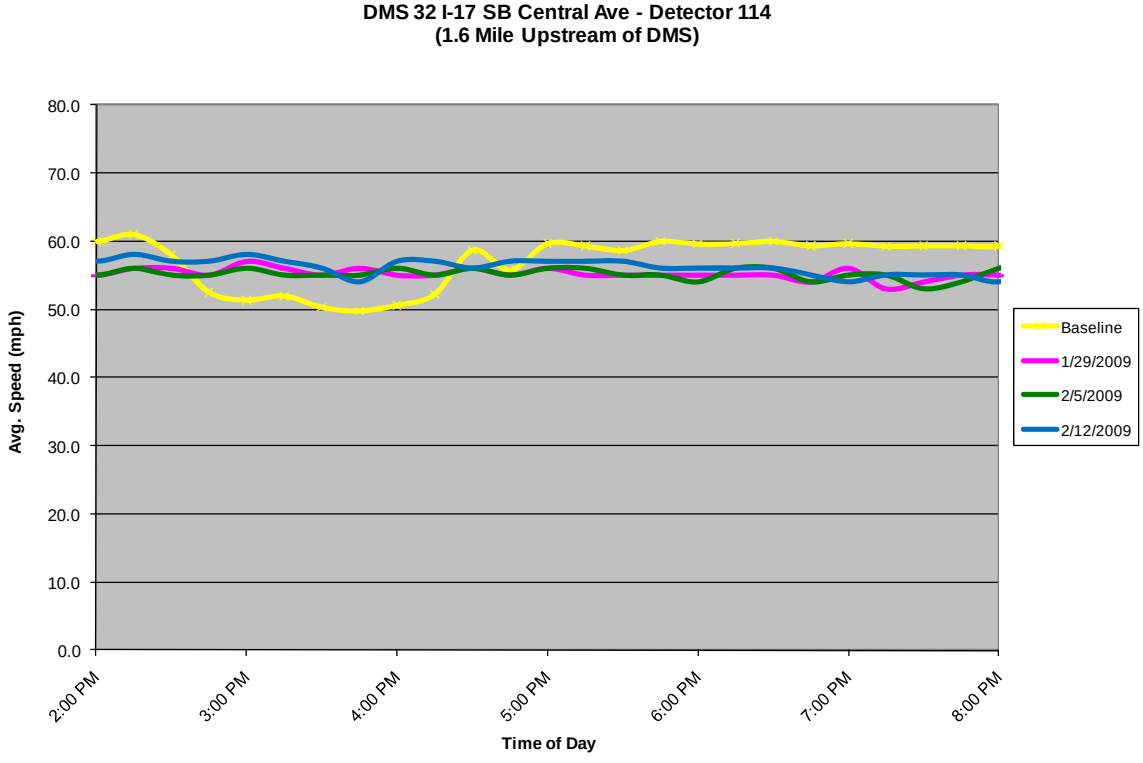
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

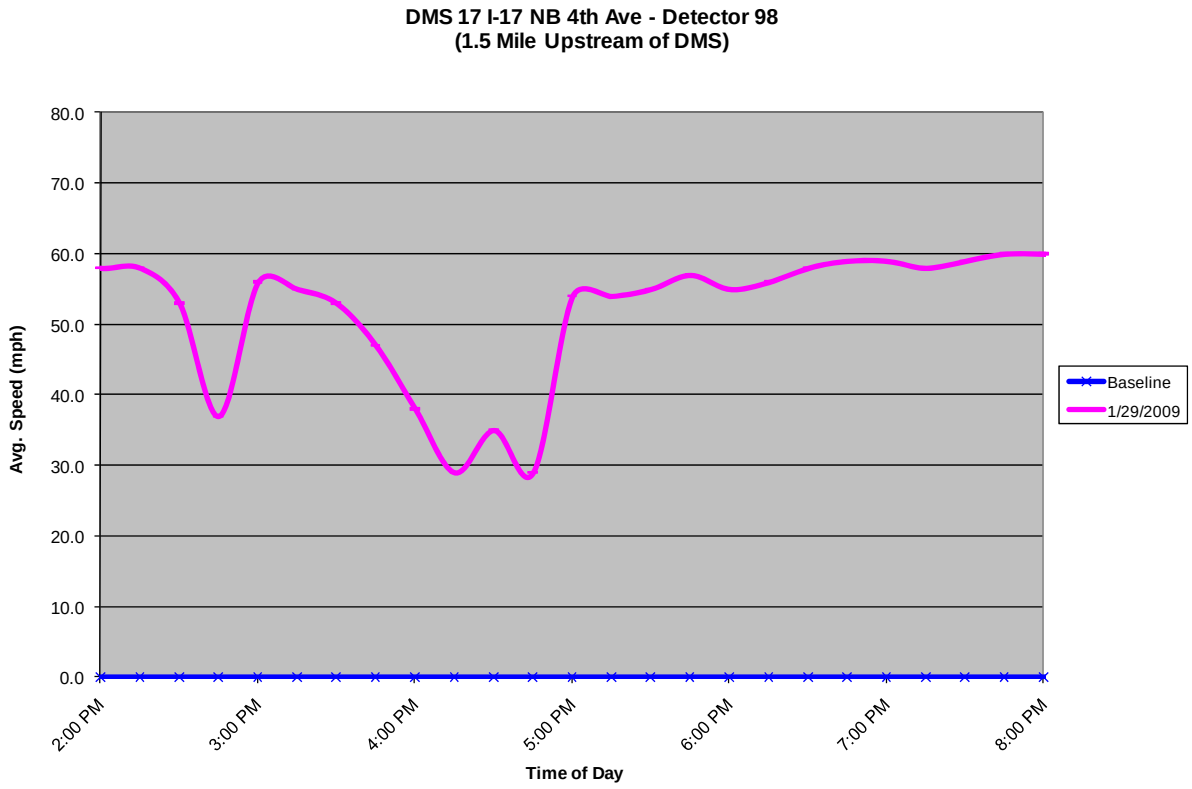




DMS 17 I-17 NB 4th Ave

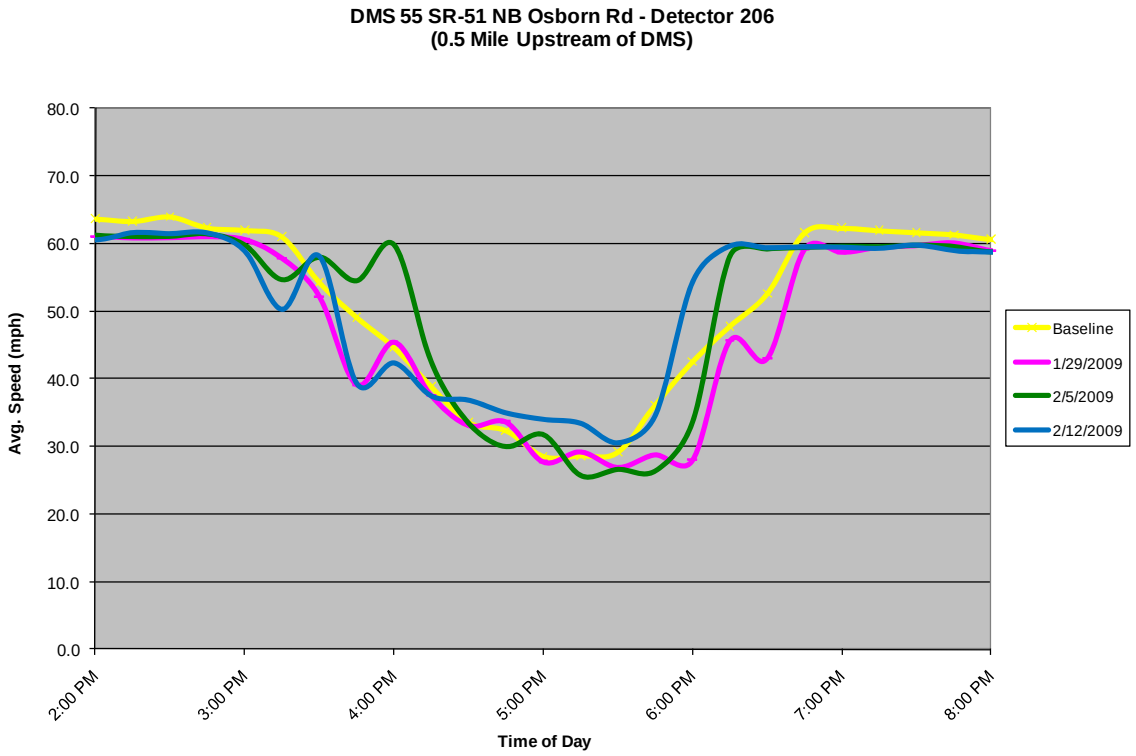
MINUTES TO
PEORIA AVE XX
I-10 83RD AVE YY

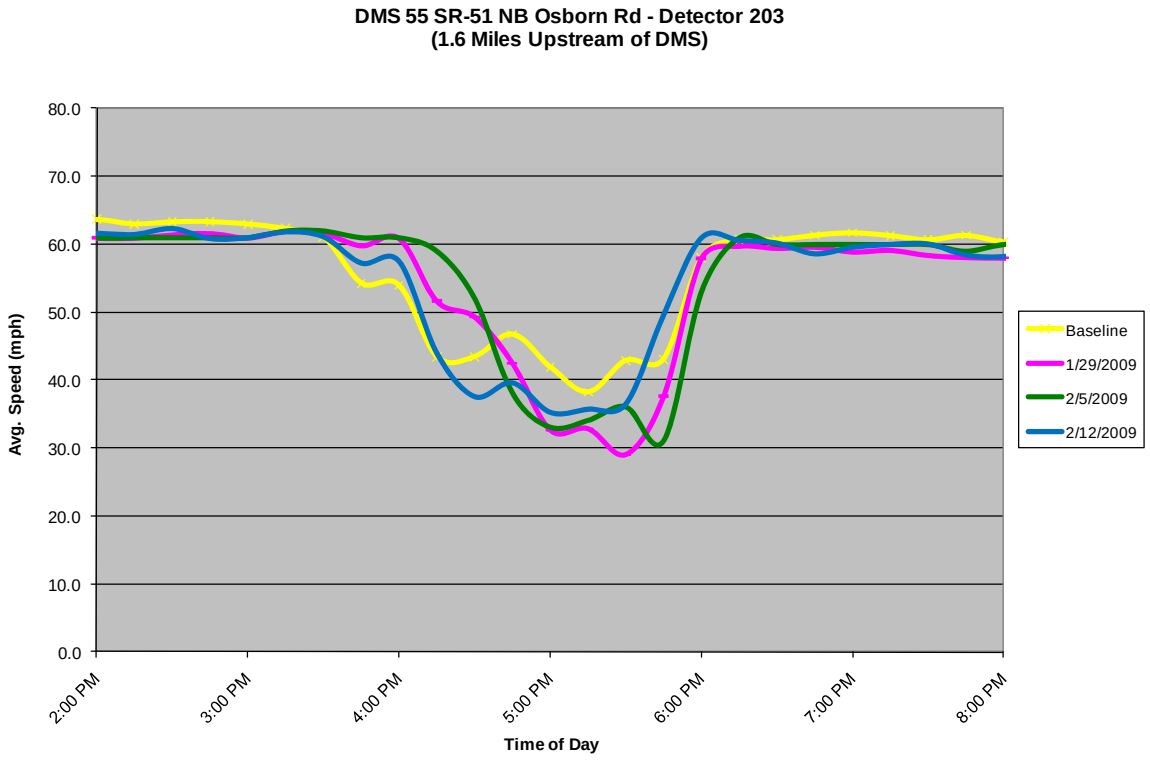
No Available Data on Detector 104



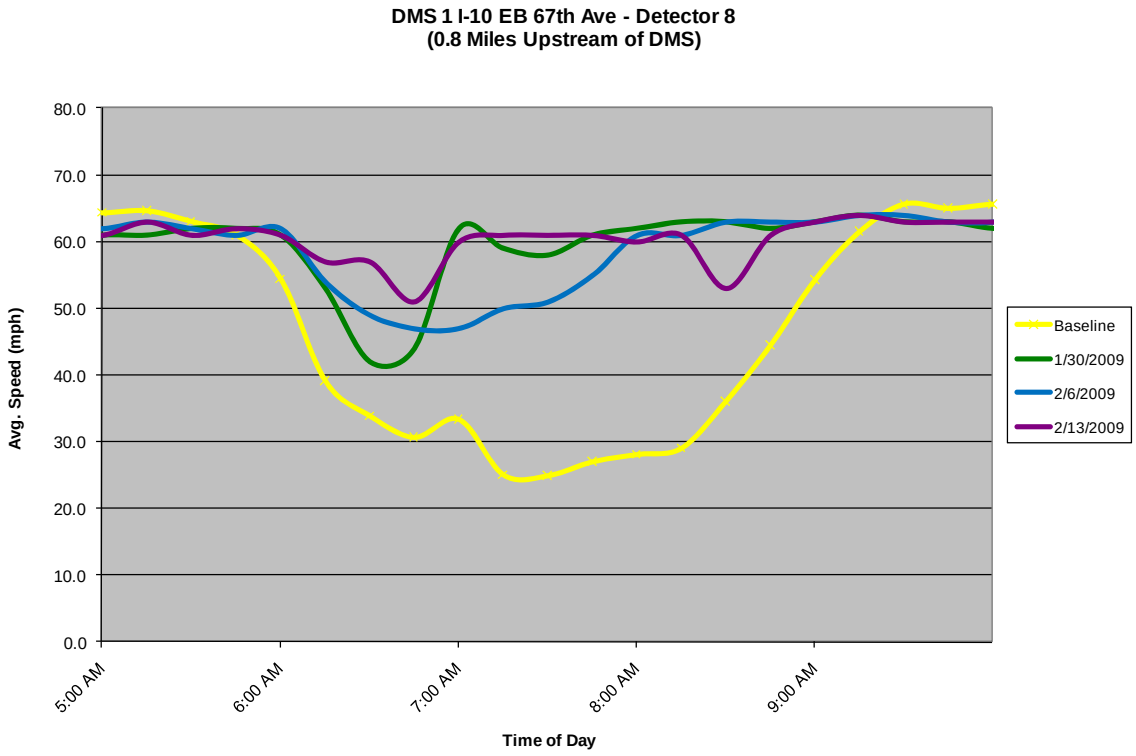
DMS 55 SR-51 NB Osborn Rd

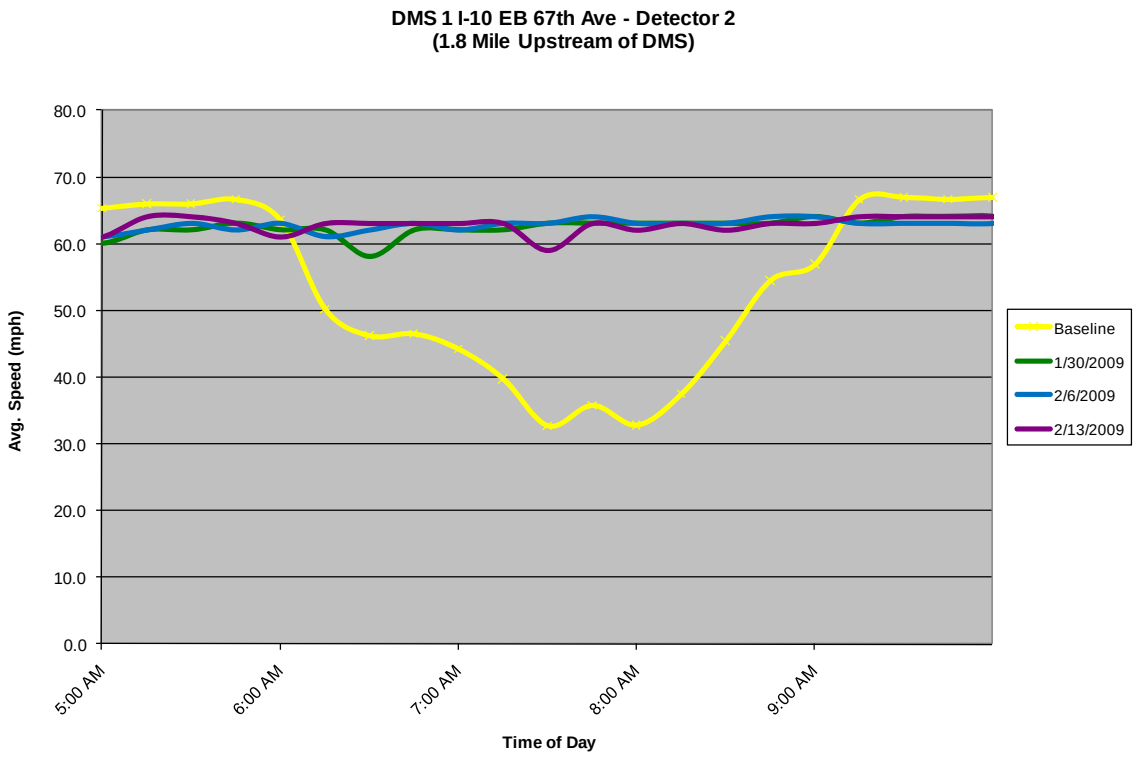
MINUTES TO
BELL RD XX





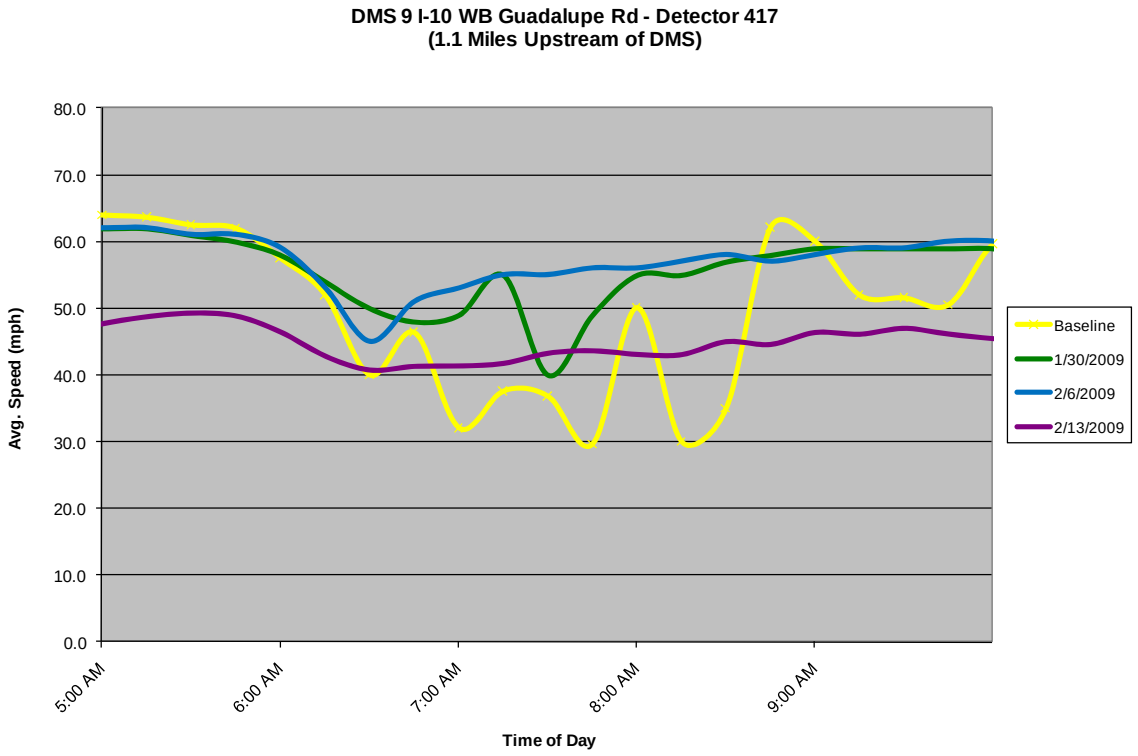
DMS 1 I-10 EB 67th Ave

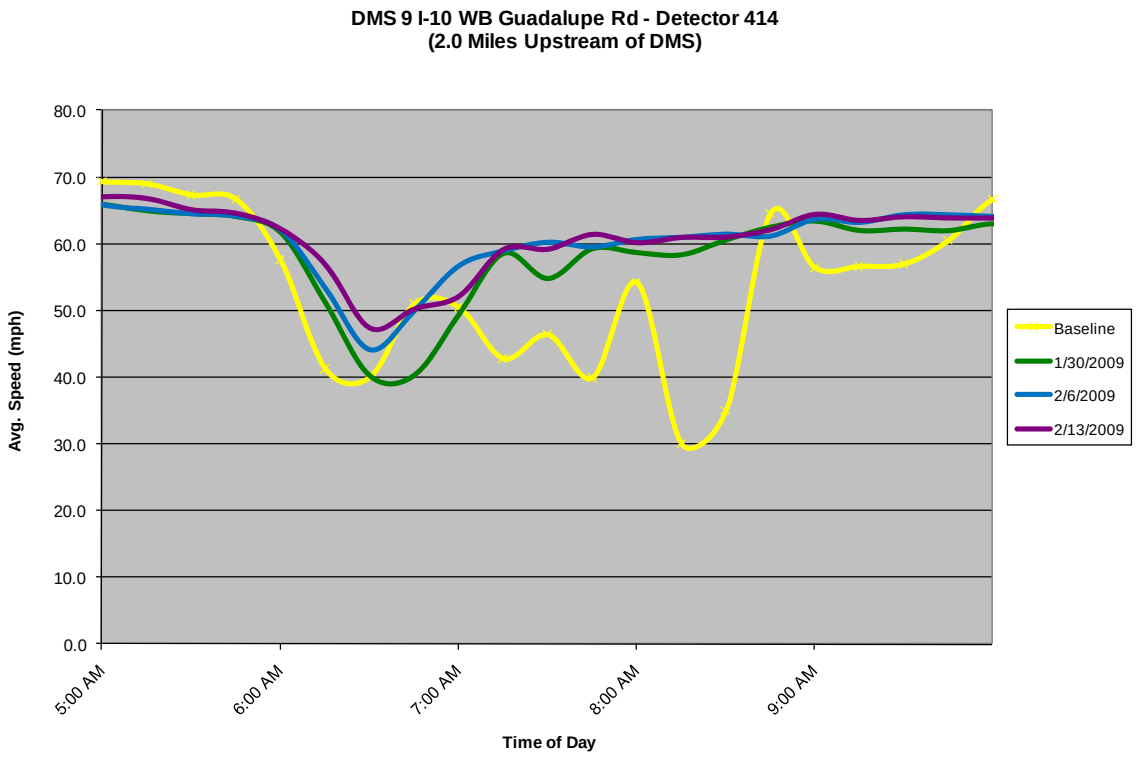




DMS 9 I-10 WB Guadalupe Rd

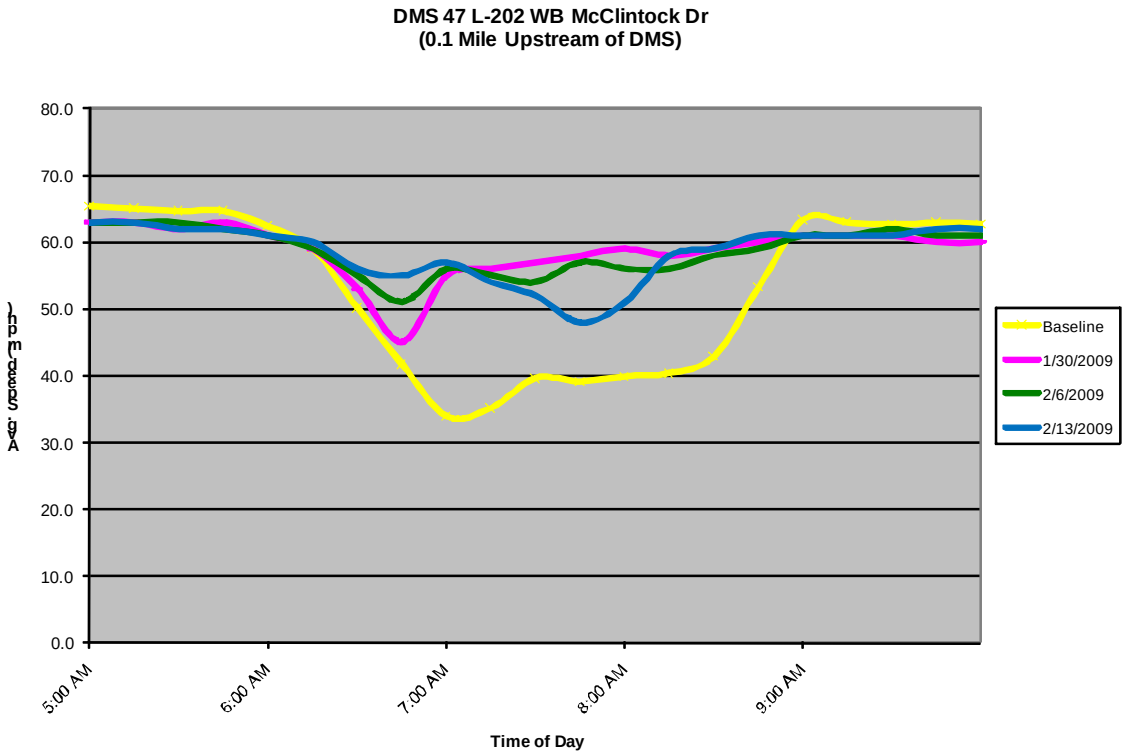
MINUTES TO
SR-143 XX
TUNNEL YY





DMS 47 L-202 WB McClintock Dr

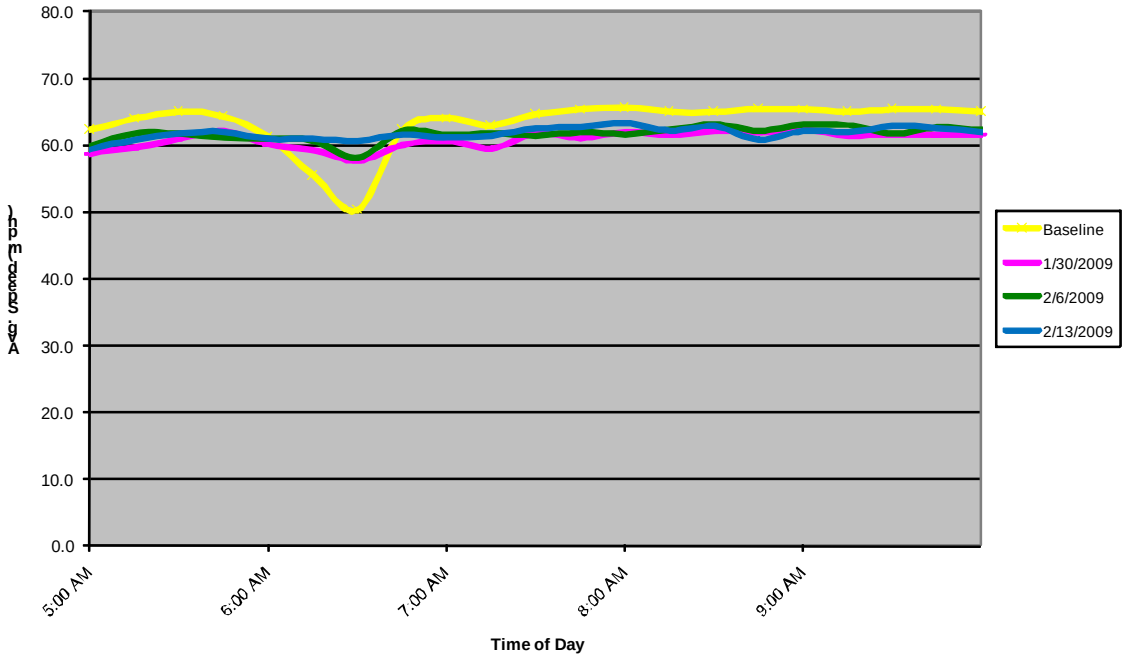
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



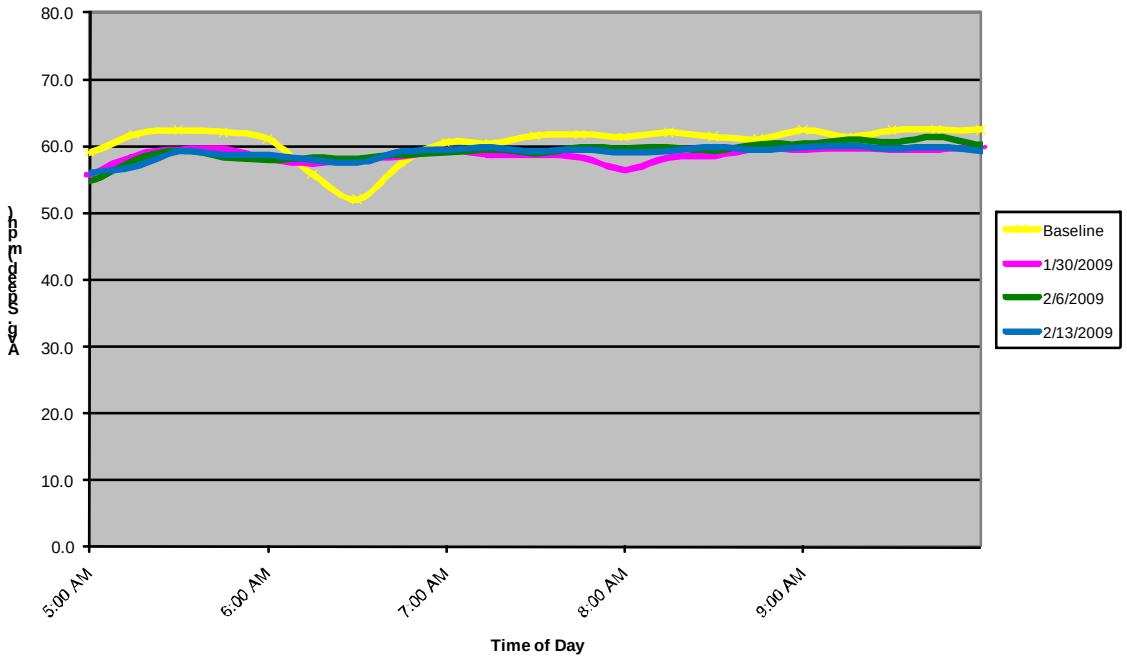
DMS 42 US-60 WB Extension Rd

MINUTES TO TUNNEL
VIA I-10 XX
VIA LOOP 101 YY

DMS 42 US-60 WB Extension Rd - Detector 482
(0.5 Miles Upstream of DMS)

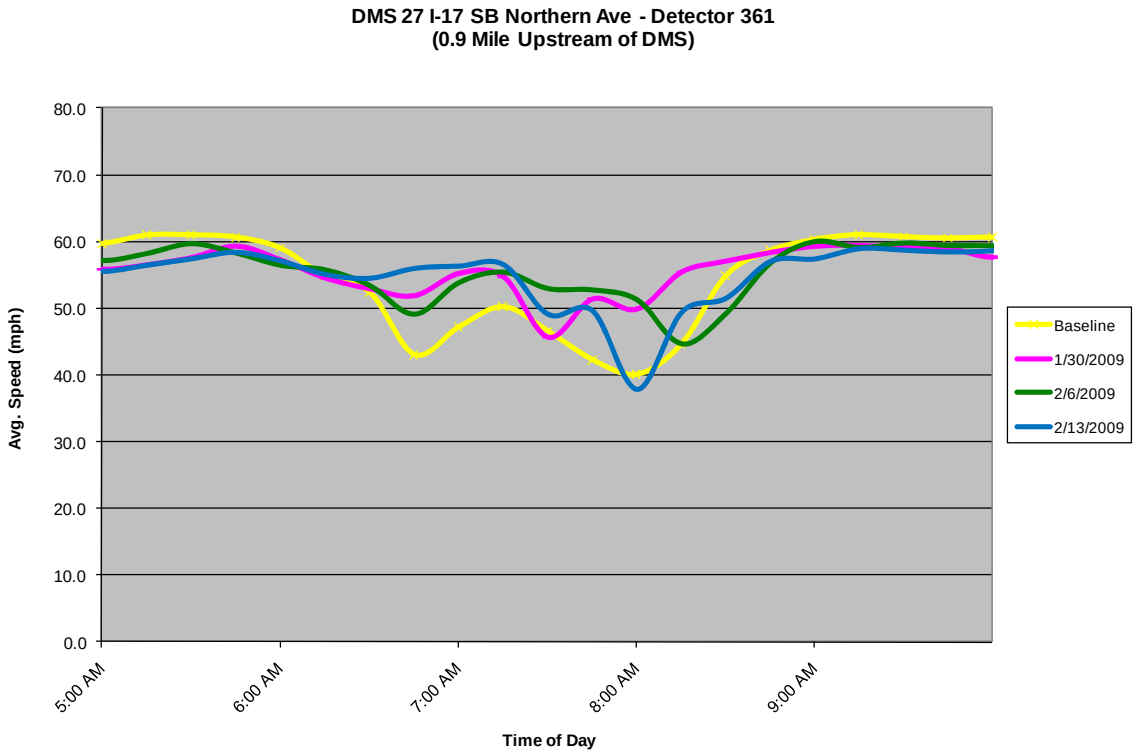


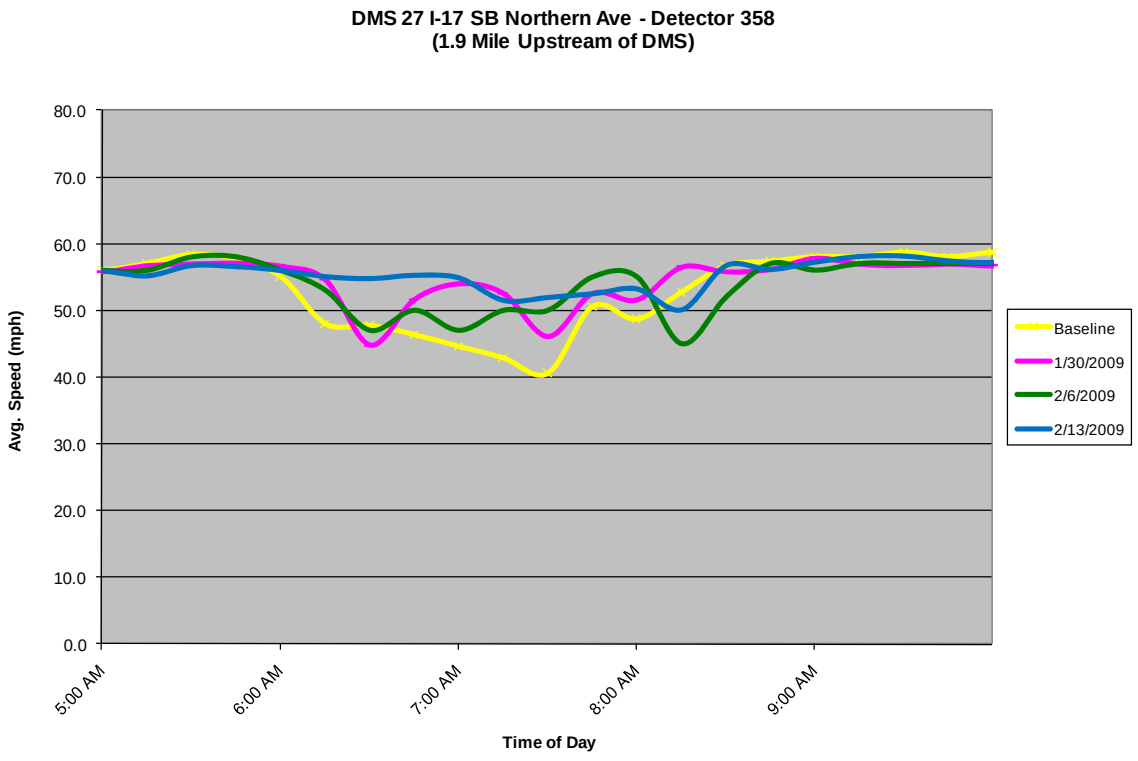
DMS 42 US-60 WB Extension Rd - Detector 479
(1.5 Miles Upstream of DMS)



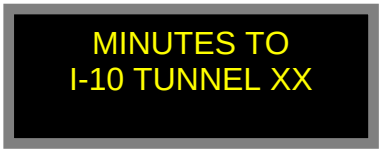
DMS 27 I-17 SB Northern Ave

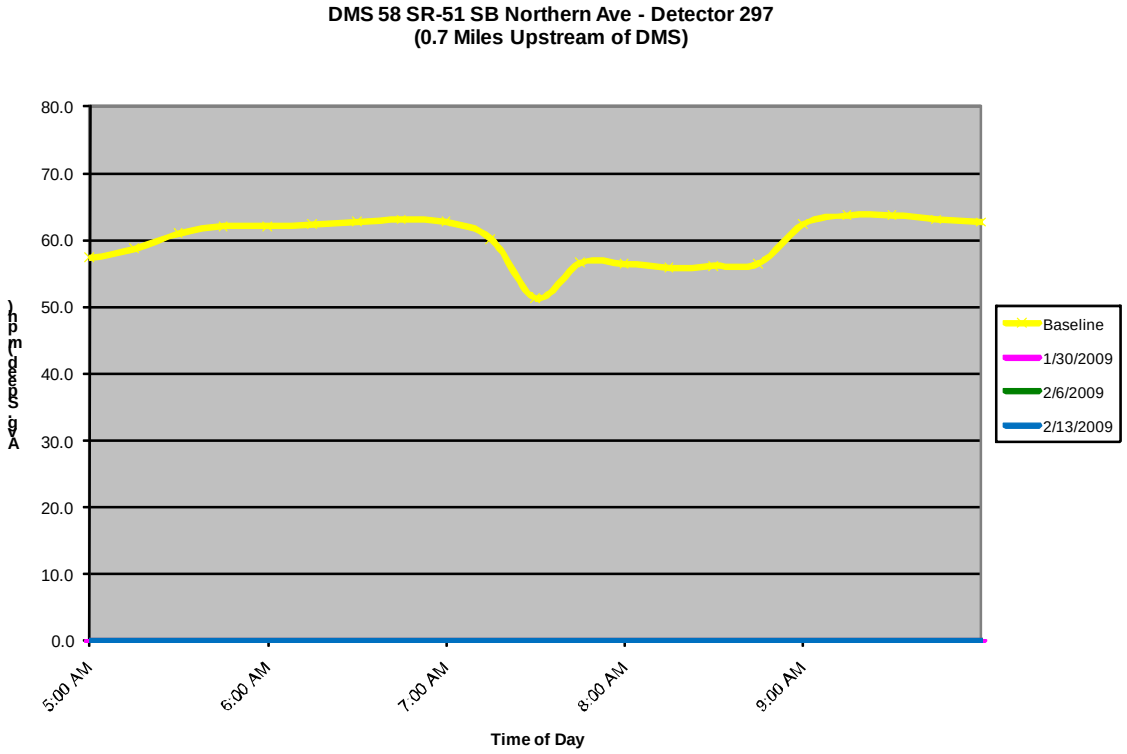
MINUTES TO
I-10 TUNNEL XX

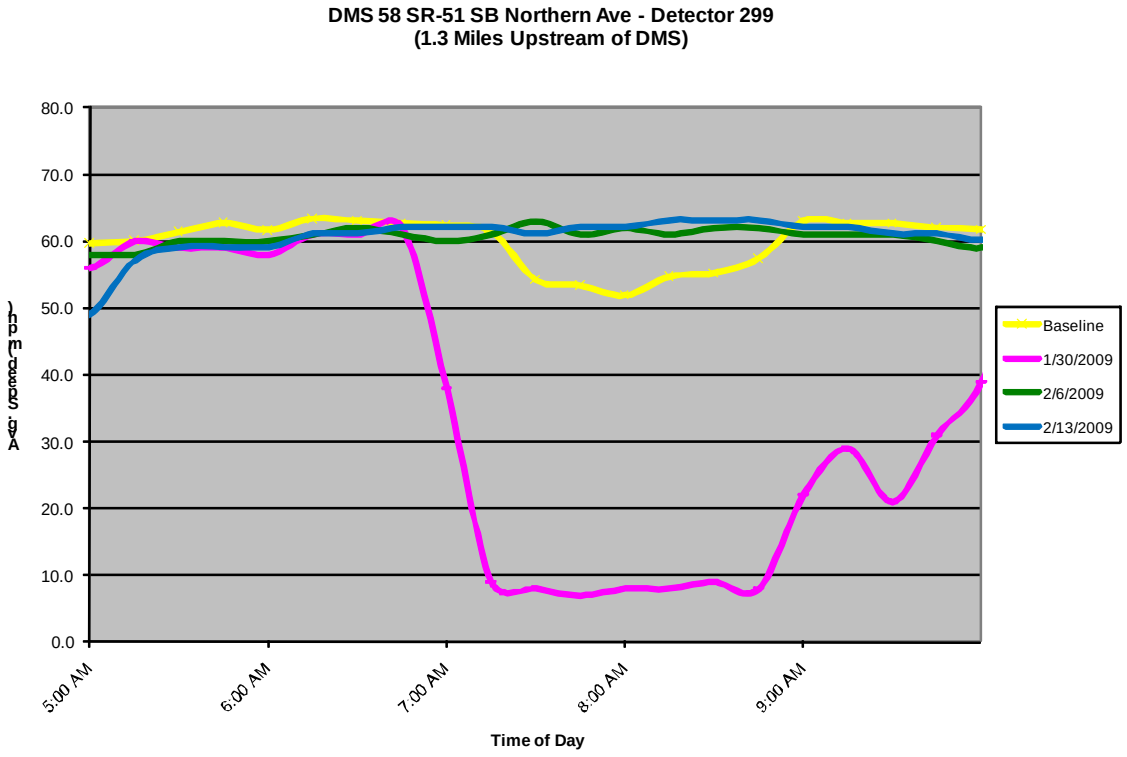




DMS 58 SR-51 SB Northern Ave

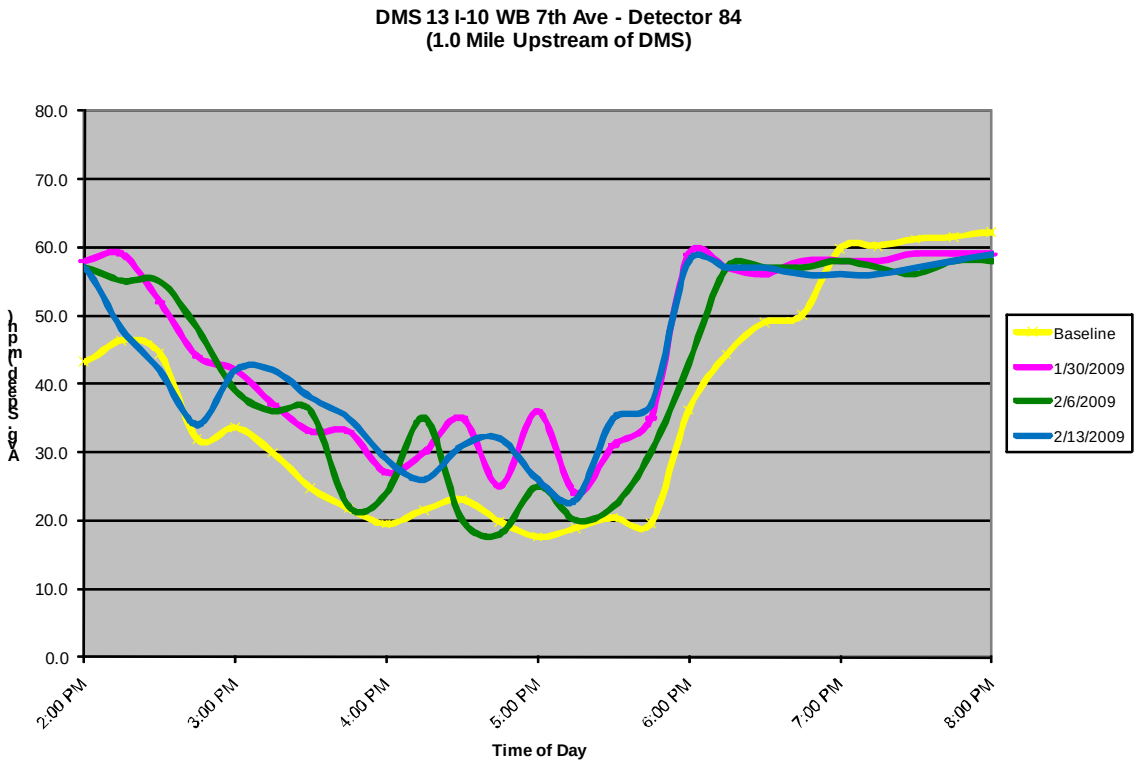


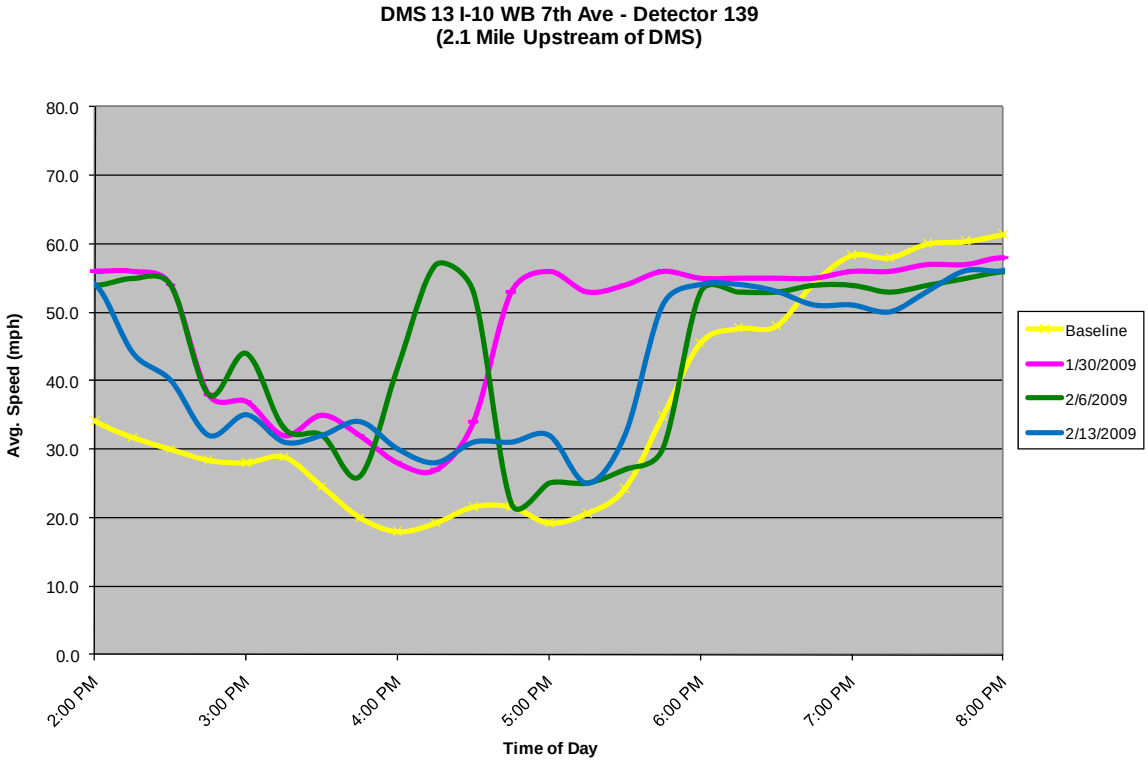




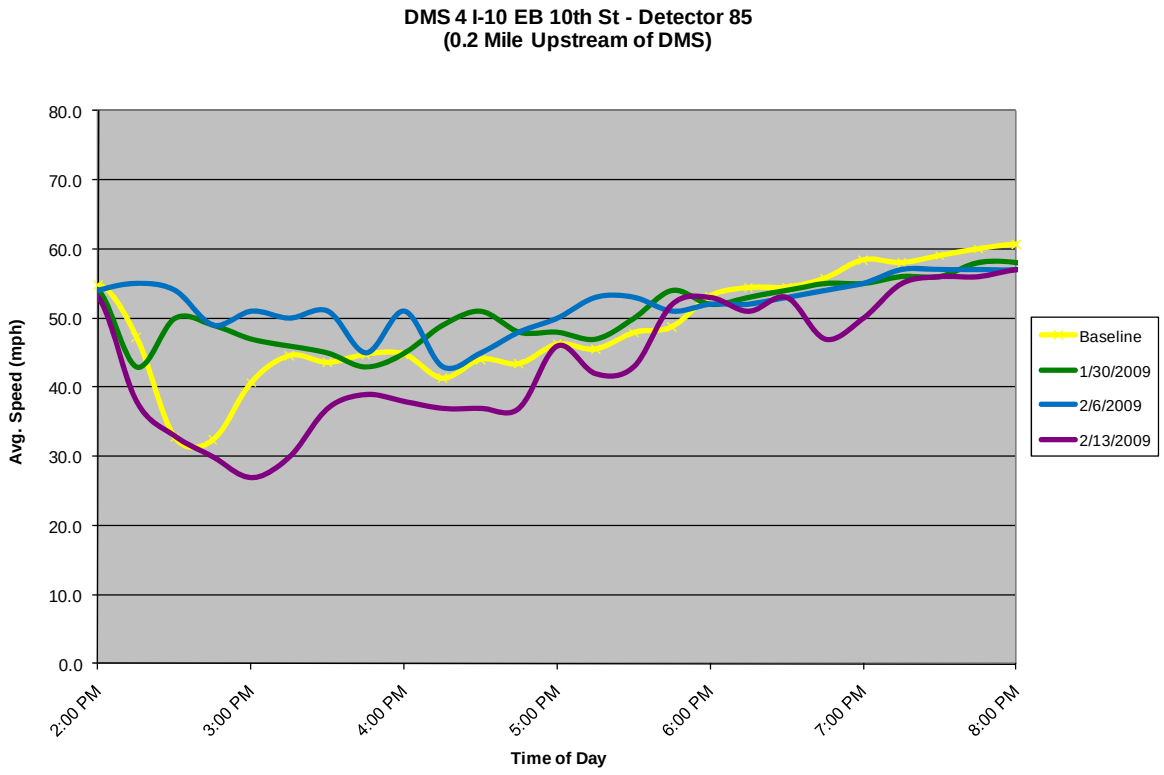
DMS 13 I-10 WB 7th Ave

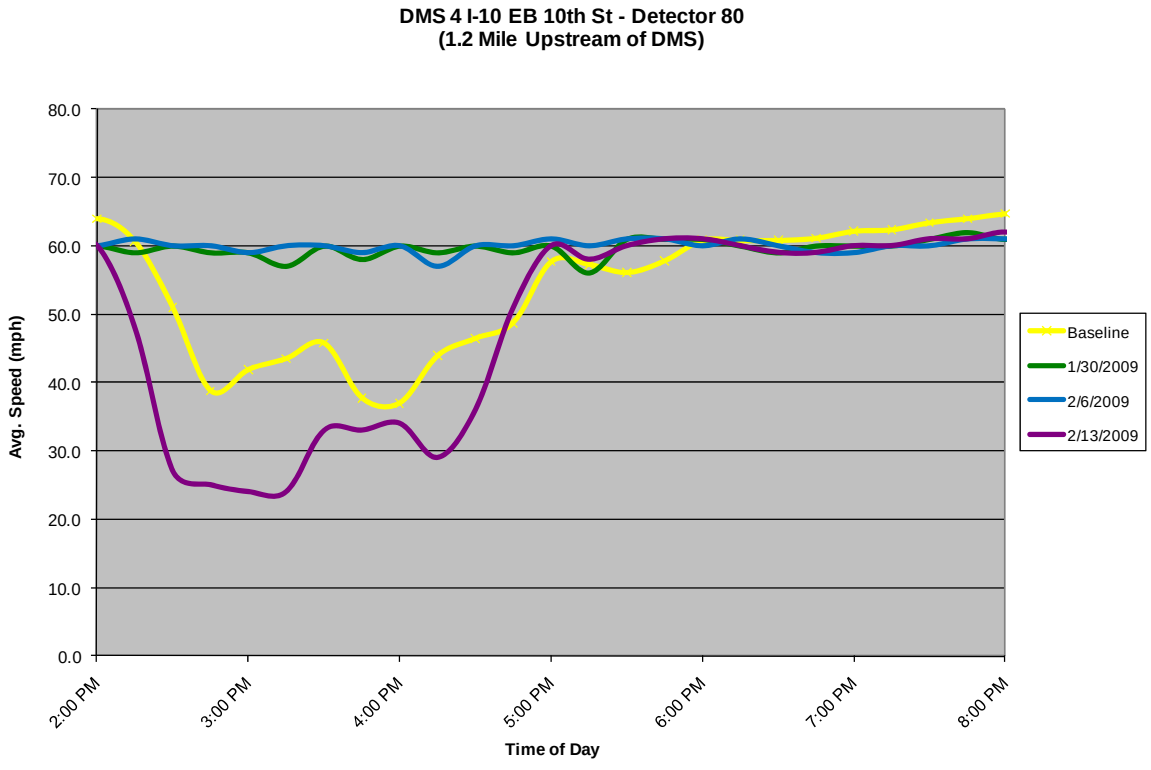
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





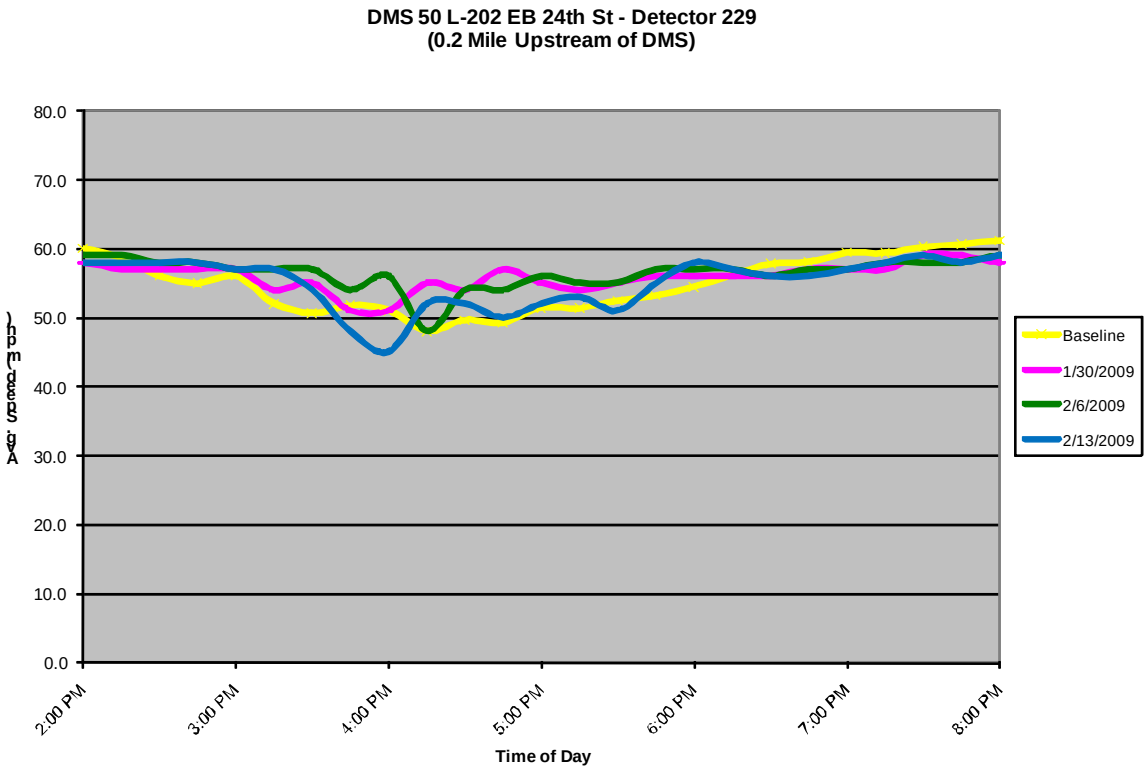
DMS 4 I-10 EB 10th St





DMS 50 L-202 EB 24th ST

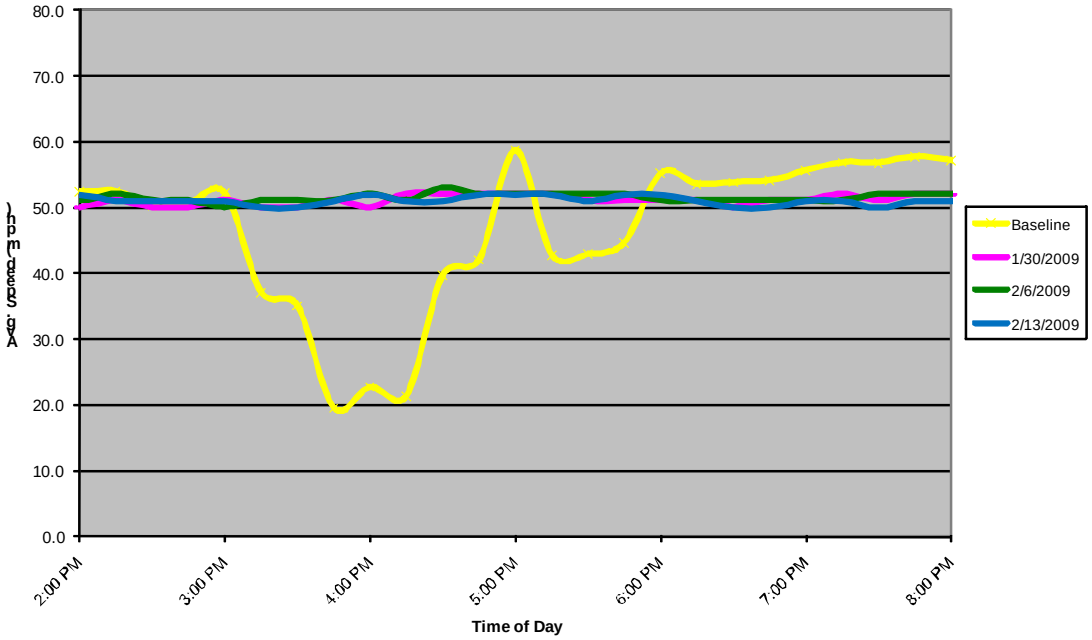
MINUTES TO
LOOP 101 XX



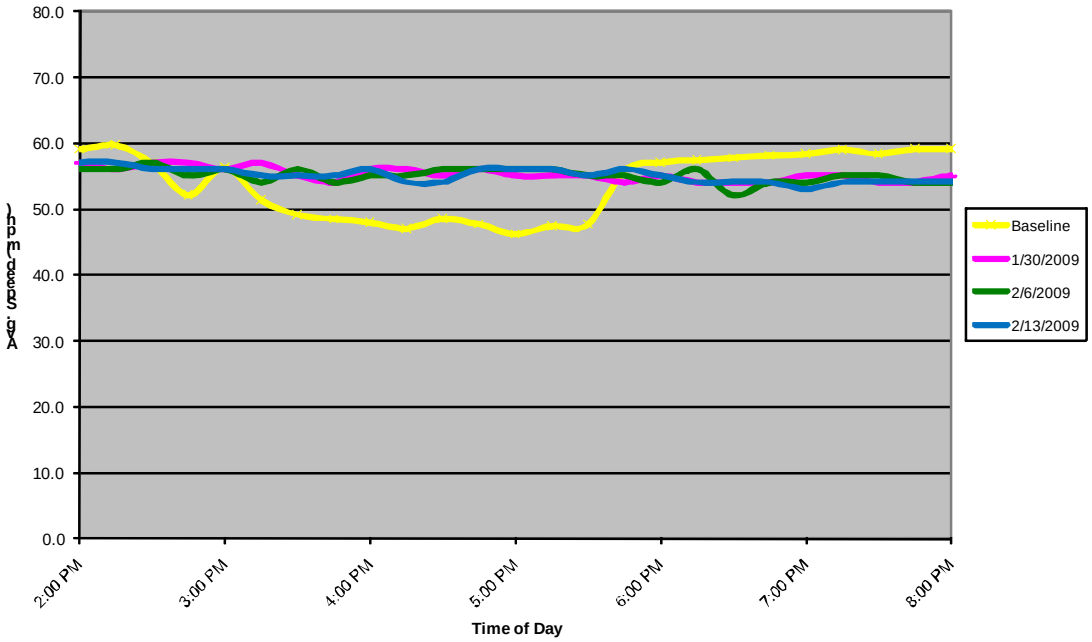
DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

DMS 32 I-17 SB Central Ave - Detector 108
(0.5 Mile Upstream of DMS)



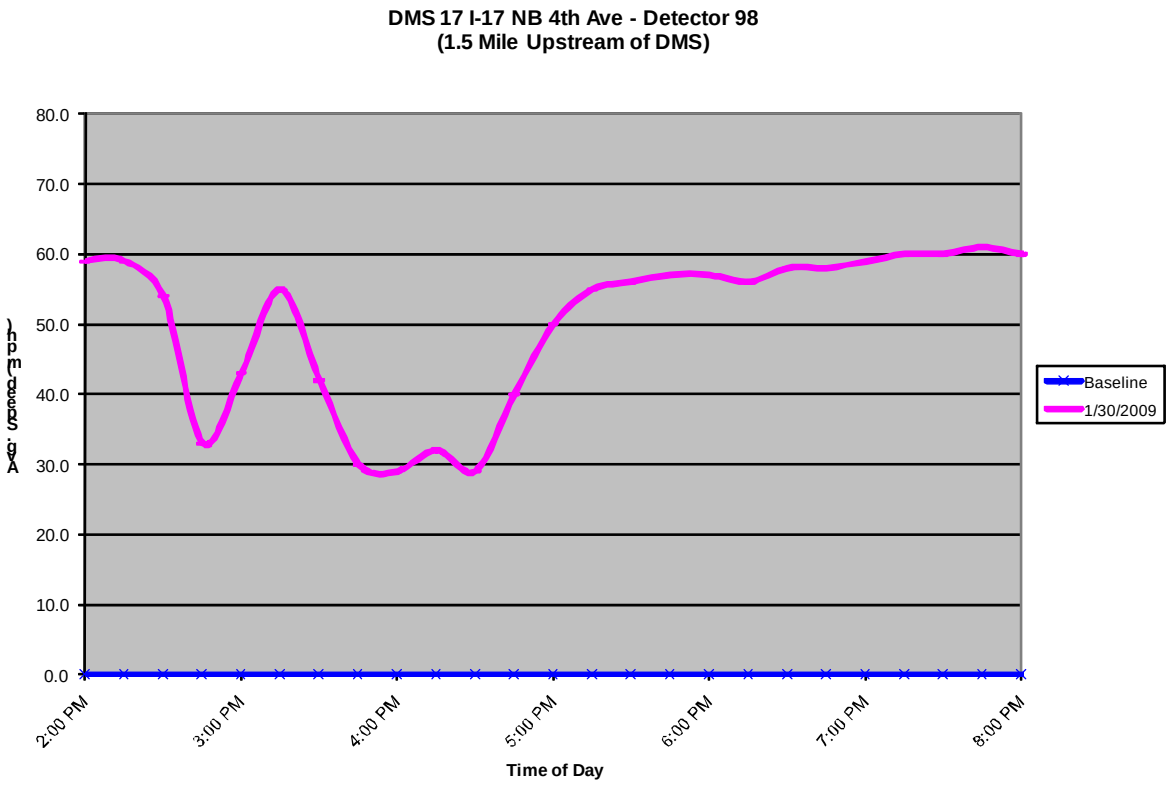
DMS 32 I-17 SB Central Ave - Detector 114
(1.6 Mile Upstream of DMS)



DMS 17 I-17 NB 4th Ave

MINUTES TO
PEORIA AVE XX
I-10 83RD AVE YY

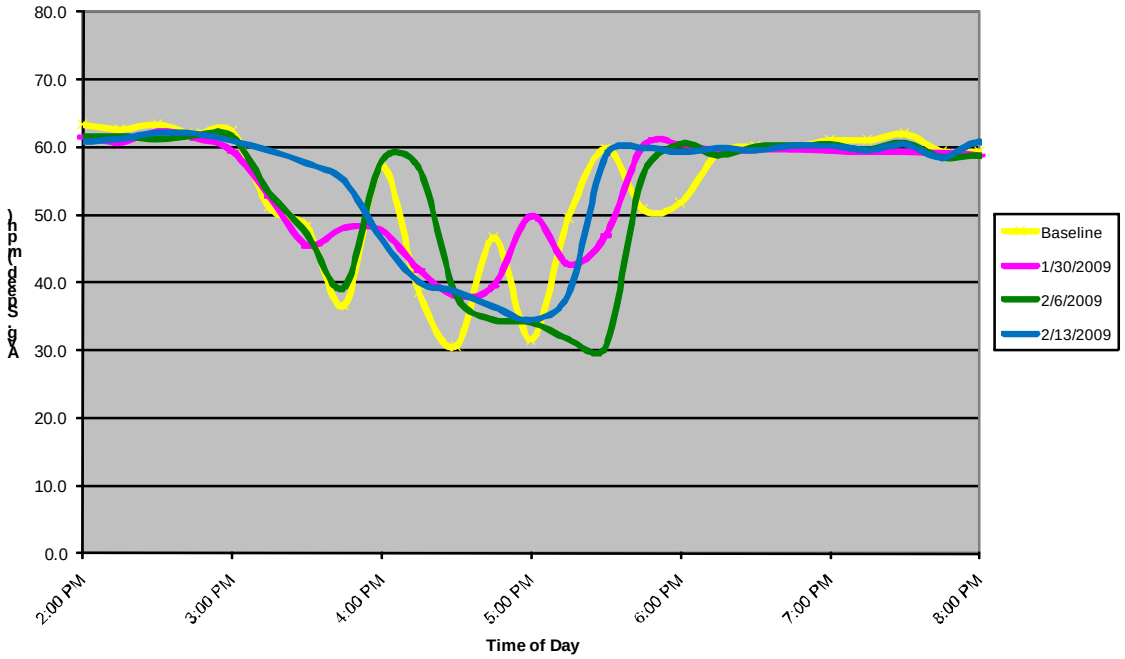
No Available Data on Detector 104



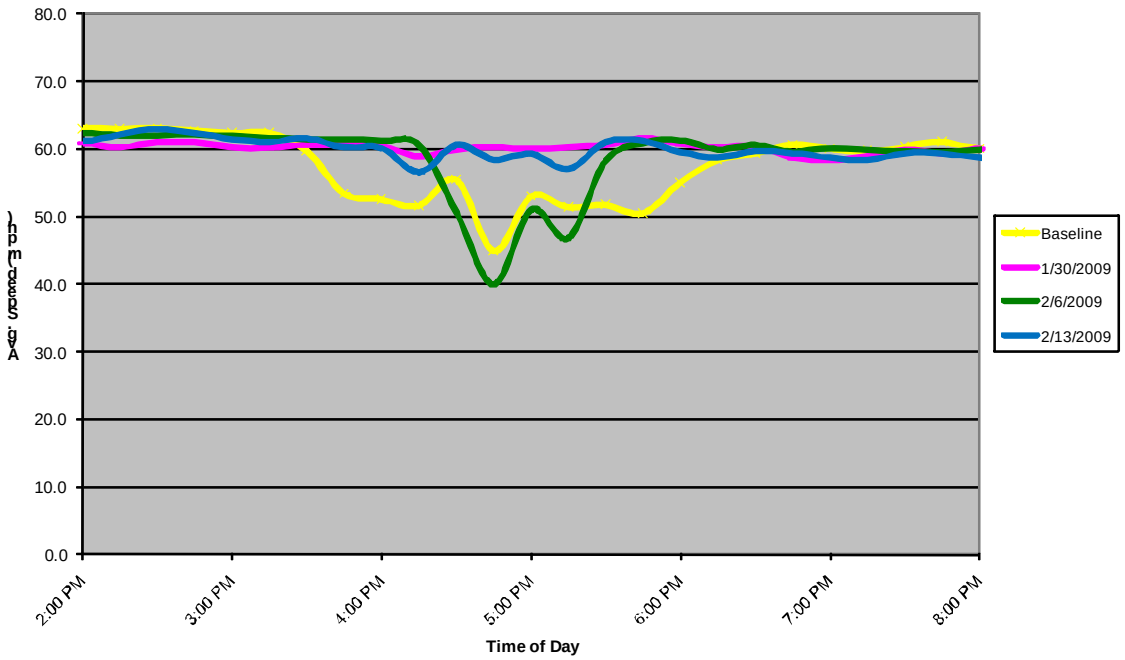
DMS 55 SR-51 NB Osborn Rd

MINUTES TO
BELL RD XX

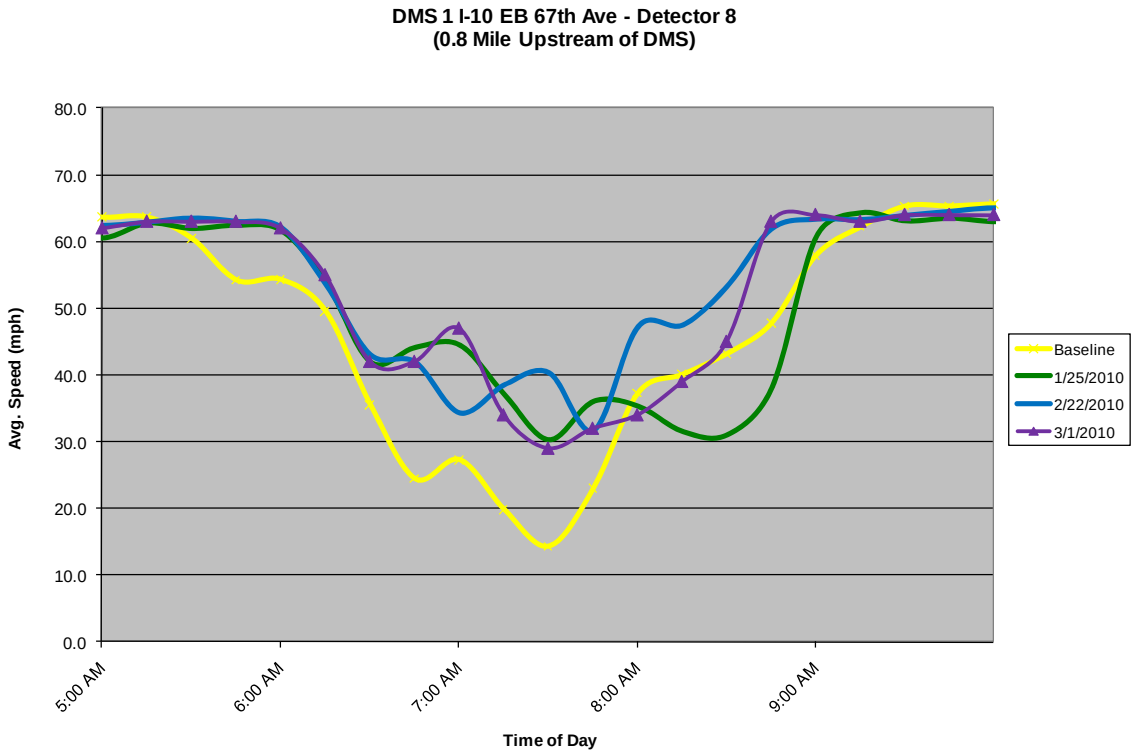
DMS 55 SR-51 NB Osborn Rd - Detector 206
(0.5 Mile Upstream of DMS)

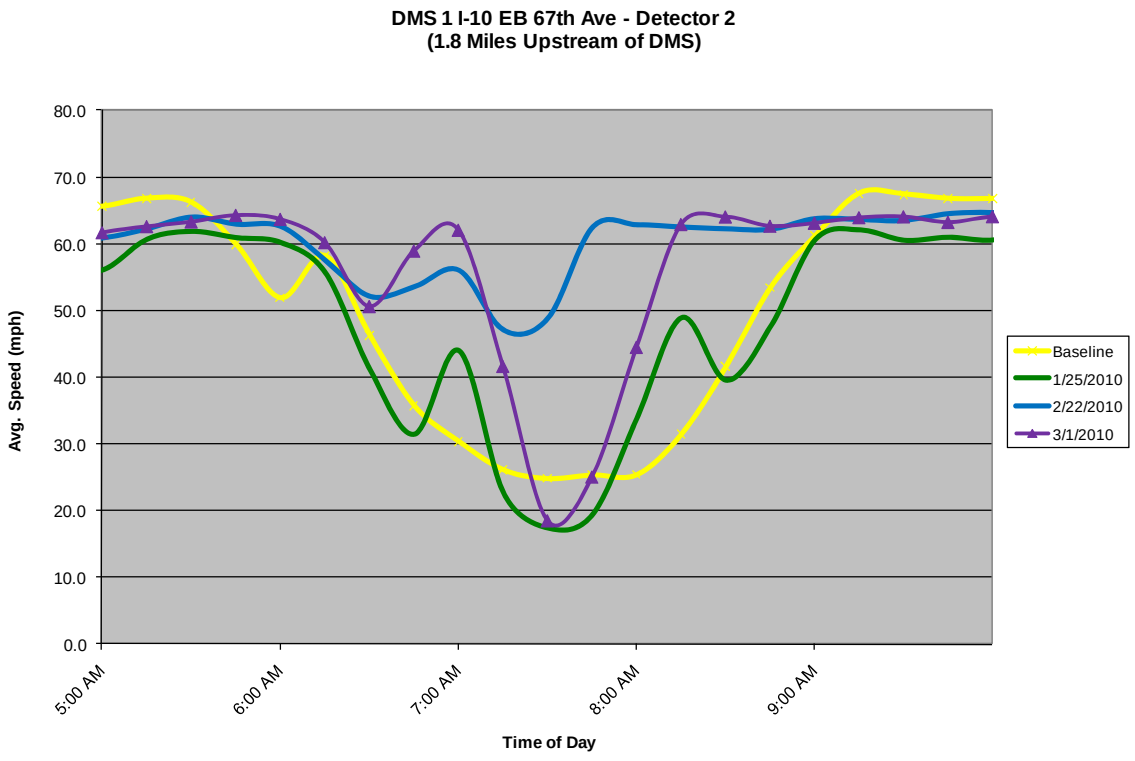


DMS 55 SR-51 NB Osborn Rd - Detector 203
(1.6 Miles Upstream of DMS)

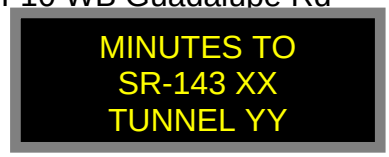


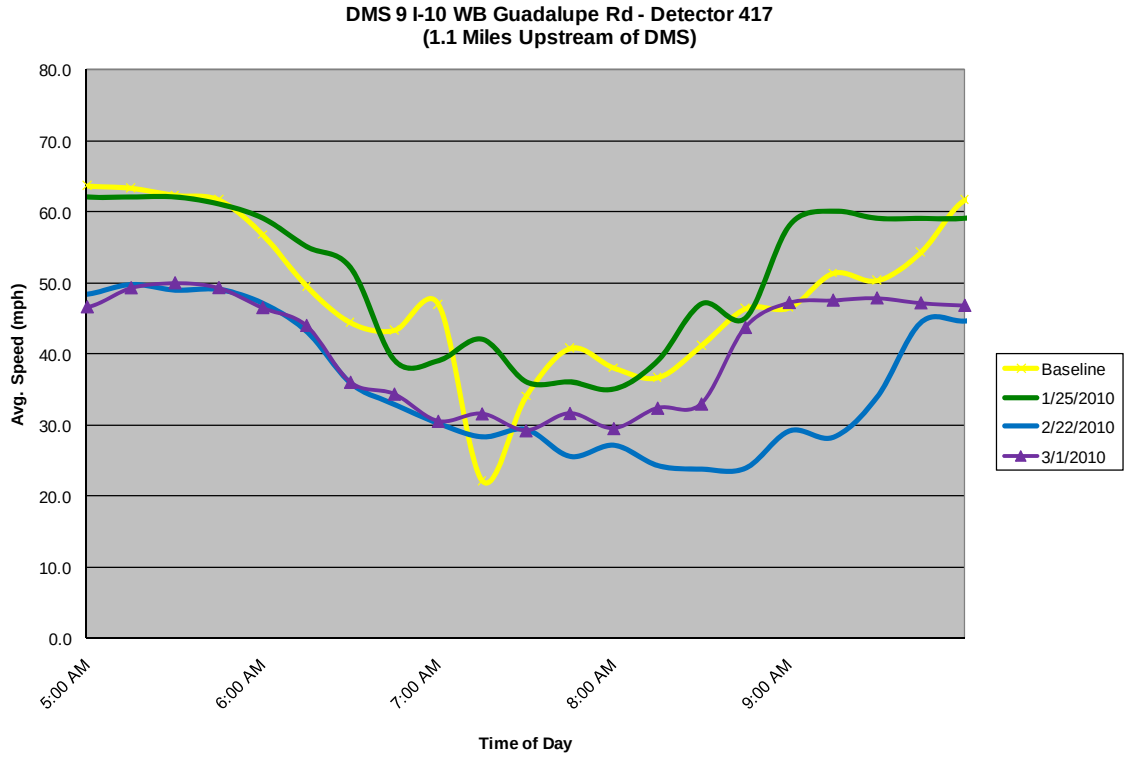
DMS 1 I-10 EB 67th Ave

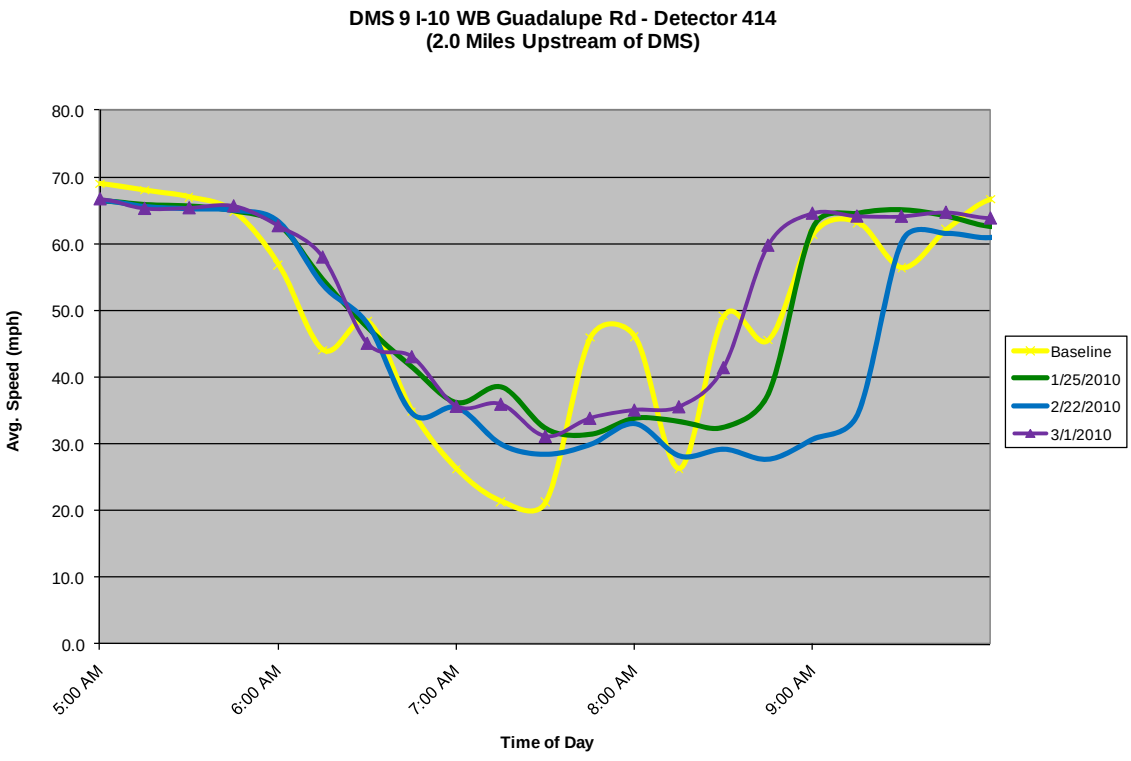




DMS 9 I-10 WB Guadalupe Rd

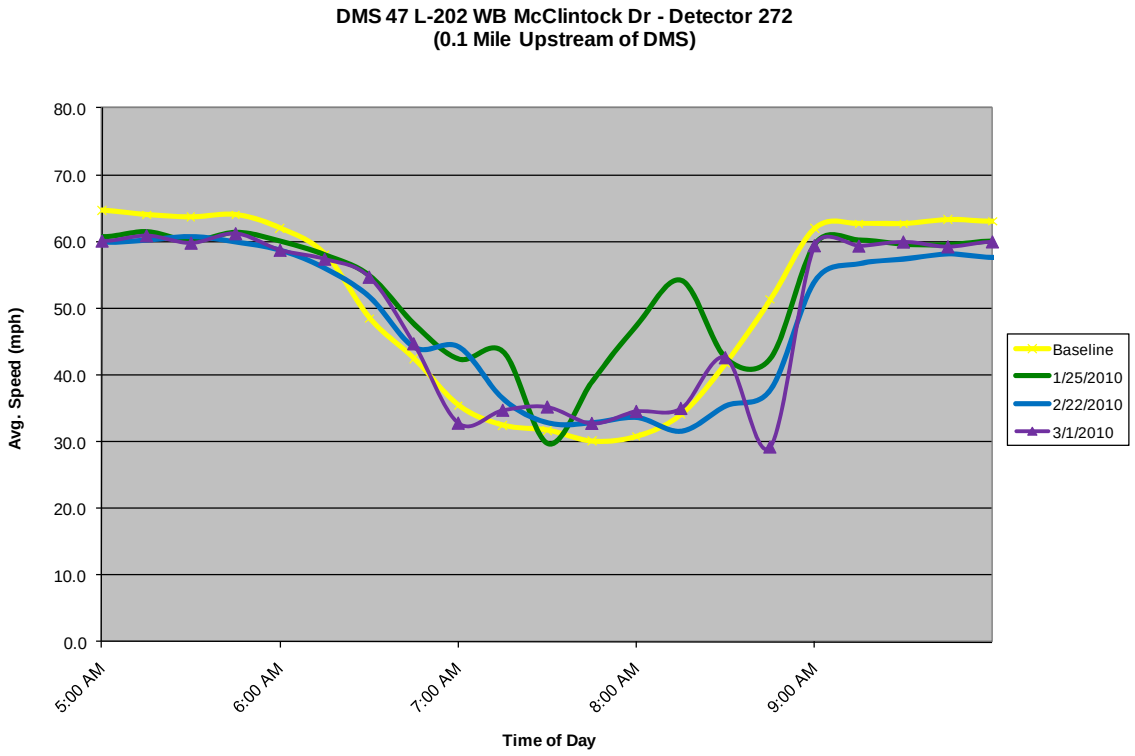




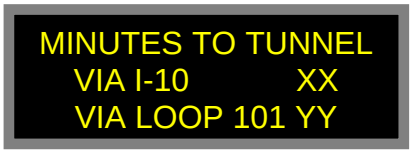


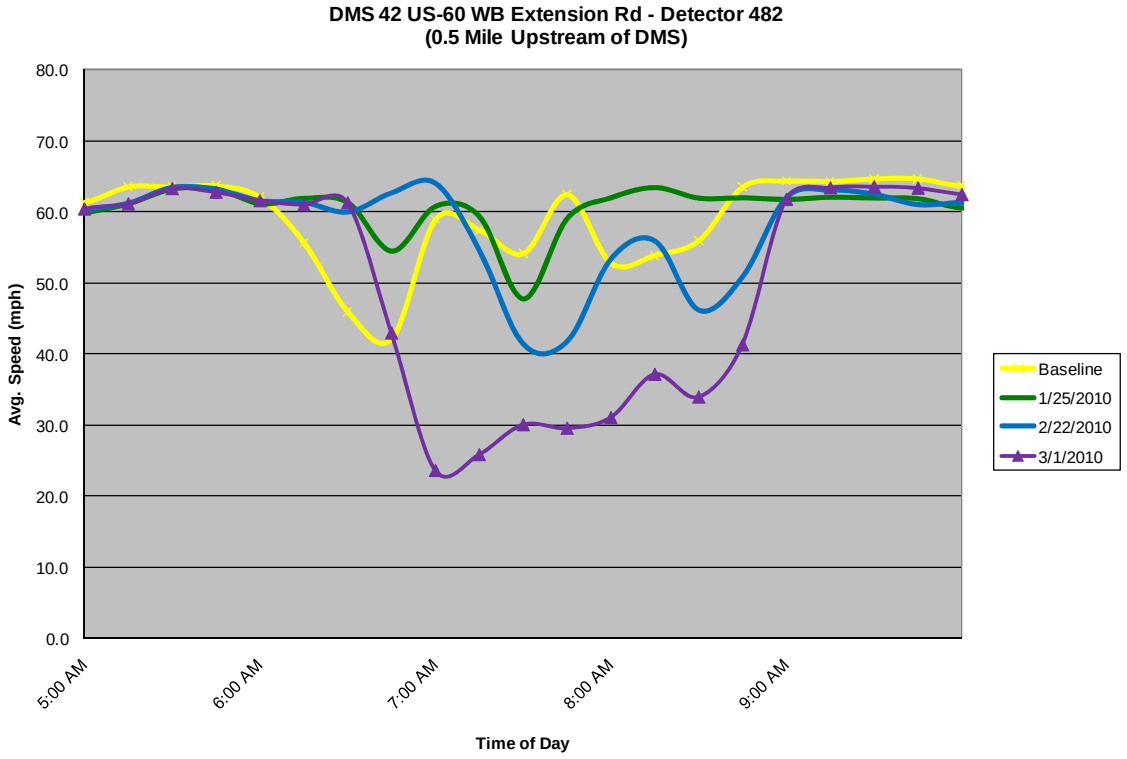
DMS 47 L-202 WB McClintock Dr

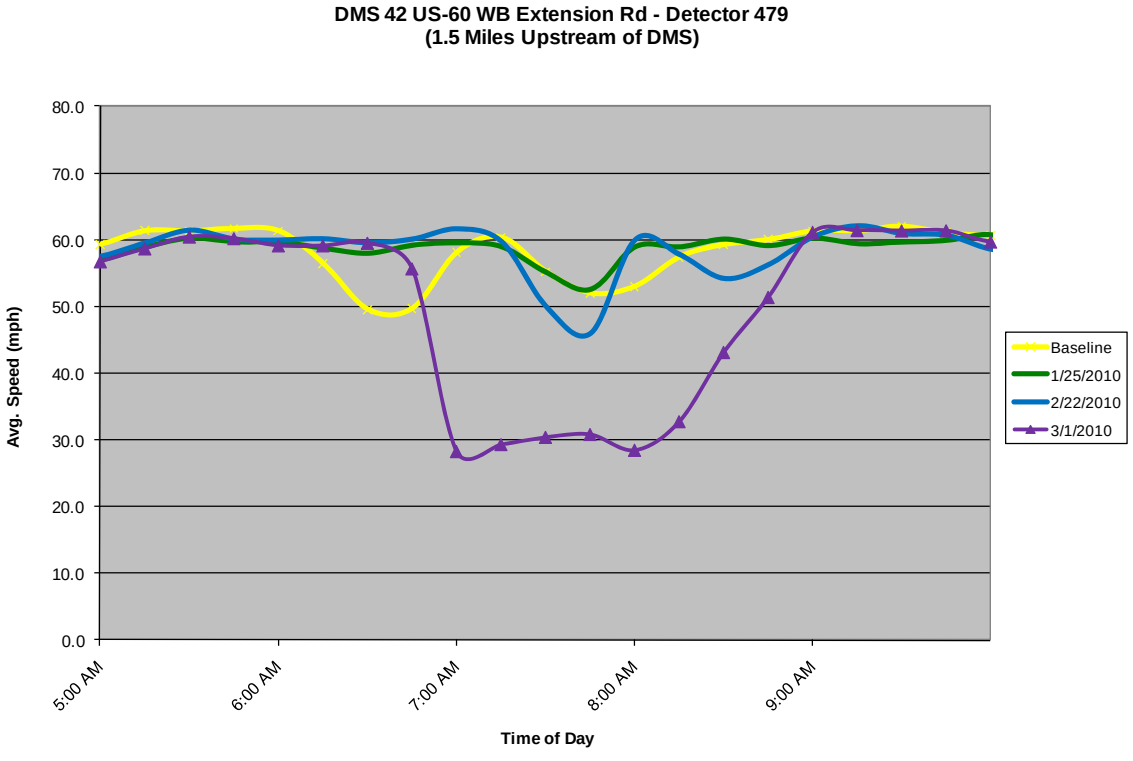
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

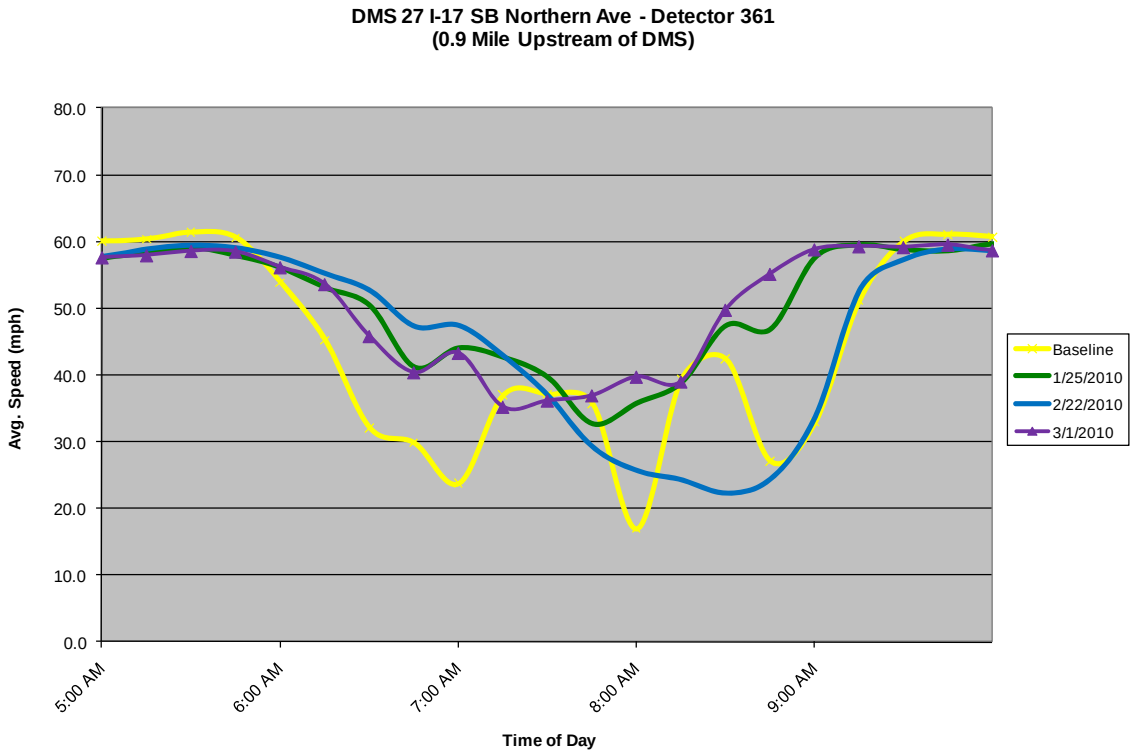


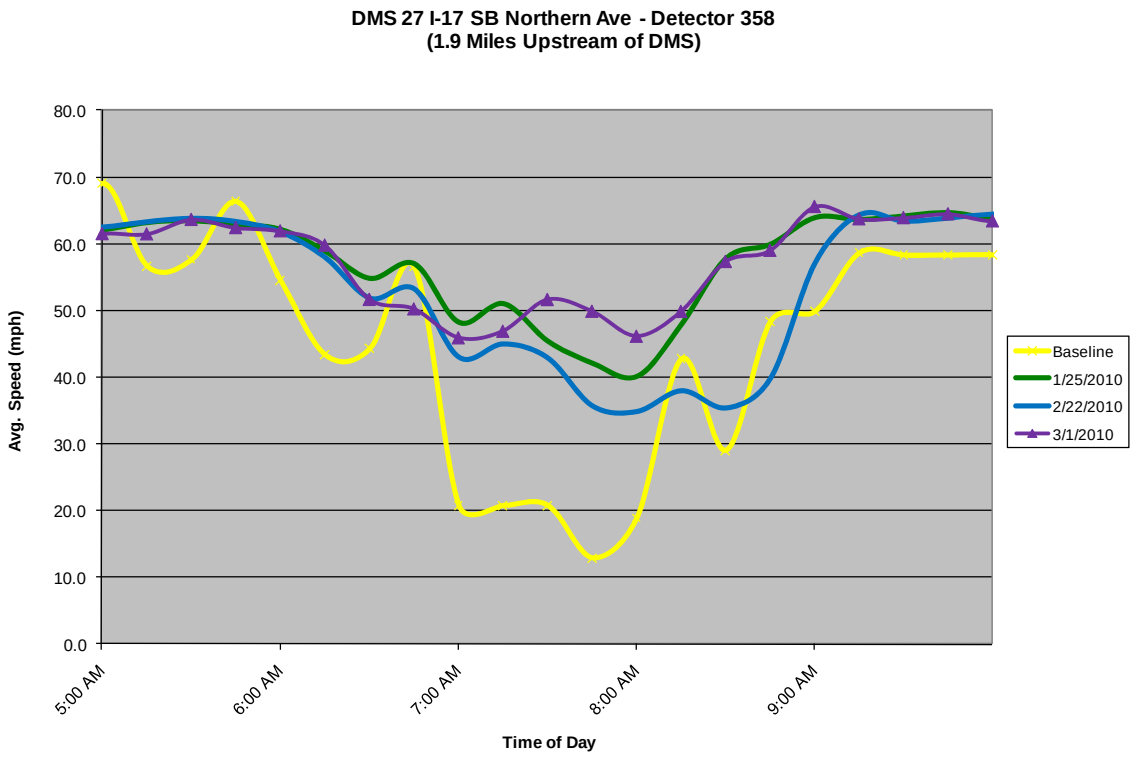




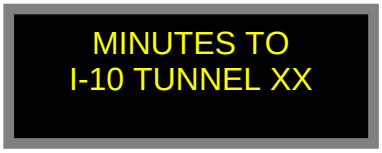
DMS 27 I-17 SB Northern Ave

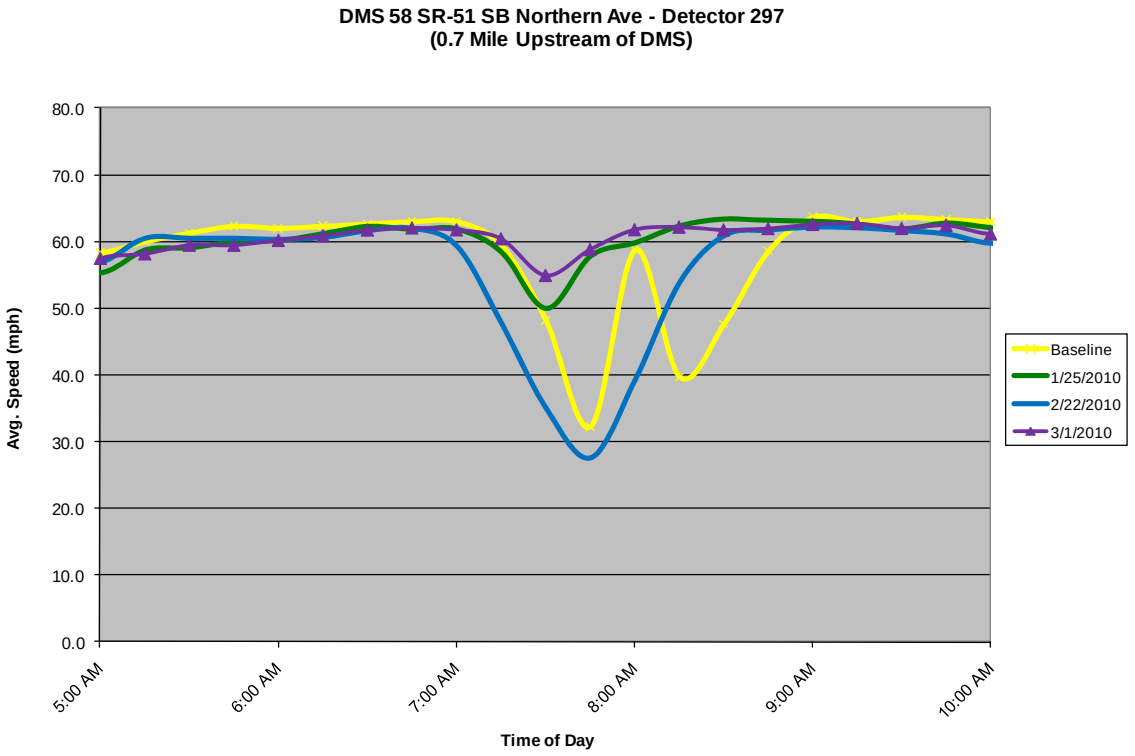
MINUTES TO
I-10 TUNNEL XX

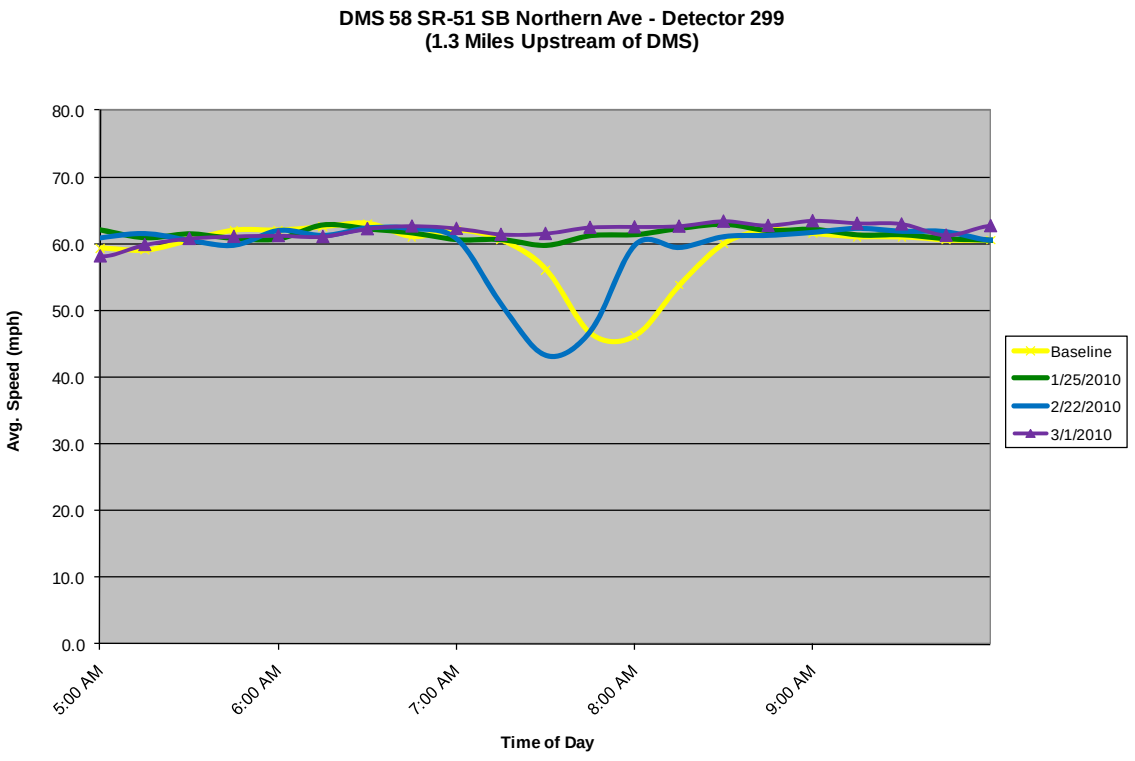




DMS 58 SR-51 SB Northern Ave

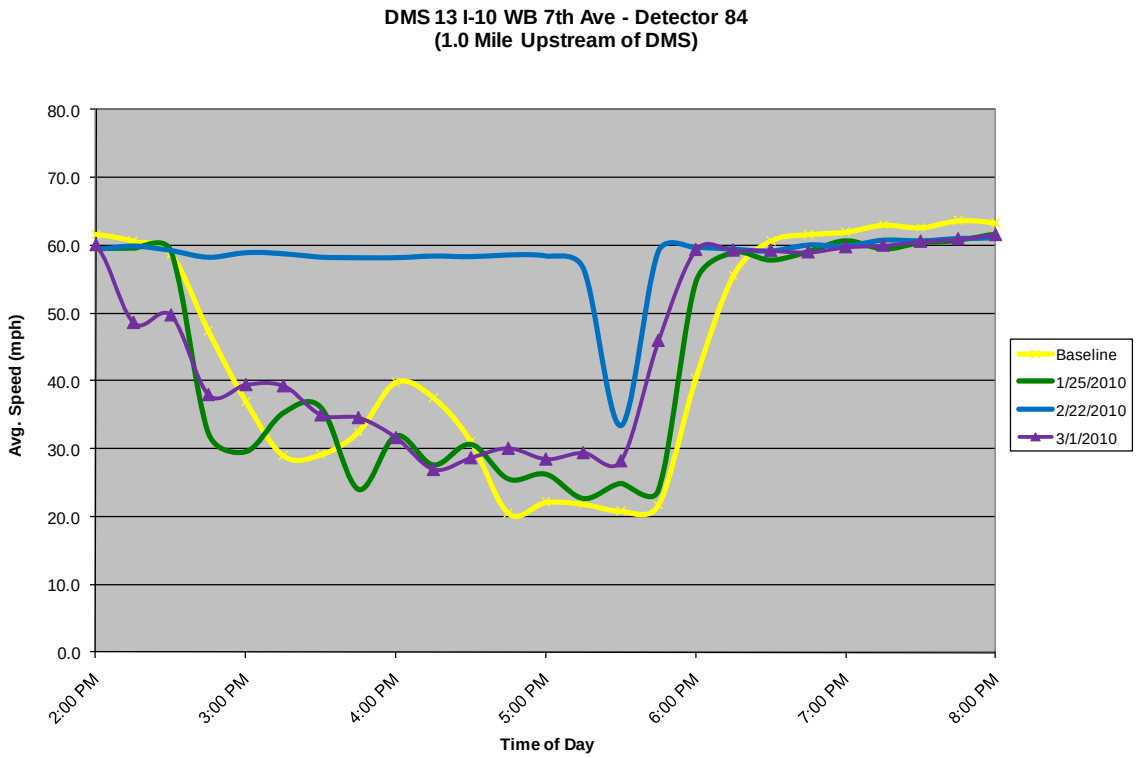


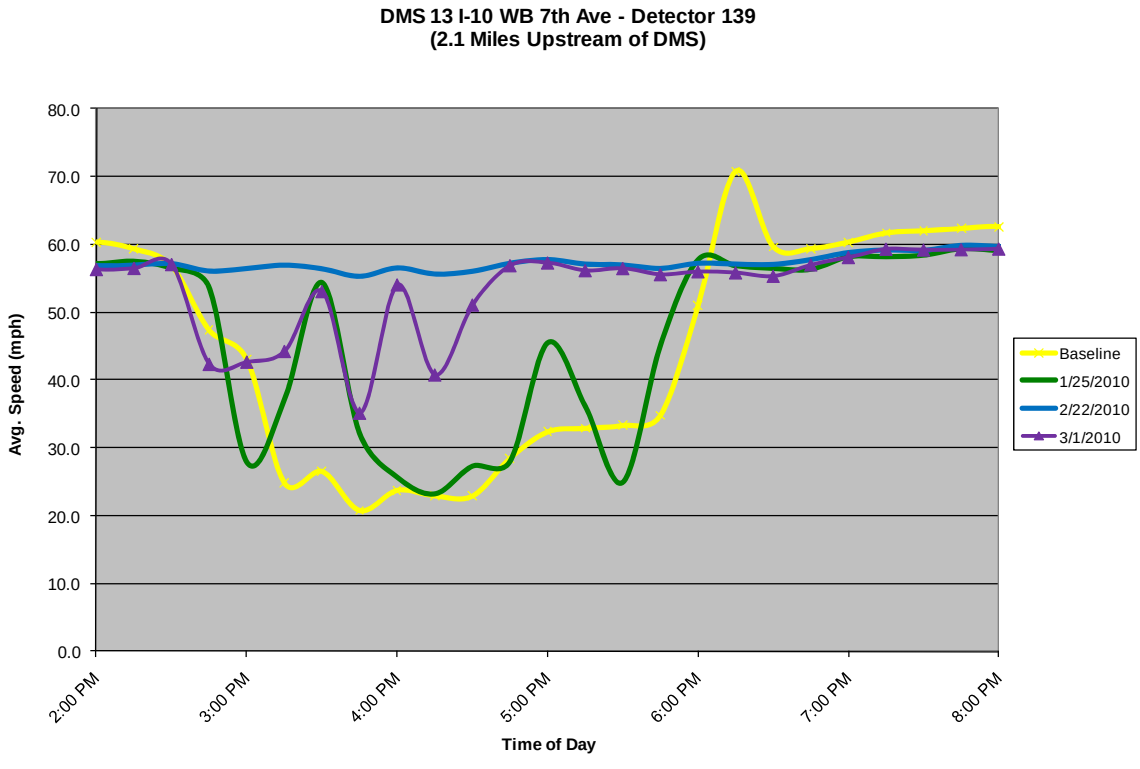




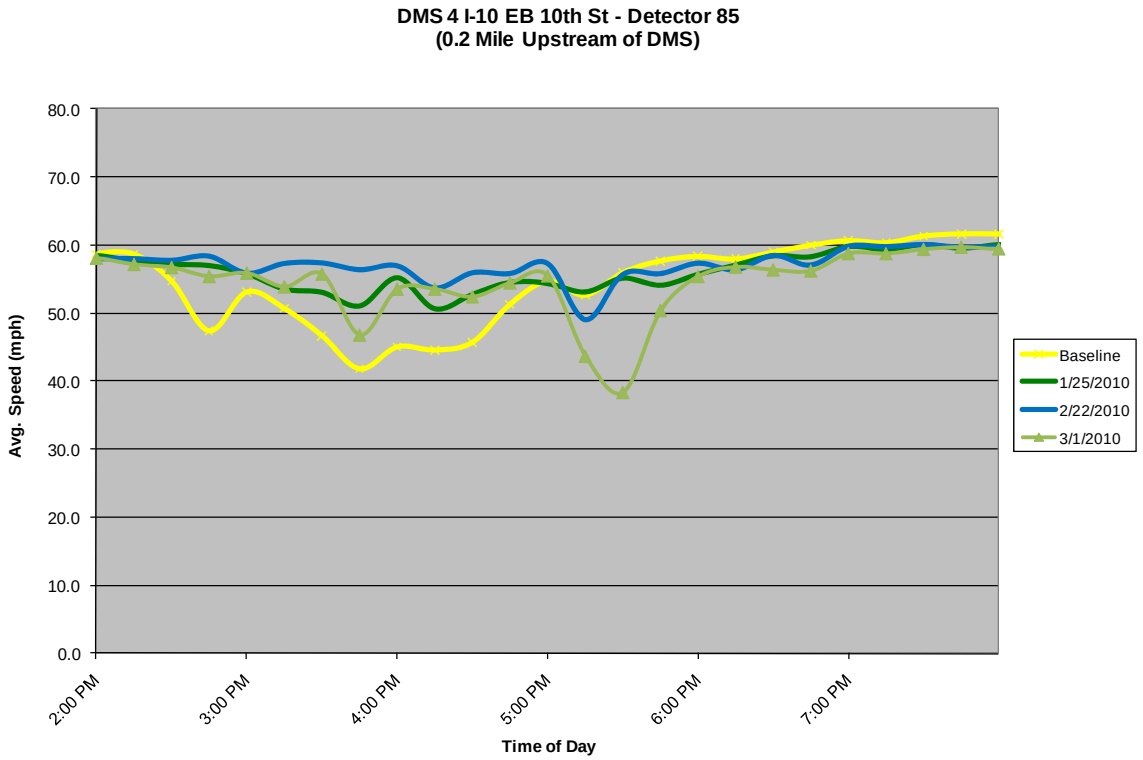
DMS 13 I-10 WB 7th Ave

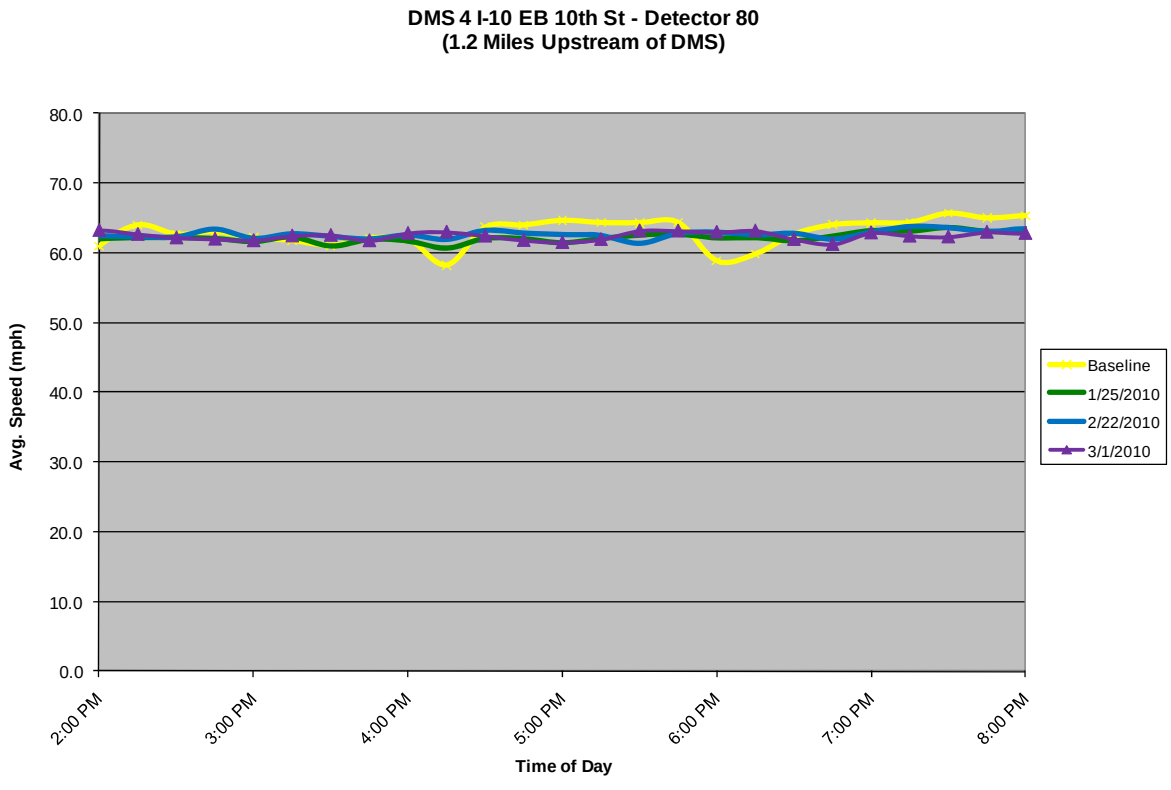
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





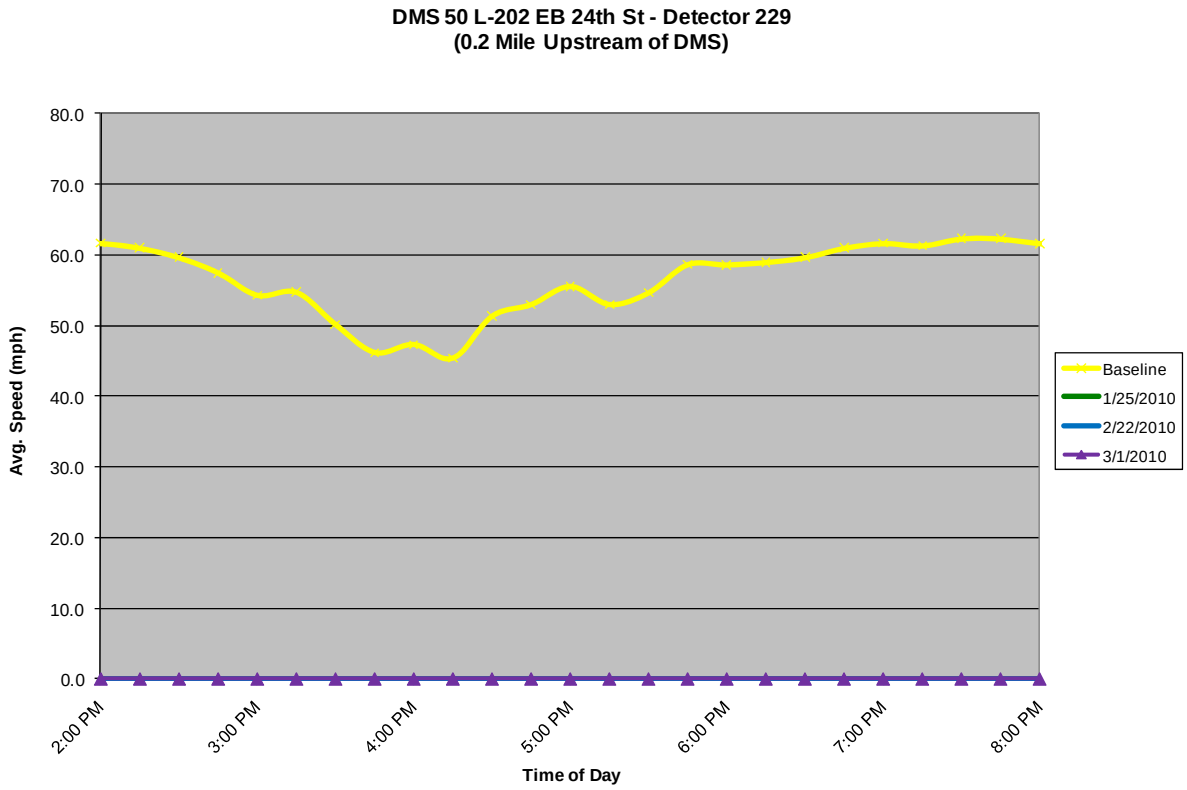
DMS 4 I-10 EB 10th St





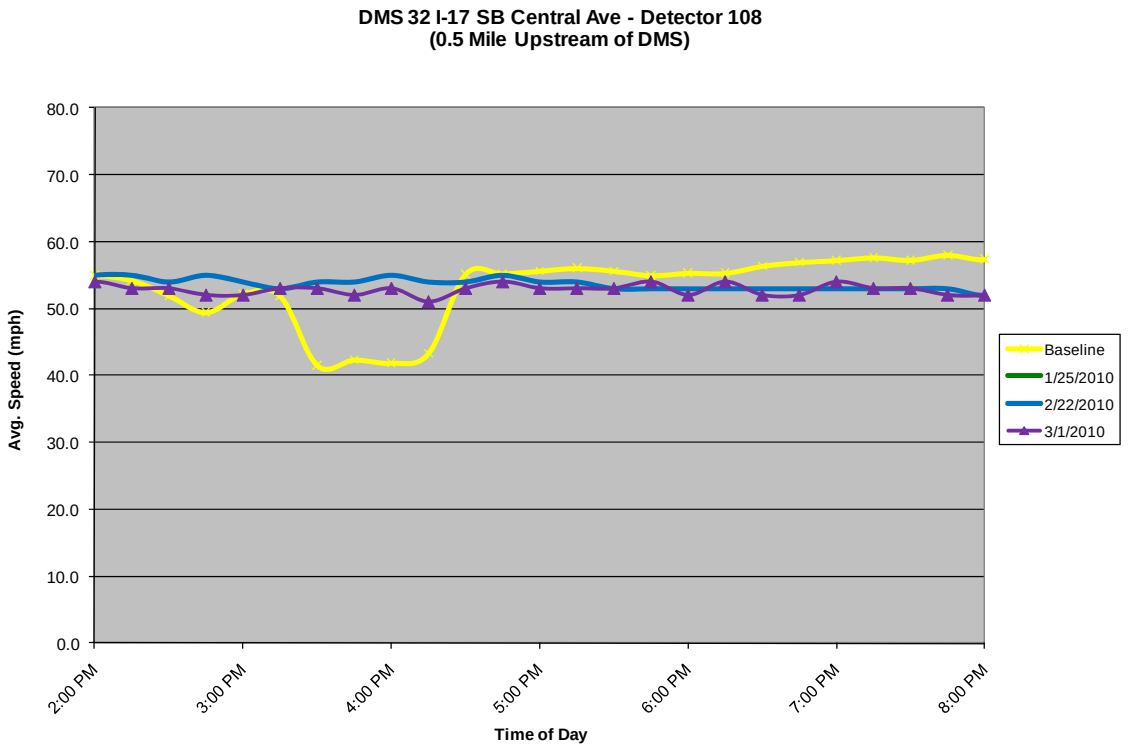
DMS 50 L-202 EB 24th ST

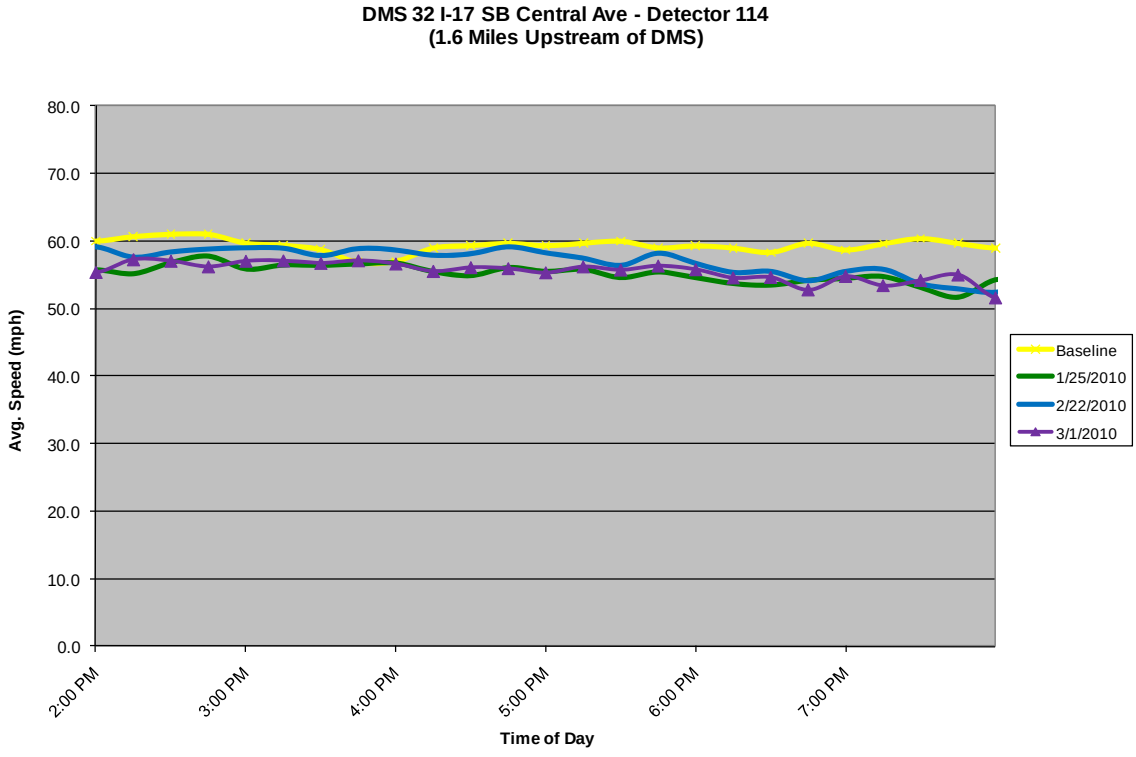
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

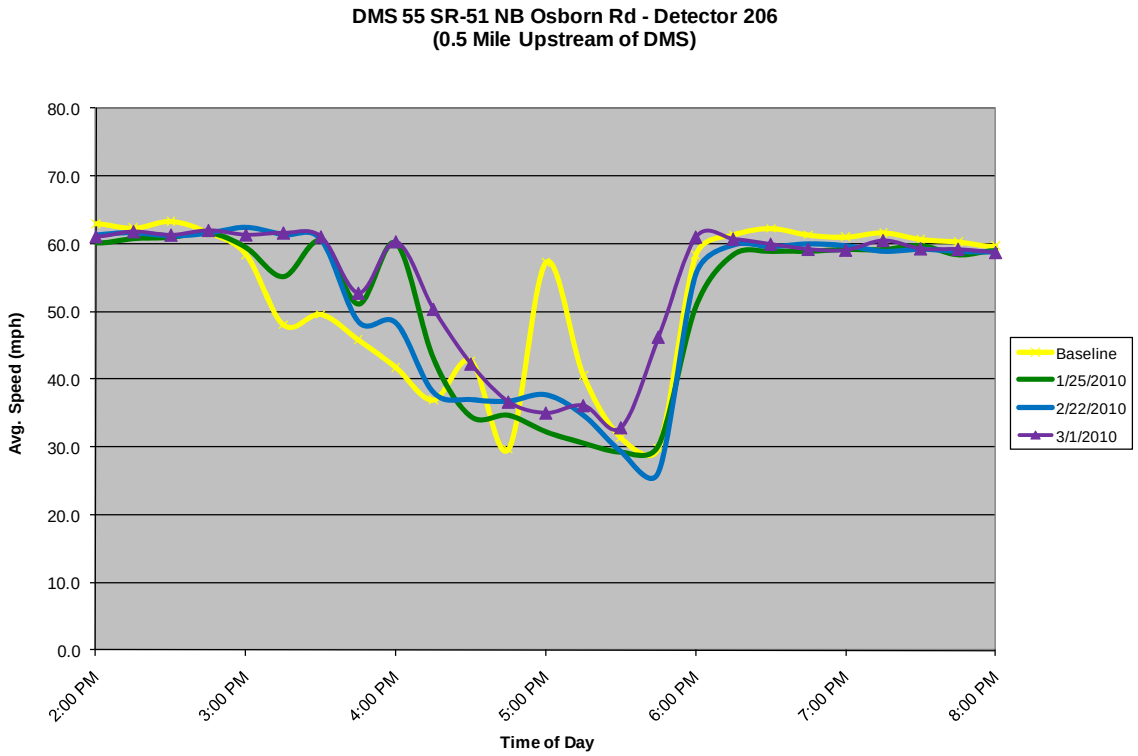


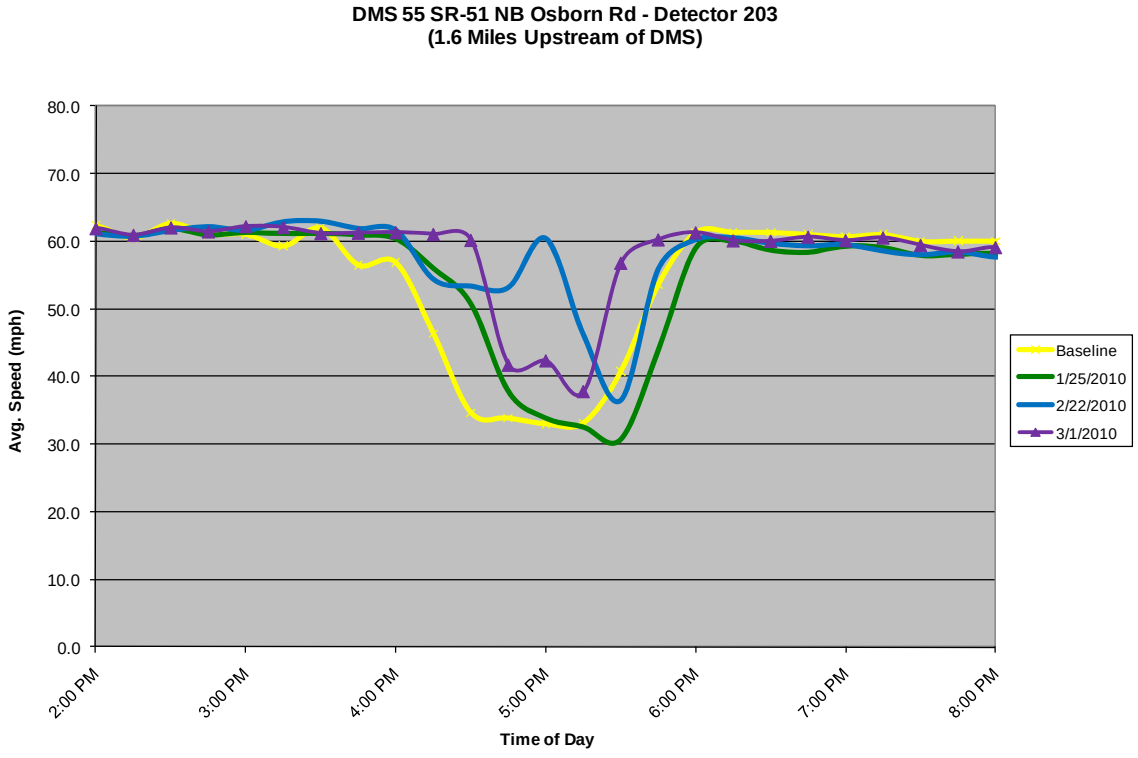


DMS 17 I-17 NB 4th Ave 
No Available Data on both Detector 104 and 98

DMS 55 SR-51 NB Osborn Rd

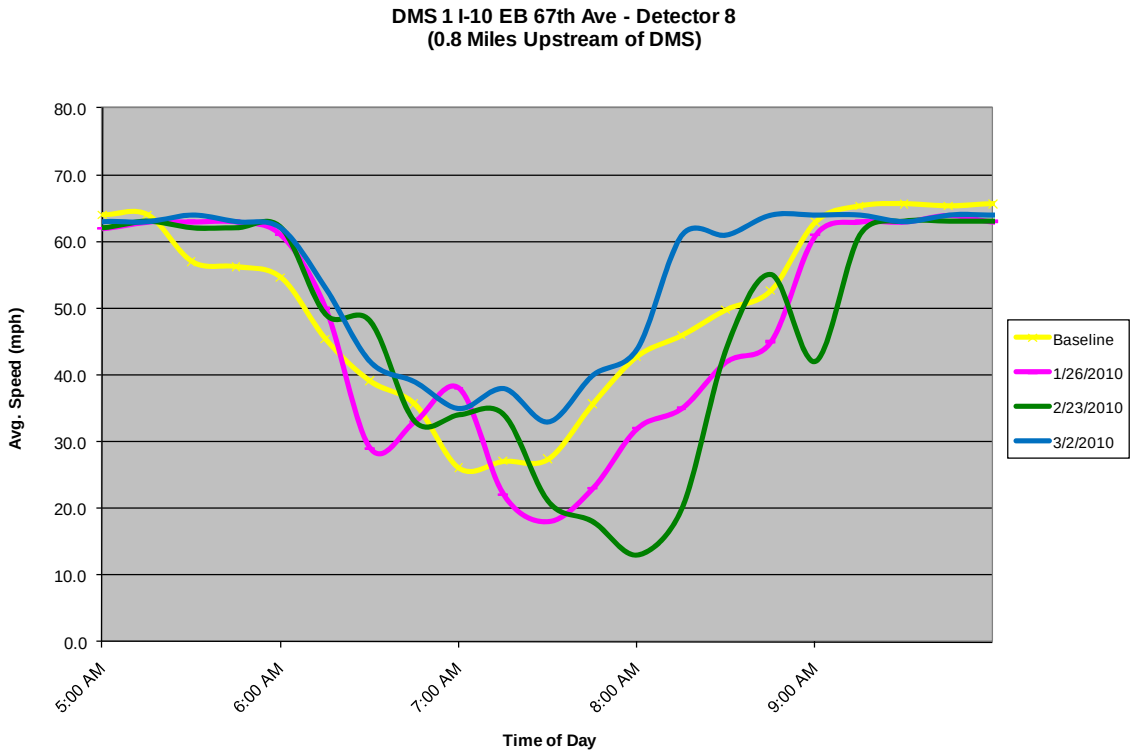
MINUTES TO
BELL RD XX

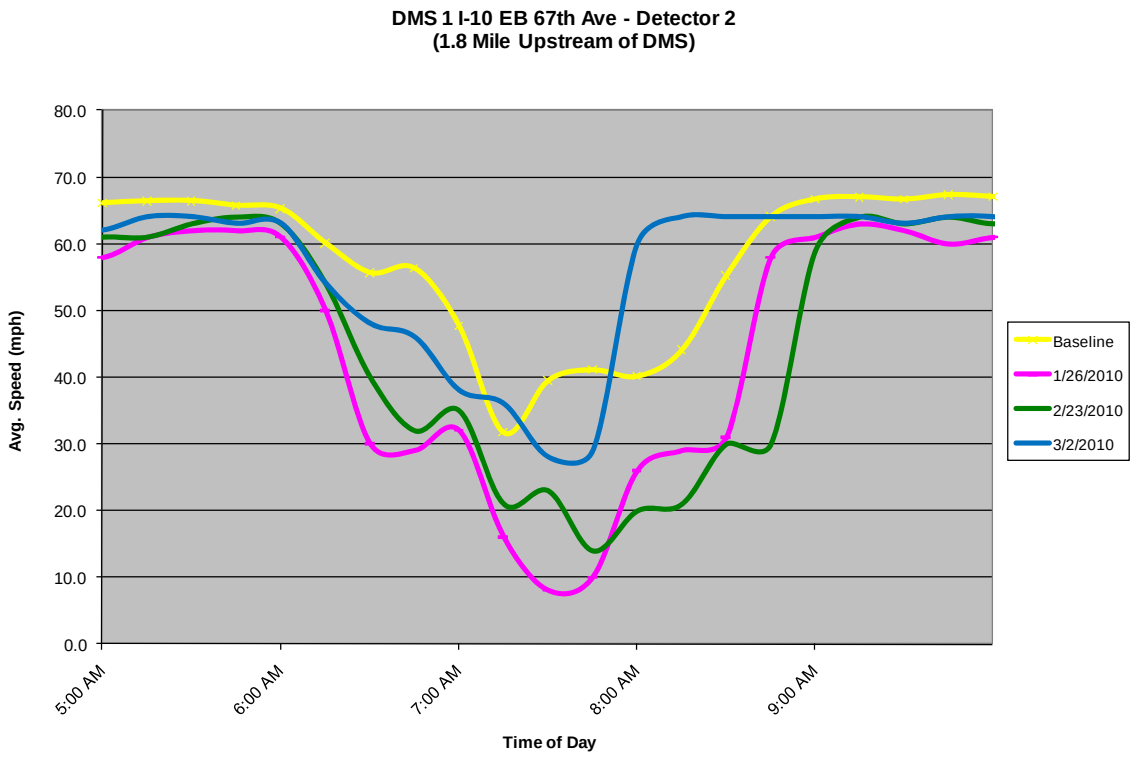




DMS 1 I-10 EB 67th Ave

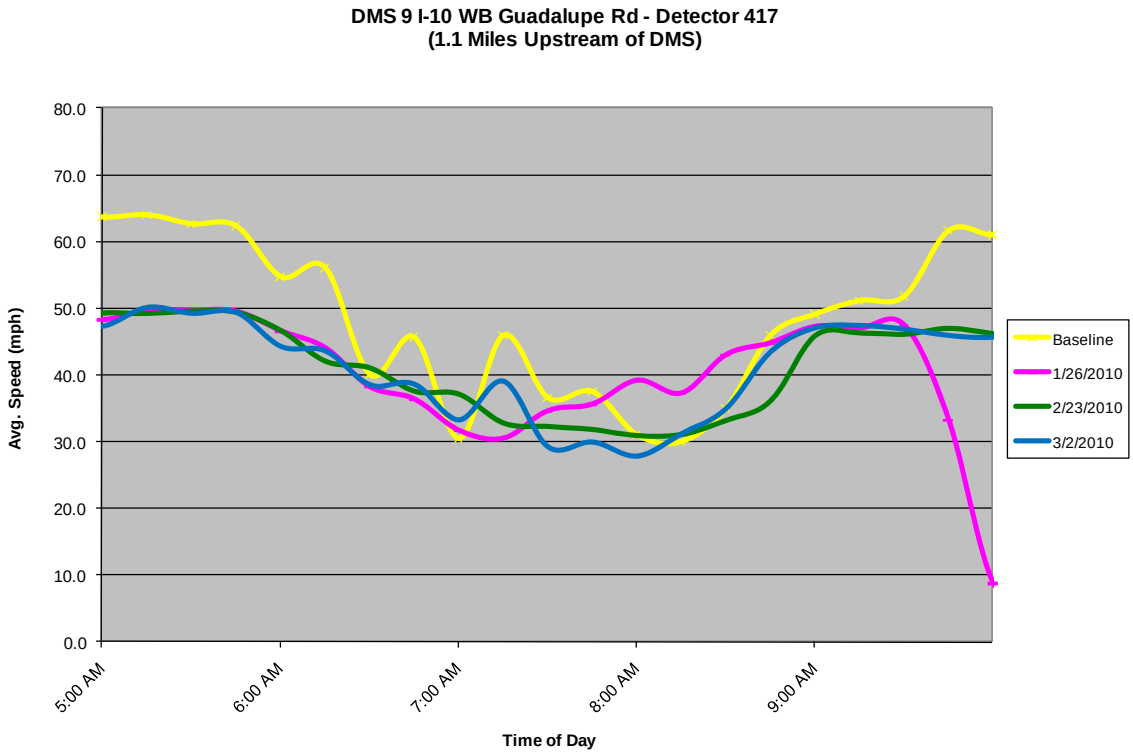
MINUTES TO
TUNNEL XX
AIRPORT YY

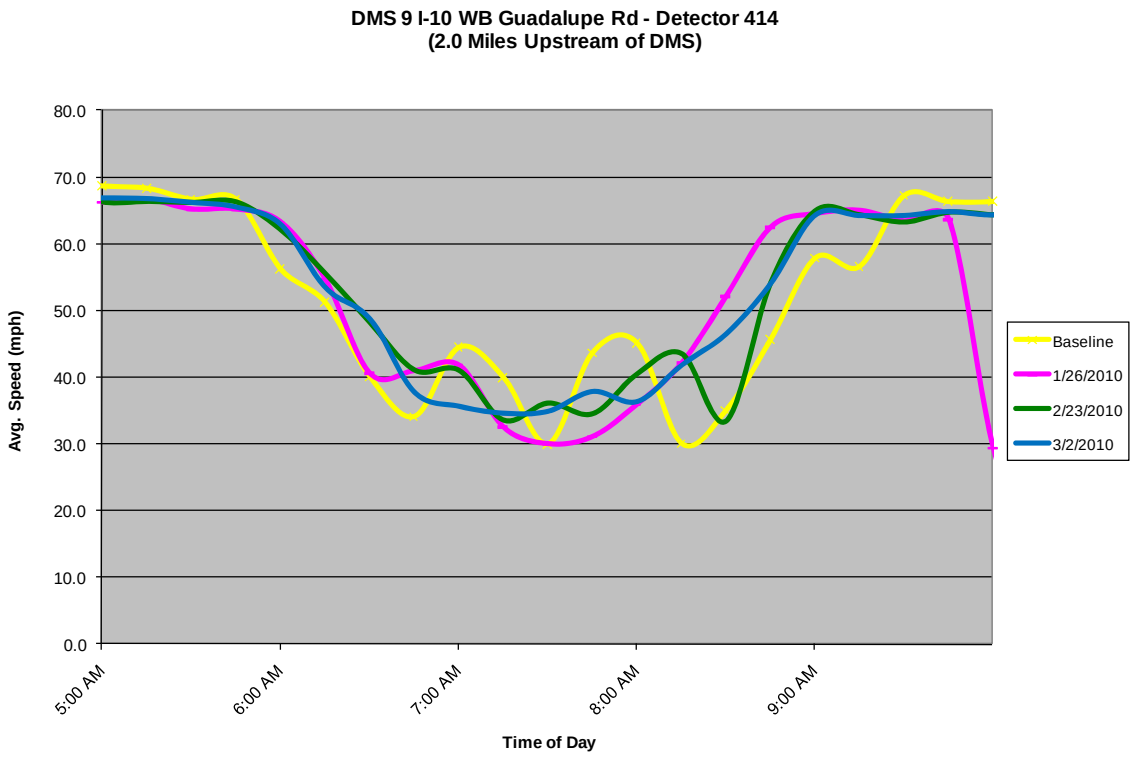




DMS 9 I-10 WB Guadalupe Rd

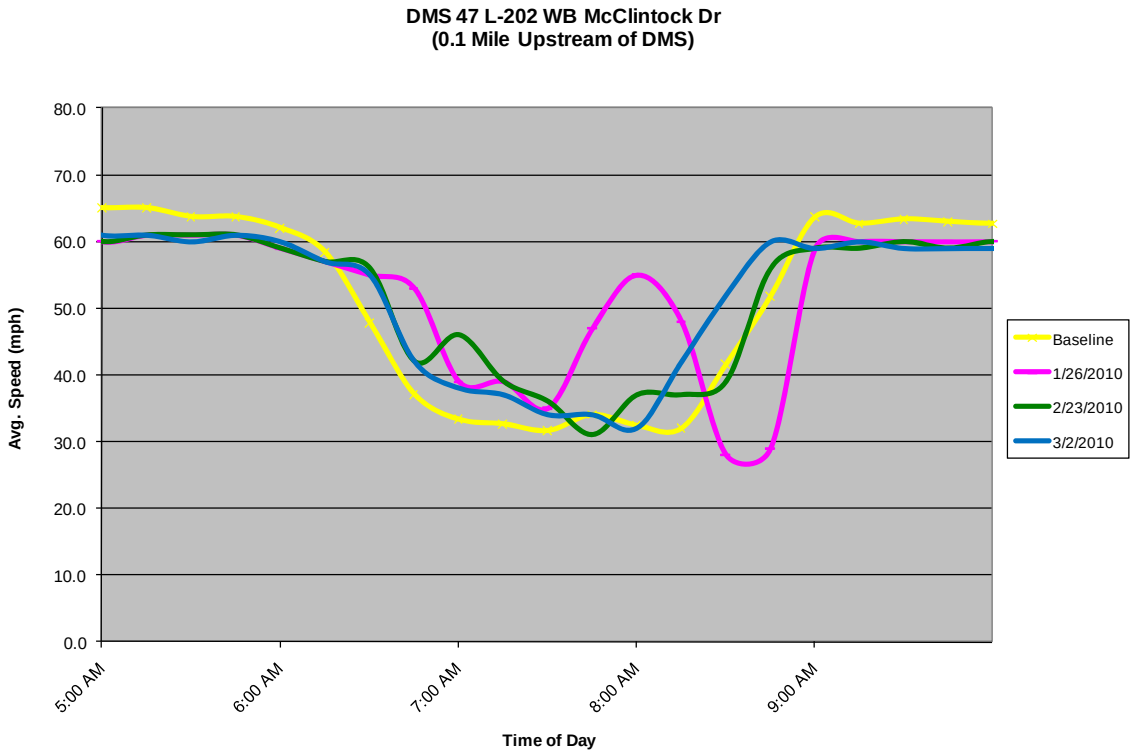
MINUTES TO
SR-143 XX
TUNNEL YY



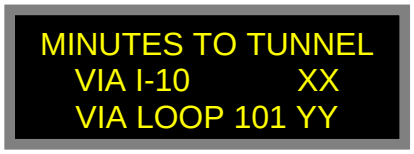


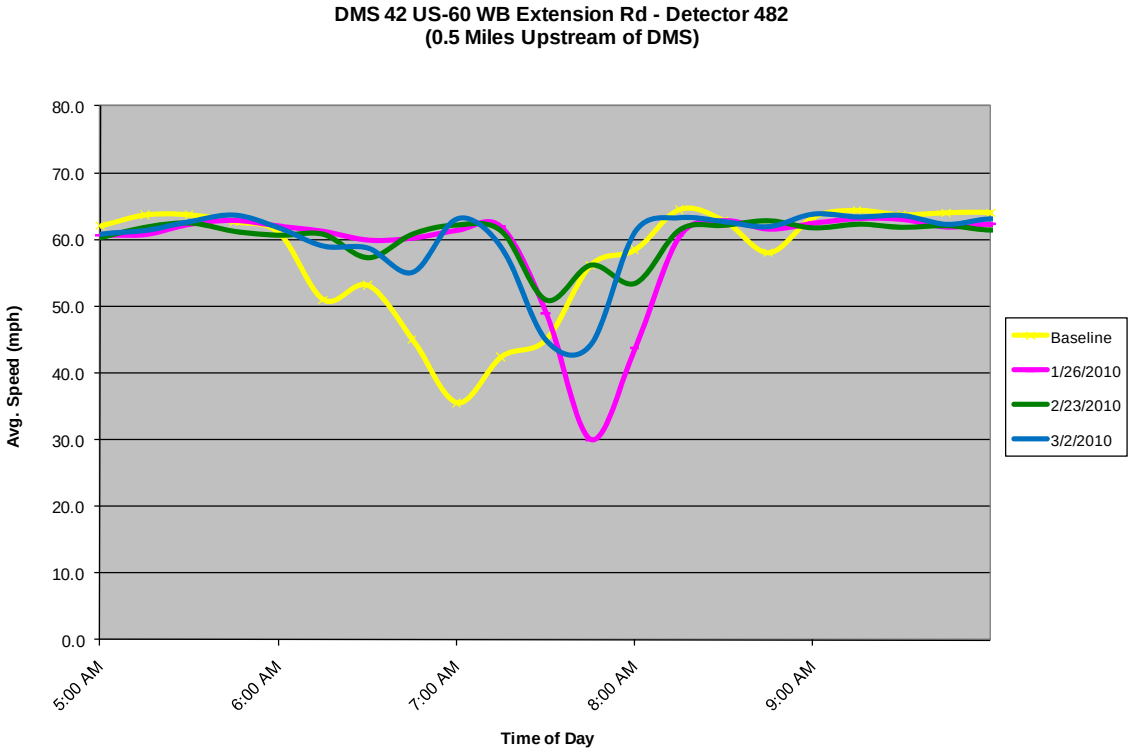
DMS 47 L-202 WB McClintock Dr

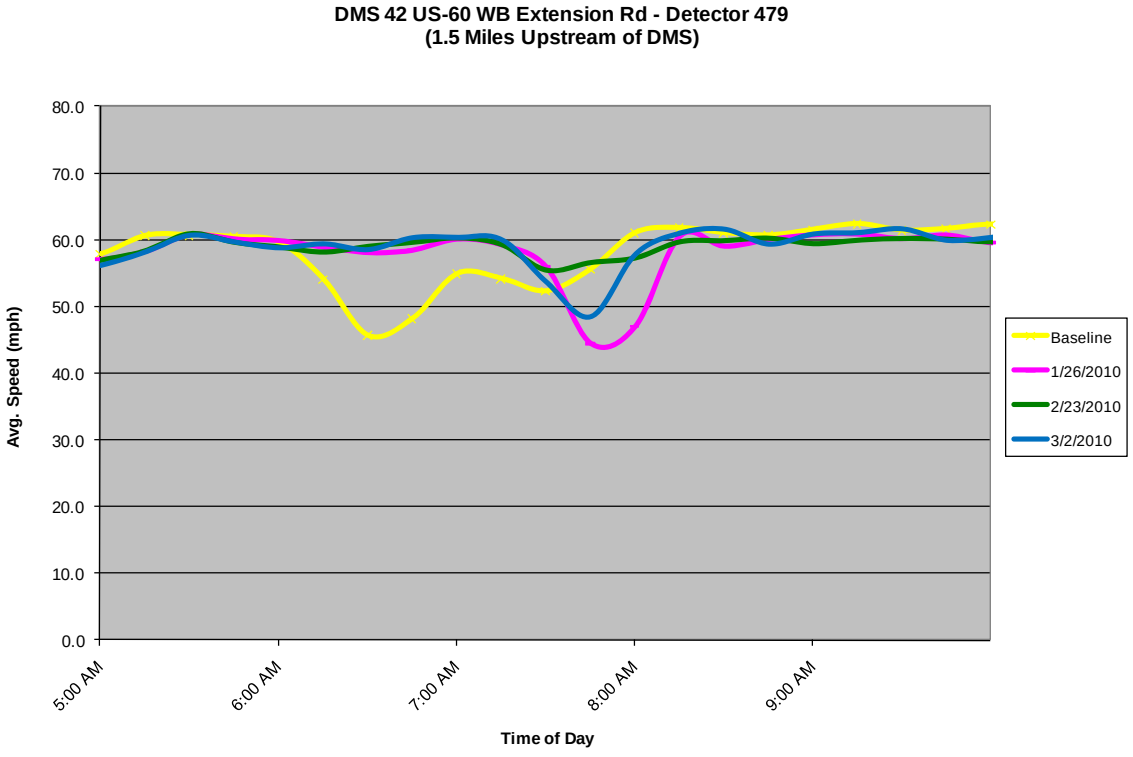
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

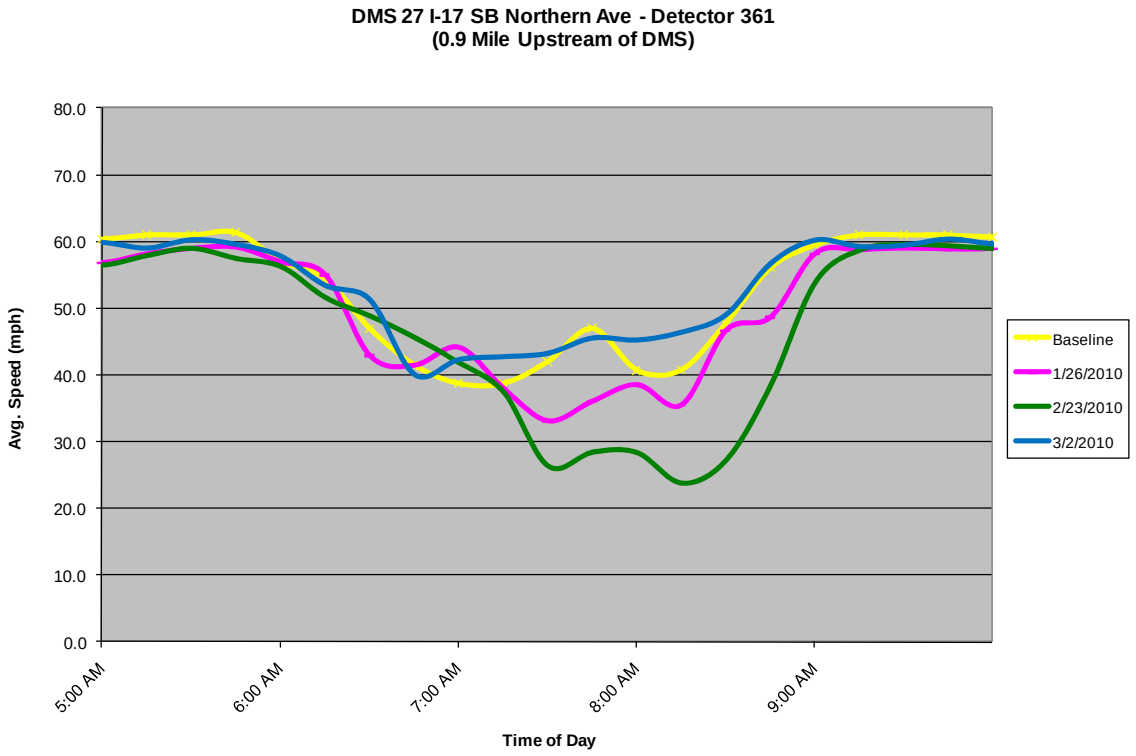


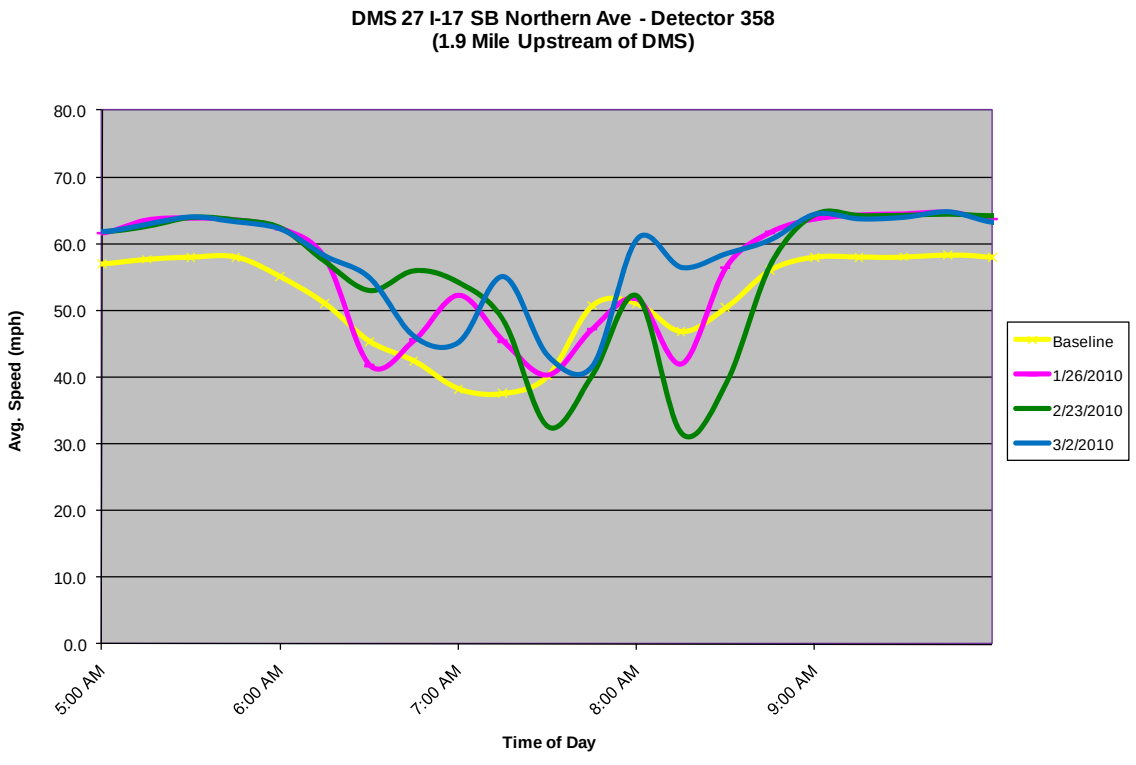




DMS 27 I-17 SB Northern Ave

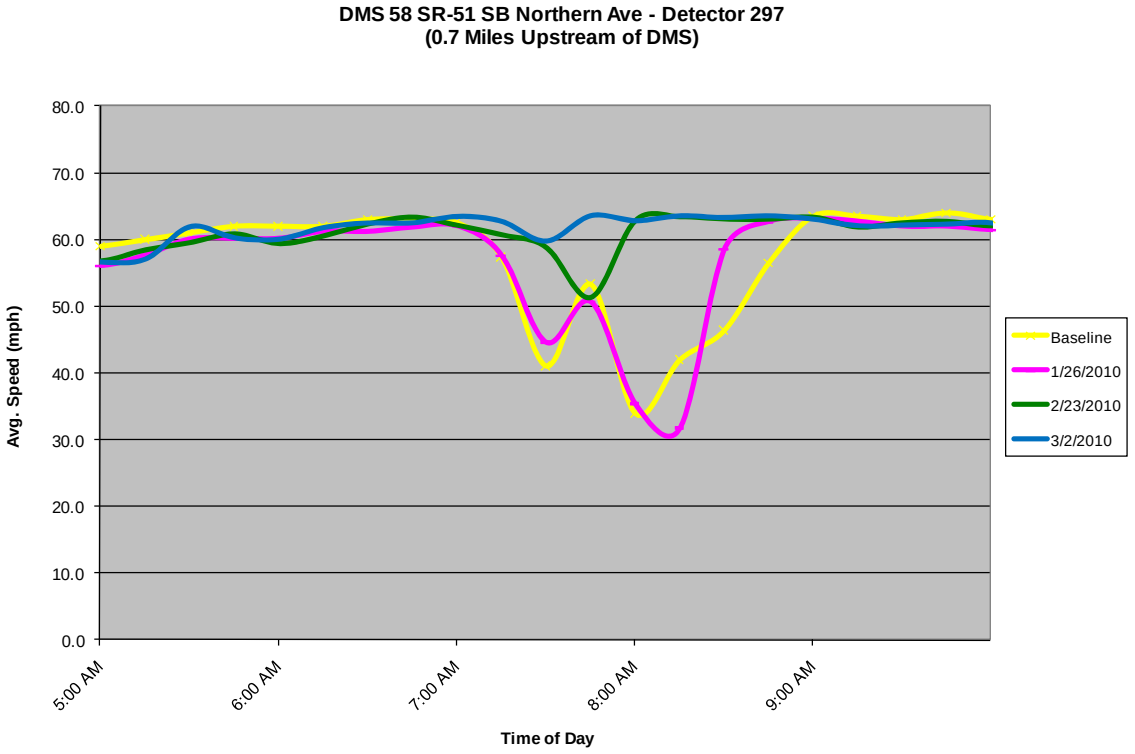
MINUTES TO
I-10 TUNNEL XX

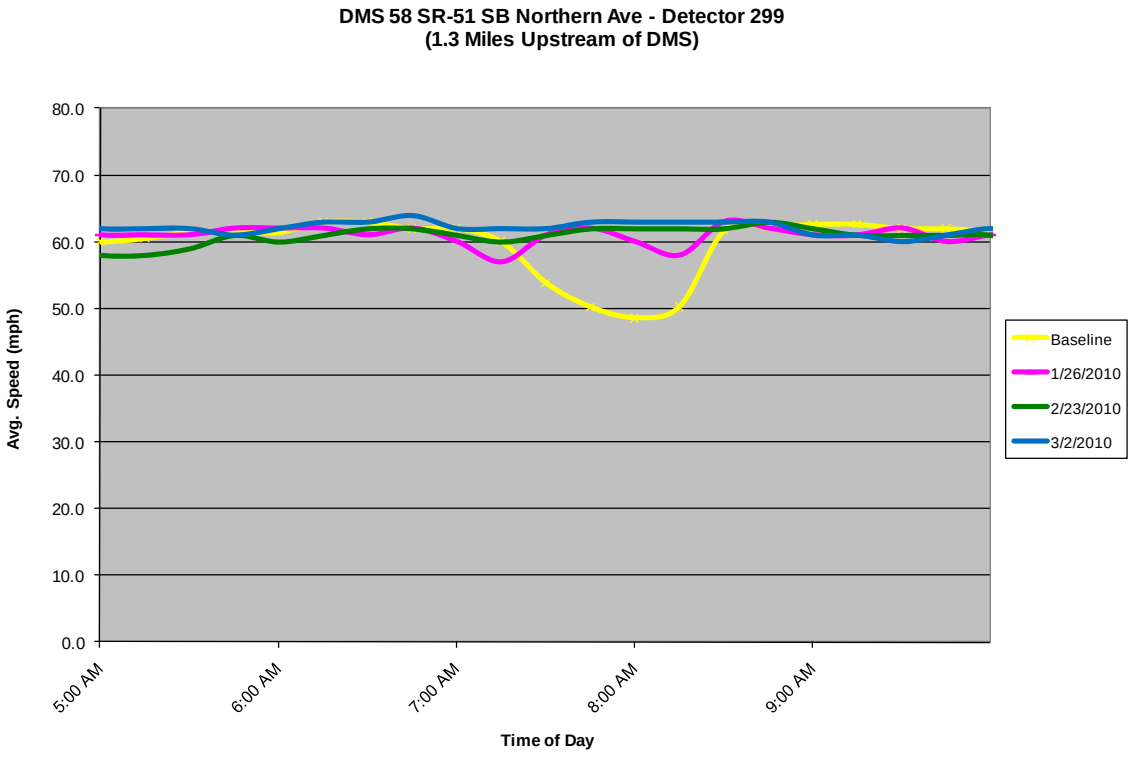




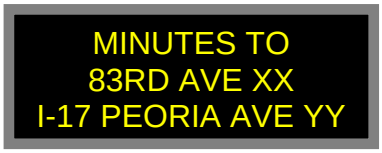
DMS 58 SR-51 SB Northern Ave

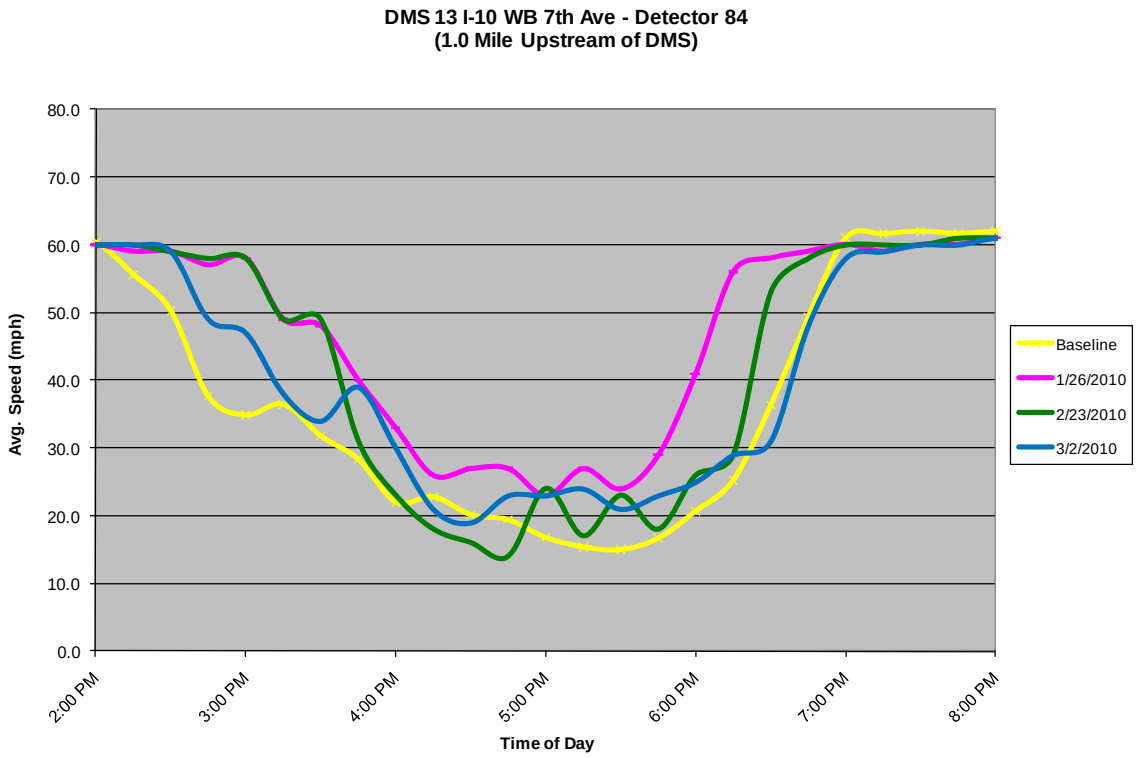
MINUTES TO
I-10 TUNNEL XX

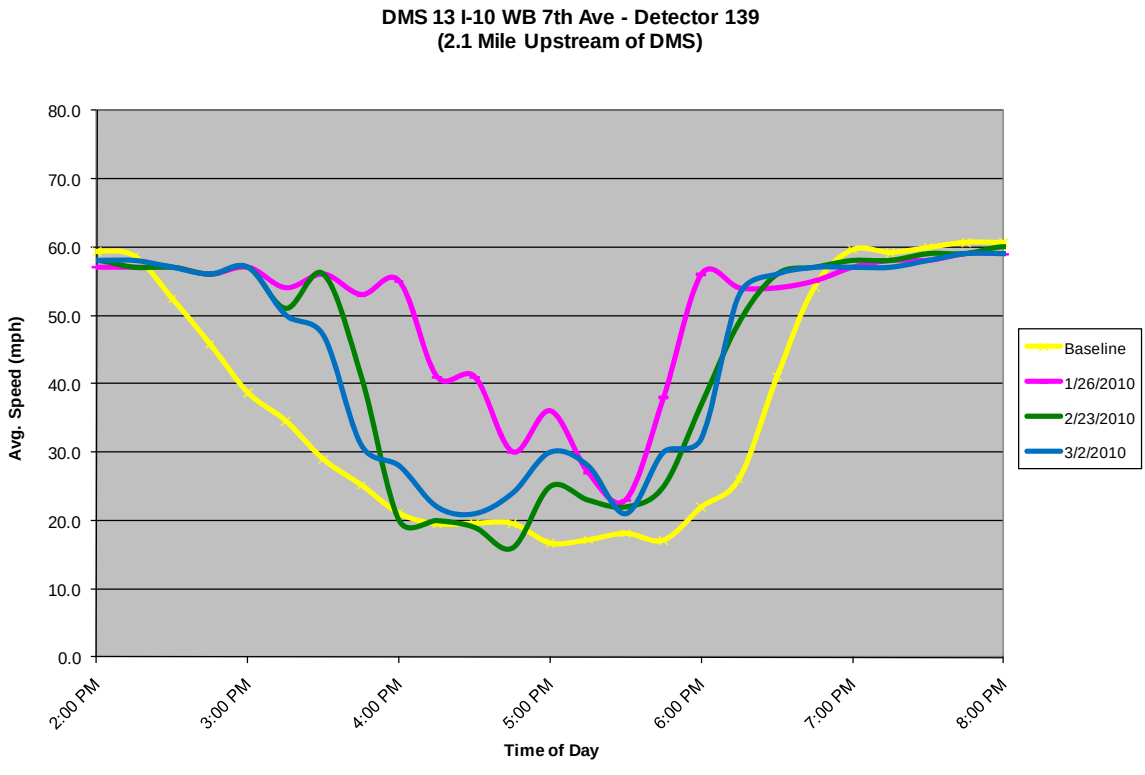




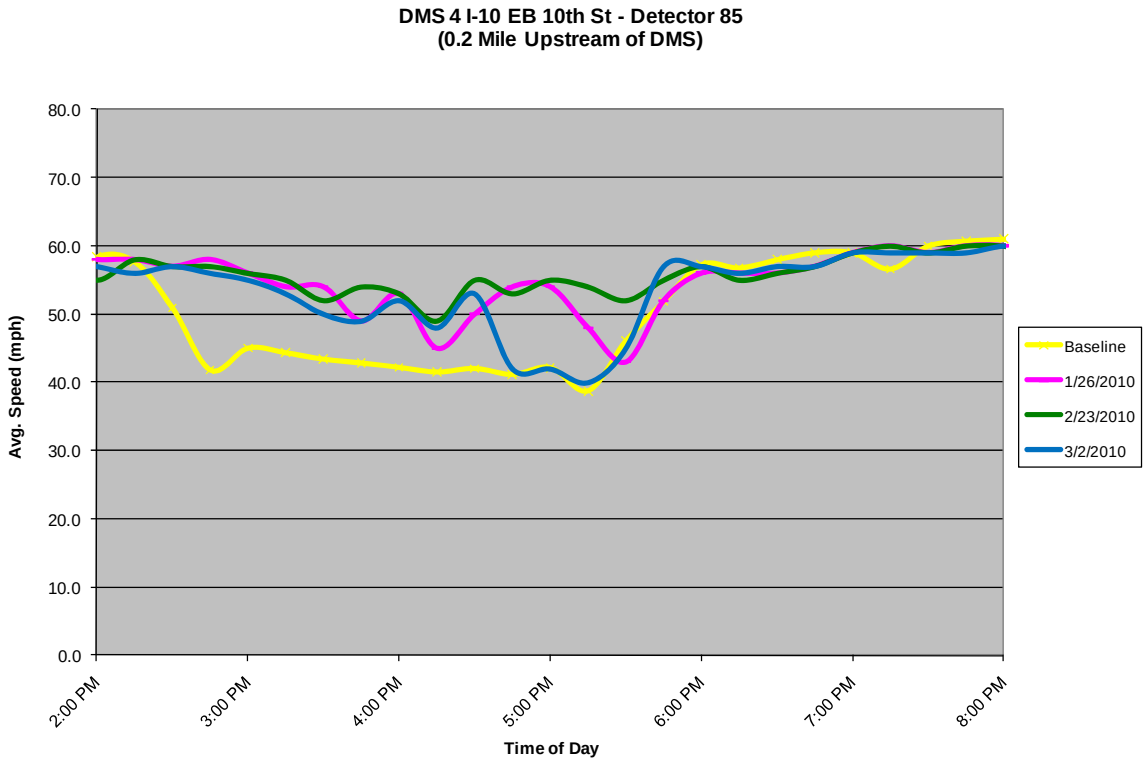
DMS 13 I-10 WB 7th Ave

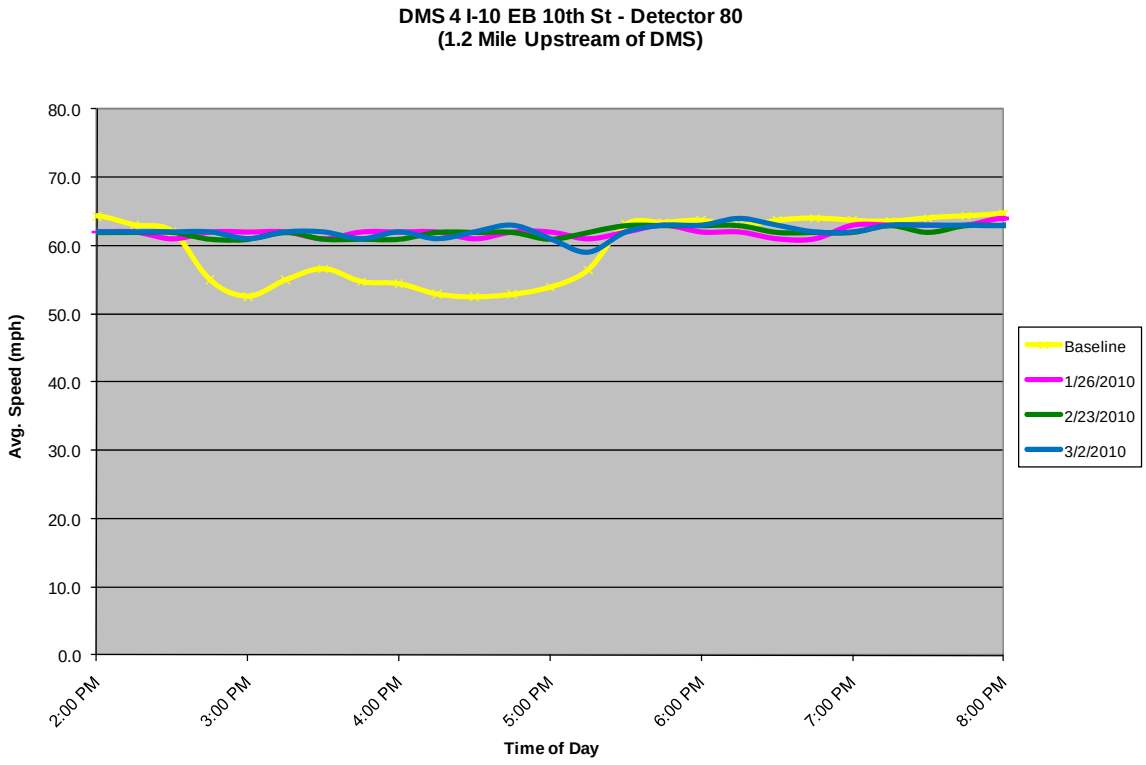






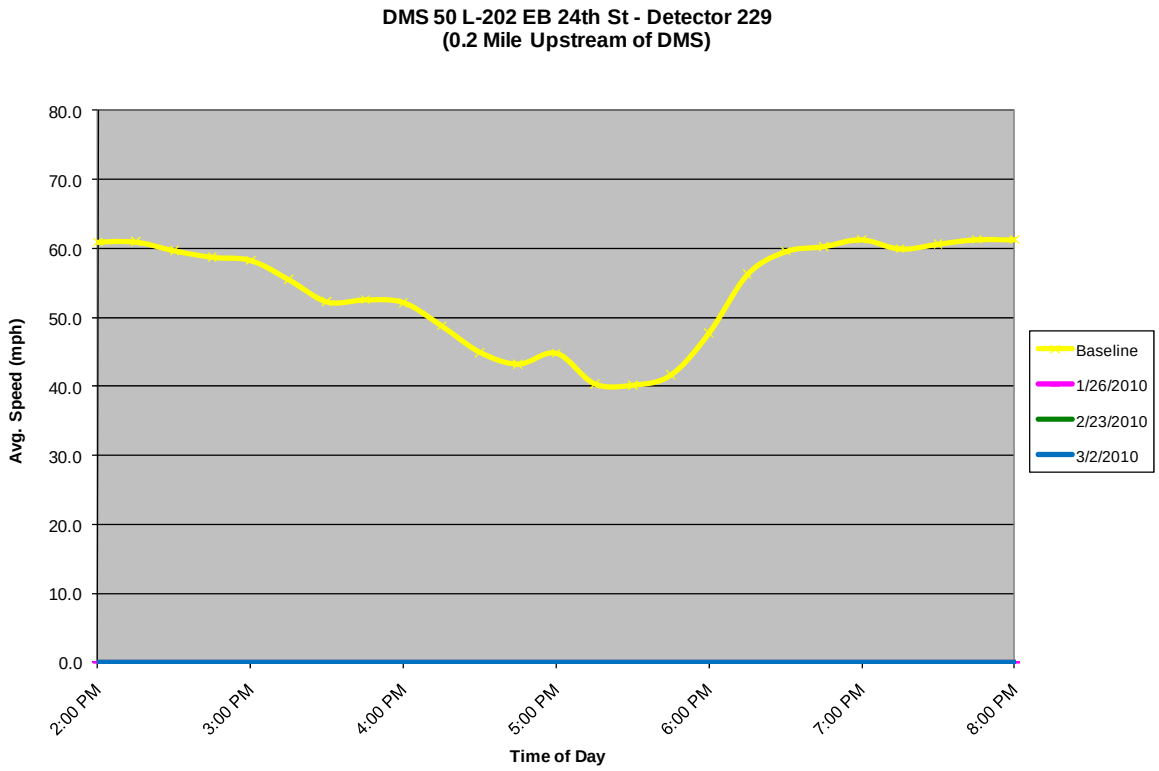
DMS 4 I-10 EB 10th St





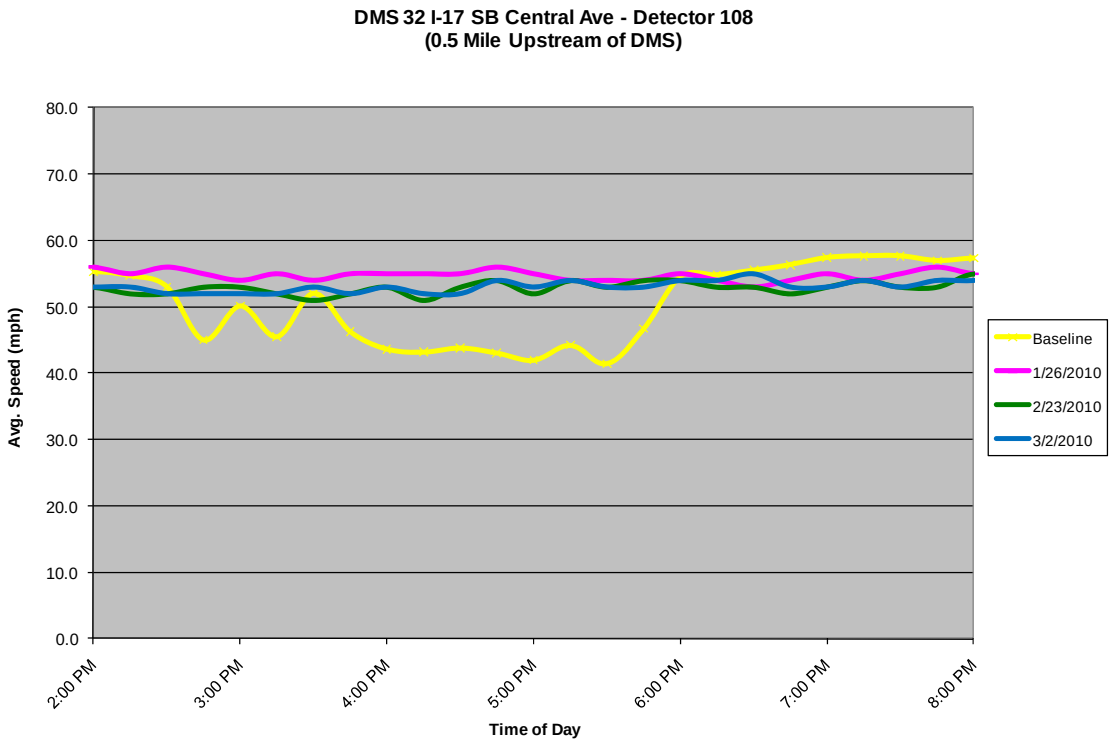
DMS 50 L-202 EB 24th ST

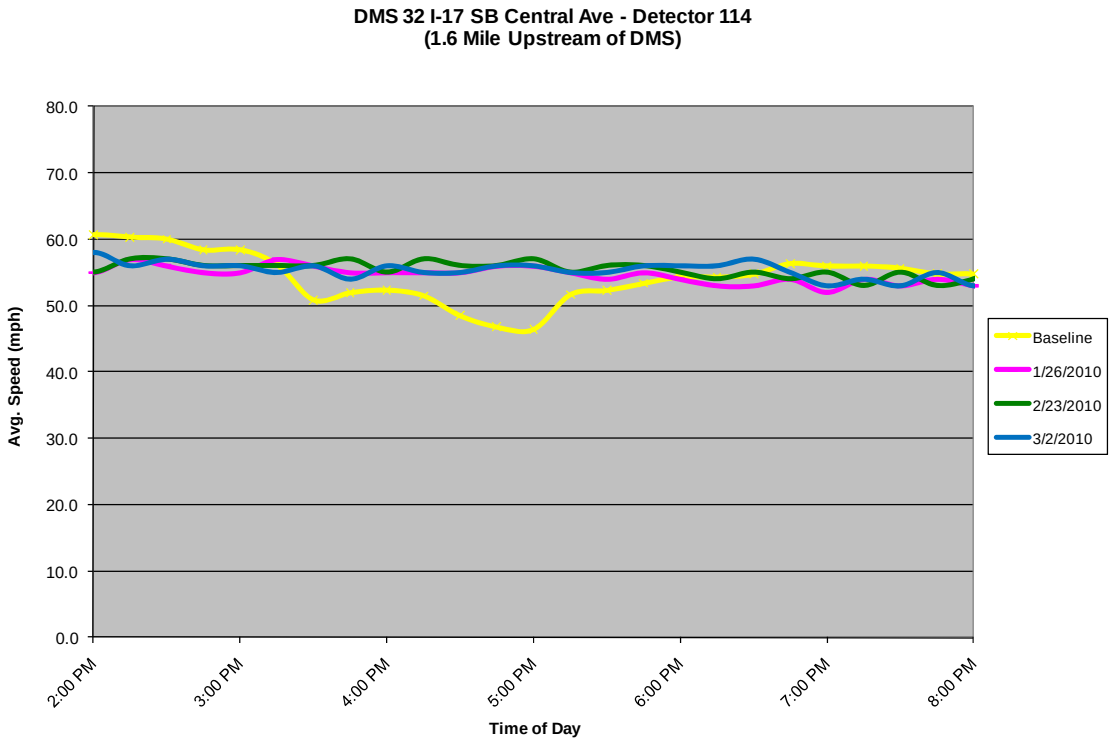
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

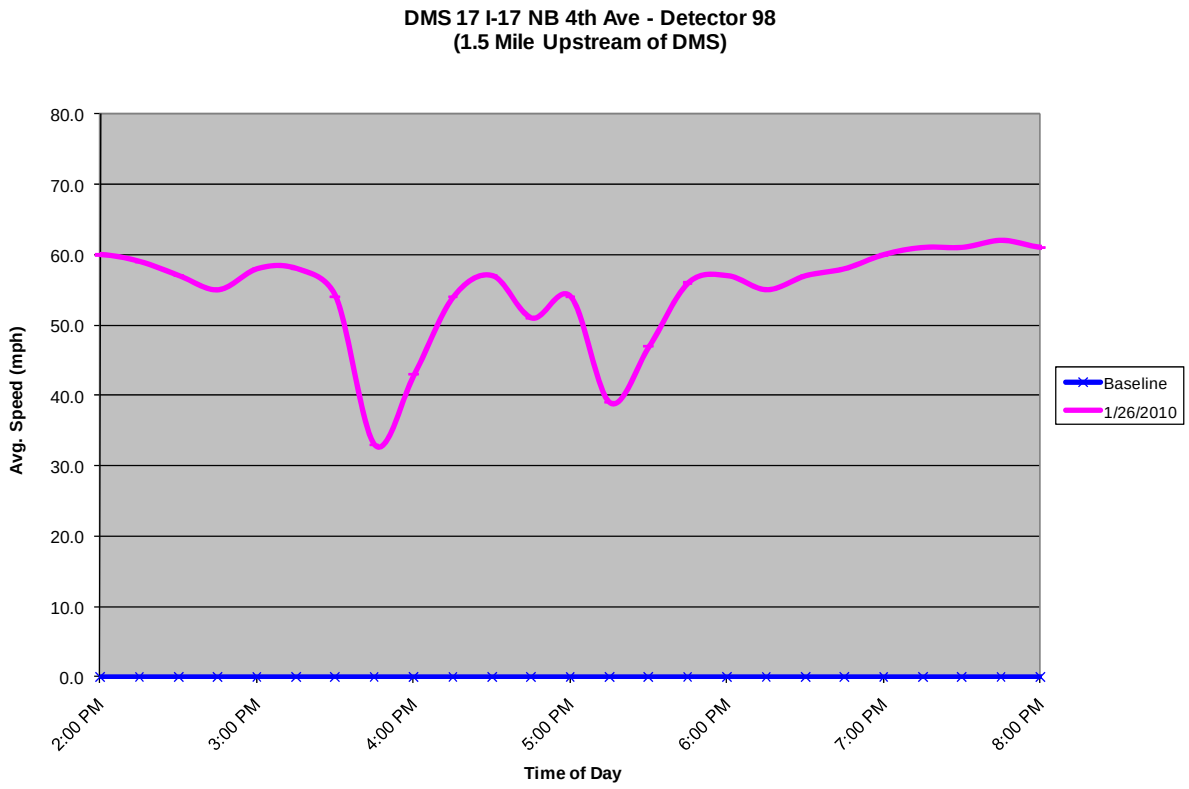




DMS 17 I-17 NB 4th Ave

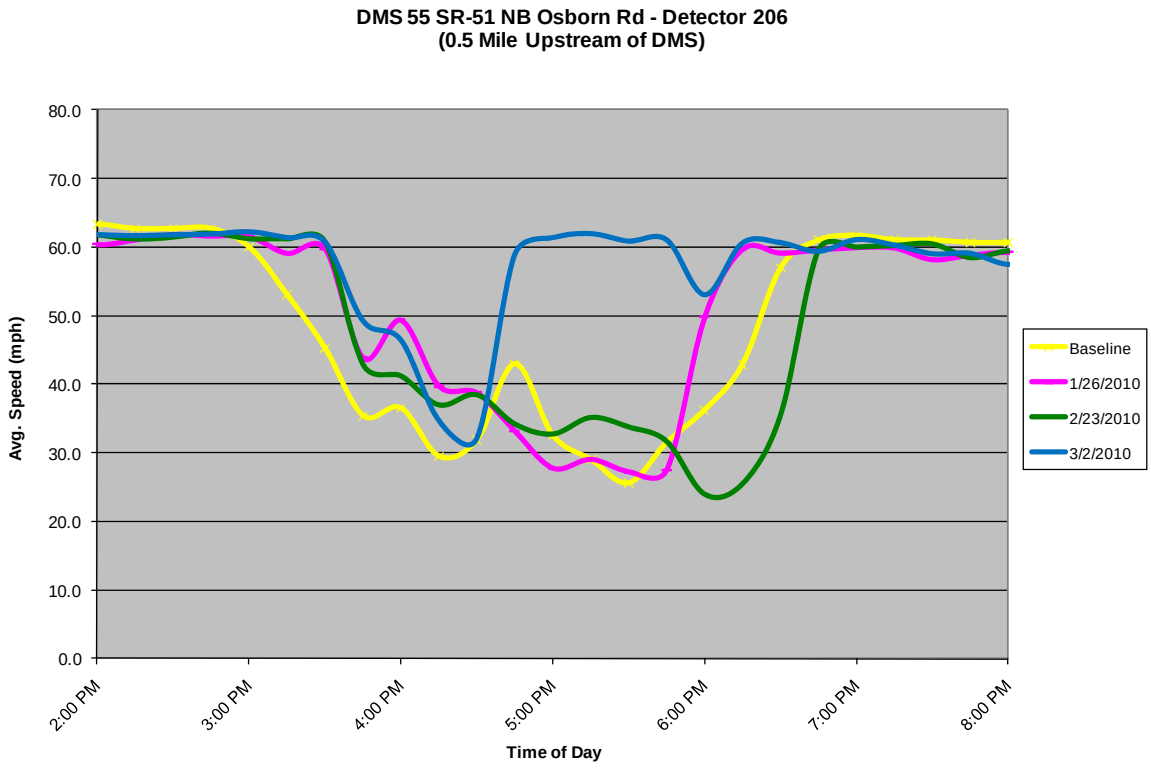
MINUTES TO
PEORIA AVE XX
I-10 83RD AVE YY

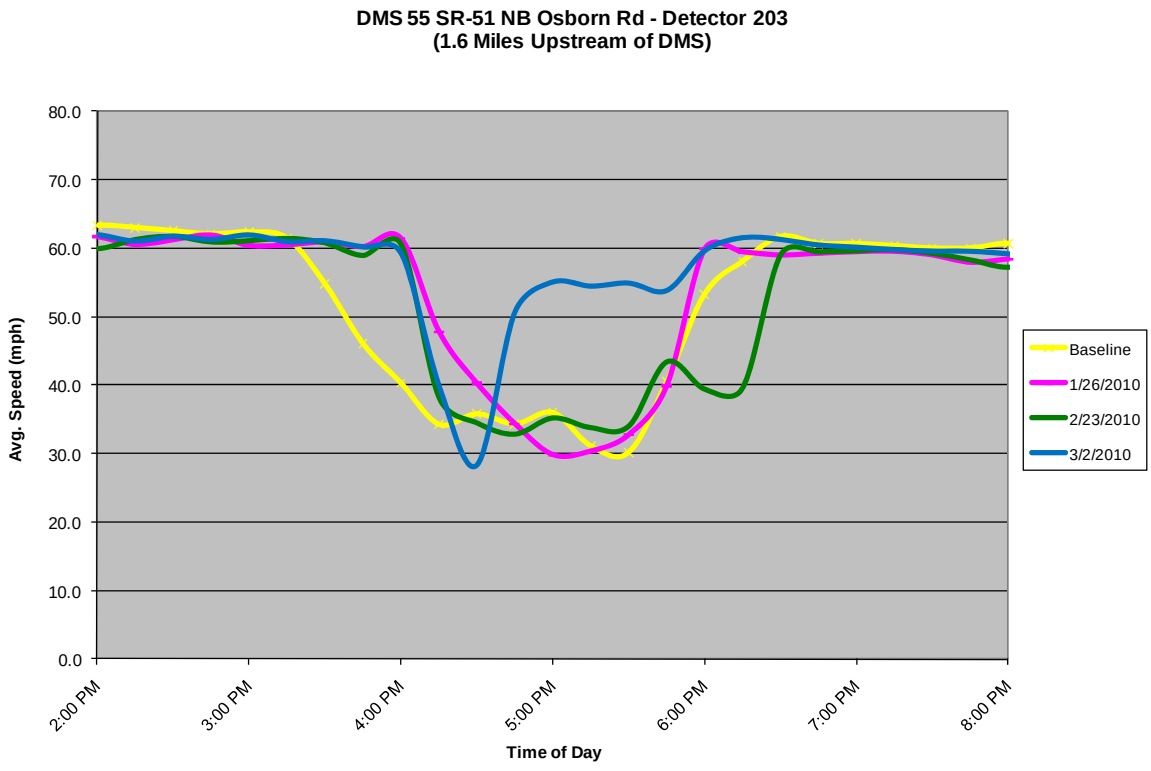
No Available Data on Detector 104



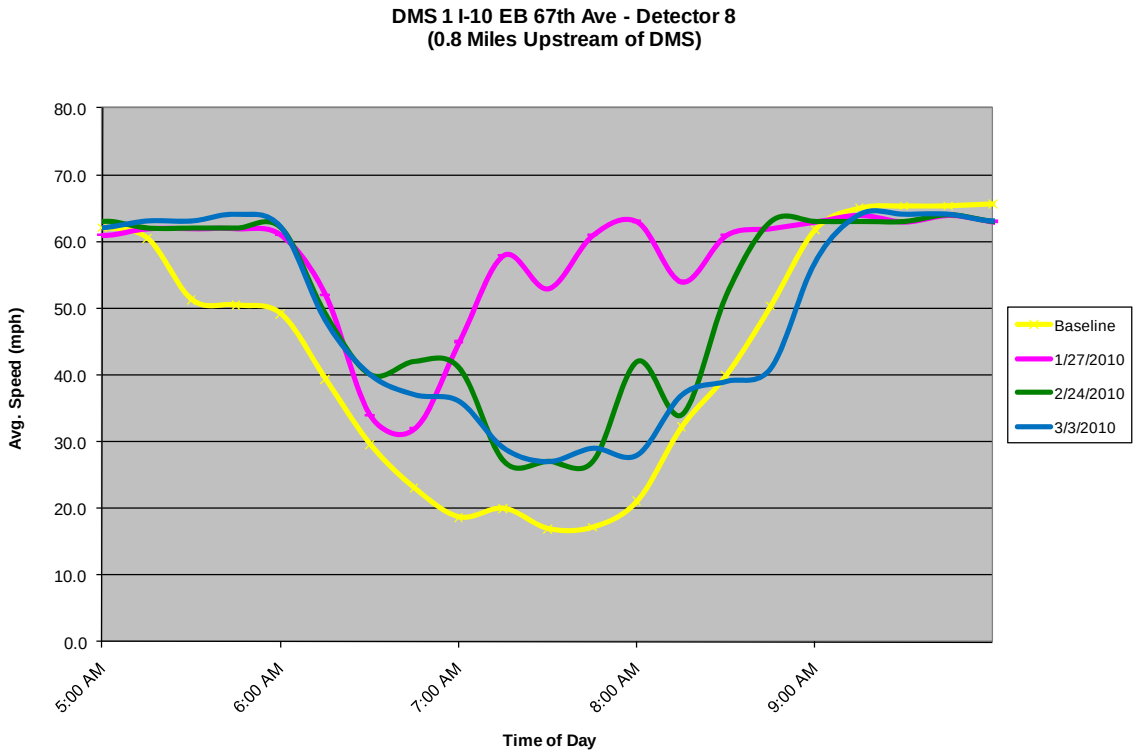
DMS 55 SR-51 NB Osborn Rd

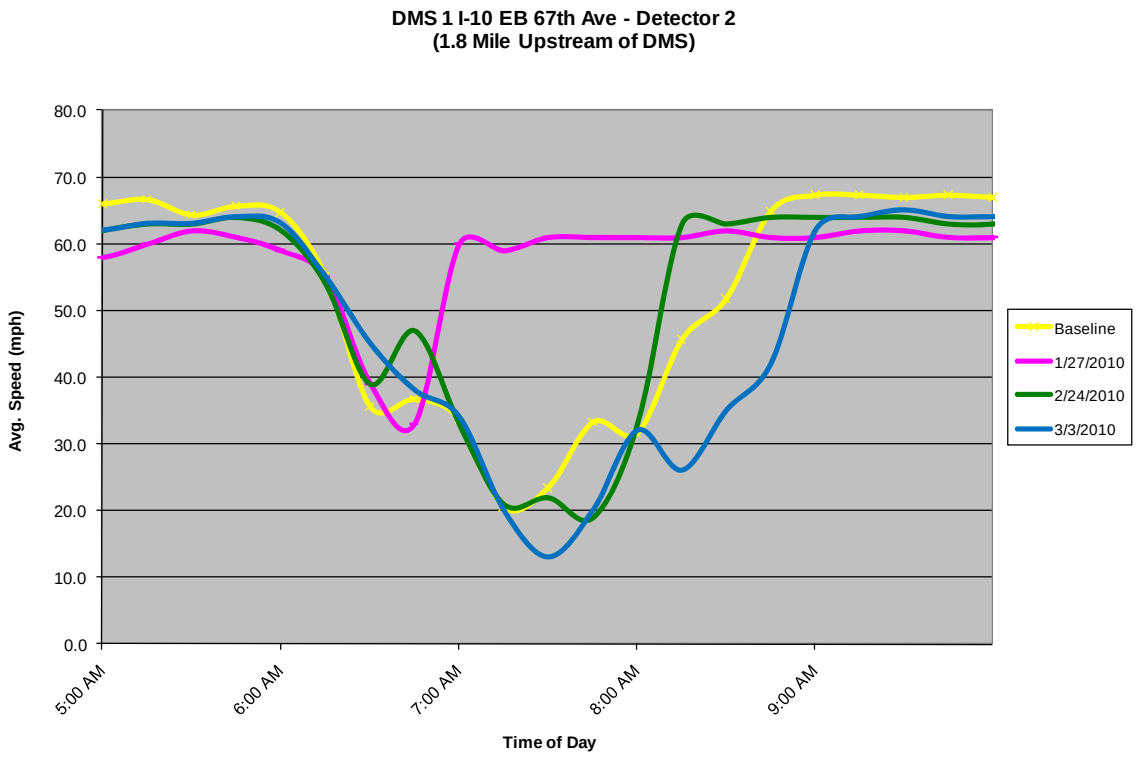
MINUTES TO
BELL RD XX





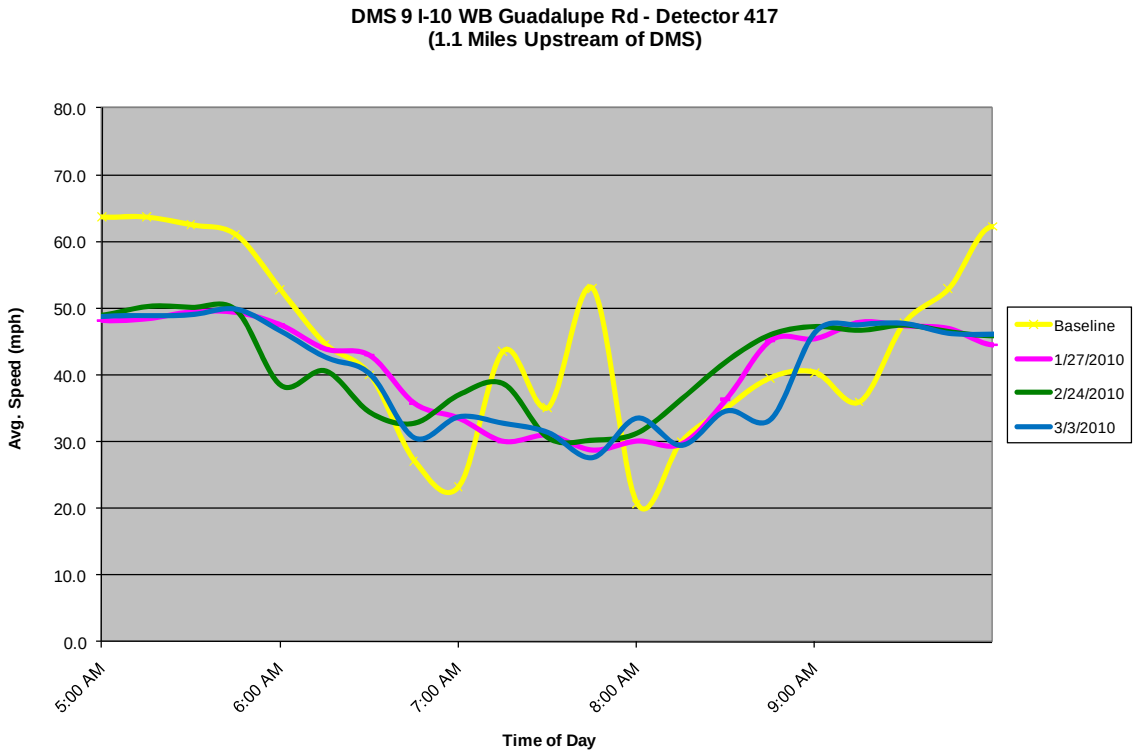
DMS 1 I-10 EB 67th Ave

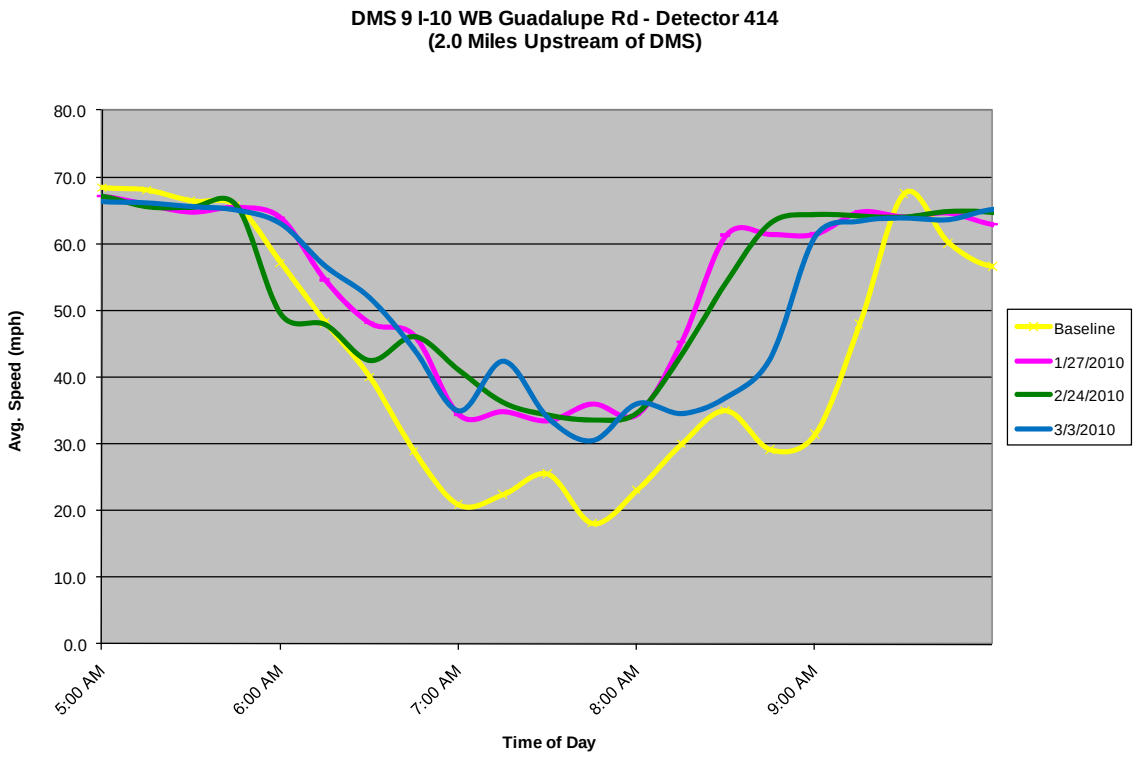




DMS 9 I-10 WB Guadalupe Rd

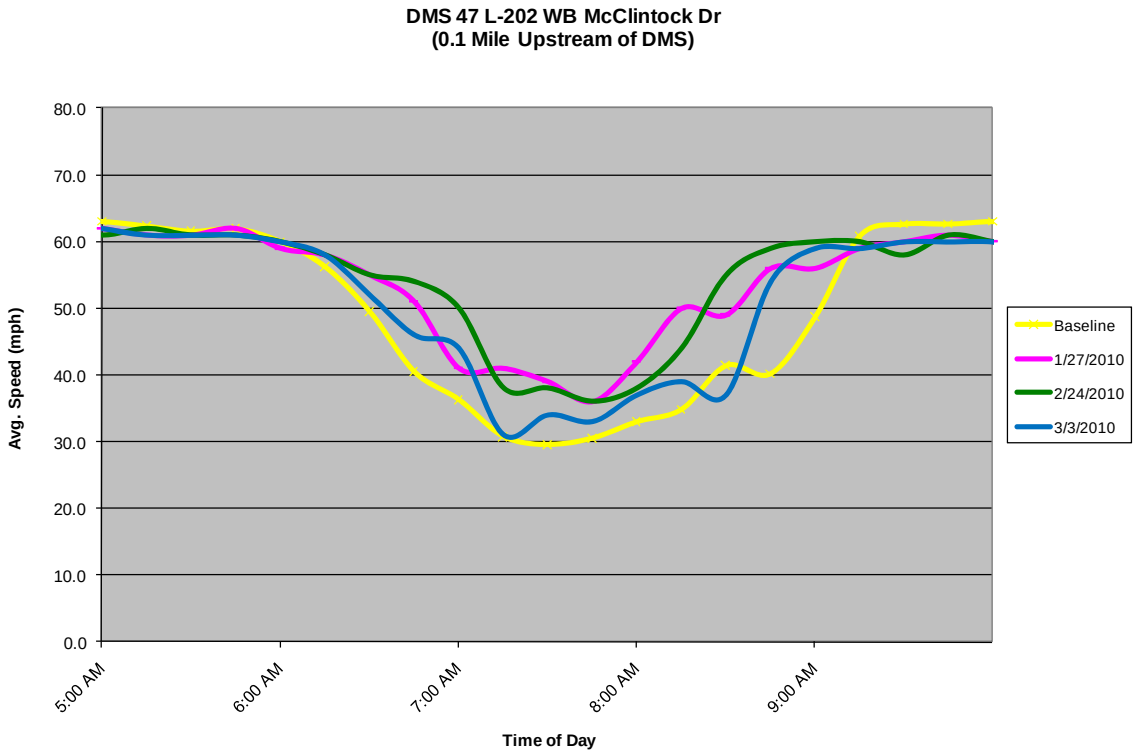
MINUTES TO
SR-143 XX
TUNNEL YY





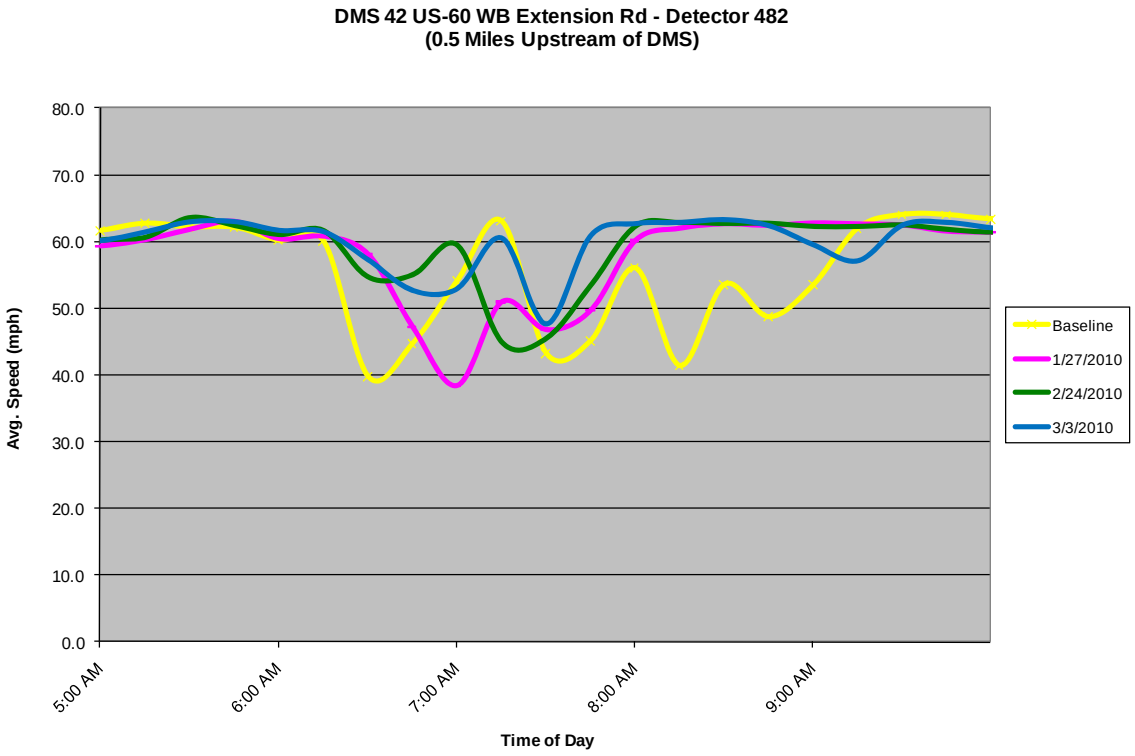
DMS 47 L-202 WB McClintock Dr

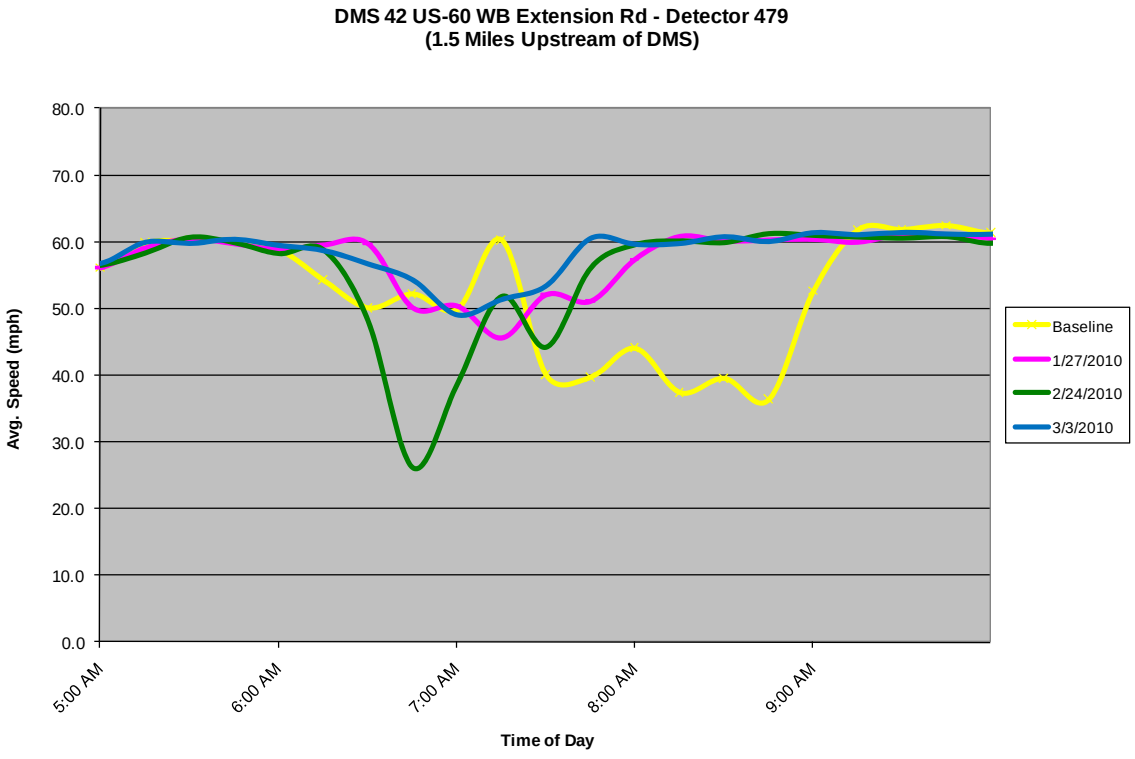
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

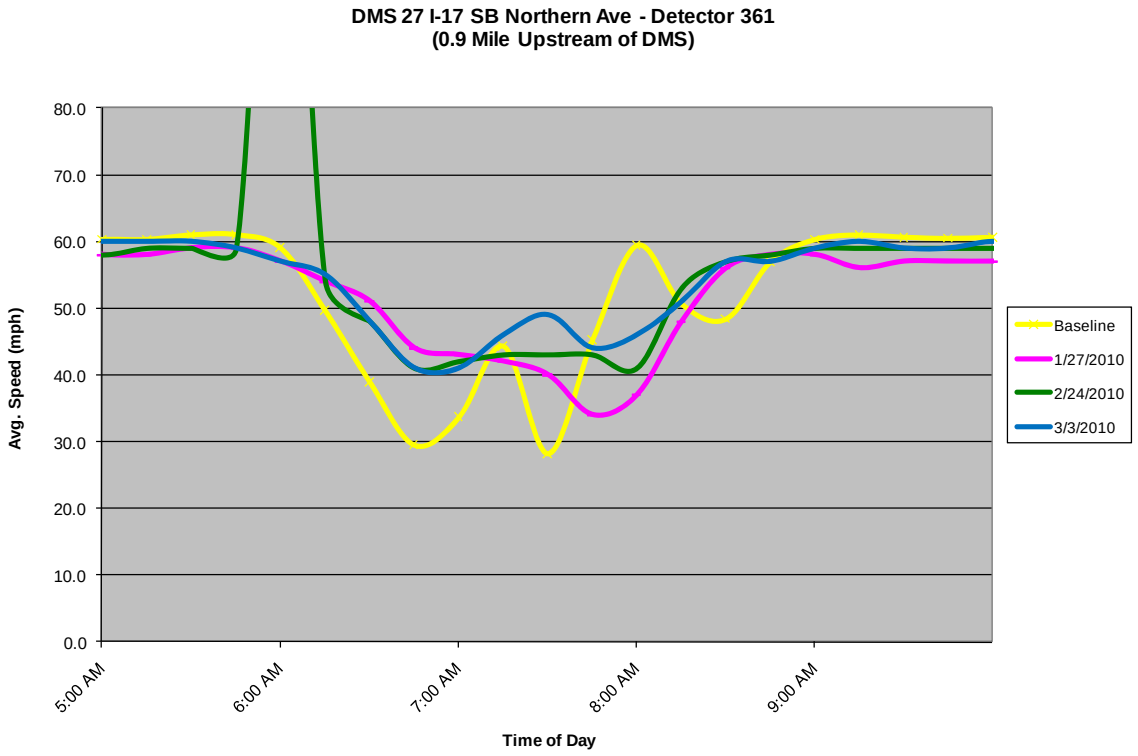
MINUTES TO TUNNEL
VIA I-10 XX
VIA LOOP 101 YY

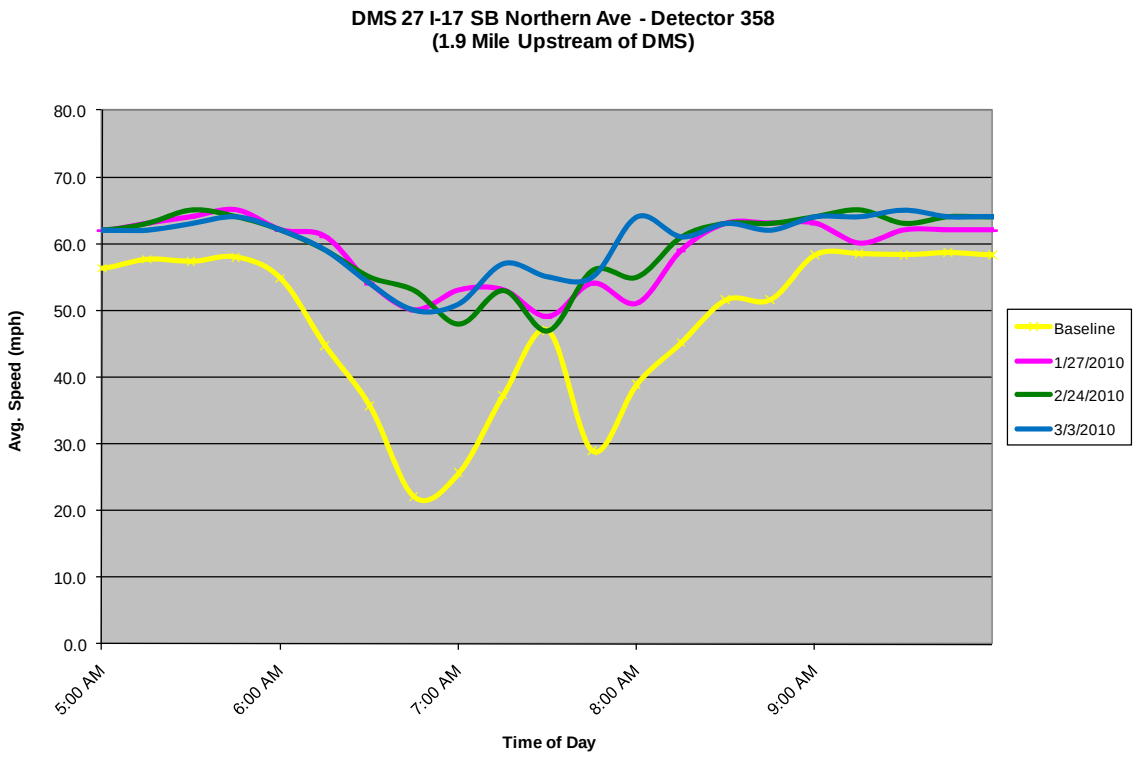




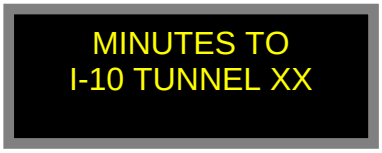
DMS 27 I-17 SB Northern Ave

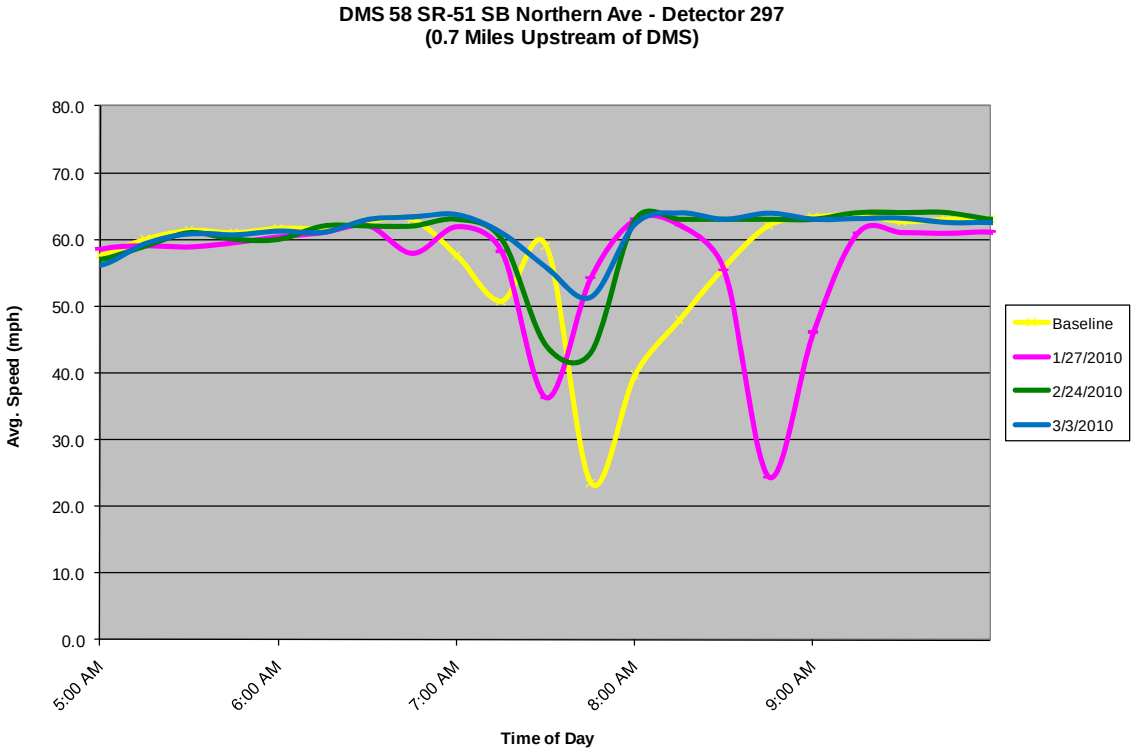
MINUTES TO
I-10 TUNNEL XX

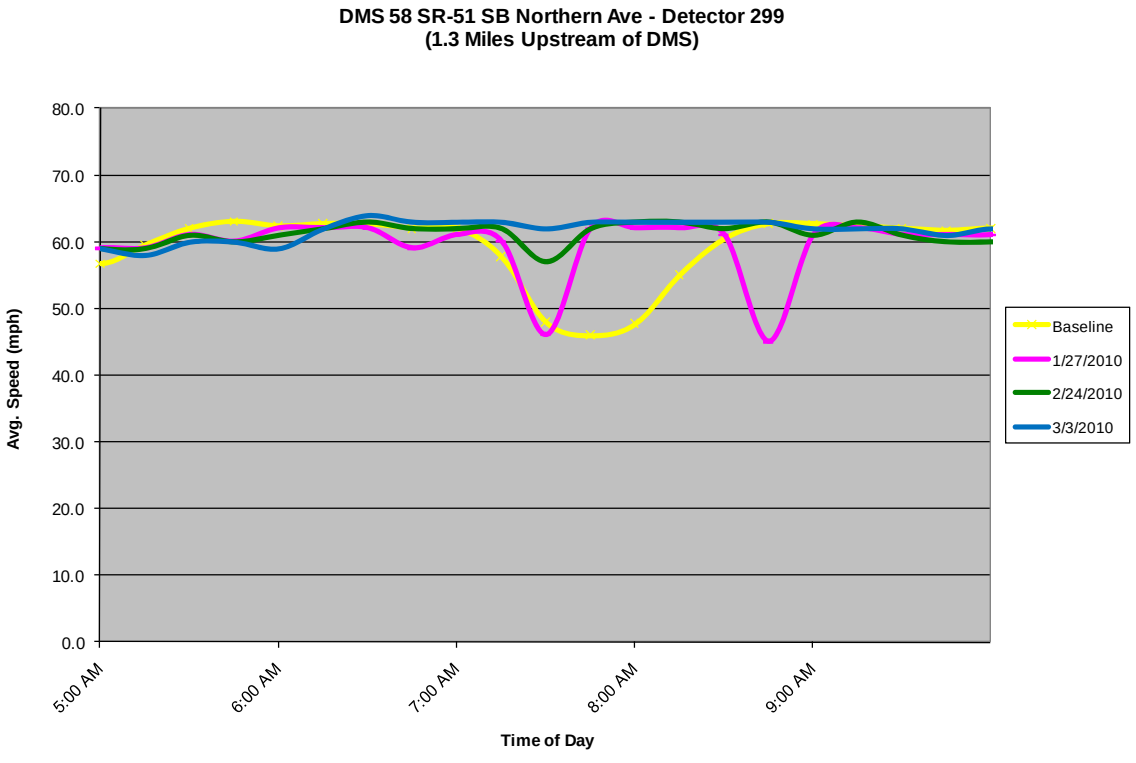




DMS 58 SR-51 SB Northern Ave

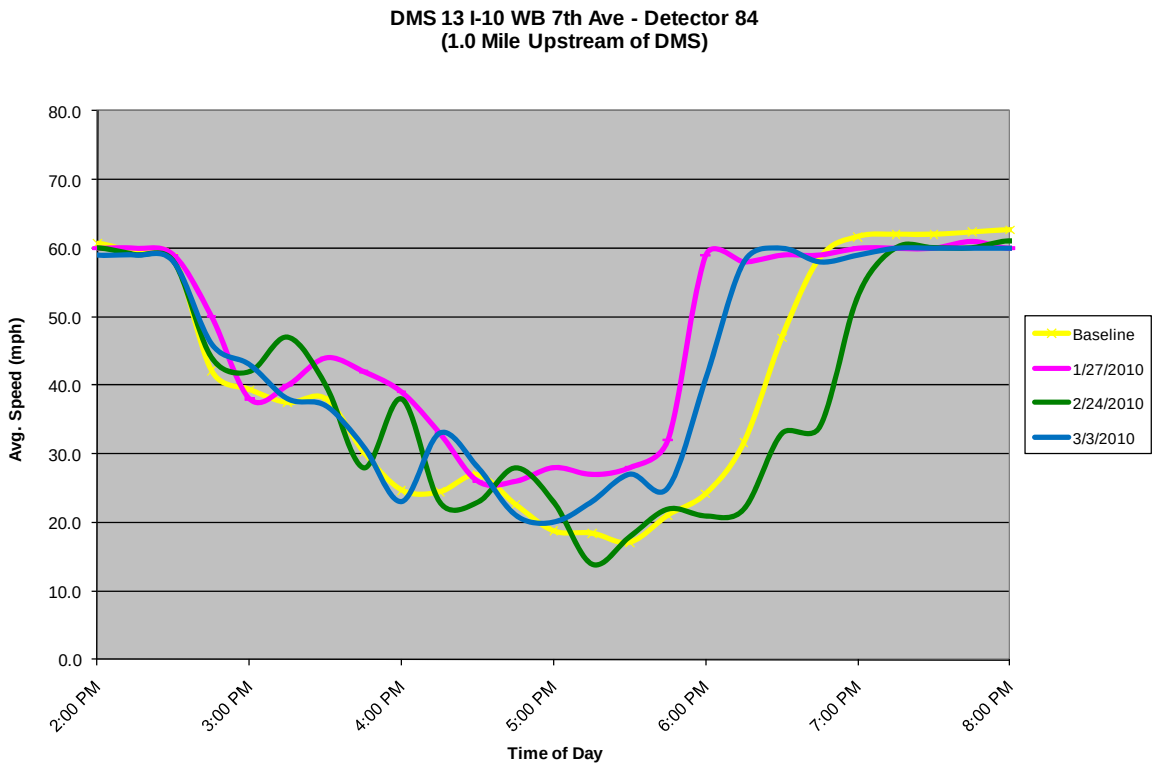


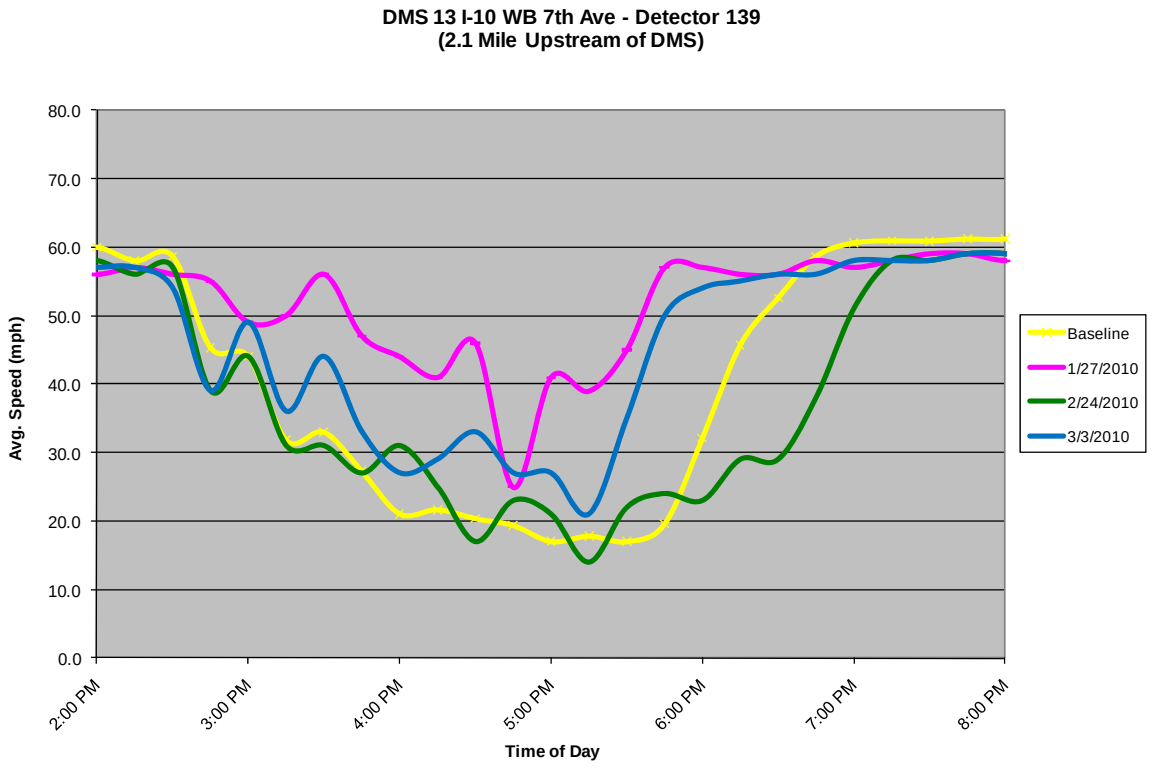




DMS 13 I-10 WB 7th Ave

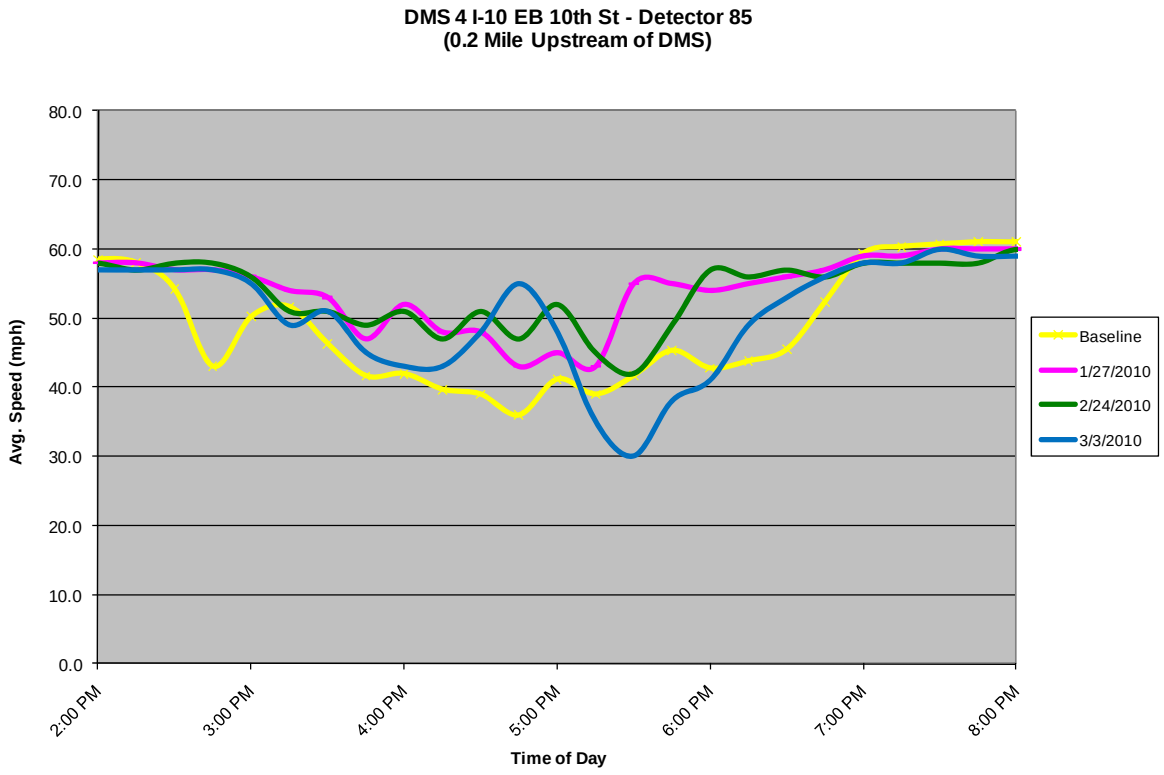
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY

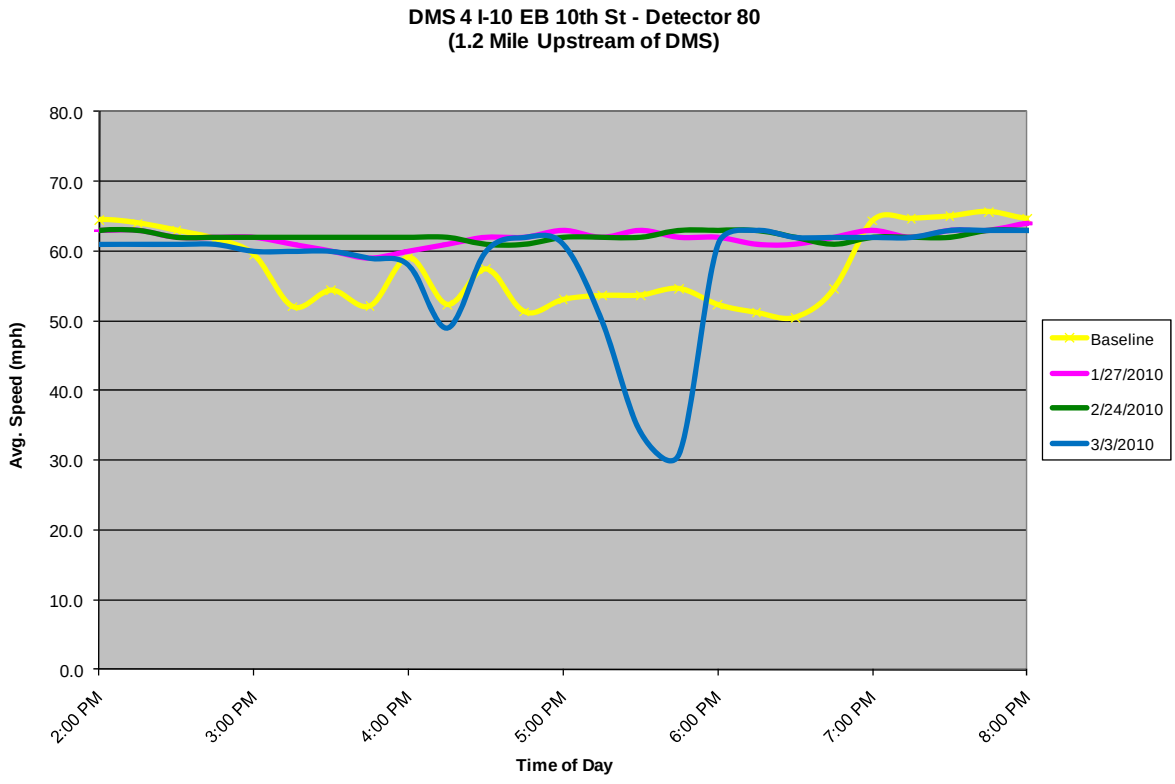




DMS 4 I-10 EB 10th St

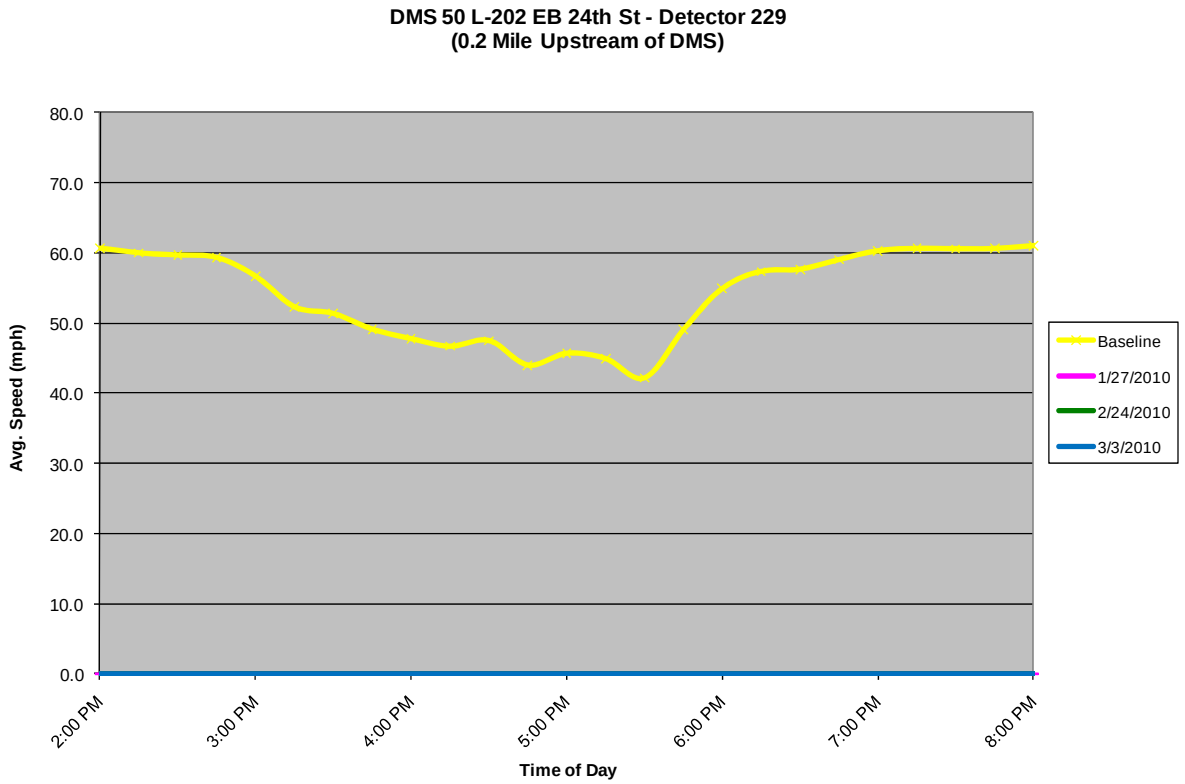
MINUTES TO
RAY RD XX
SR-51 BELL RD YY





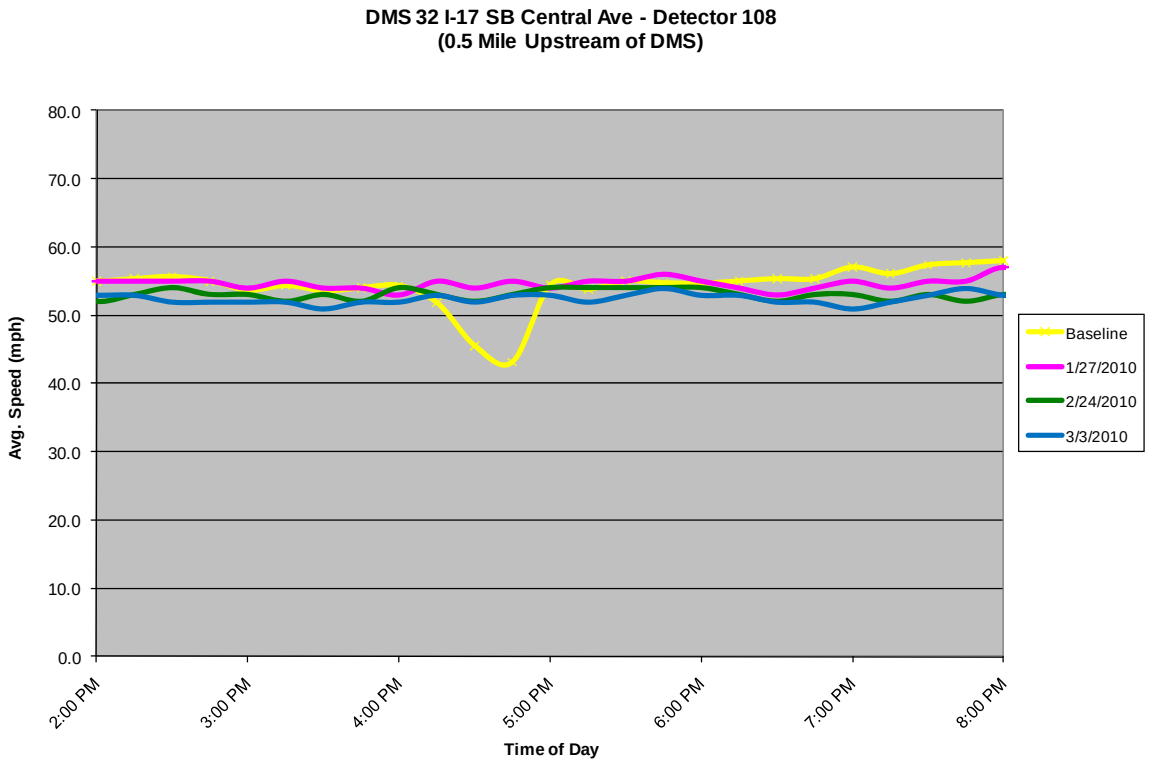
DMS 50 L-202 EB 24th ST

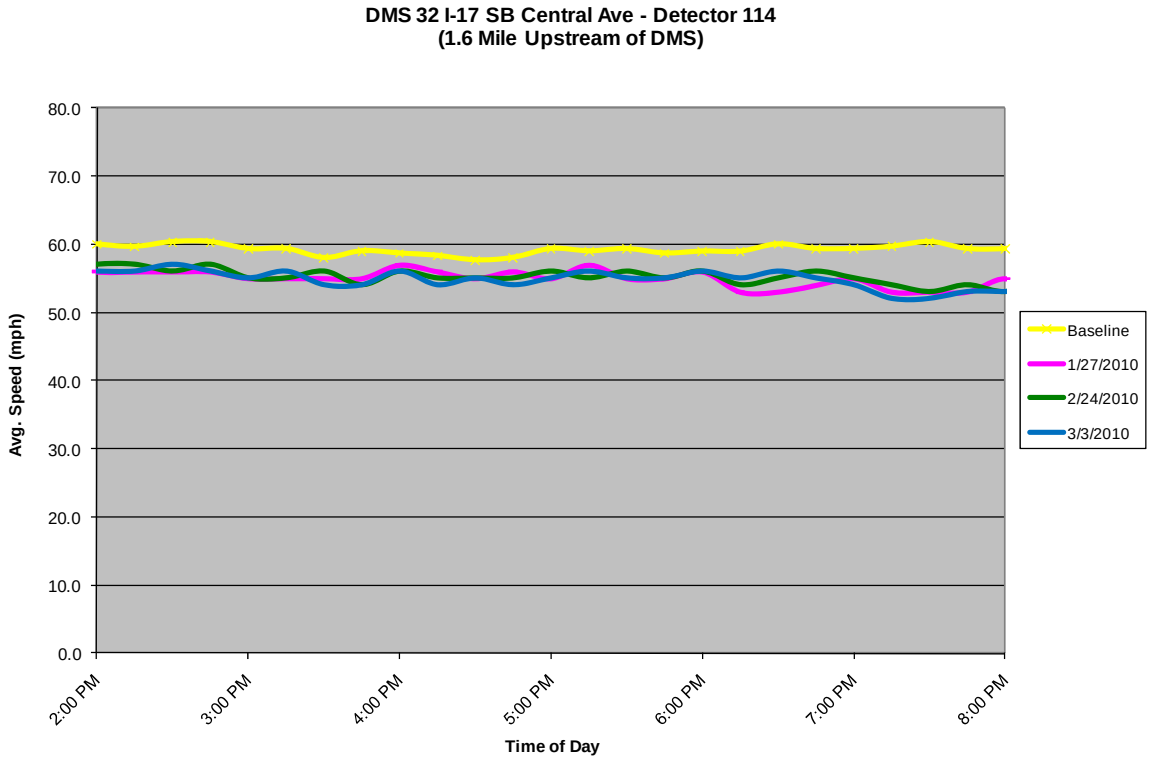
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

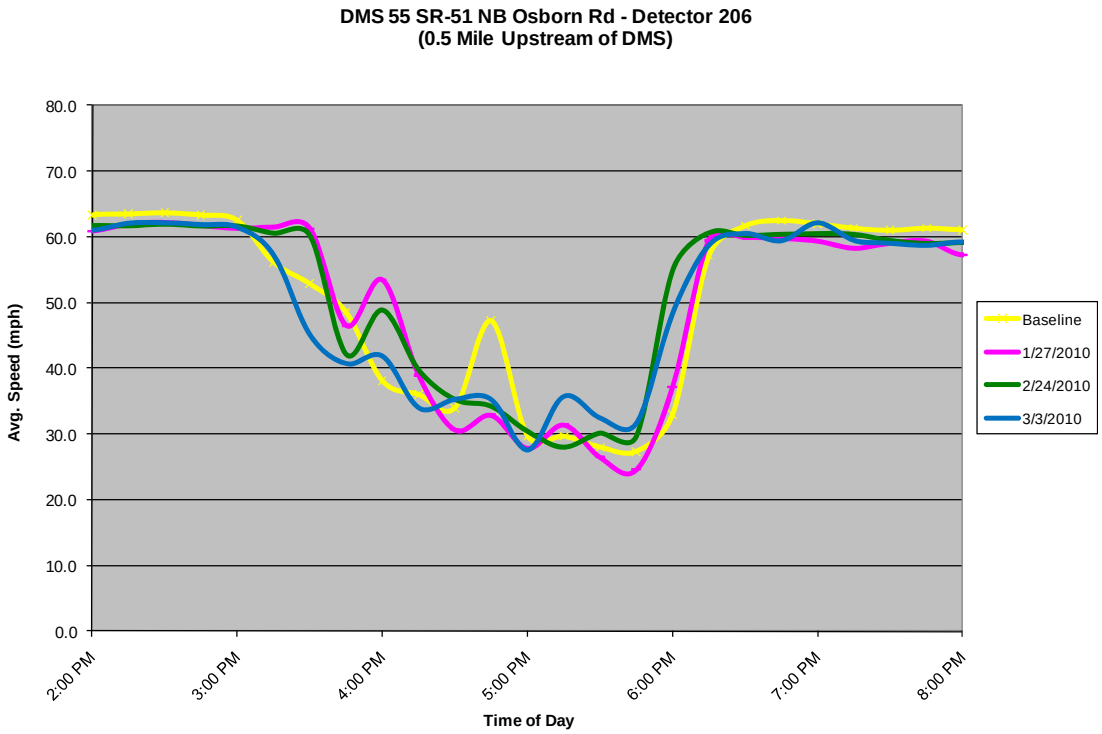
MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

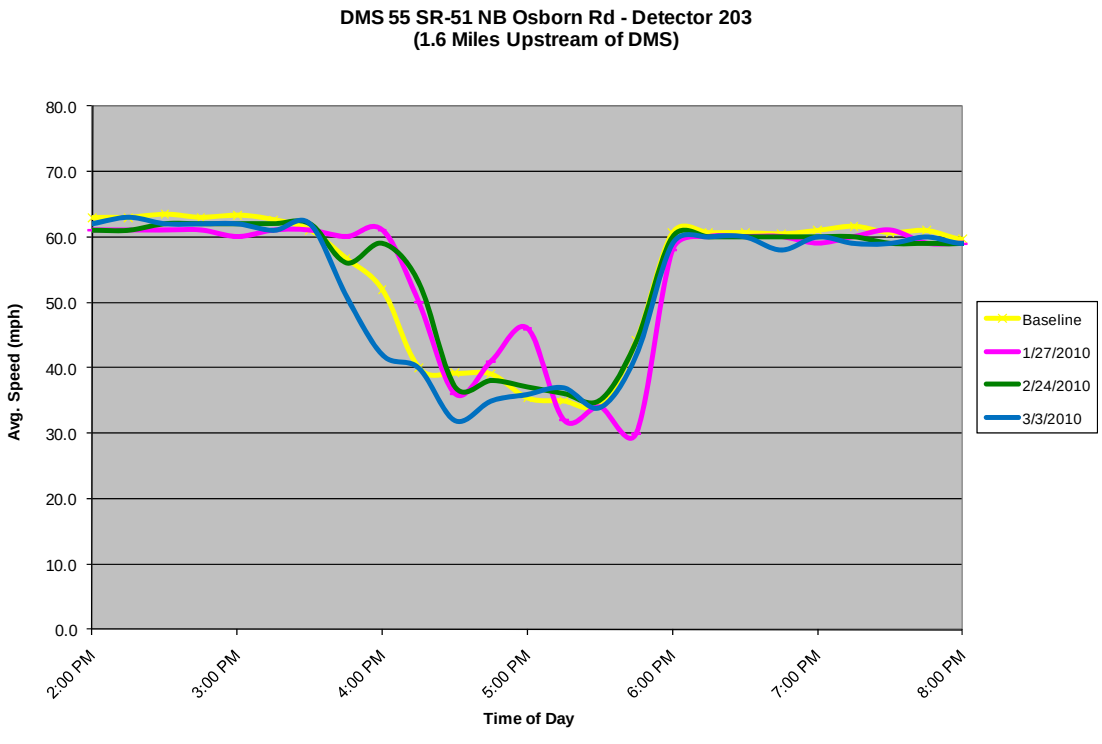




DMS 17 I-17 NB 4th Ave 
No Available Data on both Detector 104 and 98

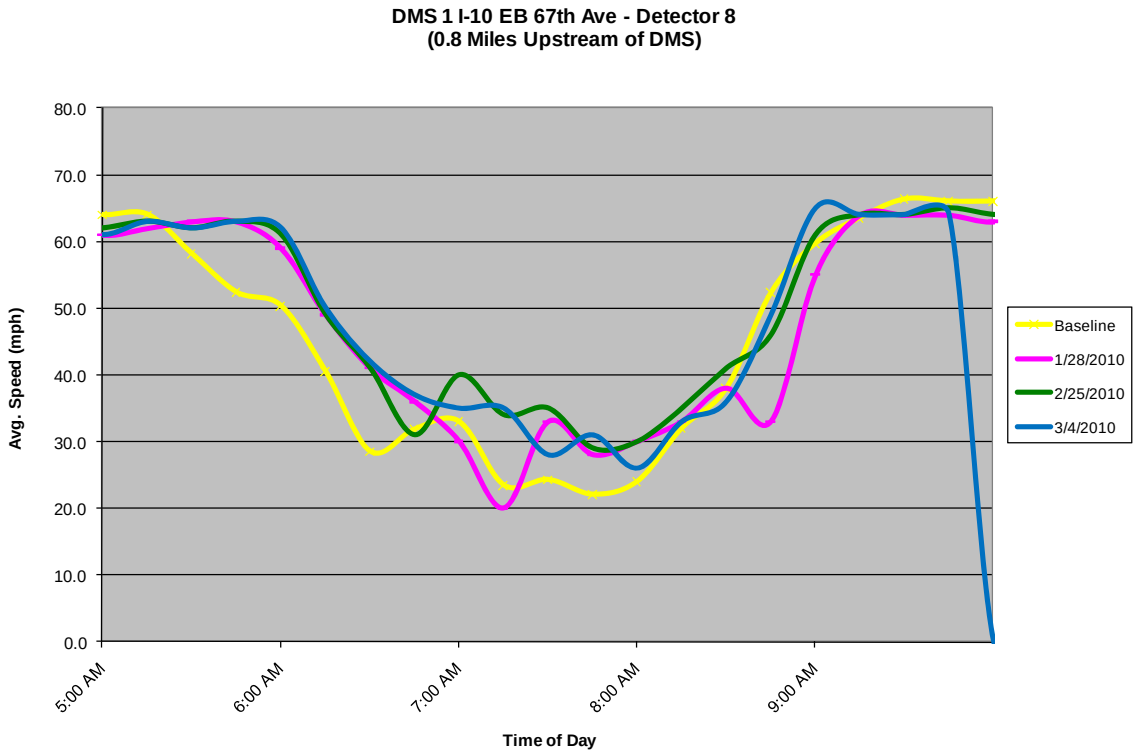
DMS 55 SR-51 NB Osborn Rd

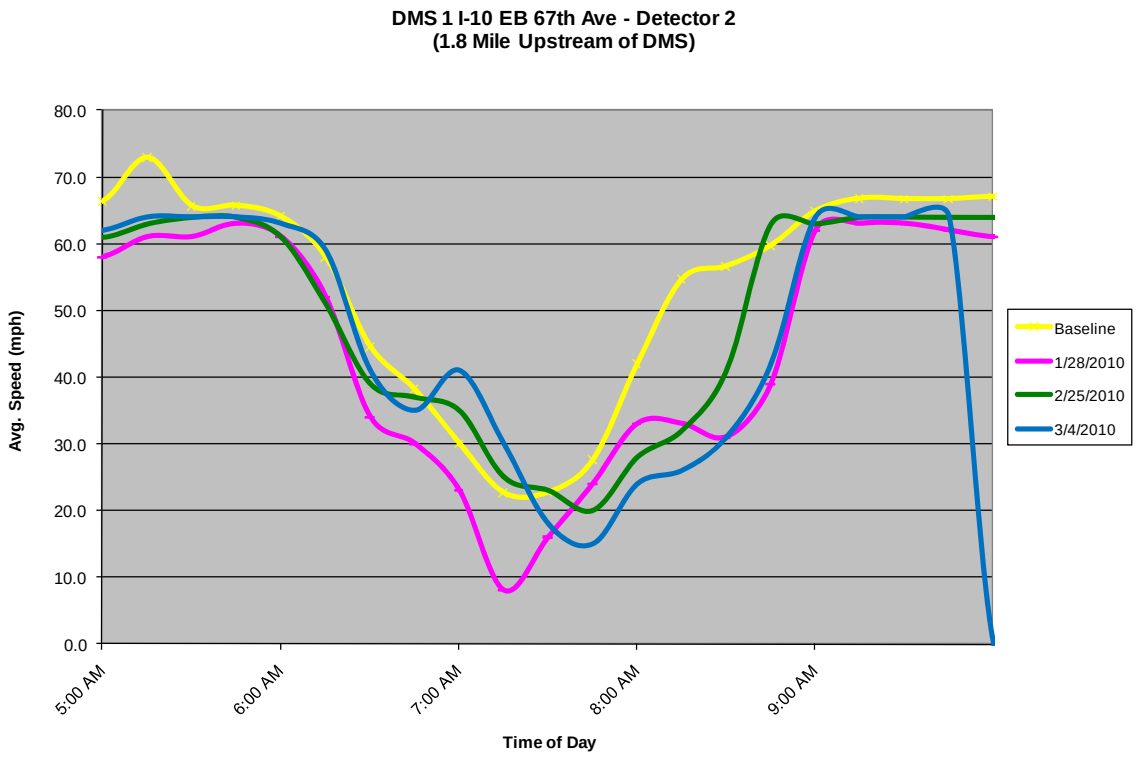




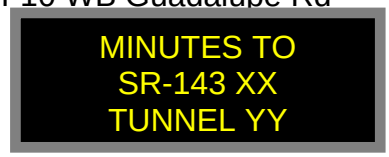
DMS 1 I-10 EB 67th Ave

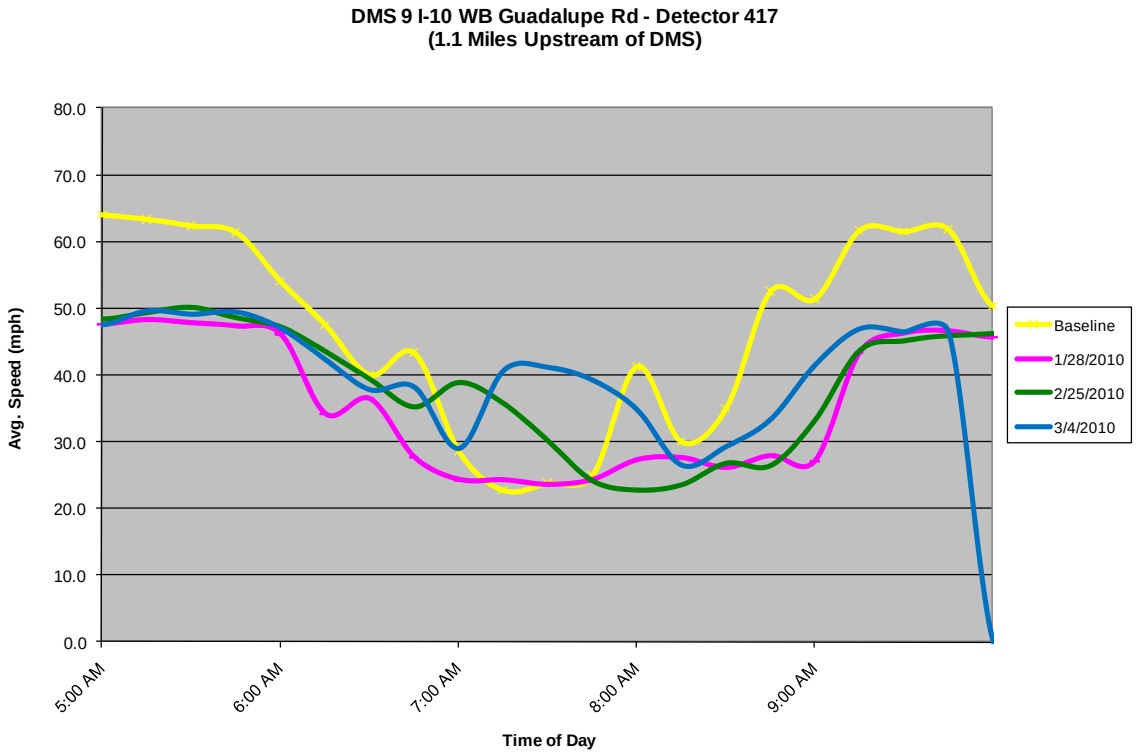
MINUTES TO
TUNNEL XX
AIRPORT YY

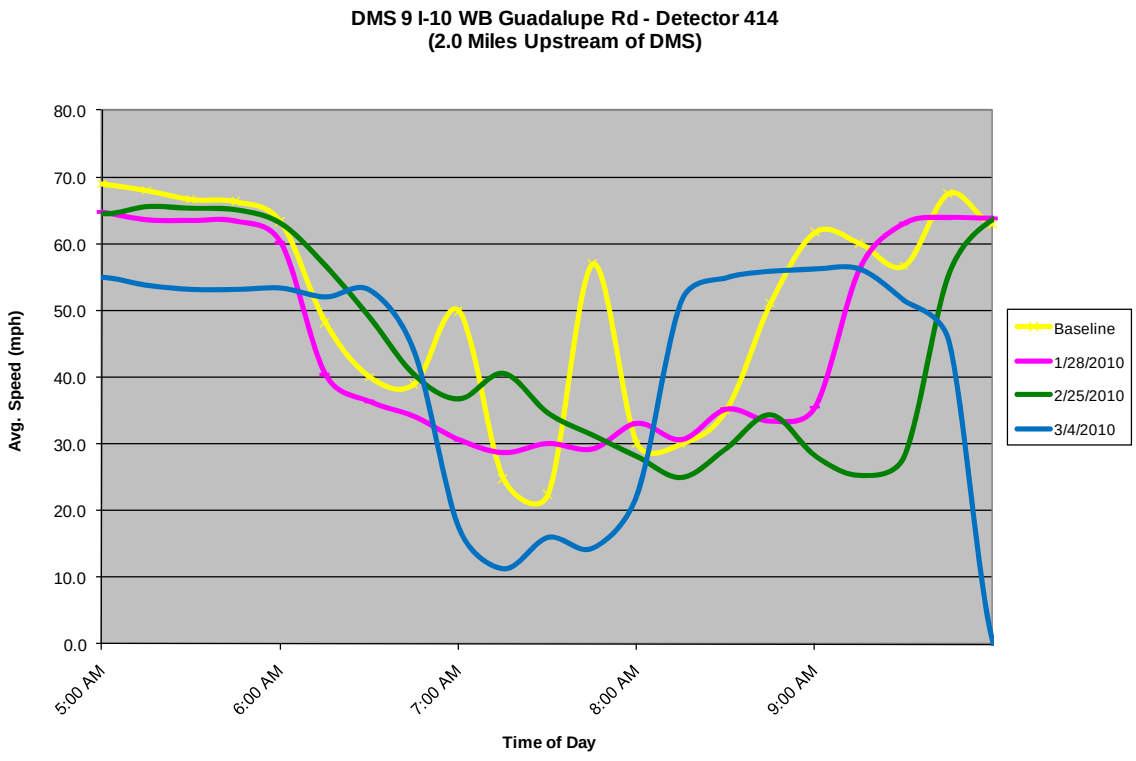




DMS 9 I-10 WB Guadalupe Rd

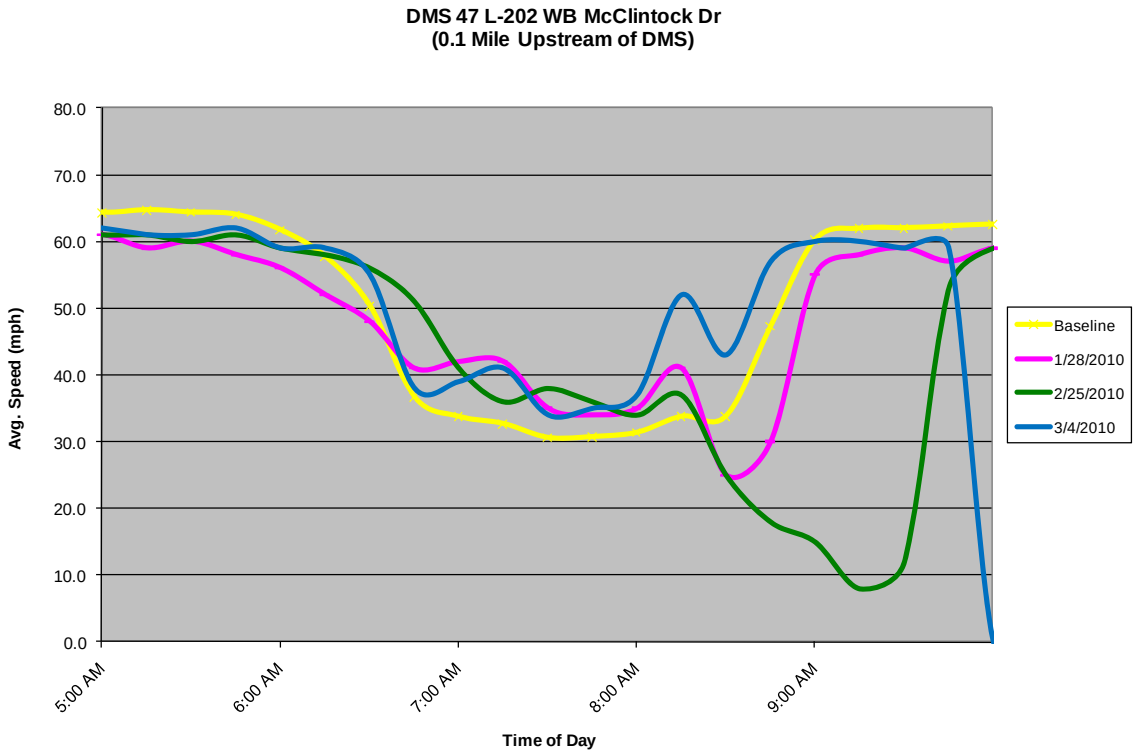






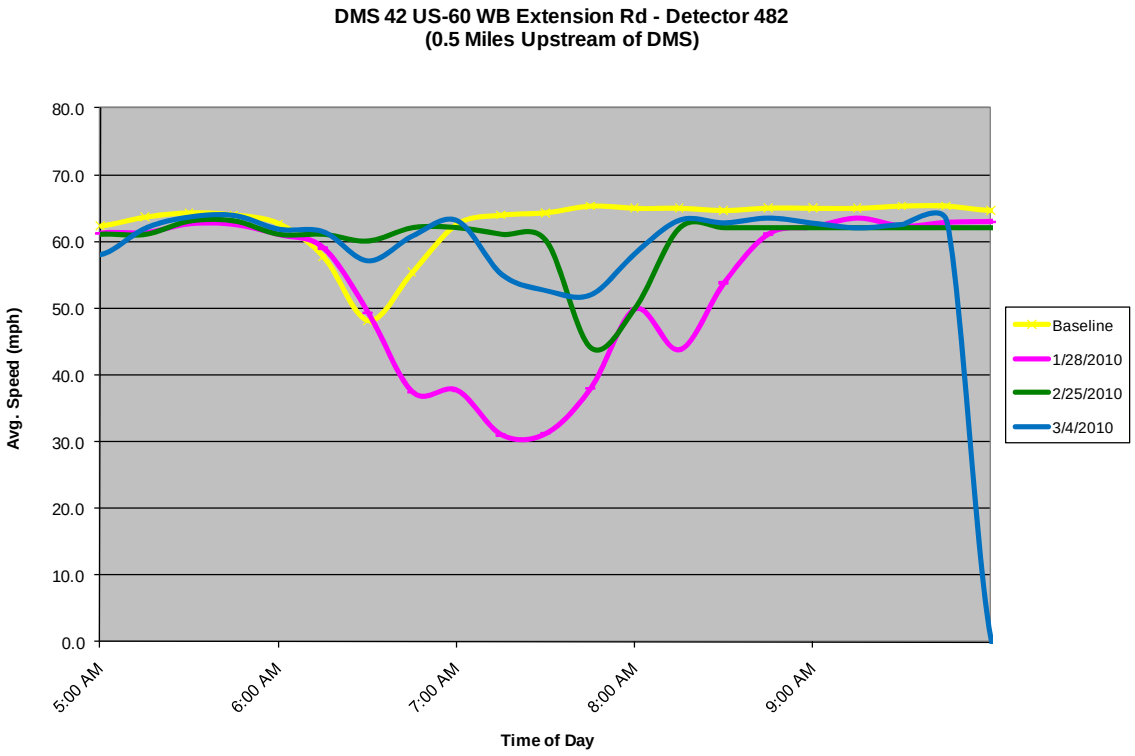
DMS 47 L-202 WB McClintock Dr

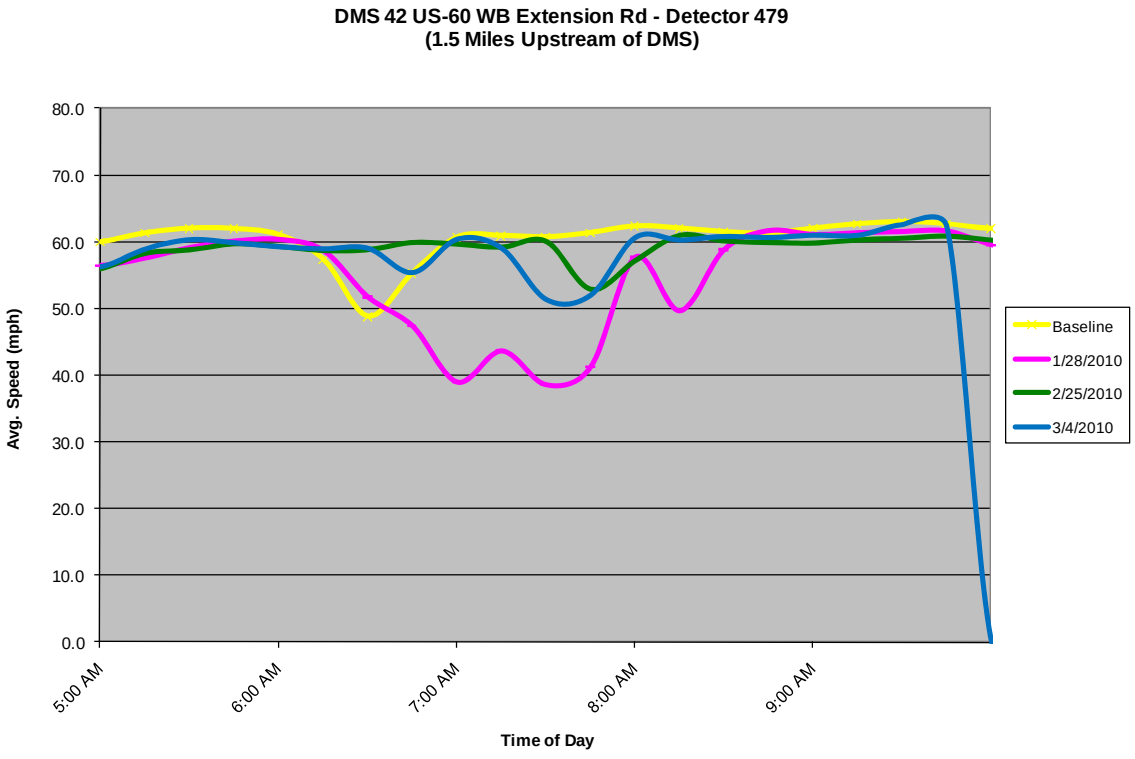
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

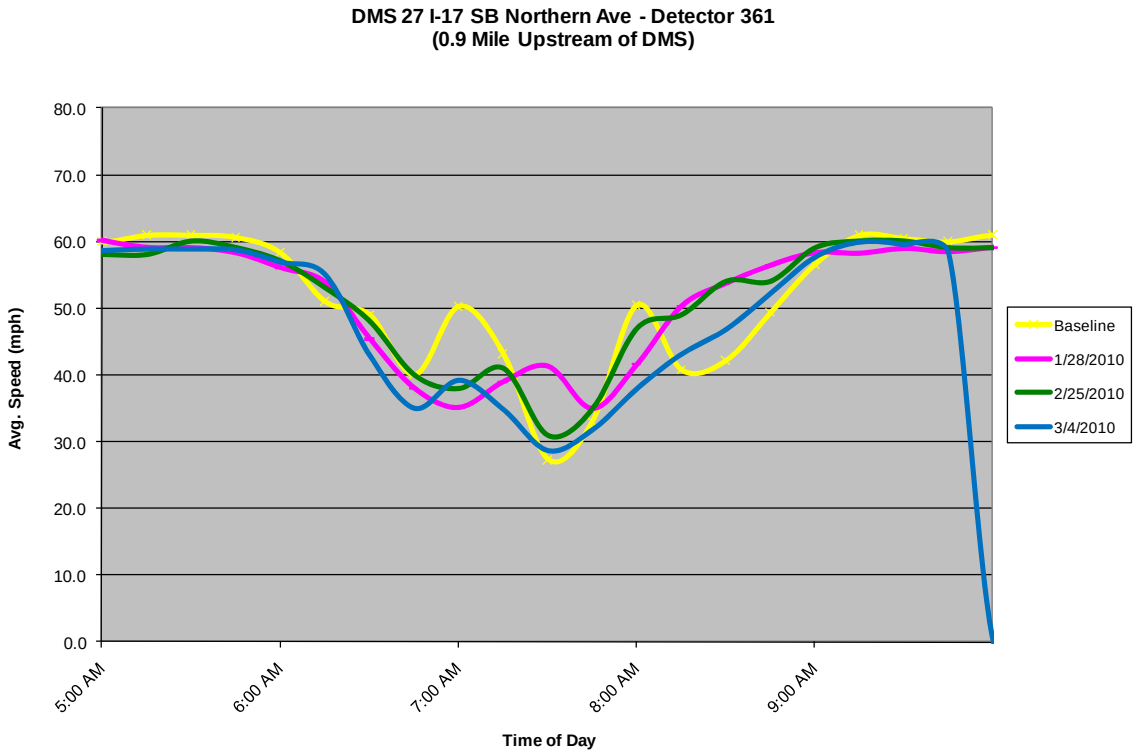
MINUTES TO TUNNEL
VIA I-10 XX
VIA LOOP 101 YY

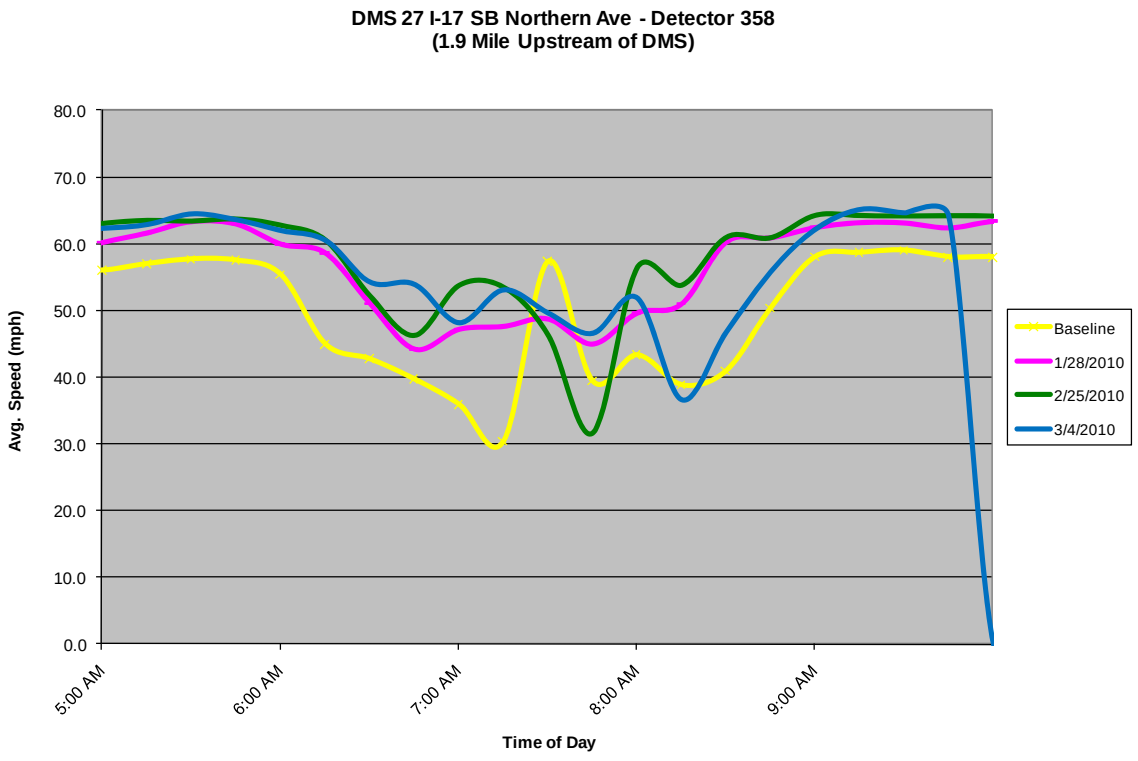




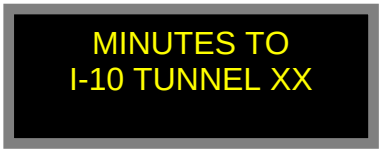
DMS 27 I-17 SB Northern Ave

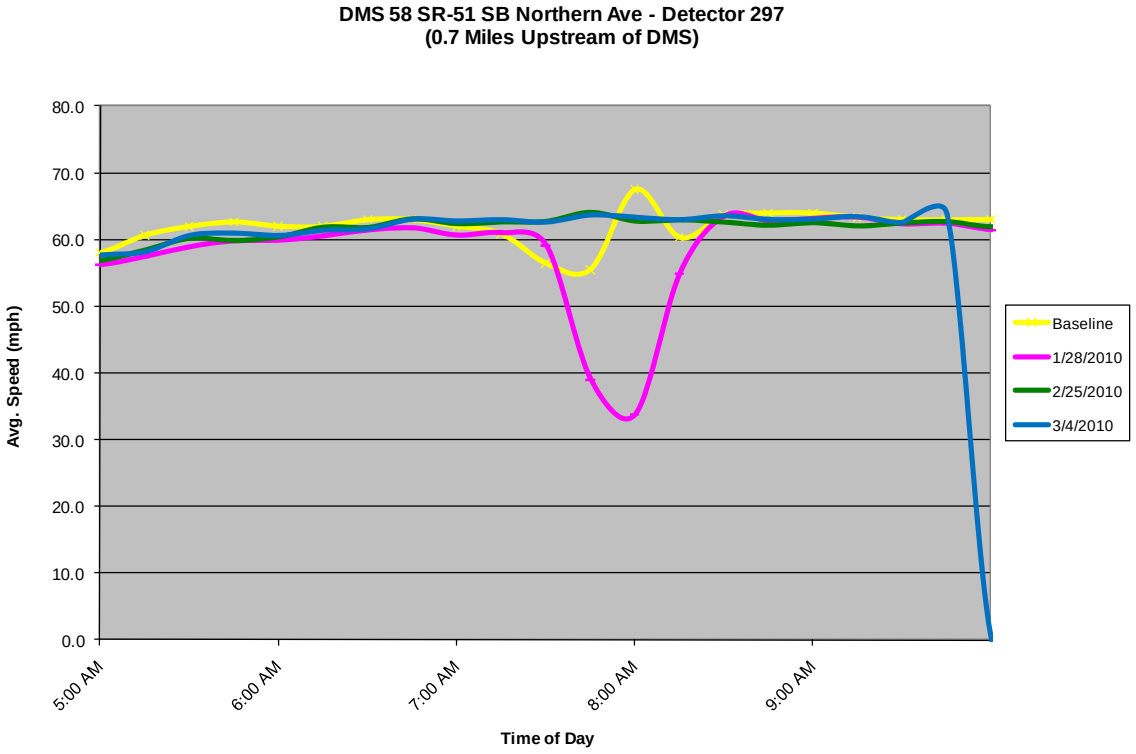
MINUTES TO
I-10 TUNNEL XX

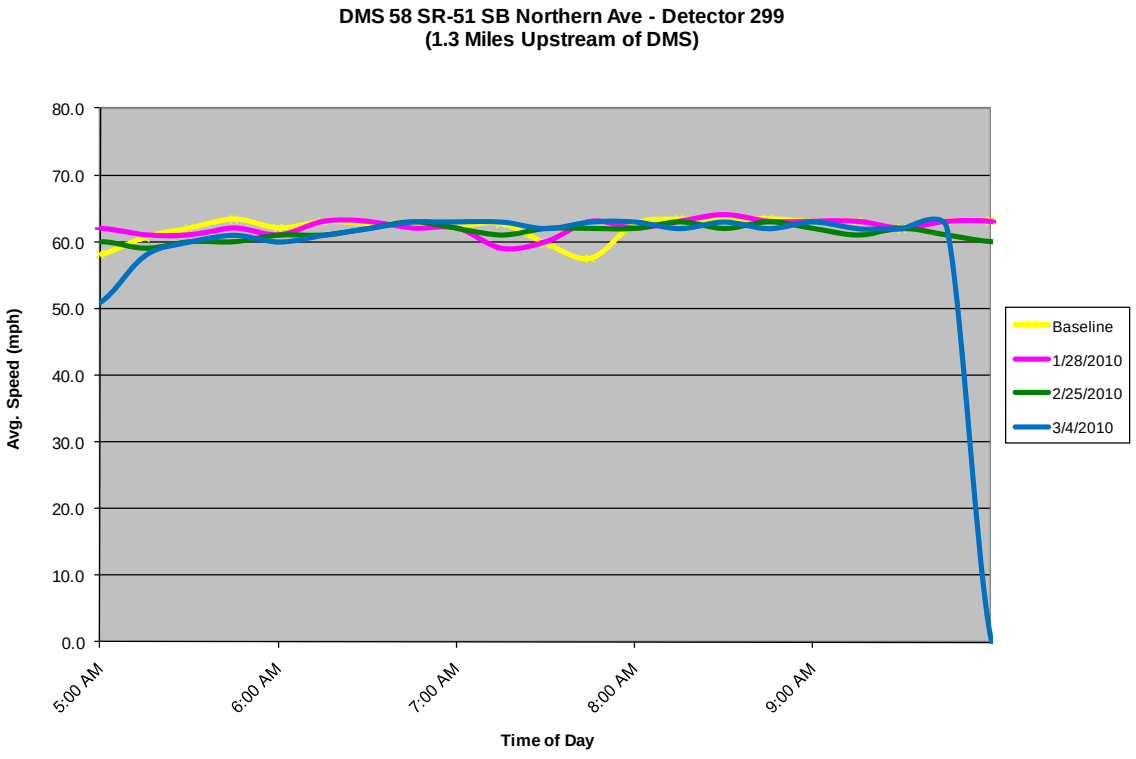




DMS 58 SR-51 SB Northern Ave

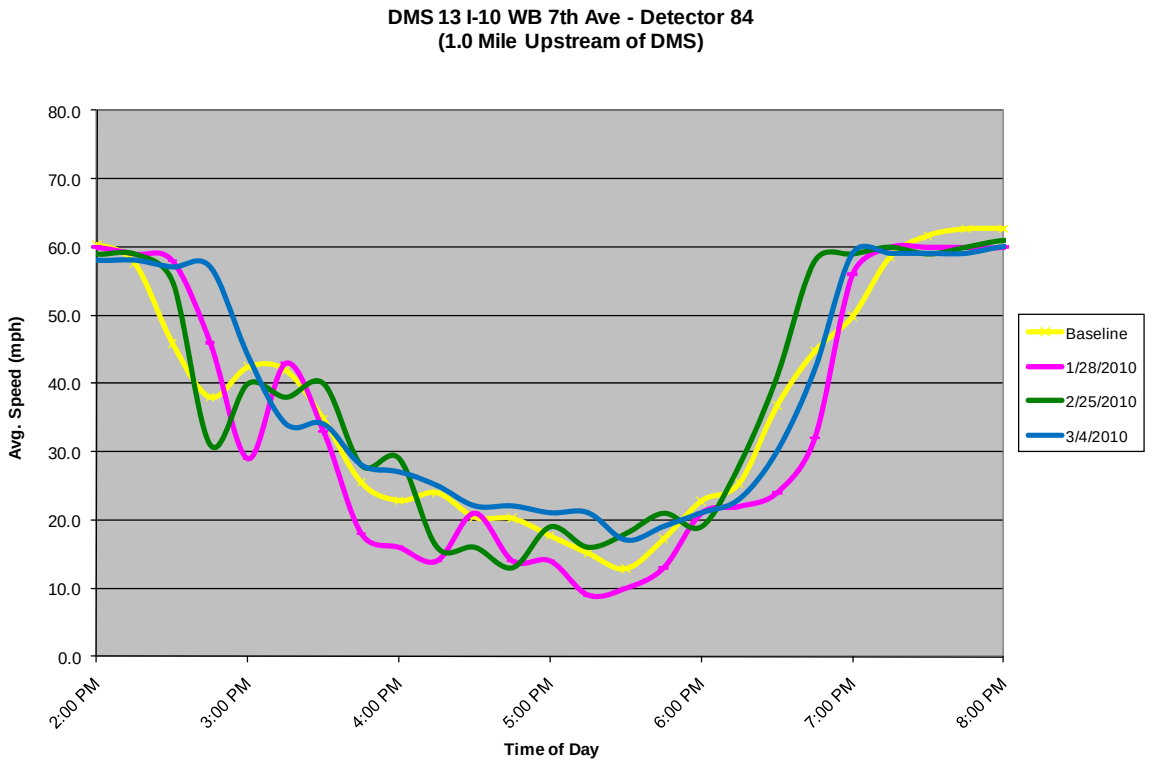


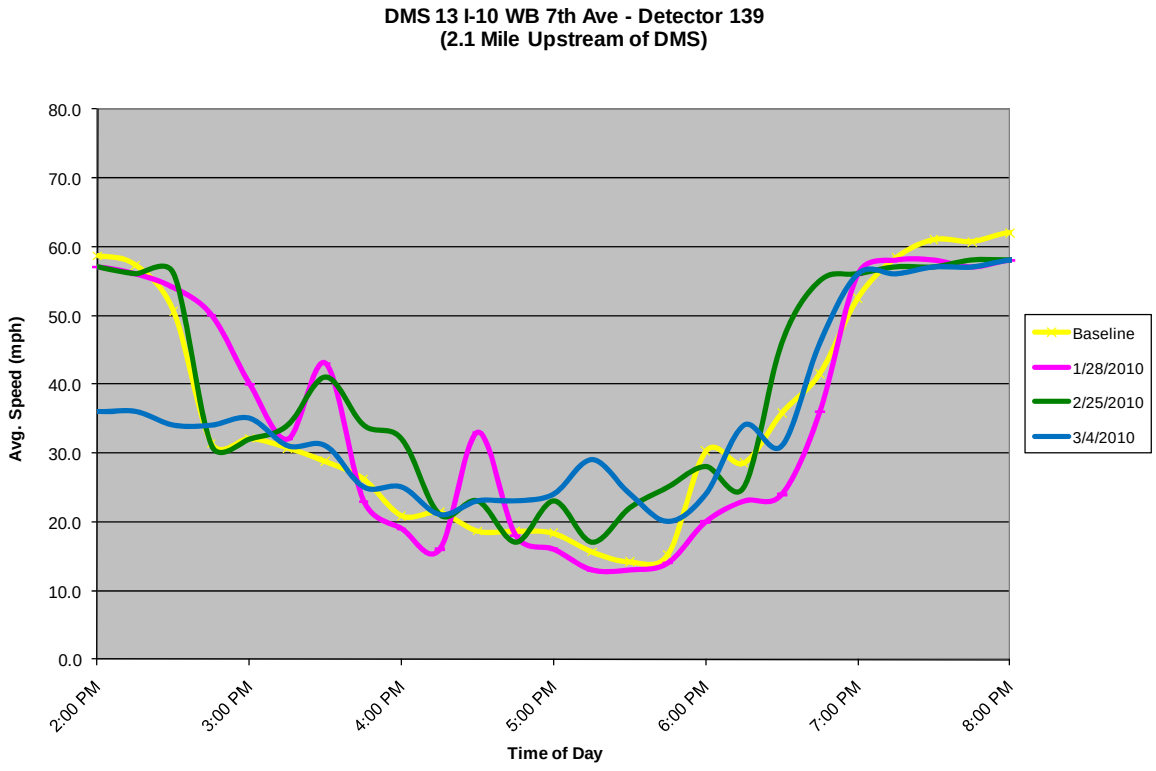




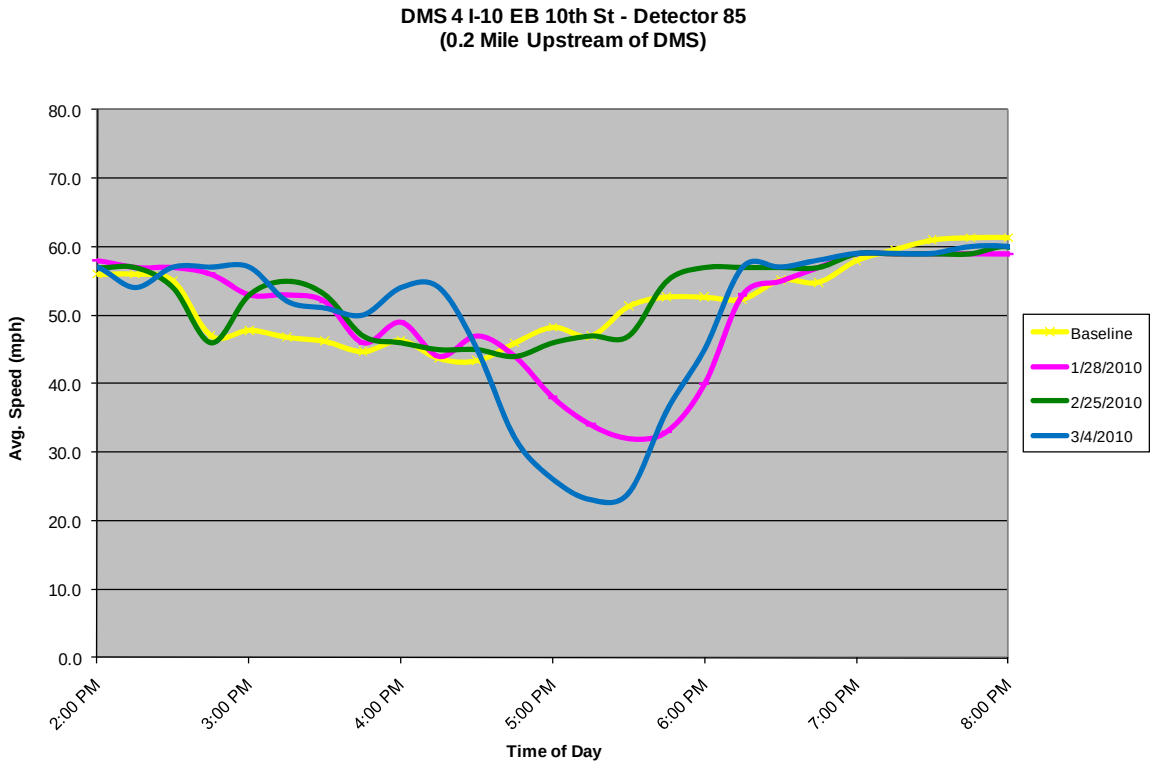
DMS 13 I-10 WB 7th Ave

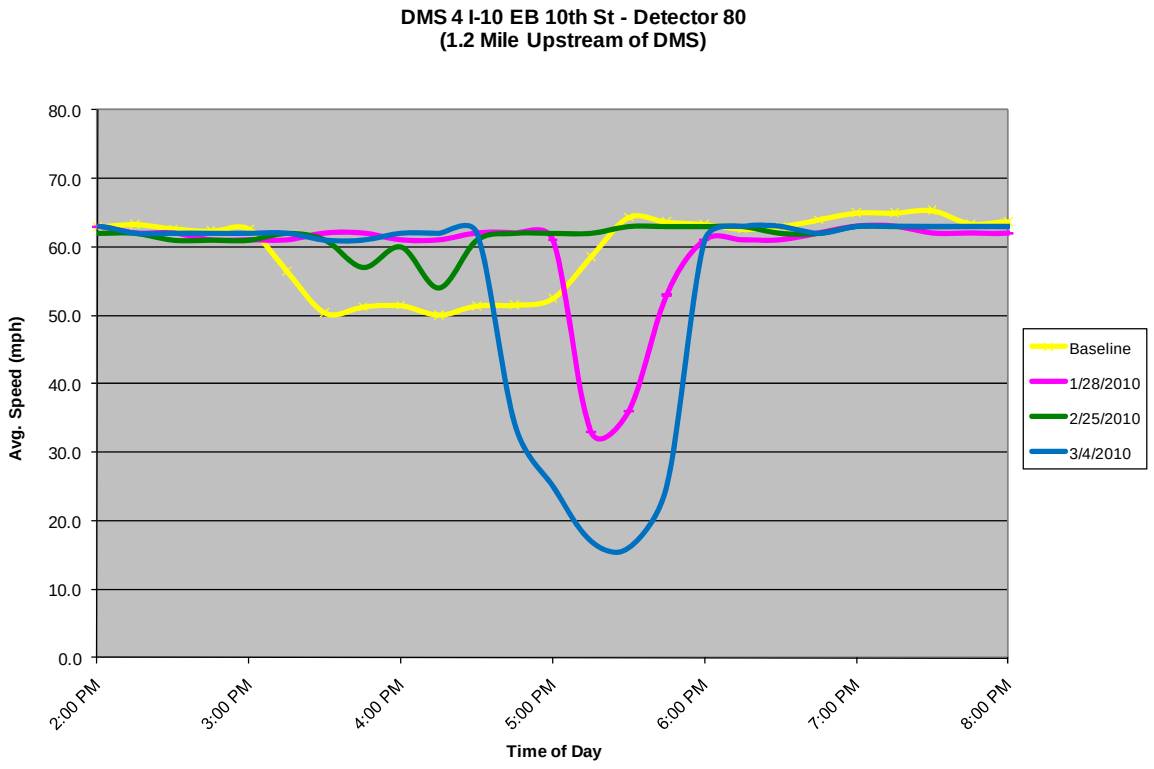
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY





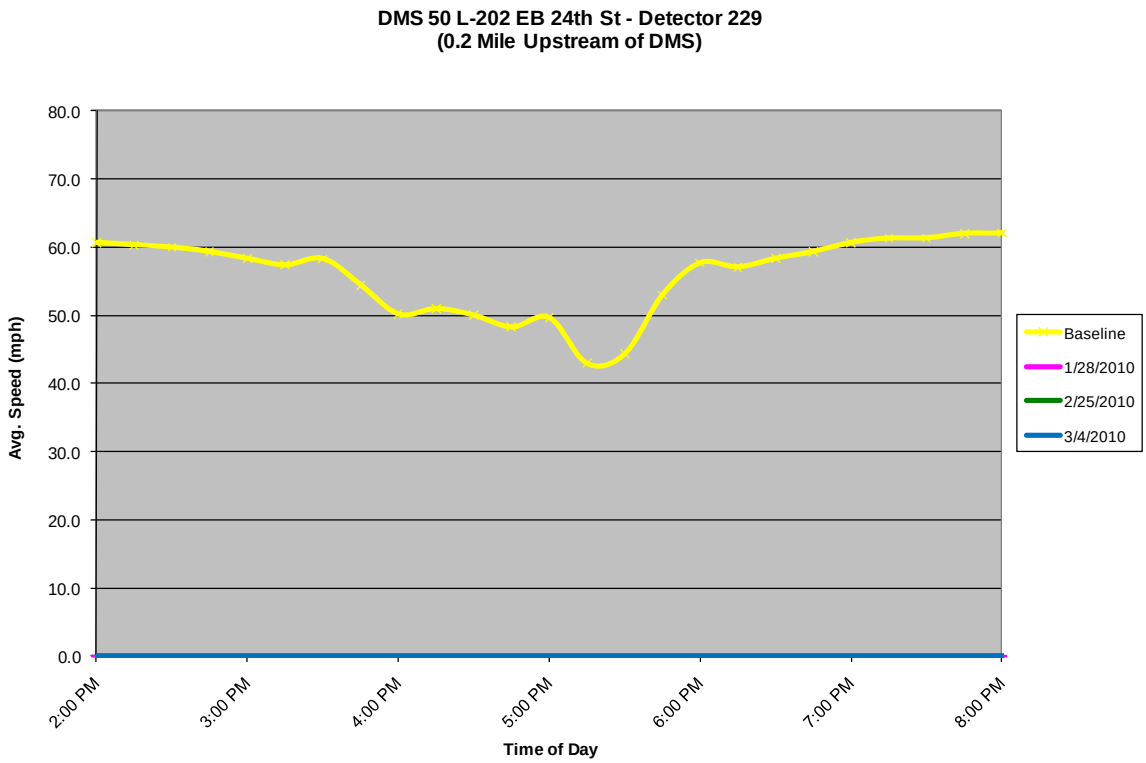
DMS 4 I-10 EB 10th St





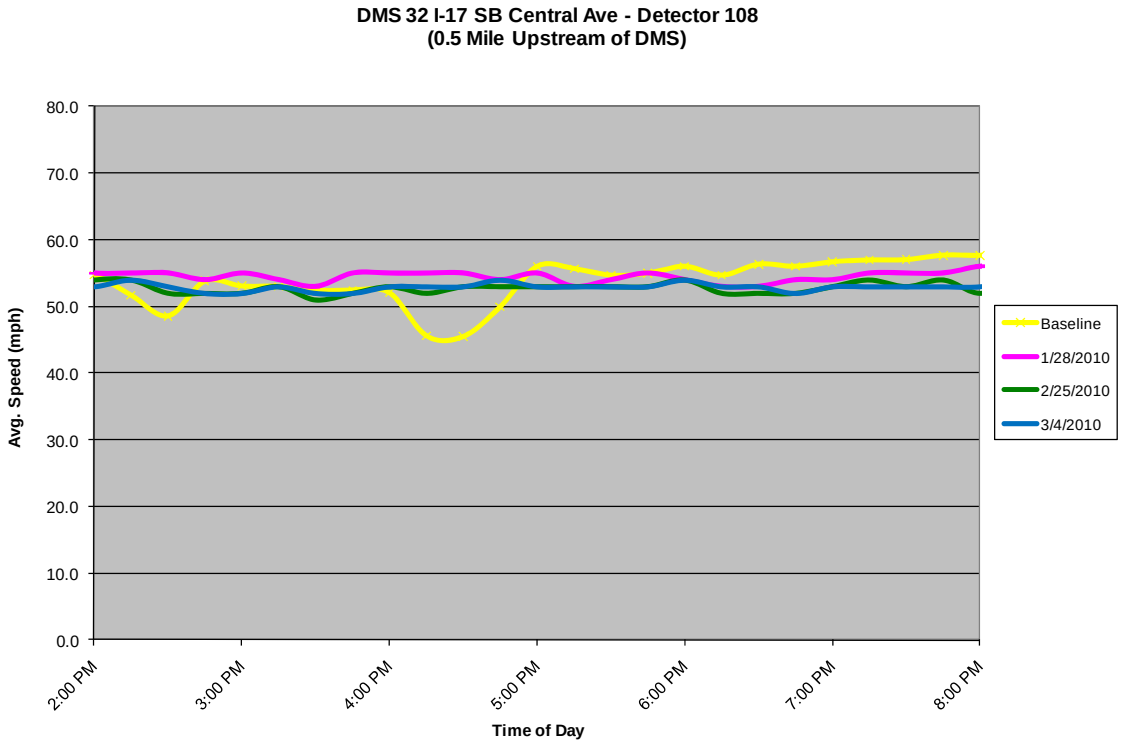
DMS 50 L-202 EB 24th ST

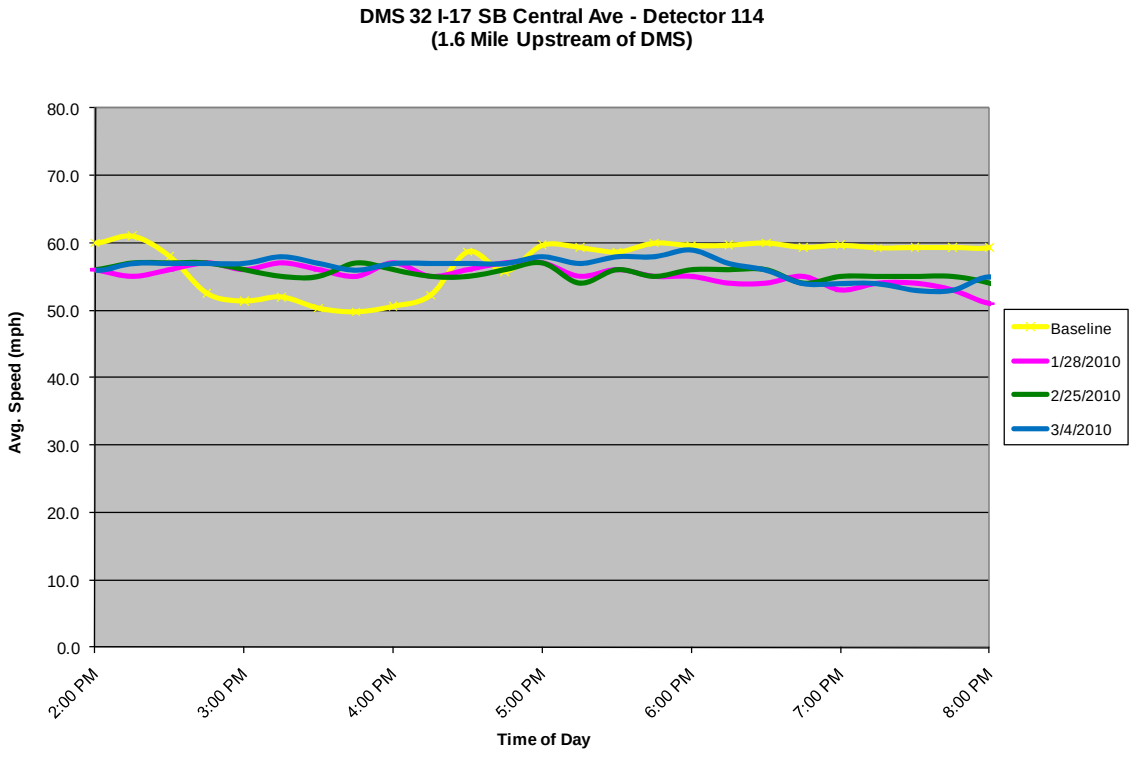
MINUTES TO
LOOP 101 XX



DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

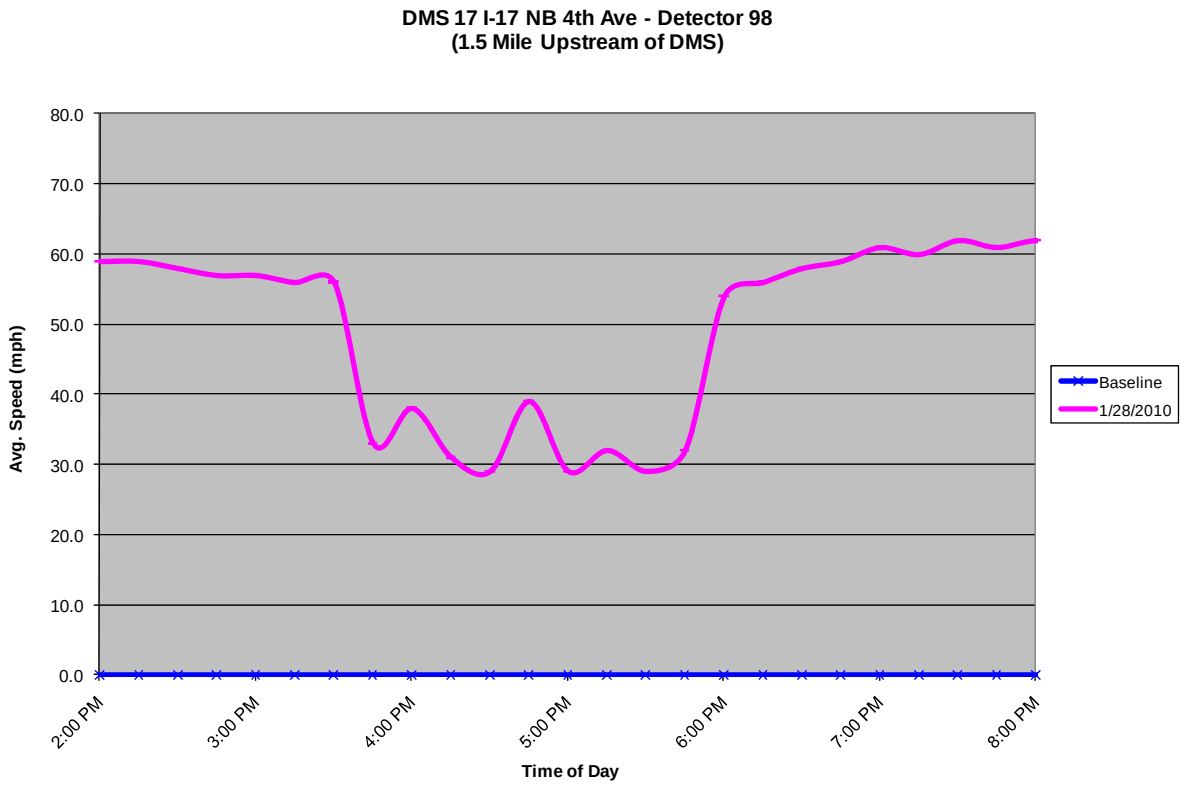




DMS 17 I-17 NB 4th Ave

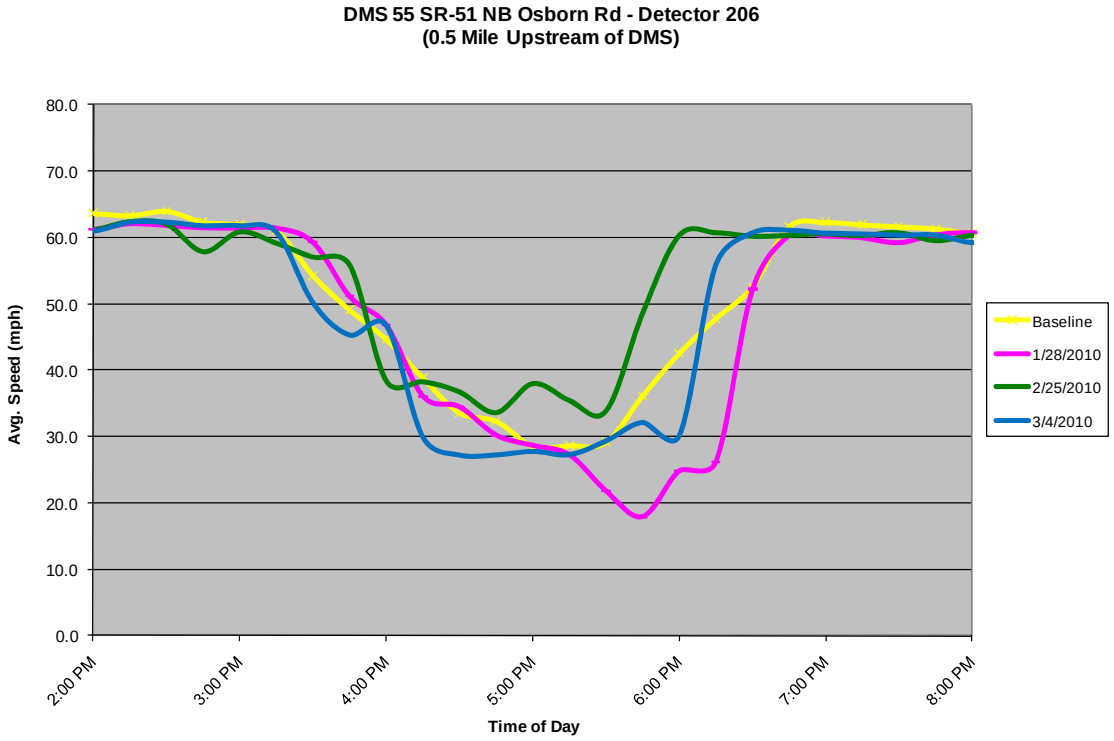
MINUTES TO
PEORIA AVE XX
I-10 83RD AVE YY

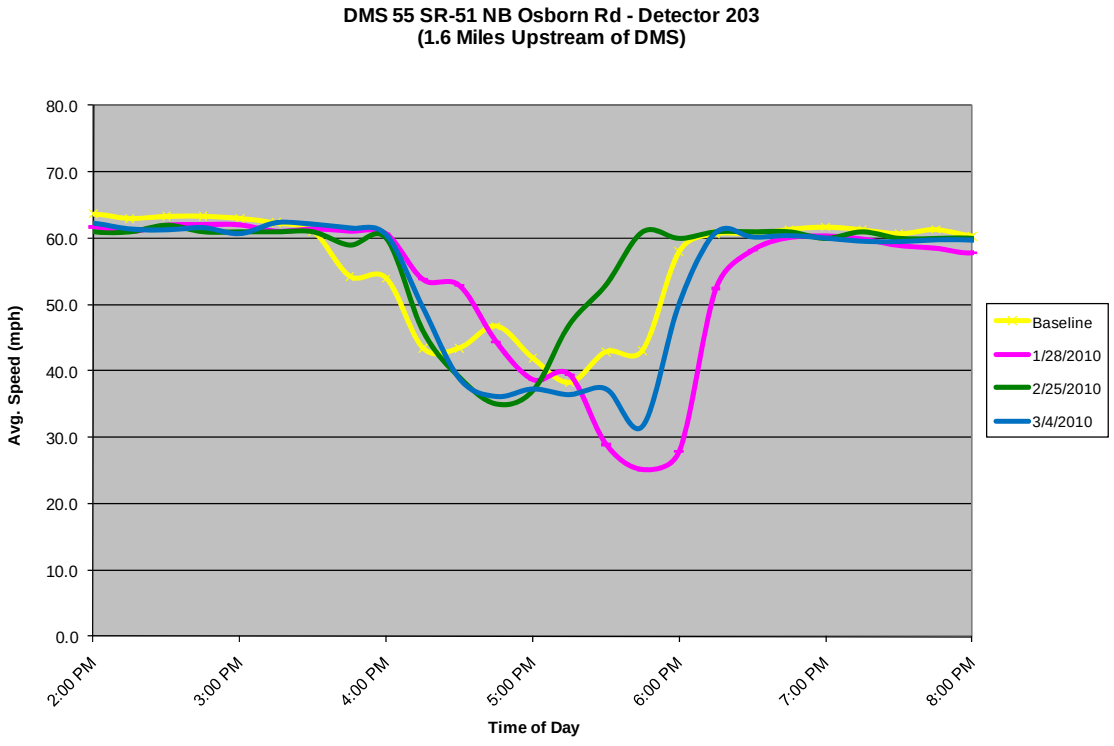
No Available Data on Detector 104



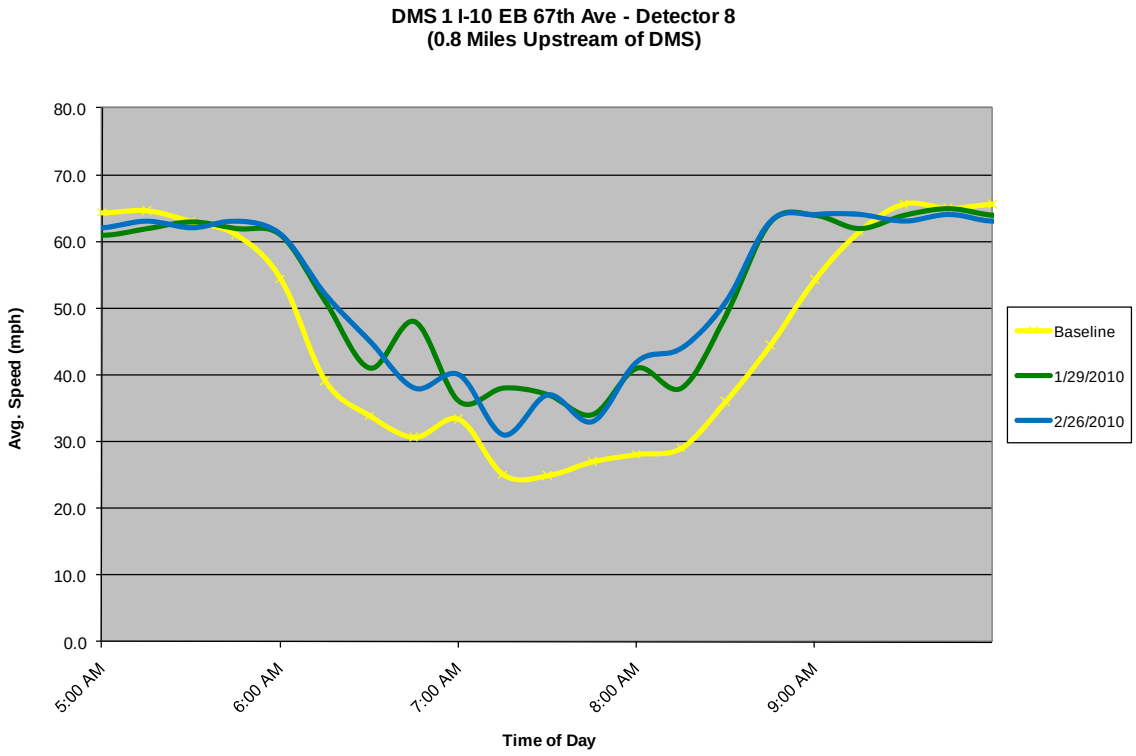
DMS 55 SR-51 NB Osborn Rd

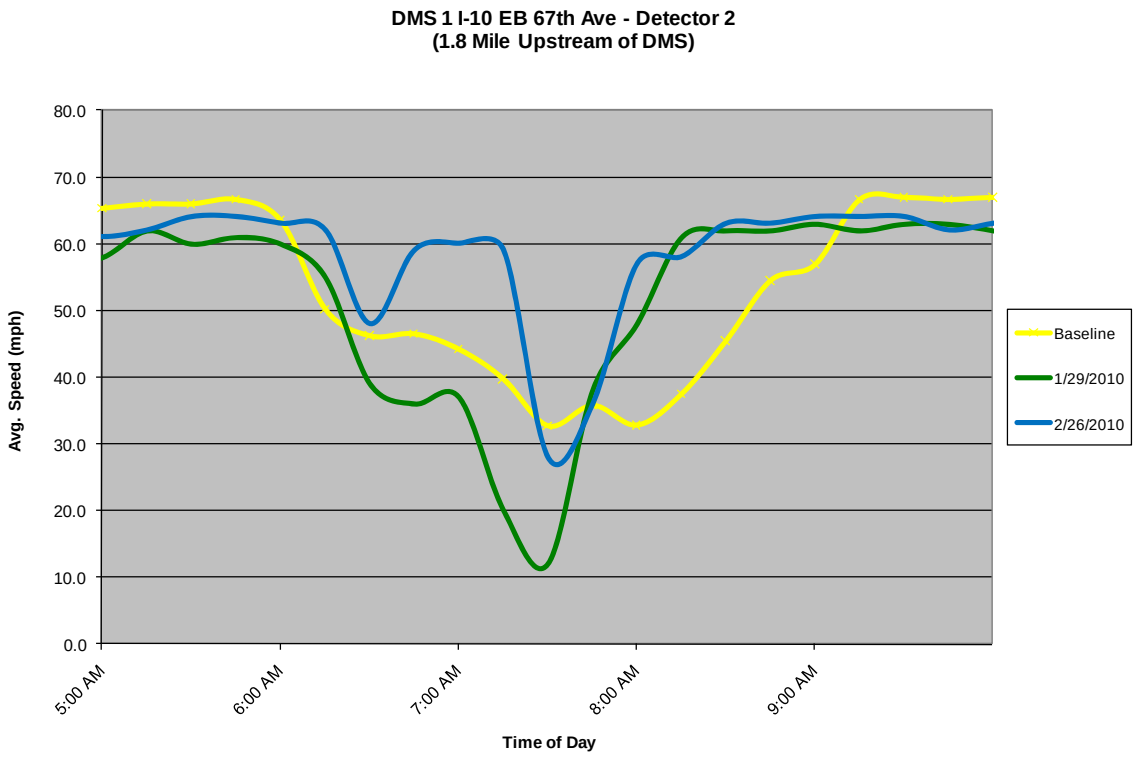
MINUTES TO
BELL RD XX





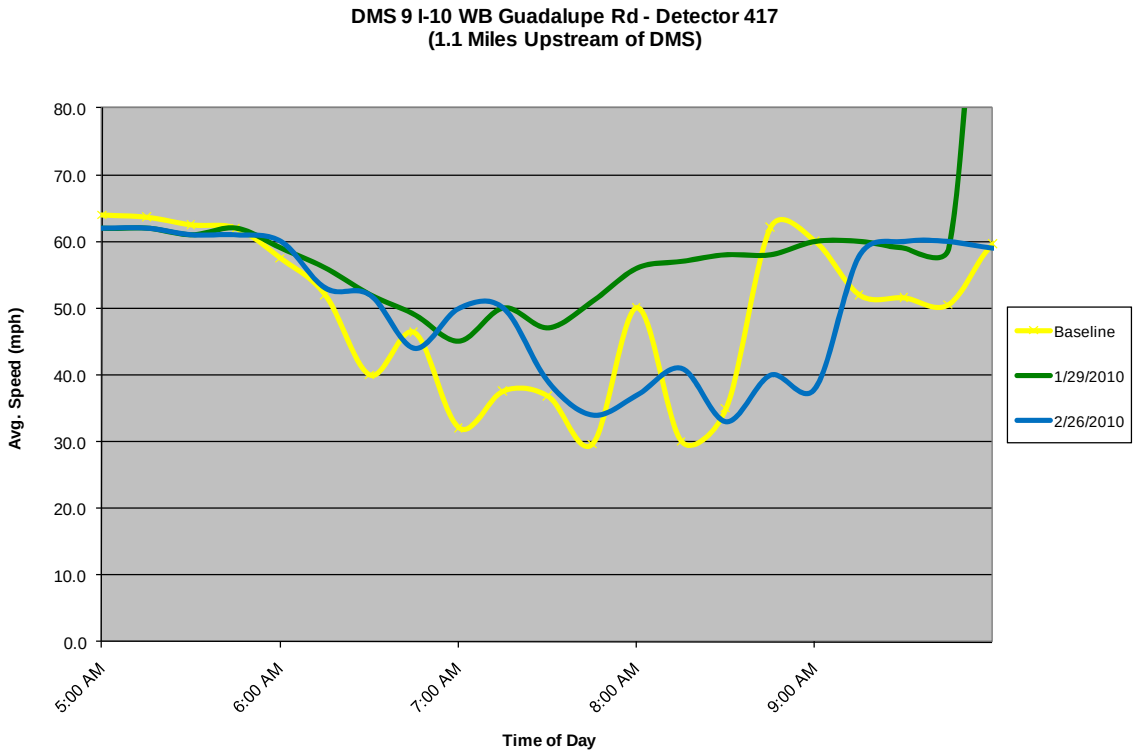
DMS 1 I-10 EB 67th Ave

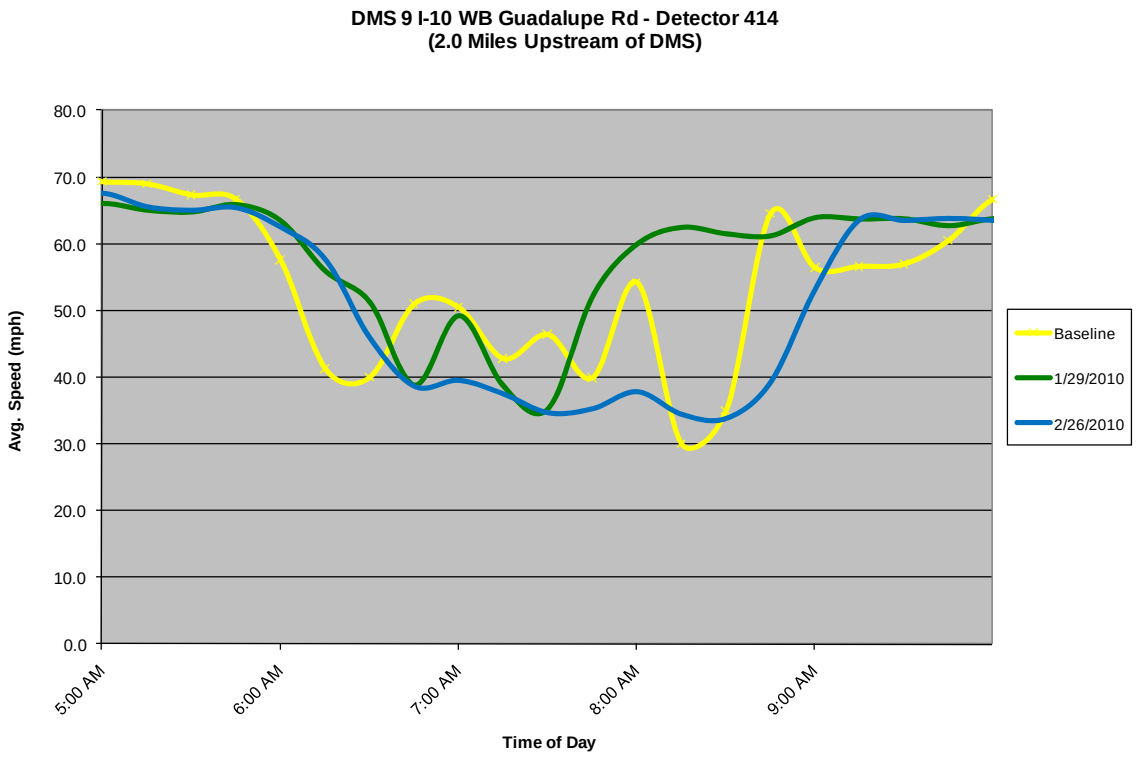




DMS 9 I-10 WB Guadalupe Rd

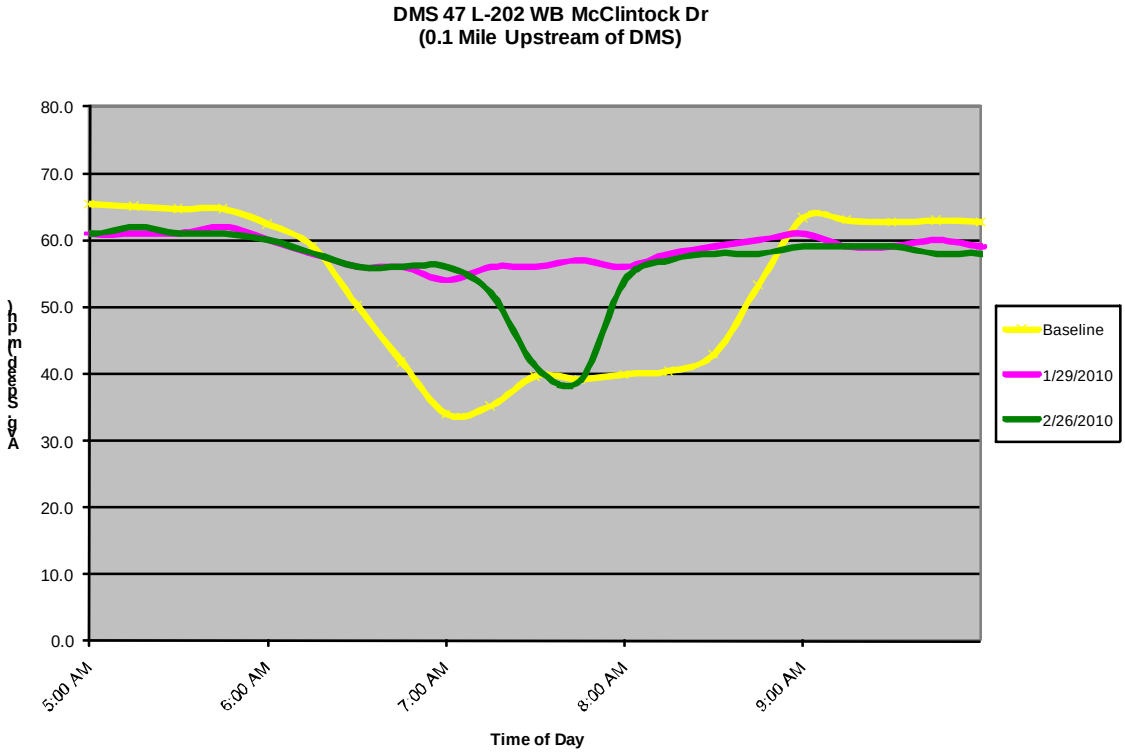
MINUTES TO
SR-143 XX
TUNNEL YY



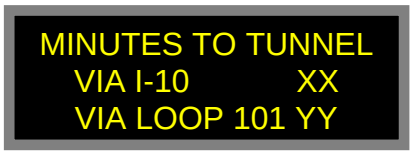


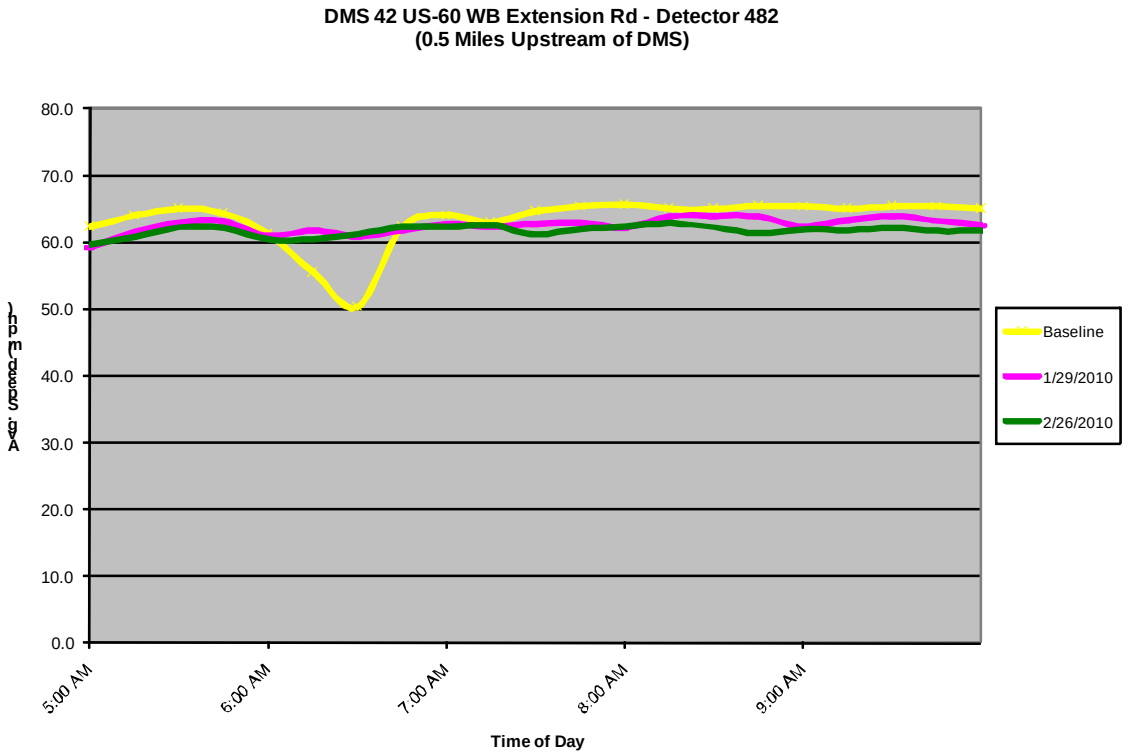
DMS 47 L-202 WB McClintock Dr

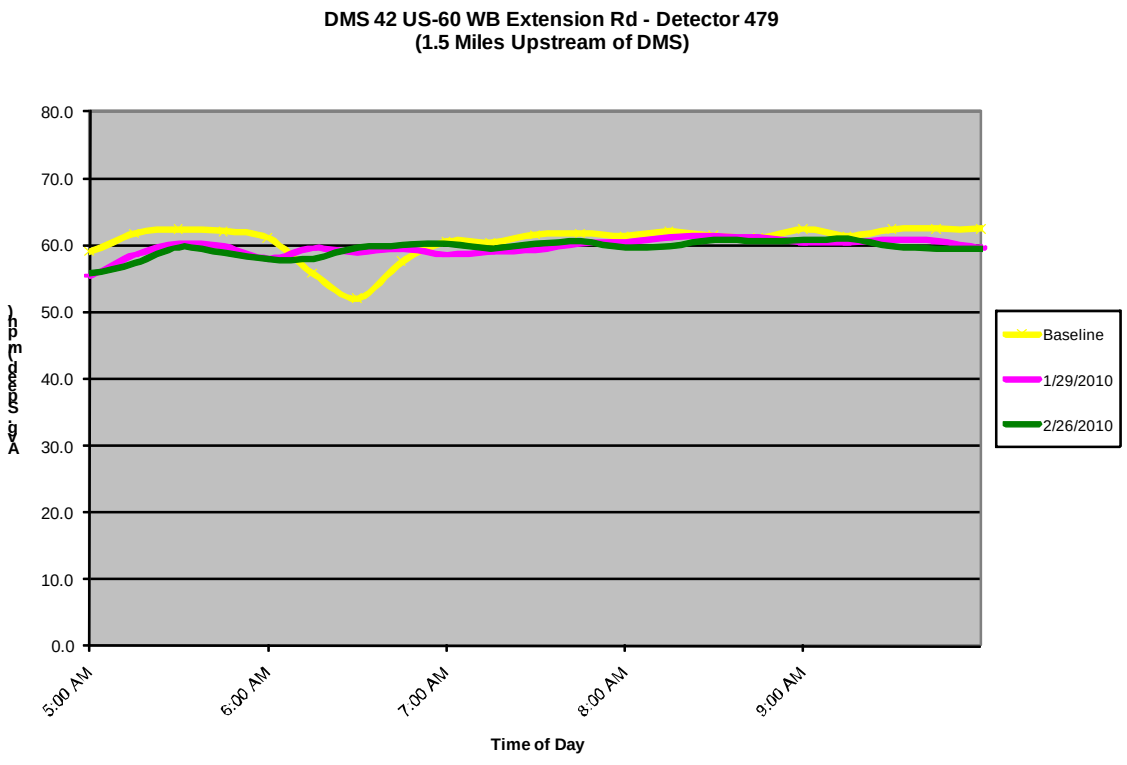
MINUTES TO
SR-143 XX
I-10 TUNNEL YY



DMS 42 US-60 WB Extension Rd

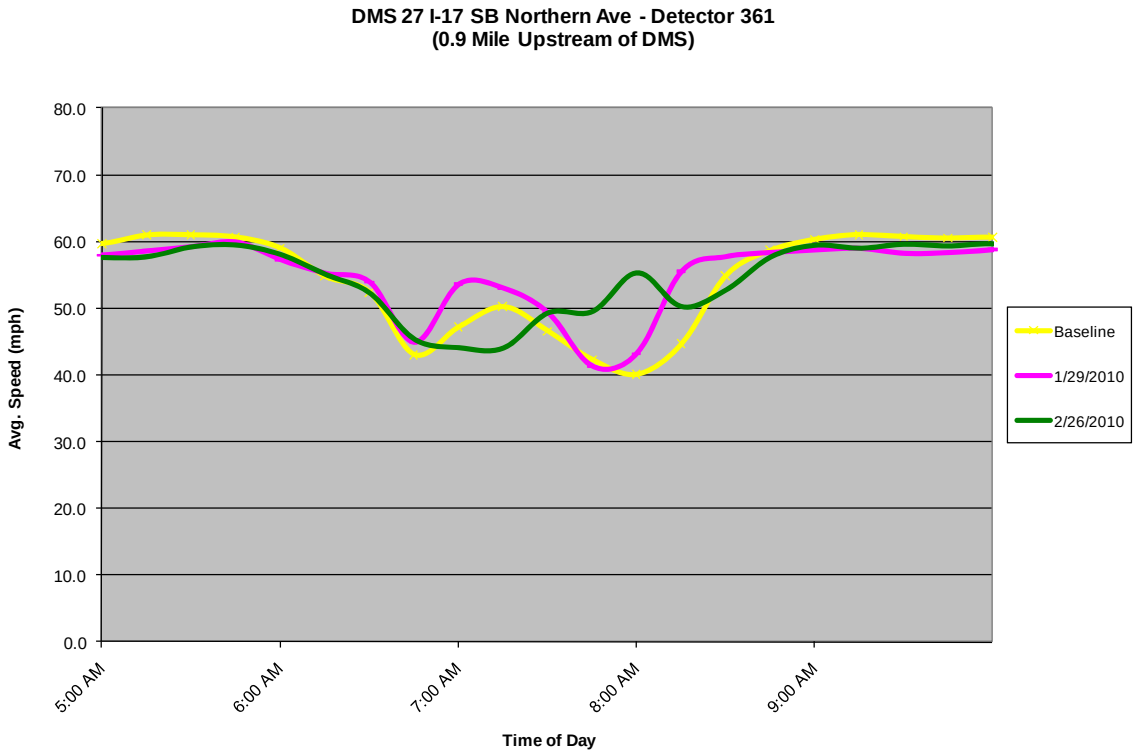


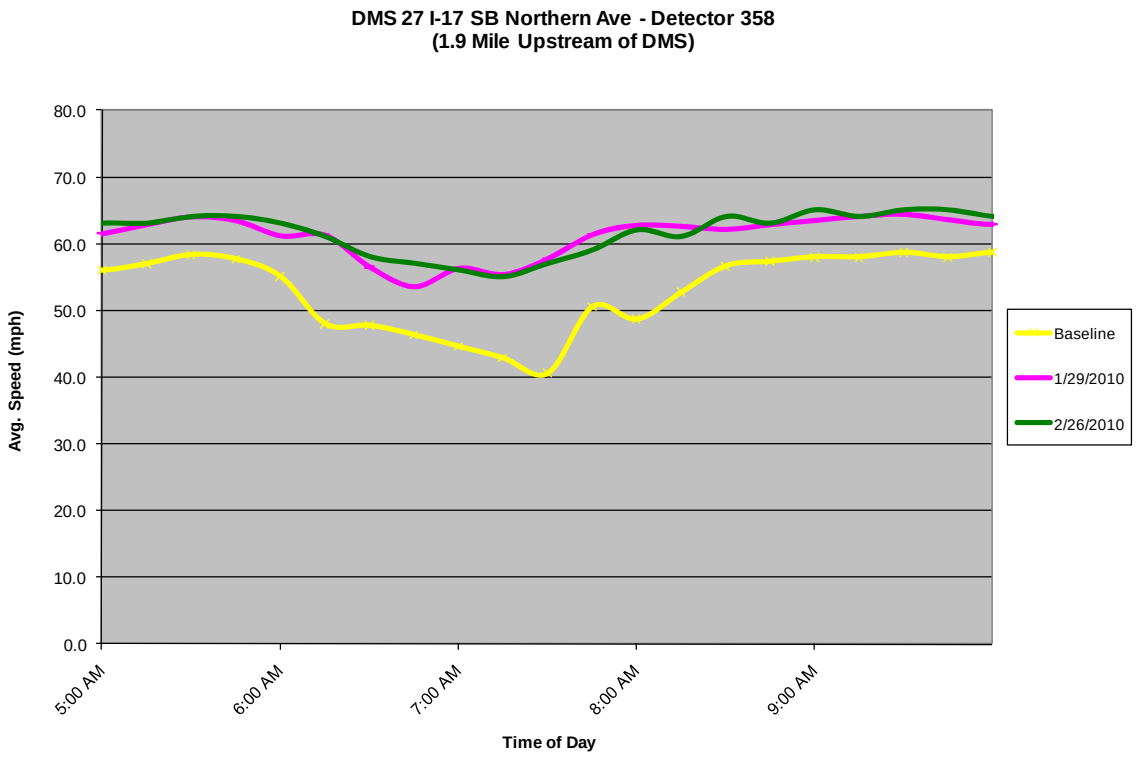




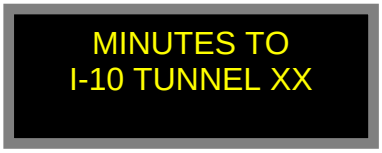
DMS 27 I-17 SB Northern Ave

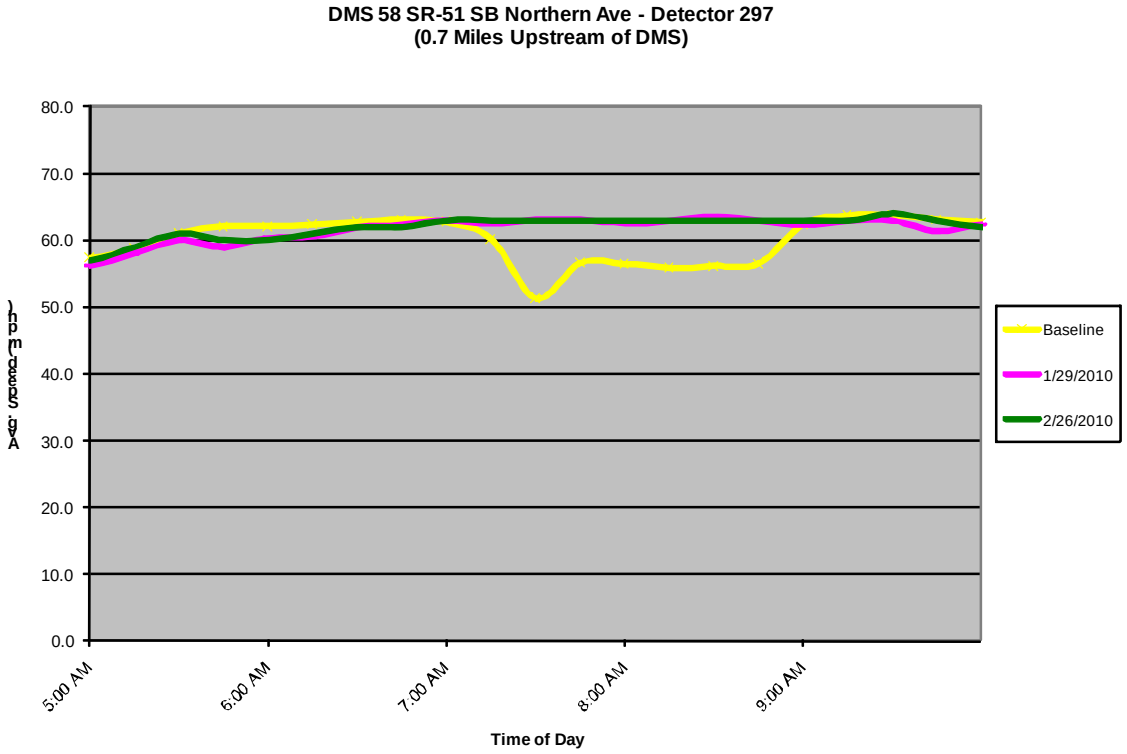
MINUTES TO
I-10 TUNNEL XX

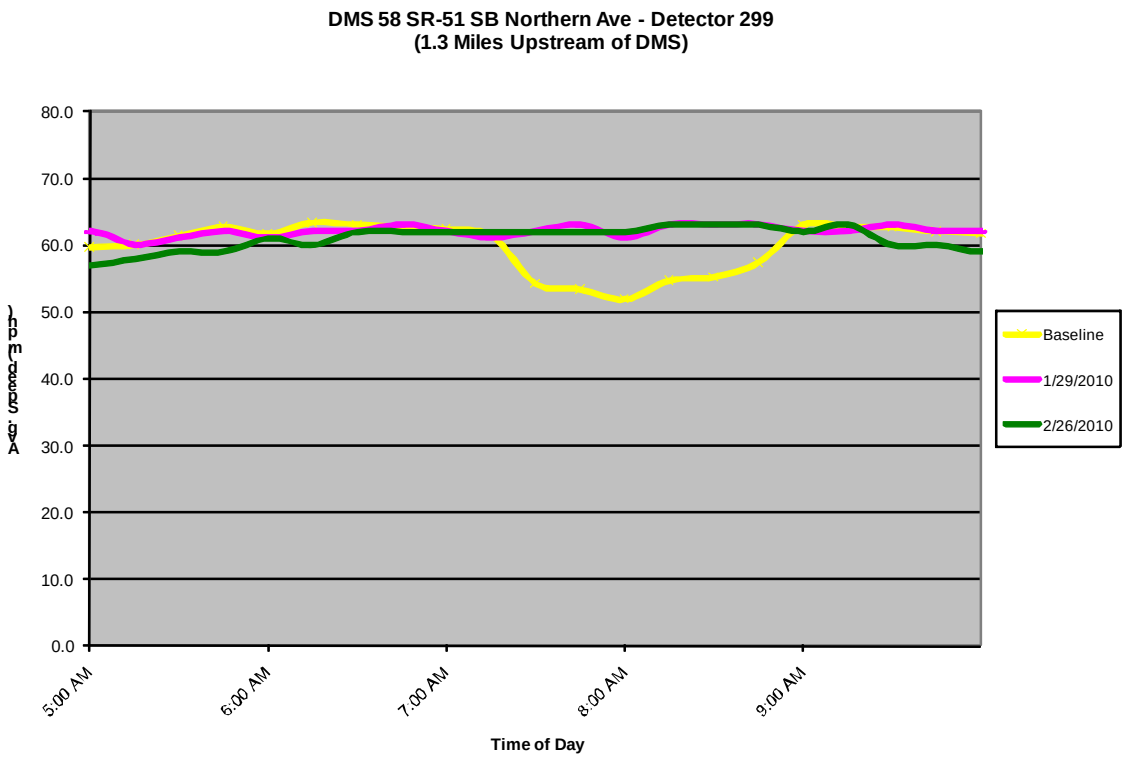




DMS 58 SR-51 SB Northern Ave

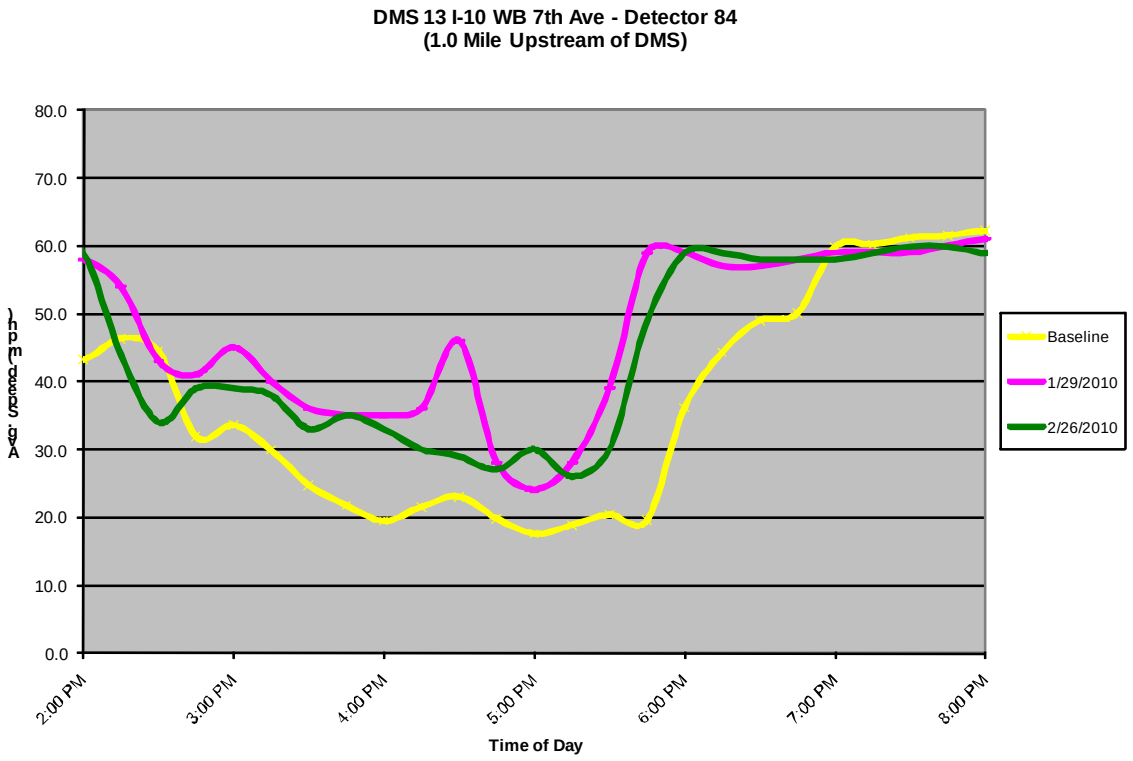


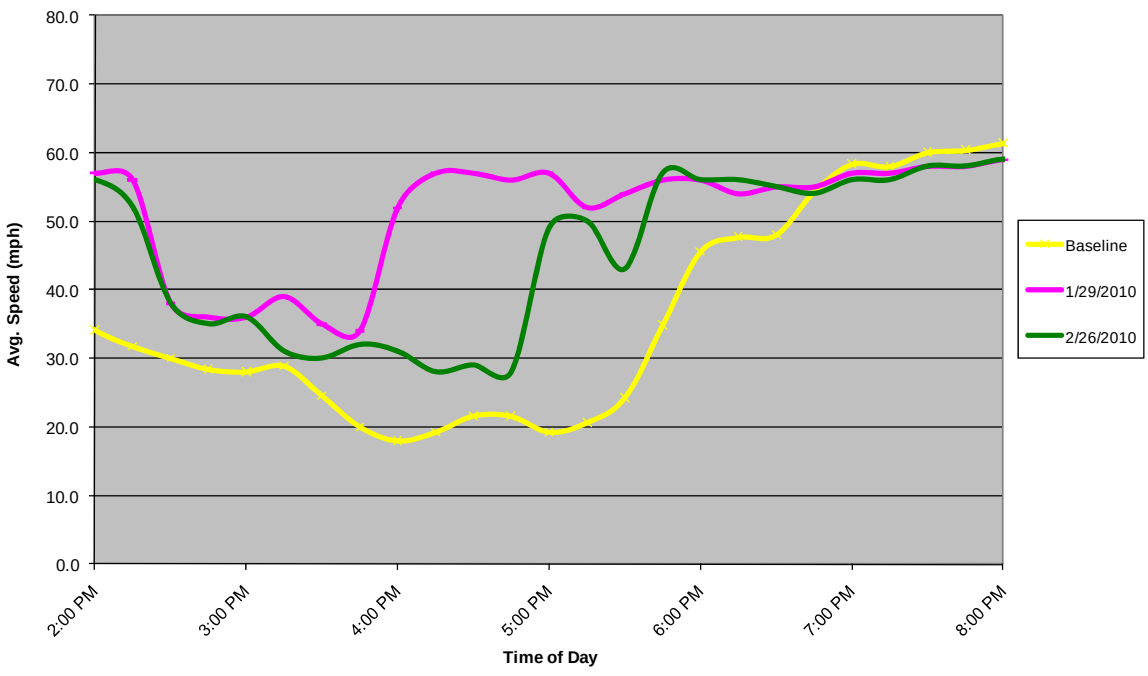




DMS 13 I-10 WB 7th Ave

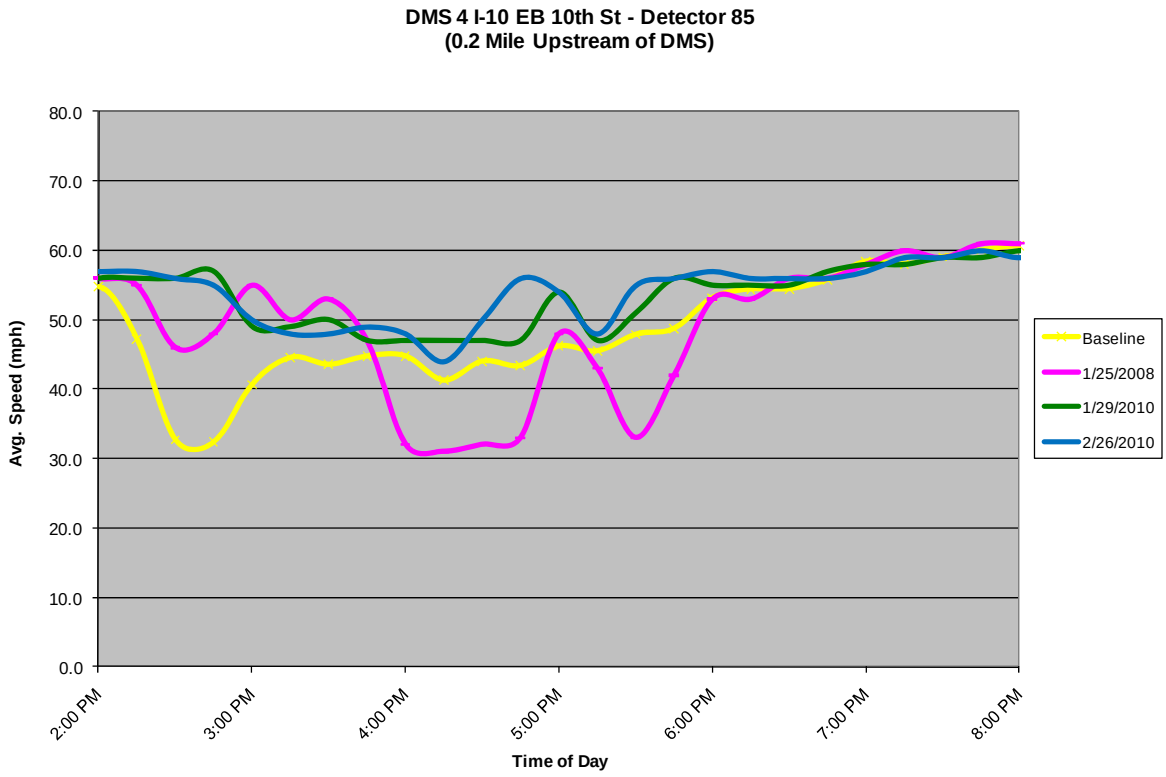
MINUTES TO
83RD AVE XX
I-17 PEORIA AVE YY

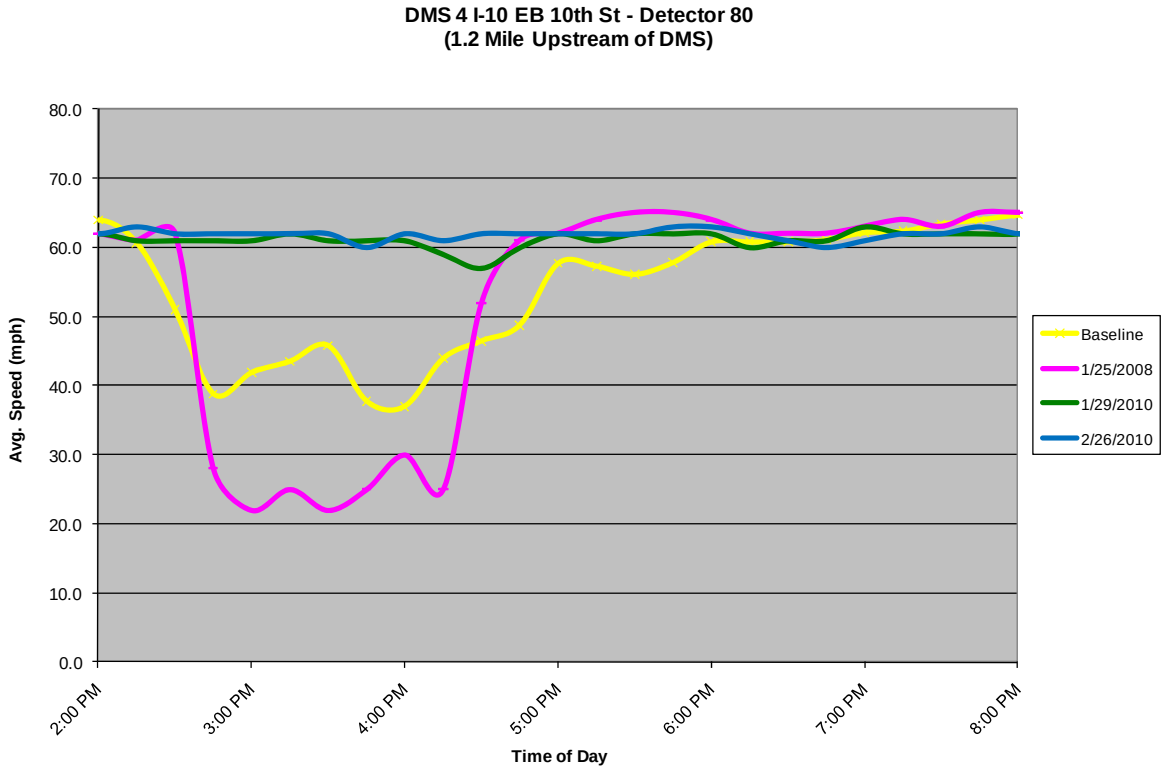




FRIDAY - JANUARY 2010

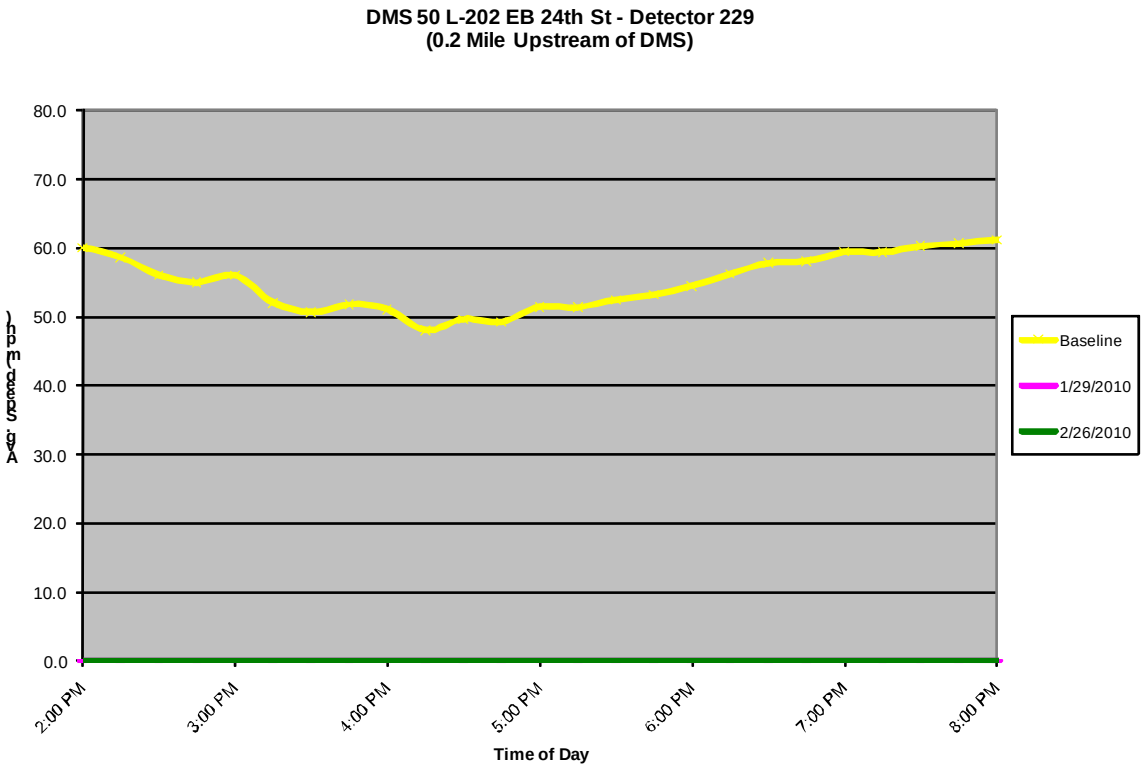
DMS 4 I-10 EB 10th St





DMS 50 L-202 EB 24th ST

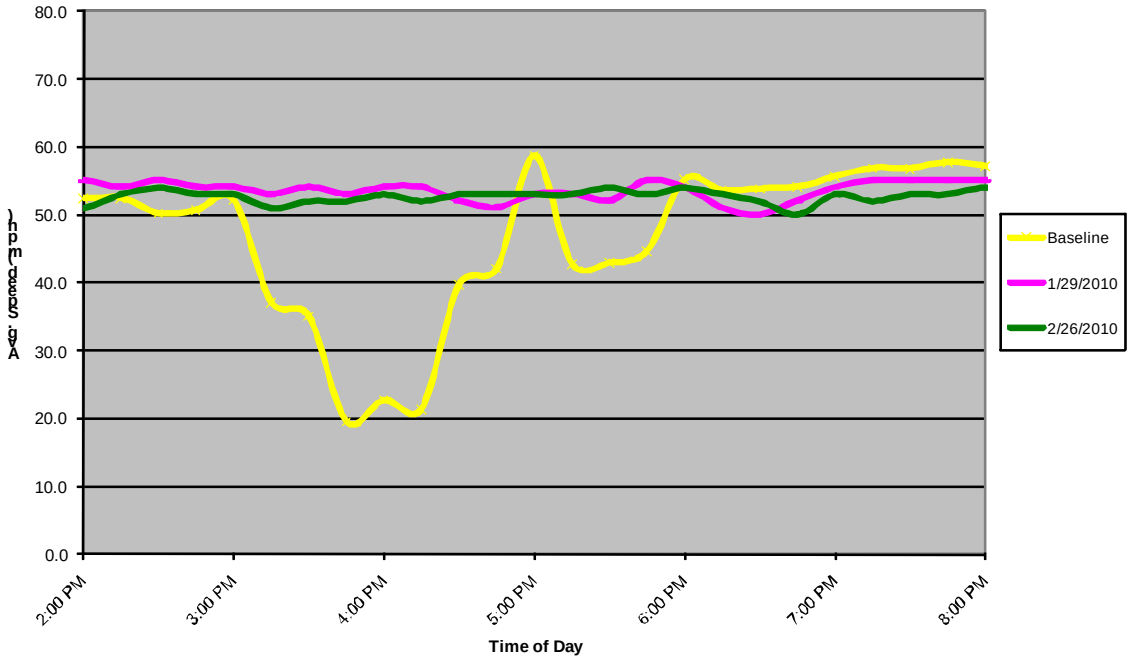
MINUTES TO
LOOP 101 XX



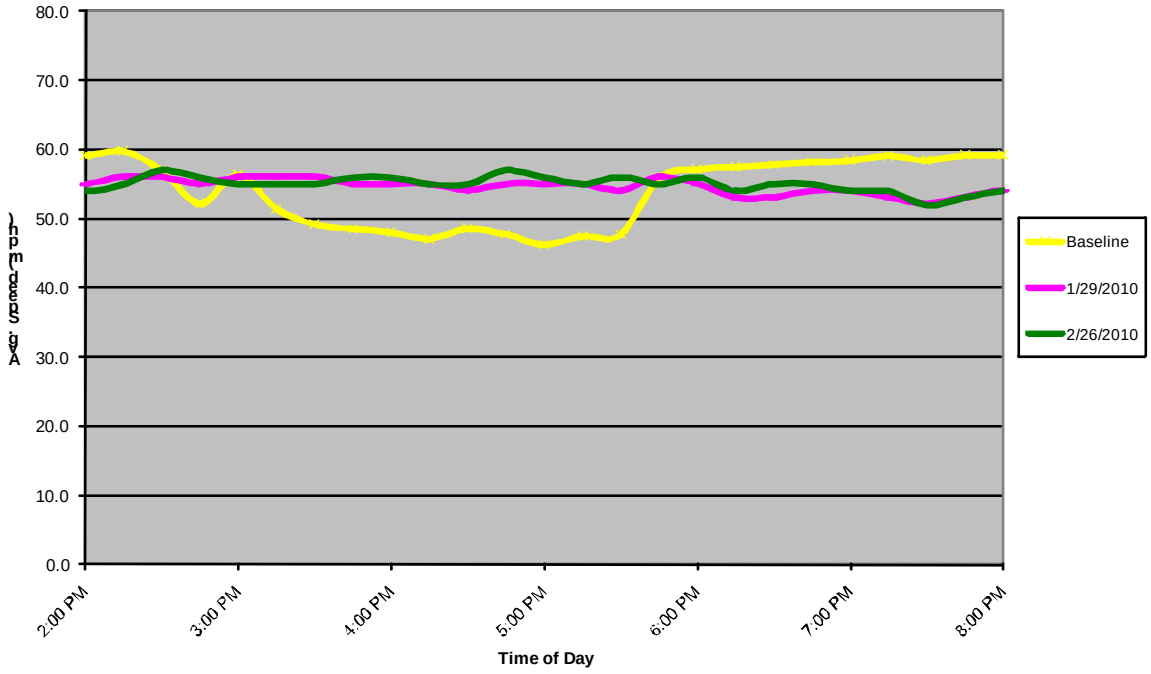
DMS 32 I-17 SB Central Ave

MINUTES TO
I-10 RAY RD XX
US-60 VAL VISTA YY

DMS 32 I-17 SB Central Ave - Detector 108
(0.5 Mile Upstream of DMS)



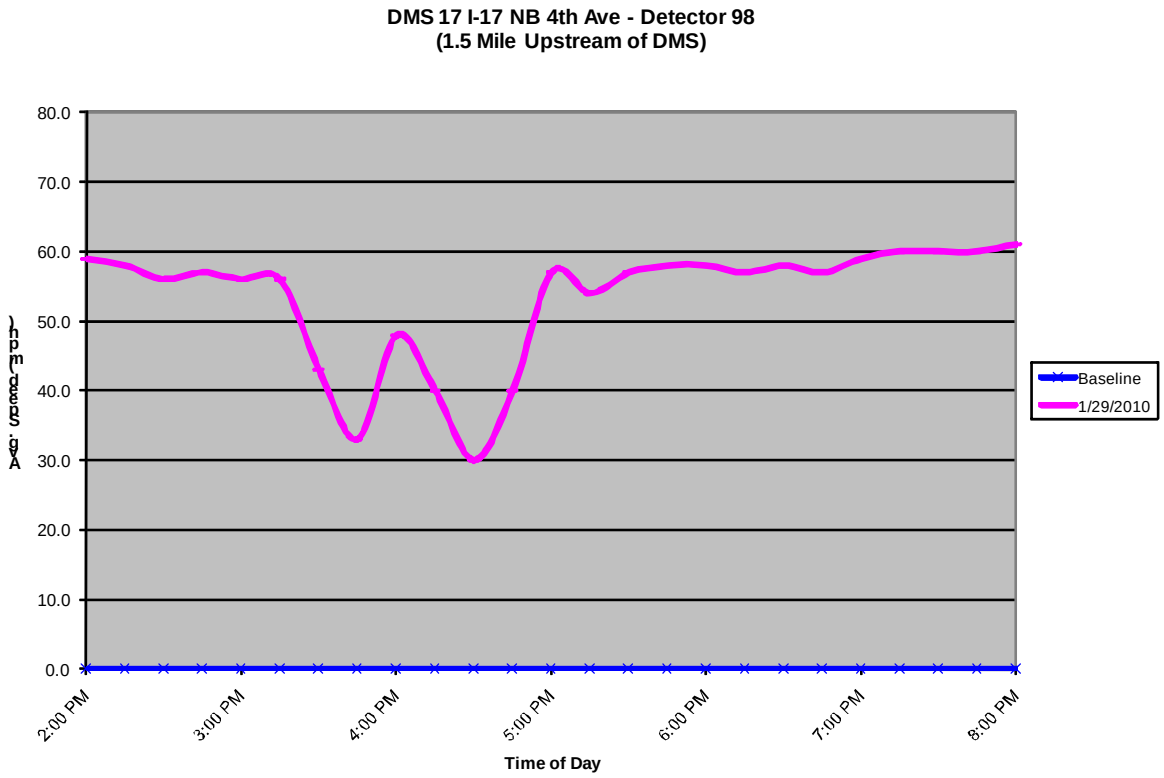
DMS 32 I-17 SB Central Ave - Detector 114
(1.6 Mile Upstream of DMS)



DMS 17 I-17 NB 4th Ave

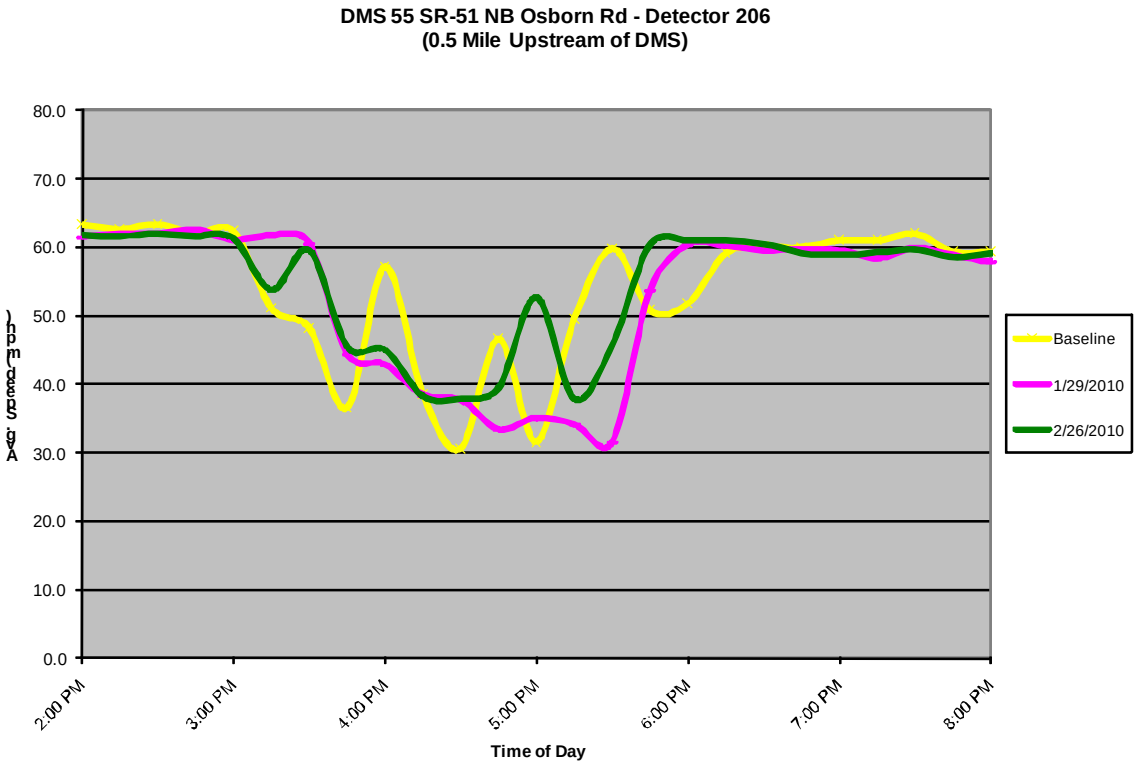
MINUTES TO
PEORIA AVE XX
I-10 83RD AVE YY

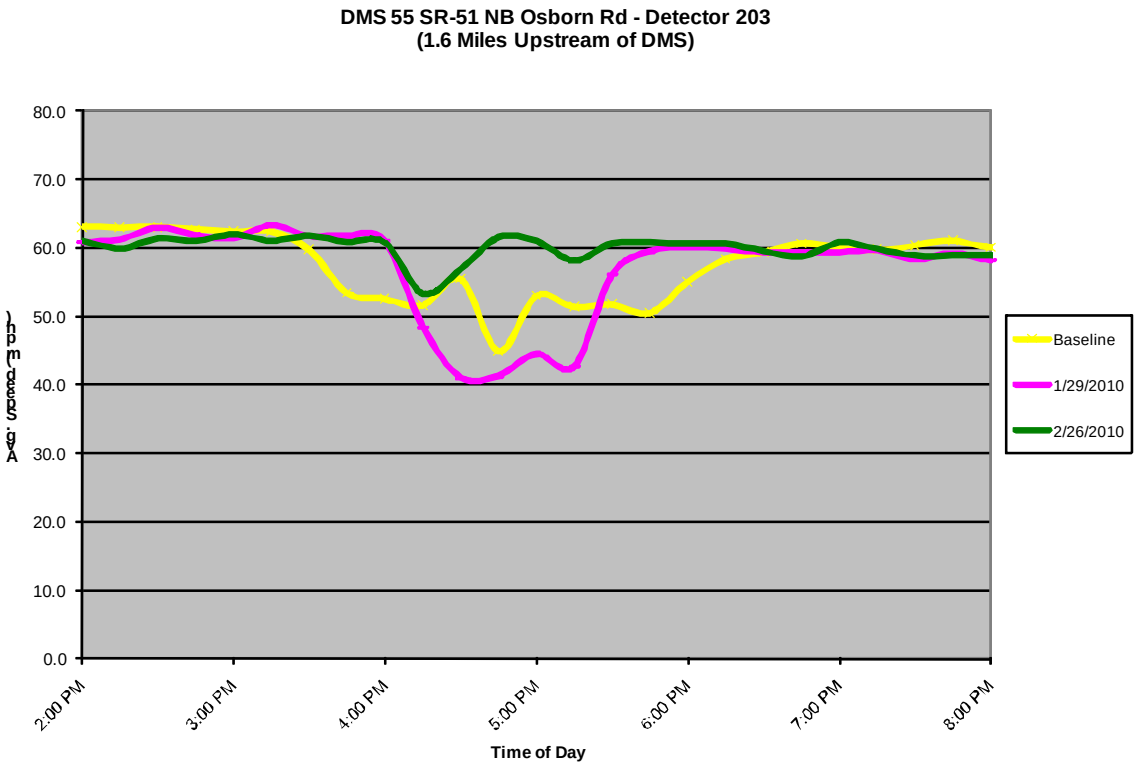
No Available Data on Detector 104



DMS 55 SR-51 NB Osborn Rd

MINUTES TO
BELL RD XX





APPENDIX B – TELEPHONE INTERVIEW QUESTIONNAIRE AND RESPONSE SUMMARY

Hello, my name is _____ and I am calling for Dr. Bruce Merrill who is doing an extremely important survey related to how people use our freeways in Maricopa County.

Do you drive on our freeways frequently, occasionally, rarely or never?

IF RARELY OR NEVER: Thank and end interview
IF FREQUENTLY OR OCCASIONALLY: Will you answer a few questions for us please. The interview only takes a few minutes and your responses really could help the state do a better job with the freeways.

1. The Arizona Department of Transportation has put signs on the freeways telling drivers what the travel time is from where they are to various destinations. Do you recall seeing any of these signs? 1.yes 2.no – go to question xx

2. Do you remember seeing these signs more frequently traveling on the freeways in the 1.mornings or the 2.afternoons? 3.no difference 4.don't know

3. Have you changed the route you were driving based on what you learned from the travel time signs, 1.frequently 2.occasionally 3.rarely or 4.never? 5.na

4. Do you find the travel time message signs to be accurate? 1.yes 2.no

5. IF NO: In general, how many minutes would you say they tend to be off?

6. Do you find the destinations listed on the signs generally relevant to where you do most of your driving? 1.yes 2.no

7. Do you have a specific location you would like to see listed that currently isn't displayed on the signs? 1. yes 2.no

8. IF YES: What destination would you like to see listed?

9. Would you recommend that the Arizona Department of Transportation 1.keep or 2.discontinue the signs? 3.no opinion

10. IF KEEP: Would you recommend 1.adding more signs or 2.keeping the number of signs currently being used? 3. no opinion

11. If you could make one suggestion to improve the travel time sign program, what would it be?

12. Thinking now of when you drive during the MORNING hours, do you use the following freeways (1)frequently, (2) occasionally or 3) never. Let's start with the –

13. Interstate 17 traveling south or in-bound toward central Phoenix. _____
14. Interstate 10 traveling in-bound toward central Phoenix from the east valley _____
15. Interstate 10 traveling in-bound toward central Phoenix from the west valley _____
16. US highway 60 (the Superstition) in-bound in the morning _____
17 State Route 51 (the Squaw Peak) in-bound _____
18. State Route 202 (the Red Mountain Expressway) in-bound _____

Now, thinking about when you drive during the AFTERNOON and EVENING hours, do you use the following freeways (1)frequently, (2) occasionally or (3) never. Let's start with –

19. Interstate 17 south or out-bound from central Phoenix. _____
20. Interstate 17 north or out-bound from central Phoenix _____
21. Interstate 10 west or out-bound from central Phoenix _____
22. Interstate 10 east or out-bound from central Phoenix _____
23. US highway 60 (the Superstition) _____
24. State Route 51 (the Squaw Peak) _____
25. State Route 202 (the Red Mountain Expressway) _____

We are almost finished and only need a little information about you for demographic purposes.

26. Do you the freeways in Maricopa County 1.almost every day or 2.only occasionally?

27. Do you carpool to work 1.frequently 2.occasionally 3.rarely or never

28. Do you use the freeways 1.mainly in the morning 2.mainly in the afternoon or 3.both

29. How many years of formal education have you completed? 1.high school or less
2.some college or trade school 3. college graduate 4.post-graduate degree

30. Do you drive in the HOV lane 1.frequently 2.occasionally 3. rarely or never?

31. By observation: 1.female 2.male

The purpose of this survey was to determine the degree to which drivers commuting to and from the central Phoenix area recall ADOT signs that drivers what the travel time is from their present location to various destinations. The survey was designed to also measure whether commuters find these signs helpful and to determine if the sign program should be kept of discontinued.

The results of this research are based on a telephone sample of 1,000 adult heads of households residing in the Phoenix SMSA (Standard Metropolitan Statistical Area) who use the freeway system frequently or occasionally. Fifty-seven percent of those interviewed said they used the freeways system frequently; 43 percent occasionally. The sampling error for the sample when the proportion (P) giving a dichotomous response to a question is 50 percent and assuming the 95 percent level of significance is plus or minus 3.1 percent.

Since drivers must be aware of the signs in order to evaluate them, the sample was further screened by asking respondents the following question: "The Arizona Department of Transportation has put signs on the freeways telling drivers what the travel time is from where they are on the freeway to various destinations. Do you recall seeing any of these signs?" The information which follows is based on the 512 drivers (51 percent) who said they recall seeing the signs. The sampling error for those who have seen the signs is plus or minus 4.3 percent.

The study was designed, pre-tested, and conducted by Dr. Bruce D. Merrill, Professor Emeritus of Mass Communication at Arizona State University. Dr. Merrill is also currently director of the Cactus State Poll which is conducted monthly by the Walter Cronkite School of Journalism and Mass Communication and the Public Broadcast Station Eight. Dr. Merrill has been conducting surveys for public and private sector clients in Arizona for forty years. He holds a Ph.D. in Political Behavior from the Institute for Social Research at the University of Michigan where he trained at the Michigan Survey Research Center. He was the founding director of three survey centers at Arizona State including the Survey Research Center, the Public Opinion Research Center and the Media Research Program in the Walter Cronkite School. He also served as director of the Center for Urban Studies. Dr. Merrill conducted this survey as a consultant for Kimley-Horn Consulting.

1. The Arizona Department of Transportation has put signs on the freeways telling drivers what the travel time is from where they are to various destinations. Do you recall seeing any of these signs?

	Yes
All freeway users	51%
Use freeways frequently	60%
Use freeways occasionally	40%
Use freeways mainly in the mornings	45%
Use freeways primarily in the afternoons	42%
Use freeways both mornings and afternoons	56%
Carpool to work	70%
Don't carpool to work	52%
I-10 inbound mornings from the east	61%
SR 51 inbound mornings	61%
Superstition in-bound mornings	59%
I-17 inbound mornings	57%

I-10 inbound from west	57%
202 inbound mornings	57%
I-17 south outbound afternoons	57%
I-10 west outbound afternoons	57%
I-10 east outbound afternoons	57%
SR 202 outbound afternoons	56%
Superstition outbound afternoons	54%
SR 51 outbound	54%
I-17 north outbound afternoons	53%

Drivers who use the freeways frequently are more likely to see the signs than those who drive the freeways occasionally. People who drive the freeways both morning and afternoon are more likely to see the signs than those who drive mainly mornings or mainly afternoons. Carpoolers are more likely to see the signs than non-carpoolers.

There were no statistically significant differences found in awareness of the signs on the 13 routes commuters use for in-bound and out-bound traffic. The awareness of the signs for those who use the routes frequently or occasionally is shown below.

2. Do you remember seeing these signs more frequently traveling on the freeways in the mornings or the afternoons?

	morn.	after noons	no diff.	not sure	total
All freeway users	29%	32	25	14	100%
Use freeways frequently	33%	33	22	12	100%
Use freeways occasionally	20%	31	30	19	100%
Use freeways mainly mornings	55%	23	7	15	100%
Use freeways primarily afternoons	6%	45	33	16	100%
Use freeways both	32%	30	25	13	100%
Carpool to work	36%	35	22	7	100%
Don't carpool to work	27%	32	26	15	100%
I-10 inbound mornings from the east	32%	29	27	12	100%
SR 51 inbound mornings	31%	32	22	15	100%
Superstition in-bound mornings	31%	31	26	12	100%
I-17 inbound mornings	33%	27	27	13	100%
I-10 inbound from west	28%	33	25	14	100%
202 inbound mornings	34%	29	22	15	100%
I-17 south outbound afternoons	29%	31	25	15	100%
I-10 west outbound afternoons	28%	24	24	24	100%
I-10 east outbound afternoons	28%	28	27	14	100%
SR 202 outbound afternoons	29%	30	27	14	100%
Superstition outbound afternoons	27%	33	25	15	100%
SR 51 outbound	28%	35	23	14	100%
I-17 north outbound afternoons	31%	28	26	15	100%

Drivers who use the freeways frequently are more likely than occasional drivers to see the signs in the morning ($p<.05$). People who use the freeways primarily in the morning are more likely to see the signs than those who use the freeways in the afternoon or use the freeways both morning and afternoon ($p<.05$). The difference between those who do and do not carpool was not statistically significant ($p>.05$). There were no statistically significant differences by routes people use to commute.

3. Have you changed the route you were driving based on what you learned from the travel time signs frequently, occasionally, rarely, or never?

	freq.	ocas	rarely	never	total
All freeway users	5%	16	10	69	100%
Use freeways frequently	7%	17	9	67	100%
Use freeways occasionally	2%	14	13	71	100%
Use freeways mainly mornings	7%	16	9	68	100%
Use freeways primarily afternoons	4%	13	14	69	100%
Use freeways both	5%	17	9	69	100%
Carpool to work	9%	28	9	54	100%
Don't carpool to work	5%	14	10	71	100%
I-10 inbound mornings from the east	6%	21	11	62	100%
SR 51 inbound mornings	5%	21	11	63	100%
Superstition in-bound mornings	6%	23	10	61	100%
I-17 inbound mornings	7%	18	10	65	100%
I-10 inbound from west	4%	20	11	65	100%
202 inbound mornings	7%	18	9	66	100%
I-17 south outbound afternoons	4%	17	11	68	100%
I-10 west outbound afternoons	5%	22	10	63	100%
I-10 east outbound afternoons	5%	20	13	62	100%
SR 202 outbound afternoons	6%	18	11	65	100%
Superstition outbound afternoons	7%	19	9	65	100%
SR 51 outbound	4%	18	9	69	100%
I-17 north outbound afternoons	6%	17	9	68	100%

No statistically significant differences were found in regard to how often or what time of the day the freeways are used or what routes they use. Carpoolers change their routes more than non-carpoolers. No statistically significant differences were found for those who drive the various routes in and out of Phoenix.

4. Do you find the travel time message signs to be accurate?

	Yes
All freeway users	84%
Use freeways frequently	83%
Use freeways occasionally	86%

Use freeways mainly in the mornings	80%
Use freeways primarily in the afternoons	92%
Use freeways both mornings and afternoons	83%
Carpool to work	83%
Don't carpool to work	84%
I-10 inbound mornings from the east	86%
SR 51 inbound mornings	80%
Superstition in-bound mornings	85%
I-17 inbound mornings	79%
I-10 inbound from west	83%
202 inbound mornings	82%
I-17 south outbound afternoons	86%
I-10 west outbound afternoons	87%
I-10 east outbound afternoons	82%
SR 202 outbound afternoons	83%
Superstition outbound afternoons	82%
SR 51 outbound	83%
I-17 north outbound afternoons	83%

Commuters who use the freeways primarily in the afternoon are more likely to feel the signs are accurate than those who the freeways in the mornings or both mornings and afternoons. No statistically significant differences were found based on the various freeways people use to commute.

5. IF NO: In general, how many minutes would you say they tend to be off?

five minutes or less	20%
six thru nine minutes	7
about 10 minutes	38
eleven thru 15 minutes	18
over 15 minutes	17
	100%

Average = 10.8 minutes

No statistically significant differences were found based on how often people use the freeways, when they use them, whether they carpool or the routes they use.

6. Do you find the destinations listed on the signs generally relevant to where you do most of your driving?

yes	75%
no	25
	100%

No statistically significant differences were found based on how often people use the freeways, when they use them, whether they carpool or the routes they use.

7. Do you have a specific location you would like to see listed that currently isn't displayed on the signs?

yes	18%
no	82
	100%

No statistically significant differences were found based on how often people use the freeways, when they use them, whether they carpool or the routes they use.

8. IF YES: What destination would you like to see listed?

Along the 101	26
Just along the 101	(4)
Northbound to the I-17	(3)
Near the 202 exchange	(3)
Approaching the 60	(2)
The 101 loop both ways	(2)
Southbound on the 101	(2)
Northbound near the 51	(2)
Between Scottsdale and Glendale outbound	(1)
Between Union Hills and MacDonald Drive	(1)
Outbound near 7th. Ave	(1)
Northbound near Bell Rd	(1)
East bound	(1)
Near Chaparal to Frank Lloyd Wright	(1)
Near 99th. Ave	(1)
Westbound on the 101	(1)

(*) Numbers in parentheses are the number of mentions for each location

Along Interstate 10	15
Between 1-10 and I-17	(2)
Westbound on I-10	(2)
East bound before I-17 near the airport	(1)
Between I-10 and the 202 south	(1)
Closer to the i-10	(1)
From the 60 to I-10 then to the 51	(1)
From the 101 to the I-10	(1)
From I-10 to U.S. 60	(1)
Near 83rd. Ave	(1)
I-10 toward Tucson	(1)
The 17 and 10 to Quartsite	(1)
The Broadway curve and the 101	(1)
Central and the I-10 inbound	(1)

Along the 202	13
Loop 202 and the 101	(4)
Southbound on the 202	(2)
Between I-10 and the 202	(2)
Coming in from the east valley	(1)
Going east out of Mesa	(1)
Along the 202	(1)
From the 51 to the 202	(1)
Near Shea Blvd.	(1)

Near Sky Harbor Airport	11
Along I-17	9
Northbound	(2)
I-17 and the 101	(2)
Outbound west	(2)
Outbound east	(1)
Near I-10 both east and west	(1)
Near Deer Valley Rd	(1)
Along the 51	7
Near the 101 loop	(1)
Between Shea and the 101	(1)
Near the 101	(1)
Near Thomas Rd.	(1)
North outbound	(1)
Southbound out of Phoenix	(1)
Near the 202	(1)
Along the 51	3
From Country Club to Ellsworth	(2)
Eastbound at Rural	(1)
Near ASU	2

9. Would you recommend that the Arizona Department of Transportation keep or discontinue the signs?

	Keep	discontinue	don't know	total
All freeway users	81%	7	12	100%
Use freeways frequently	83%	6	11	100%
Use freeways occasionally	79%	8	13	100%
Use freeways mainly in the mornings	86%	5	9	100%
Use freeways primarily in the afternoons	87%	5	8	100%
Use freeways both mornings and afternoons	73%	10	17	100%
Carpool to work	86%	3	11	100%
Don't carpool to work	82%	5	13	100%
I-10 inbound mornings from the east	82%	7	11	100%
SR 51 inbound mornings	82%	8	10	100%
Superstition in-bound mornings	78%	8	14	100%
I-17 inbound mornings	84%	7	9	100%
I-10 inbound from west	83%	6	11	100%
202 inbound mornings	82%	9	9	100%
I-17 south outbound afternoons	83%	8	9	100%
I-10 west outbound afternoons	81%	7	12	100%

I-10 east outbound afternoons	82%	8	10	100%
SR 202 outbound afternoons	80%	8	12	100%
Superstition outbound afternoons	85%	8	7	100%
SR 51 outbound	83%	6	11	100%
I-17 north outbound afternoons	80%	8	12	100%

There were no statistically significant differences by frequency of use, when the freeways are used, whether or not people carpool and the routes traveled.

10. IF KEEP: Would you recommend adding more signs or keeping the number of signs currently being used?

add more signs	53%
keep current number	33
no opinion	14
	100%

The only statistically significant difference in regards to whether more signs should be added or the number kept the same was that people who use the freeways frequently were more likely (56%) than those who use the freeways occasionally (45%) to favor adding more signs. When the freeways are used, whether or not people carpool or the various routes people use commuting showed not statistically significant differences.

11. If you could make one suggestion to improve the travel time sign program, what would it be?

Need more signs	33%
Make signs more accurate both in terms of times and routes	15
Make the signs easier to read, bigger letters, flashing, colors, brighter	11
Update the signs more frequently to get info out faster	7
Include information about accidents	6
Add more destinations	4
Get rid of signs they are a waste of money	4
More on or near freeway on and off ramps	4
Put the signs farther out on the freeways	4
More lanes to roads	2
Put advertising on the signs to pay for them	2
Put on information about HOV lanes	2
Have them on longer hours	2
Use some portable signs	1
Have more or better information	1
Include information about special events	1
Keep them maintained	1
Advertise them on the radio	1
	101%

Thinking now of when you drive during the MORNING hours, do you use the following freeways frequently, occasionally or never.

	Freq.	occasion.	never
12. Interstate 17 traveling south or in-bound toward central Phoenix.	8%	17%	75%

13. Interstate 10 traveling in-bound toward central Phoenix from the east valley	10%	25%	65%
14. Interstate 10 traveling in-bound toward central Phoenix from the west valley	11%	19%	70%
15. US highway 60 (the Superstition) in-bound in the morning	10%	19%	71%
16. State Route 51 (the Squaw Peak) in-bound	9%	25%	64%
17. State Route 202 (the Red Mountain Expressway) in-bound	14%	25%	61%

Now, thinking about when you drive during the AFTERNOON and EVENING hours, do you use the following freeways (1)frequently, (2) occasionally or (3) never.

	Freq.	occasion.	never
18. Interstate 17 south or out-bound from central Phoenix.	6%	21%	73%
19. Interstate 17 north or out-bound from central Phoenix	8%	25%	67%
20. Interstate 10 west or out-bound from central Phoenix	11%	28%	61%
21. Interstate 10 east or out-bound from central Phoenix	10%	32%	58%
22. US highway 60 (the Superstition)	13%	27%	60%
23. State Route 51 (the Squaw Peak)	12%	30%	58%
24. State Route 202 (the Red Mountain Expressway)	16%	37%	47%

DEMOGRAPHICS

25. Do you the freeways in Maricopa County almost every day or only occasionally?

almost daily	46%
occasionally	54
	100%

26. Do you carpool to work

frequently	5%
occasionally	9
rarely or never	86
	100%

27. Do you use the freeways mainly in the morning, mainly in the afternoon or both?

morning	10%
afternoon	26
both	64
	100%

28. How many years of formal education have you completed?

high school or less	16%
some college or trade school	33
college graduate	34
post-graduate degree	17
	100%

29. age

18-30	11%
31-45	19
46-60	35
Over 60	100%

30. How often respondent uses the HOV lanes.

frequently	17%
occasionally	48
rarely or never	35
	100%

31. sex of respondent:

Males	47%
Females	53
	100%

APPENDIX C – FREE-FORM COMMENTS ON WEB SURVEY

INACCURATE DISPLAY TIMES	
Response Date	**Response Text**
01/24/2008	I find the times posted on the sign south of the Broadway Curve to be inaccurate for the 143 vs I-10 tunnel. It usually shows only 5 minutes difference from that point...not possible!
01/25/2008	Showing the same times to the tunnel and to the airport (20 min each) could cause problems to newcomers -- as soon as they see the tunnel they're going to be looking for the airport if they ar told they are the same length of time away. That has been the case twice this week!
01/28/2008	Today the message board in Mesa predicted a 25 minute drive to the tunnel via 101 and 202. After 20 minutes of driving on the 101 anad 202 I reached the message sign on 202 that predicted another 20 minutes to reach the tunnel.
01/31/2008	i do not believe the times are accurate, i believe you should add about 15 minutes on to the board-from 7th street to ray road takes 20 minutes, without traffic, but with all the traffic in the valley now, it takes atleast 45 minutes~
02/05/2008	EVERY time they were wildly inaccurate. They are a waste of time and money.
02/06/2008	These signs are infrequent and wrong. Regardless of traffice they seem to post the same time.
02/07/2008	The sign at Indian School has never changed from "15 minutes to Bell".....why is that? Just curious if it will ever be accurate/helpful to us. Thanks
02/08/2008	I have experienced sign boards in other cities and they work well - usually the commute is less than the time posted. Here it appears the commute is longer than posted. Example, I-17 SB posts 25 minutes to Ray Road which it may be at the time I pass the sign board but by the time I merge with I-10 more time has past and the commute is longer. Perhaps the delay factor (later time equals more vehicles equal even later time than originally thought) needs to be re-evaluated.
02/11/2008	I take the Express Bus and I notice that the travel time (usually stated as 25 minutes) from 7th Street to Ray Road is not accurate. It usually takes the bus 25 minutes or more just to get to Elliot Road.
02/13/2008	Travel times posted are usually wrong within a mile or two of passing them.
02/19/2008	Great idea! Los Angeles can been doing this for years and is quite helpful. Although the times posted have not been accuarate. The other day, the sign said 15 minutes from just south of SR 51 and I-10 toward Awhatukee (Ray Rd) and it took over 30 minutes from the sign to Ray Road. I would have exited the freeway had I known that. On Friday, Feb 15 - it took 2 hours and 6 minutes to get from SR51 and Cactus to I-10 and Ray Road because of a ramp closure on the 202. The signs were not working then. Had I known it would take that long, I would have stayed in N Scottsdale.
02/22/2008	15 minutes to 143. Sure. Tunnel in 20 -- going 90MPH from the 143 to the tunnel??? There is always a 5 minute difference between the 143 and tunnel travel time, even though thet tunnel is 9 miles from the 143.
03/01/2008	The times stated are so far off. It usually states 30-35 minutes to get from US-60 and Country Club, to the tunnel downtown. It takes at least that long to get to 40th street and the I-10, and that is only half the way to the tunnel.
03/05/2008	Usually when I come up to the sign just past the Deck Park tunnel to go north on I-17, the travel time usually tells me 25-30 minutes (this is usually at 5:45-5:50 p.m. every day). I usually end up reaching the destination listed on the board (I-17 and Peoria) in usually half the time that is listed on the board, so many times I have found it highly inaccurate.
03/05/2008	The time estimates for SR-51 (Southbound) travel in the AM are not accurate. The times where it is the least accurate are between 7:00a - 7:30a. It seems that, unless there is a collision on the freeway, it always states 15 or 20 minutes to the Deck Park Tunnel. It typically takes me approximately 25 minutes to reach the SR-51/Loop 202/I-10 split. However, it is helpful that there is a substantial difference between collision or non-collision conditions which helps immensely.
03/08/2008	Signs are not reliable. Always overestimate time to get there

03/27/2008	I find that the travel time estimates posted are way off base during the afternoon commute. For example I-10 eastbound out of the tunnel, when the sign says like 30 minutes to Ray Rd, it's really 30 minutes to the Broadway curve.
01/28/2008	Why do they ALWAYS say 15 minutes (on the 51)? This is the case regardless of the traffic flow. I'm getting to the point where I ignore them. Will this ever change?
02/05/2008	The travel time is always the same within 5 minutes on the US 60 West during the AM commute, which is often inaccurate.
05/27/2008	Posted times are usually 5 - 7 minutes longer than actual travel times. Thanks for providing this opportunity for feedback on this system
06/26/2008	I have found the travel time estimates to be about 5 to 10 minutes higher than the actual commute.
07/11/2008	The travel time on the board near Elliott road says travel to SR-143 is 10 or 15 minutes in the AM?? Today I did notice it at 5min. This is more accurate.
07/13/2008	The signs are almost always wrong in my brief experience with them. Either the actual travel time is significantly higher or lower than the time posted. This is from five different travels on I10 East from the avenues to the 60 (the ValVista travel time to be exact) Seriously, my guess is that you've spent tens to hundreds of thousands of dollars on this "study" that should have been used to build more lanes and buy more buses. All for what? Maybe to justify the millions you've spent on these roadway signs that are frequently broken, under test or simply idle? Now you can post travel times to make it look like the millions were well spent. Only government committees can waste this much money so efficiently.
07/22/2008	In the morning, westbound I-10 from Elliot to the tunnel, the time estimates don't add up. From Guadalupe Rd. to the 143 it will show 10 minutes, and to the tunnel it will show 15 minutes. Given that it is over eight (8) miles from the 143 to the tunnel, how does one legally travel that distance in five (5) minutes? Also, even with traffic, why does it take 10 minutes to travel a little over three (3) miles from Guadalupe Rd. to the 143?
07/23/2008	Depends on the day. Many times they are accurate. However, there are times when unexpected things happen on the freeway like break downs and such. After passing the signs there is no way to know. It is usually a toss up though. I have had days it was correct, and days where actual times are longer. People don't know how to drive in this state so that does not help the case!
09/18/2008	I think the estimates are a little over estimated. Generally when it says 16 minutes to tunnel in the morning when I'm not carpooling I'm there in 12 and that's close to the speed limit. I do find the signs useful and have detoured thanks to the times. Thank you.
09/23/2008	i find the travel times to be off more than 10-17 minutes when not traveling in the HOV lanes. If I'm in the HOC lane with another occupant, I find the times to be close to accurate.

MORE SIGN LOCATIONS, EXPAND TRAVEL TIME CAPABILITY, MORE DESTINATION LOCATIONS/TIMES	
Response Date	**Response Text**
01/22/2008	more signs
01/24/2008	It would be great to see the sign on westbound I-10 on the broadway curve displaying information about how long it would take to reach ray road, chandler blvd/LOOP 202 Santan, queen creek road, the maricopa county line and such. I noticed that nothing was displayed for my commute home today!
01/25/2008	Keep them but expand it to all signs.
01/25/2008	Showing the same times to the tunnel and to the airport (20 min each) could cause problems to newcomers -- as soon as they see the tunnel they're going to be looking for the airport if they ar told they are the same length of time away. That has been the case twice this week!
01/28/2008	More signs!
01/29/2008	need more cameras, sensors and screens on more freeways

02/02/2008	I would like to see more segments for the heavy commute from Chandler to US60/SR143 - There is only one sign and it is so far north I don't have an option to change my plan at that point.
02/03/2008	Have more boards
02/04/2008	Add more locations perhaps. Example, on the 202EB add a few more roads than just the 101. Time is farly accurate within about +/- 5min. of time shown. Pehaps add them to more of the Message signs insted of just one.
02/04/2008	need one at I10 202 santan to be effective
02/04/2008	I've noticed the new time estimates on some of my drives, since my commute destination tends to vary once in a while. Personally, I'd find more value from a message that would said (for instance) "NORTHERN-SHEA SLOW" instead of just "BELL RD: 15 MIN". (Assume I'm headed NB on SR51 here.) This would be much more useful for proactive detour planning. Just my thoughts. Thanks!
02/05/2008	Signs would be nice on the 101.
02/06/2008	Too many blank signs without times listed. Could list more than 1 or 2 times measured.
02/06/2008	I would like to see more of the signs used.
02/06/2008	Too many blank signs without times listed. Could list more than 1 or 2 times measured.
02/08/2008	On the US-60, you give the travel time to the tunnel. I don't go that far. I would be much more interested in knowing the travel time to the I-10.
02/14/2008	Can you put more times on - instead of just one time for the general length of the freeway, it would be nice to see some times for points in between. For example on the 51 it only gives the time it will take to get to Bell Rd. - how about a couple additional lines for the time to the 101 or maybe to Shea...just a thought
02/14/2008	Please add information about the 101. It, as you know, is a mess and when there is an accident or a change in construction restrictions, it can cause problems. If I have the knowledge, then I can adjust my route and it will help all.
02/15/2008	Need to provide multiple travel times just not two from down town. From the tunnel east bound provide 51 North, 202 East, 10 East and 60 East. Sign need to show single minute increments not the rounded 5 minutes periods. Accuracy counts.
02/15/2008	Add Loop 101 to the program
02/18/2008	It would be nice to have one most east so that those of us coming in from Ellsworth or Power Road could be more informed about traffic we'd be getting into. By the time I see the report I'm almost getting off of 60, as I get onto the 10 South. Thank you.
02/21/2008	I wish there were more--more signs, more freeways, more reliable aternate transportation.
02/29/2008	Need more message signs. Emergancy exits from the freeway to other roads would sure help reduce back up traffic. The gate could be opened by the DPS only and relieve traffic.
03/07/2008	Why do you have SR 143 on the WB 202 as a timing indicator when going WB in the morning? It makes more sense to have the NB 51 interchange listed instead.
03/10/2008	not enough. There are no signs on the 101 or i-17 where i travel
03/14/2008	Have all message boards with this information
03/15/2008	i would like to see options for example on the sign at I-17 we should have two options going to downtown via I-10 or continue on I-17. City of Atlanta has this implemented and lets people shift onto the least occupied freeway.
03/19/2008	Put the travel time further north. The first sign I see is just north of northern traveling south.
03/26/2008	The question, Do you find the travel time estimates to be accutate is not applicable because the destination displayed does not apply to where I'm traveling, from US 60 westbound to downtown Phoenix. The sign in the morning on US 60 currently displays travel time to the tunnel. I would guess the majority of travelers in the morning are not going to the tunnel area.
03/27/2008	I love them, wish you had it in more places. I drive all of the time and need more of them. I love the time things.
03/28/2008	You need to get sensors and signs on loop 101 in the NW valley

03/28/2008	The Northbound I17 sign only shows a time to a point on westbound I10. It should also show a time to somewhere on I17, Peoria perhaps?
03/28/2008	POST MORE TRAVEL TIMES!
03/29/2008	I am a "suburb to suburb" commuter. I need to know, as I travel Southbound on I-17, or Eastbound on I-10, Stack to 101 as compared to Stack to Superstition.
04/01/2008	Additional information as to time of day of posting for travel time. Post the expected delays at what point(exits)in the travel, also better sign or additonal sign locations (more signs).
04/04/2008	I'd like to see these on the L101 please
04/15/2008	I would love to see these more frequently, especially one before the tunnel, as well as perhaps one on the 101 before connecting to the I-10 to head east into phoenix. (Est time from I-10/101 Jct. to I-10/SR51 Jct) Also, please install sensors on the west segment of the 101!
04/24/2008	Posting an alternate route would be very helpful in cases of extreme delay.
04/28/2008	wished they went further west than 67th ave, that's half the commute before i see the first sign!
04/29/2008	I'd like to see travel time estimate for once you get past the stack on I-17. I have yet to see it. I heavily rely on the one going southbound in the morning. Seen these over in Cali and loved them! Great Job!!!
04/30/2008	they have the travel boards on I-17 and I travel at rush time and the only time these boards have been used was for an amber alert and once for a stupid message about smoking but they are NEVER in use to tell us about travel time. Such a waste, so if they are not going to be used for their purpose, then why not post a message that using the HOV lane for one person is illegal and the amount of the fine and put it in spanish, since most of the ones using it illegally are mexicans.
05/06/2008	We would love to see some of these up in the North and North West Valley especially with all the construction on I-17. It would help to know if we should consider Carefree Hwy or other alternate routes now that I-17 is always backed up due to construction delays.
05/09/2008	I would like to see miles added to the signs for those who don't know the valley freeways. What good does it do to know that it will take 15 minutes to get from 101 to SR51 if you don't know how far it is. 15 minites to go 5 miles if good but 15 to go 1 mile is bad!
05/20/2008	I travel from Peoria on I17 to Rural and the 60 and then back every day as my commute. There are multiple routes I can take to get through / past downtown, but the I17 board only tells one path times, would be great to have a tunnel path and one that takes I17 all the way to the split in order to compare and take the better route for the day. Could also start travel times at about 2pm as traffic seems to start then in the afternoons and i try to be off the freeway by 3 pm.
05/29/2008	I would love to see more travel times posted on all signs.
06/04/2008	Conditions generally change between the time I read the sign and the time I reach the location indicated on the sign. This greatly affects the reliability of the information. Could you install more signs?
06/11/2008	I think every piece of information helps. I like the program and hope it will expand east on US 60.
06/11/2008	MORE OF THEM, PLEASE. GOOD JOB.
06/19/2008	Please expand the system to cover all of the freeways
07/22/2008	Great system--just need to add more signs
08/22/2008	I would prefer to see traffic info regarding all possible connecting freeways
09/02/2008	I would like the time posted on I-10 past the 101. The freeways goes on into Goodyear & there is never anything posted and that is where it bogs down the worst. Please don't for the people in Goodyear/Buckeye! Thank You!!
09/13/2008	As I vacation in San Diego, I notice they use similar information. I would like to see this posted in more areas including my morning travel time home since I work the night shift. Thanks
09/19/2008	I think you should have more of them and they should run all the time.

09/26/2008	Have more Travel Time Board Installed.
10/01/2008	Keep them going and put the I-10 info on the 101 and 202 signs that aren't used. Thanks
10/22/2008	put a sign at I10 and 202 San Tan Westbound
11/03/2008	Need it available more ... should not suspend posting to put up following day air quality advisories.
11/14/2008	Travel times unposted on 88th Ave/Bell Rd, and on south/b L101???
11/15/2008	I have seen the travel times on I-10 & I-17, but they need to be everywhere, in every direction, at all times of the day. You should also have 3 places listed on each message board. For instance, I-10 Eastbound at 67th Ave should have travel times for the tunnel, airport & US60. Other states have 3 destinations and also run there travel times in both directions at all times of the day. Every Message board should be displaying travel times.
11/20/2008	Please extend them to all VMS boards on all freeways. This is a very useful tool that I'm glad to finally see on the freeways here in the Valley. I had seen them before in cities such as Tampa and San Antonio and am pleased that they're finally here.
11/28/2008	signs further east on the 202 red mountain would be nice
11/28/2008	I think it's a good idea to help people decide whether surface streets or freeways would be better for them. A slight increase in the number of signs would be beneficial.
12/02/2008	I travel east bound on the 10 in the evening rush hour. Travel times are posted at about 7th street for the time to Ray Rd and SR51 bell rd. the travel times that should be posted there are ray road and time to the 101. many drivers like myself could take either the 202 or the 10 and it would be helpful to know that info - not how long it is to bell rd.
12/03/2008	Put more signs and devices on north valley loop 101
12/16/2008	I would like to see a sign on I-10 east of riggs rd on the westbound side so I know if I should get off I-10 and go across riggs rd to 51st ave.
12/17/2008	would like to see a portable VMB along the eb 101 with travel time to the 202 split until construction is completed. that is the route I usually take to chandler.
12/18/2008	More freeways to and from the WESTSIDE!!!!
12/21/2008	Show shortest time below current time or current average m.p.h.

SPEED SLOWING NEAR SIGNS	
Response Date	**Response Text**
01/23/2008	Yesterday afternoon, traffic came to a near stop at the sign near 7th st on I-17 Northbound. Once past the sign, traffic flow was moving better than usual. I have driven NW phx to Chandler daily for over 20 years and the warning signs of weekend closures always cause traffic to slow or stop. It is almost like everyone is talking on a cell phone at the same time. I can not see how travel time info will help as there is no alternative. It does more harm than good. If someone wants to know how long it will take they can listen to the traffic reports on the radio like I do. -Dave (dwjibeault@yahoo.com)
01/23/2008	i saw a travel time to bell road (15 mins) yesterday for the first time. it seems like traffic slows down to read the signs anytime there is information posted on them. i'm assuming people are slowing down to read what's on the signs. i'd prefer that the boards not be used at all during rush hours.
02/06/2008	The signs slow down traffic. Everyone stops to read the sign. Are they really doing any good?
02/07/2008	At this time the apperance of these messages actually slows travel approaching these signs. hopefully when people get used to it they will stop slowing just to read it!
02/11/2008	I have noticed traffic seems to bottleneck or slow up to these signs with the est. travel times, then seems to open up a bit after the signs. They travel times really aren't useful and actually slow traffic.
02/15/2008	Travel Time interferes with smooth traffic flow since people step on their brakes to read the signs. It is irrelivent information and more of a hinderence when there is no congestion.

03/16/2008	Too much irrelevant information on DMS, such as Pollution, Don't drink&drive, Amber alert etc that is not helpul for motorists, but rather distractive. Drivers excessively and needlessly use breaks and cause rearend collision situations when reading those long non-traffic related messages (especially elderly drivers- so common in AZ!) DMS have to be short, informative, and only traffic related. Law enforcement should have their own independent system for their needs.
03/18/2008	Just seems to me it slows traffic down even slower. People are reading the message board and not paying attention to traffic around them.
04/29/2008	I have found that many lighted traffic signs CAUSE traffic. Speeds have significantly slowed down 10-15 mph because of motorists trying to read the signs which often are not critical (such as amber alerts or road conditions). Other motorists who do not slow to read the signs or do not look at the signs find themselves suddenly breaking because of those who do. Lighted signs SHOULD ONLY be used for occasionaly for urgent or important messages. Messages about air pollution, dui, or other "marketing" messages should not be posted there.
05/15/2008	I find that near the information signs, traffic seems to slow, possible for drivers to read the sign, and this may have an adverse impact.
09/08/2008	TRAFFIC SLOWS DOWN AT THE SIGNS WHILE PEOPLE TRY TO READ THEM

ROUNDING AND ESTIMATING	
Response Date	**Response Text**
01/24/2008	Why are they rounded to 5 minutes periods? This is useless. Does not tell me if it is a good day or typical bad day.
02/04/2008	time increments of 5 minutes seem to be to large. suggest travel time need to read to the nearest two minutes to detect changes that are subtle versus something that needs to be paid attention too.
02/04/2008	I have only seen "15" or "20" minutes as the SR51 NB travel time. My experience shows to interpret this data as "normal slowness" to "extreme slowness" only and not as a good quantitative estimate of travel time.
02/05/2008	The traffic is very heavy before 6am, suggest you turn it on a little earlier (5 or 530). Rounding to 5 minutes is silly if you only have a 7 minute drive and it shows 10 minutes. Suggest rounding to even numbers.
03/13/2008	The fact that the time estimtes are apparently rounded off to the nearest 5-minute interval discredits any accuracy they may have. If you always see it with the same value, then you tend to not believe its information. I would suggest using estimates rounded off to 2-minute intervals, which would increase the likelihood of different values being shown from update to update (or day to day). Also, WB 202 - it references the "SR 143" - is that the exit for SR 143 or to the actual SR 143 roadway via the exit road which feeds into the airport after the "real" exit to SR 143 (the parclo ramp)?
03/27/2008	Excellent idea - I work for Valley Metro Rideshare and this is a fantastic tool for commuters. I would suggest only that the times are more specific. The 20, 25, 30 minute times on there seem arbitrary... and are the same almost all the time. I learned from your site that data is collected every 20 seconds, which is great. I think commuters would believe the times if they reflected more accurate data and said 18 or 23 minutes vs. 5 minute ballpark intervals. I like your survey, too.
01/23/2008	It is a very usefull tool to predict how long I will be on the freeway. However, reading the message boards, I believe estimations are much better than approxomatations. Here is a example, from what I used to see while I lived in San Antonio... row 1: TRAVEL TIME row 2: LOOP 410 10-14 MINS row 3: LOOP 1604 26-29 MINS.
05/14/2008	These are an excellent idea, thank you for finally using this system! Please try now to get travel times more accurate, as they are only in 5 minute increments.

ALWAYS SAME TIME SHOWN	
Response Date	**Response Text**
01/28/2008	Why do they ALWAYS say 15 minutes (on the 51)? This is the case regardless of the traffic flow. I'm getting to the point where I ignore them. Will this ever change?
02/05/2008	The travel time is always the same within 5 minutes on the US 60 West during the AM commute, which is often inaccurate.
02/18/2008	Why are the time estimates ALWAYS 15 minutes? They have never changed regardless of road conditions. They should be turned off until working. Otherwise, they'll always be ignored as useless.
02/22/2008	The freeway sign located just south of Shea on SR-51 ALWAYS shows 15 minutes to downtown. It cant ALWAYS be 15 minutes because traffic flows change considerably. Therefore, I doubt that flows are monitored as frequently as your website states.
02/29/2008	SR 51 N/bound always says '15 min to Bell Rd', whether traffic is going fast, slow, or stopped. I tend NOT to believe it!
03/11/2008	The travel estimates shown around Scottsdale Road on the Westbound 202 around 8:30 AM are tremendously wrong. It almost always says 15 minutes to the I143, which is just 3 miles away and takes me 4 minutes. It almost always says 20 minutes to the tunnel, an additional 5 minutes from the I143. However, this is 7 miles and can't possibly be done in 5 minutes even during non rush hour. Neither estimate is of any practical use. Great concept, lousy execution.
03/27/2008	Excellent idea - I work for Valley Metro Rideshare and this is a fantastic tool for commuters. I would suggest only that the times are more specific. The 20, 25, 30 minute times on there seem arbitrary... and are the same almost all the time. I learned from your site that data is collected every 20 seconds, which is great. I think commuters would believe the times if they reflected more accurate data and said 18 or 23 minutes vs. 5 minute ballpark intervals. I like your survey, too.
04/30/2008	202 Eastbound - always says 10 minutes from Scottsdale Rd to the 143, but it only takes about 3 minutes.
05/12/2008	Every sign I see says 15 minutes - regardless of the actual traffic conditions. I don't feel they are accurate.
05/27/2008	Most of the time the posted travel time does not change. Useful in the morning because when I get on the freeway it seems heavy, but I trust the time posted and it is accurate in most occurances.
07/11/2008	The travel time to the tunnel does not seem to change at all. It is allways marked at 15 min. I am not sure if it is correct.
07/17/2008	They always say 15 or 20 minutes regardless of actual time. Often, HOV or not the time can be half this.
08/05/2008	The travel times are the same every day (7:15AM southbound, 5:30PM northbound) and rarely adjust as there is traffic. There could be traffic moving at 10mph or 55mph and the signs would read the same. I find that the signs actually cause people to slow down to read them, and cause traffic rather than helping travel.
08/07/2008	NB 51 Always says 15 min to Bell Rd wether traffic is doing 55 or is crawling! I tend not to believe it.

ADD TIMES TO EASY-TO-USE WEBSITE	
Response Date	**Response Text**
01/24/2008	Thank you for continuing to do this type of stuff! I'd like to see speed information on your az511 website on the 101 N and E/W thru Scottsdale.
02/09/2008	I like the estimate times, they take much of the "guess work" out of timing my commute. I would like the times to also be added to the AZ511 website too. It would influence my decision before I leave work.

02/26/2008	Travel Times should also be posted on AZ511 website , so that before leaving work we can decide our route.
04/22/2008	It would be nice if the signs were posted on the website - http://www.az511.com/RoadwayConditions/index.php
05/19/2008	Generally, I find the signs are positioned so that I am locked into a route by the time I come up on the sign. If this information could be displayed on the internet site, that would affect my planning.
09/24/2008	it would be nice to be able to check the website, before hitting the freeway to see the information~
10/10/2008	IT WOULD BE GREAT IF YOU COULD PROVIDE THE SAME INFO YOU DO FOR THE MESSAGE BOARDS ON A WEBSITE THAT THE PUBLIC COULD ACCESS. THEN I COULD PLAN MY COMMUTE BEFORE I LEAVE THE HOUSE AND AVOID DELAYS THAT WAY. DO YOU HAVE ANY WEBSITE SUGGESTIONS? THANKS FOR YOUR PRO-ACTIVE EFFORTS!
10/31/2008	this should be phx 511 if it does not apply to rest of the state
12/23/2008	It would be nice to be able to see the messages on this web site.

EXPAND HOURS	
Response Date	**Response Text**
01/28/2008	Finally!!!! Why did ADOT take this long to make this happen by using the technology and information you had for at least 10 years?? This information should be made available to the public on all message boards and from 6am to 7pm. Why do you install these boards if you are not smart enough to budget money to REALLY make use of them? We are the last large city to implement this. It is crying shame that ADOT is so backward in a state that has many smart tech people at Intel, Motorola, Honeywell etc. Give this job to them and they will show you how to do it! What about making this info available to mobile internet users?
03/21/2008	Beautiful system; I'd love to see the hours expanded a bit, though.
02/01/2008	Should be on 24 hours a day.
02/05/2008	The traffic is very heavy before 6am, suggest you turn it on a little earlier (5 or 530). Rounding to 5 minutes is silly if you only have a 7 minute drive and it shows 10 minutes. Suggest rounding to even numbers.

HOV POSTING	
Response Date	**Response Text**
01/29/2008	I would suggest that you post separate times for the HOV and regular lanes. Might give people incentive to car pool. Haven't noticed any postings on my inbound commute on the 60.
02/01/2008	I think posting the location of accidents could prove useful as well as increased sign placement. Additionally, I think listing both normal lanes and HOV travel times (which often are quicker) could be an incentive to carpool by showing drivers the time they could be saving. By carpooling I am often able to decrease my travel time to ~55% of the posted travel time on the Red Mountain 202 to the 101.
02/11/2008	Why not list the time for the same distance for the HOV lane. This could increase carpooling and use of the HOV lanes
06/02/2008	Should provide times for HOV lane as well
06/17/2008	Atlanta posts HOV and mainline travel times.... paints a nice picture of what carpooling can get you.
11/04/2008	My commute is slightly less than posted as I am traveling in the HOV lane.
11/26/2008	It would be helpful to communicate if the Drive Times are for the HOV or regular lanes.

LOCATIONS PAST DECISION POINTS	
Response Date	**Response Text**
02/15/2008	I see the signage posted just out of the tunnel (Westbound) in the evening. However, it doesn't do me much good to know how backed up the I-10 is at that point in the commute...when I've already passed any other options. The next exit I could take is 27th avenue and the only thing worse than the I-10 at rush hour are the poorly maintained, two-lane roads with four-way stops in southwest phoenix.
04/18/2008	I've tried changing my routes when travel times are excessive and it did not help.
08/26/2008	By the time I see the informaiton, I am usually in the thick of things and have few opportunities to avoid the problems.
12/23/2008	as a truck driver, pulling doubles, we are always looking for help. trucks use? which lane? we can't change lanes on a seconds notice. it would help

GENERAL NEGATIVE COMMENTS	
Response Date	**Response Text**
01/24/2008	Is ADOT serious? US 60 Westbound to the Tunnel in 25 minutes??? That's what the sign said this morning at 7:15 a.m. You can't be serious?? Someone from ADOT needs to be out there in the morning commute to see what we're dealing with. And the evening commute is worse!!! But I just got to work and had to logon to tell you what a complete joke your $400,000 signs are!!! I'm in the car 10 hours a week and hate it... ADOT should have put the $400,000 towards more HOV lanes. Can't stand it!!!!
02/04/2008	The times usually show what we already know. The roads are backed up and slow, there are few alternative routes. Don't focus on the problem focus on a solution.
02/06/2008	Has a study on driver behavior been conducted? For instance, are there studies showing that drivers will take alternate routes just to shave 5 minutes off their commute? As a driver on WB US60 in the AM, I have no clue what alternate to the tunnel via 101 is since I'd rather stay on the 60 to the 17/10 route instead of create more merging activities. I'm confident if historic travel times between two points is the same via 101 or 10, the driver will choose the route most traveled. Moreover, I'm convinced that a driver will choose route most traveled rather than shave 5 minutes off commute by taking a lesser traveled route. We educate the public by saying "stay on designated trails" when hiking. Other public awareness campaigns state "it's better to arrive late than never...drive safely". So why is it that ADOT is trying to provoke drivers to take other routes and imply get to work quicker if you take this route? Let's assume most drivers don't arrive late to work and have no problem arriving 5 minutes late to work on rare occasions, then what benefit will the message sign have on motorist? In my opinion, absolutely no benefit. In the wake of state budget deficits, I hope ADOT will cease this study immediately as it has absolutely no benefit to the motoring public and use the funds in better ways. Sincerely, happy motorist from east valley
02/06/2008	I'm not sure the time frames posted benefit the traveling public; It can either be depressing if the time is too long, or, drivers may try and beat the time by driving inappropriately. I really do not see a use for posting drive times, as most people are not going to divert onto a different highway; Now, the accident reporting is very informational and drivers can take appropriate action as needed. The slogans on holiday weekends are also encouraging, such as "drive impaired, expect the max". Also, it is an excellent resource for Amber Alerts.

02/07/2008	I do not see the value of this. If I am on the freeway, what good is knowing how late I am. It is going to prompt me to drive more offensivley to get there faster. It is good for me to be able to see it BEFORE I get on the freeway. These signs should be used for information that will help relieve our traffic congestion. I suggest reminders of basic driving "rules of the road". Keep right except to pass, slower traffic keep right. Leave 2 seconds of space between you and the person in front. This is the stuff that would help traffic.
02/12/2008	Most of the knuckleheads in the morning really should not have another distraction like this.
02/13/2008	Indicate if the travel time posted is above or lower than the average for that time of day. Also, I've noted that the travel time for the alternate routes were the same as the route I was on, so the posting of the travel times was meaningless. I think ADOT should do a better job of providing advanced warning for things that would be blocking the road like accidents (better information on the location, which lanes are blocked, and severity of the collision). That would help us more in finding an alternate faster. Just posting the location of an accident doesn't tell us if its minor or major, blocking or clear. I've noted many times that the only sign board lit up is the one right before the wreck instead of lighting up the two or three signs before that. It always seems as if ADOT refuses to put the full truth on the boards to prevent a negative image of the freeway system during high congestion times. Just tell us bluntly what's happening. If its a fatal accident...say so...that way we'll be sure to avoid the area.
02/19/2008	The information on radio is much more complete and accurate. Use these signs for details on accidents including time of posting and offer alternative routes.
02/29/2008	These messages are of little use to me, since I've altered my schedule to hit both travel peaks EARLY. I'd rather have accident & rubbernecker delays posted accurately.
03/03/2008	your signs are poorly placed, hard to read and when commercial vehicles block visibility of all lanes ahead, why do you think signs would do any good? Your people need to drive the highways and get a rush hour taste of this mess. Sitting in your air conditioned office watching monitors will not motivate you to think ahead.
03/27/2008	While they do inform you of travel times, I am not sure that is a help to most people.
04/03/2008	THE FREEWAY ENTRANCE AT 23RD AVE. NEEDS TWO LIGHTS FOR ENTRANCE OF THE IOI GOING WEST, TRAFFIC BACKS UP IN THE STREET AND THE CARS DO NOT MERGE WELL TO ONE LANE. IT WOULD BE WONDERFULL TO SEE THE SAME SET UP THERE IS AT 35TH AVE. ENTRANCE GOING WEST ON THE 101. IN THE MORNING THERE ISN'T TOO MUCH INFO ON THE TRAFFIC ON THE 101 ON THE WEST END OF PHOENIX.
05/30/2008	The message boards when the display info along the 202 it is often about an accident that happened in the past. If the imformation was more reliable on those boards than I would be more inclined to trust them. I use Google on my cell phone to give me better information than that of what the ADOT boards are telling me.
06/04/2008	Glad the boards are working and you actually post information on them, now. Before, it seemed like those big expensive signs were being wasted in times when there was not an Amber Alert! Thanks for a great job on our Freeways, too. You guys work hard to keep us moving!
06/05/2008	The consequences of posting travel times for two separate routes to the same destination on the same sign occasionally causes congestion on the shorter route time route.

08/24/2008	Closing huge parts of the freeways with no signs letting people know whats going on is outrageous. Every weekend, it is impossible for me to get from Ray and the 1-10 to Shea Rd, people do have weekend jobs, too. There were no detour signs either. It is an abuse of power that frustrates the working class in an already bad economy as they are late to work because of this. This creates a huge amount of frustration between the people and the governmental programs that encourage such an inconvenience. I believe that time travel information doesn't help get people to work on time, letting people know which freeways are closed, for when, and how long a week before hand with detour signs is the best option. Closing half the freeway with absolutely no construction workers working creates a huge riff between people who only desire to get to work on time and the government that does not think about the people its affecting while implementing these construction zones. This is just making our economy worse.
09/02/2008	I think it's a waste of time and money, people don't relie on that info as accurate. It cause's accidents from people hitting the brakes to read signs. Spend the money to improve our roadways....not more signs.
09/15/2008	PLease use the boards to warn of accidents and slow-downs more than travel times. If I am a regular commuter I am aware how long the ride should be. I am more interested in significant and unexpected delays than reoutine travel times. Other than that the boards are very helpful, thanks.
11/10/2008	I don't feel the use of times is effective. If I'm already on the freeway, I personally won't exit to get caught in traffic on a side street, or get lost in an area that I'm not totally familiar with. I think most of the time it's more efficient to stay on the freeway even if it's backed up. I'm also like when the signs are only lit for important information, Amber alerts, accidents, freeways closings. When I see text on them, I know it is important.
11/10/2008	This just adds one more distraction for commuting... I would like to see DPS clear the HOV lane of single commuters... it's epidemic on the I-17
01/06/2009	The travel time is for a section further than I go so it is not much use to me. I can, however, use it to gauge how fast traffic is moving. (but I can also do that by checking my speedomoter so it really is not needed)

GENERAL POSITIVE COMMENTS	
Response Date	**Response Text**
01/23/2008	I REALLY appreciate using this method. I am thrilled that you are doing this. It is a big help and alleviates some of the frustration by knowing "how long the wait is".
01/23/2008	it eases the anxiety of a driver, traveling these roads during the rush hour commute.
01/23/2008	I've been using the FMS web page for 1 year now. I commute from 35 AVE & Pinnacle Peak Rd to Chandler. FMS helps me pick least clogged route. KEEP UP THE GREAT WORK! ADD MORE SENSORS!
01/23/2008	It is a very usefull tool to predict how long I will be on the freeway. However, reading the message boards, I believe estimations are much better than approxomatations. Here is a example, from what I used to see while I lived in San Antonio... row 1: TRAVEL TIME row 2: LOOP 410 10-14 MINS row 3: LOOP 1604 26-29 MINS.
01/23/2008	How about putting some safe driver tip reminders on the board, like "Watch for Motorcycles" or "Check Your Blind Spot" "Use Turn Signals"
01/23/2008	You should add an arrow after each time that relates to the change from the last update. For example, I10 westbound indicates 15 minutes to the tunnel, then an arrow pointed up indicating that the time went up over the last update (like from 14 minutes). This way, if the time indicates a down arrow then traffic is lightening up and the commute time could be less than indicated, if it has an up arrow then it is getting heavier and the commute time could be longer than posted.
01/23/2008	You should make the commute numbers accessible on the web page. That way we have a general idea of how long its going to take before we leave the office. Thanks

01/24/2008	I LOVE these signs!!! PLEASE don't stop with the very helpful information!!
01/24/2008	Thank you for continuing to do this type of stuff! I'd like to see speed information on your az511 website on the 101 N and E/W thru Scottsdale.
01/24/2008	Suggest put the current message board displays on a single simple web page.
01/25/2008	I like the time estimates. I have found myself more relaxed behind the wheel by simply knowing how long it will take me to get home.
01/28/2008	Good job. Drivers need real time information concering traffic condtitions. The more information the better.
01/29/2008	My commute is less stressful thanks to this information, even when it's bad news.
01/30/2008	I like it because its a heads up to how good or bad traffic is.
02/01/2008	Great Idea, I have seen it in other cities, glad Phoenix has it now
02/03/2008	Sometimes if it looks like my actual travel time will exceed the estimate, I will illegally use the HOV lane so that I can make the estimate. They make the commute a little more enjoyable.
02/04/2008	I hope ADOT continues to post travel times, this is a very useful tool to help manage my commute better.
02/04/2008	Please do this permanently...
02/06/2008	Thank you for the plan! My commute is much more easier to work with.
02/06/2008	I really like the time messages. It makes me feel informed about what is ahead of me - especially when traffic is stopped. Thank you
02/13/2008	THE INFORMATION PROVIDED IS USEFUL AND ACCURATE
02/15/2008	The accident warnings are helpful.
02/15/2008	I hope to see continued use of the freeway travel times. I believe it helps the flow of traffic because people can see it and make better judgements about the routes they want to take, lessening congestion. Great work ADOT!
02/20/2008	Good idea - I've seen this in other major metro areas and I'm glad we're catching up.
02/22/2008	I really like the travel time signs, they're quick to read too. I legally use the HOV lane and as a rule of thumb I seem to be able to divide the posted times in half.
02/27/2008	I have flexable work hours so I use the time estimates to determine best time for commute in the morning/evening. I think they provide generally good information for local commuters.
02/29/2008	Some of the descriptions may not be helpful someone who is unfamiliar with the area. Example - "tunnel" cannot easily be found on a map. It isn't a destination either. "7th Ave" or "SR 202" might be choices.
03/04/2008	good job - let's keep looking at those strategies. is there a way for users to input there future travel plans, like for the following day - and have projections based off of that?? - i know would change, but perhaps could start streamlining traffic by having drivers better plan their joining the congestion - meaning perhaps a 6 min wait, getting coffee would be a better time to enter the major arteries??
03/26/2008	I typically check the web site before I leave work to see travel time estimates and freeway conditions.
04/02/2008	There have been a couple times the sign was not accurate but I'd say at least 90% of the time it's been highly accurate. I find it a very nice service.
04/02/2008	For some reason this past week there have been no times on I-10 and 67 Ave and there use to be in the past. It was fairly accurate within 2-4 minutes which was very very helpful
04/02/2008	Good idea to have the times!
04/05/2008	The information is very helpful.
04/09/2008	I find the times posted to be positive, but I have never timed my driving to determine if they are correct.
04/11/2008	The times aren't so accurate as knowing how bad backups are...I know if it says 10 to sr-143 & 15 to the tunnel that it's full speed the whole way. If it says 25+ to the tunnel, I know it's slow.

04/17/2008	This is a great service, it has helped me to relax and not wonder so much about how bad the traffic ahead will be.
04/22/2008	I like them :)
05/20/2008	During rush hour, I find them very helpful in determining my best route home that day.
05/29/2008	I am very happy to see this and find it usefull to determine if i'll be late and need to call ahead.
06/06/2008	we need MORE of this
06/24/2008	Good Job! I use the information to know if i need to detour and change my route.
07/15/2008	I love the info. It helps me manage my commute better.
07/29/2008	Keep up the good work. Thanks.
08/06/2008	I think the signs are wonderful,they are a great tool in helping my commute be timely.
08/20/2008	Getting more accurate. Thanks
08/21/2008	Last week when there was an accident on I10 at elliot the travel time was what I say that made me take an alternate route.
08/29/2008	Very valuable information. Keep it going.
09/19/2008	This was the best idea ever! I am alway wondering how much longer till this ext or that ext. But the estimated time travel is great.
	Keep it going. I find it useful along with the traffic reports I listen to on the radio.
11/13/2008	As a driver that has to commute frequently during high traffic times, it is very helpful to have these signs giving us updates on times and accidents. Keep up the good work!
11/14/2008	Going westbound on US 60 in the morning, I usually need to exit at Rural or Mill depending on if I'm taking my son to daycare. If the travel time to the tunnel via I-10 is above 30 minutes, I usually exit on McClintock because I anticipate a big bottleneck before Rural.
12/02/2008	I LIKE HAVING THE TRAVEL TIME INFO POSTED-I ALSO LIKE HAVING THE CAMERAS WHICH ARE HELP FULL IN CASE OF AN INCIDENT OR ACCIDENT.
12/02/2008	I like it.
12/07/2008	Have changed commuting route based on travel time sometimes, depending on time amount. I like the travel time info and would like to see it remain.
12/10/2008	great work!
12/23/2008	Great study. I would not like to see this feature disappear.
12/24/2008	I think the system works well for the most part.
12/26/2008	Keep up the good work.
01/05/2009	Great addition in terms of providing drivers information
01/08/2009	Nice service. Thanks!
01/29/2009	Thanks for the travel time. They help me a lot.

ADDITIONAL INFORMATION TO DISPLAY COMMENTS	
Response Date	**Response Text**
02/12/2008	More information about freeway conditions and less like the "Expect the Max" threats.
03/13/2008	Road closures not mention at all!!!
03/19/2008	The emergency and special event notices on these signs are great!
05/29/2008	A last update time. There are times when crash warnings seems to be slow to be corrected, and not changing the route would have been faster.
06/25/2008	when you post accident messages they aren't updated often enough, i usually move to other lanes based on messages but the accident i find is cleared away most of the time
07/21/2008	I love when an accident ahead of me is posted in time for me to find a different route. This system is wonderful.
08/29/2008	I hate it when travel times are not posted because of the pollution advisories. Is there a way to flash between the two messages? Note: I understand Amber Alerts and accident reports taking precedence.

09/01/2008	show update time. Place more info to common routes before approching them so deviations can be made in route.
01/06/2009	It would be great to see more incident message boards about an accident and in what lanes.

UNRELATED COMMENTS	
Response Date	**Response Text**
01/27/2008	I would like to be able to get road conditions for other cities ie, Flagstaff
01/28/2008	I-10 in the west Valley is a problem day and night. Hopefully You widen the freeway soon. and not just by one lane. I think the east valley freeways are wide enough now start on the other side of phoenix.
01/28/2008	When there is an accident please let us know WHICH lanes are closed
02/03/2008	Yes. I live in Show Low and want to know road conditions in winter from here to Phoenix.
02/04/2008	I carpool every day and do my best to be a good citizen. I think the hours of the car pool lane should be expanded. I see routine abuse of the HOV lane so I am always happy to see DPS ticketing offenders. I also spend a lot of time caught in traffic because someone ahead of me got into an accident. I'd like to see a fine for individuals who get into accidents during peak traffic hours. An accident during peak hours inconveniences many motorists, not to mention adds to air pollution. I've been driving safely on Airzona for the past ten years (OK, I had one minor collision on the freeway) and there are no state or federally backed incentives for safe driving.
02/04/2008	Add them to the metered ramps to show best merging speed
02/04/2008	There is more to Arizona than this. With WINTER STORM'S all over the state you can be sure Phoenix is covered! But the people all around this state have to work with outdated reports and camera film that is over ten hrs old. This helps to make fore a safe trip??????
02/05/2008	my times are based on the use of the HOV lane useage. Our van pool alwaysa beets the estimated time usally posted on I-17 to get to Peoria.
02/07/2008	This probably should have been done years ago, Los Angeles has been doing this for years, and have dedicated boards just for this reason. I just wish the boards were updated with crash information and were monitored quicker. Since ADOT has control of the traffic cameras at real time there is no reason why they are not updated up to the minute.
02/21/2008	http://www.az511.com/RoadwayConditions/index.php Is really helpful, HOV is usually good where we use it from Pecos-I-10 to 3rdST-I-10, way home 3rdst-I10 to Pecos-I10 is slow on HOV lane.
02/28/2008	There are no traffic signals on my commute home starting on 51 southbound at Indian school, through the I-10 Eastbound, the the 60 Eastbound.
02/29/2008	in the future, please indicate on your website which lanes move the fastest and slowest during peak travel times.
03/03/2008	Today, the traffic light at the bottom of the Val Vista ramp was turned on. This has caused many problems, even though I am an "early" commuter (on I-60 by 6:15). Congenstion at the westbound entrance ramp is terrible. The northbound traffic getting onto the freeway gets 2 greens for every one southbound. This resulted in taking me 17 minutes to get onto the freeway (before it was 2 minutes, I live less than 1 mile from the freeway). My commute time more than doubled - from 17 minutes to go 12 miles to 36 minutes. One would think that the freeway would flow a lot better once I got on. Not the case. The delay between cars is way too long - 10 seconds per car, which is the primary culprit. It should be 1 second max. I believe that these lights are to make our commute quicker and safer. The implementation of the light at the Val Vista entrance has clearly accomplished neither. Congestion, northbound traffic blocking southbound traffic after their light has turned red, and a much longer commute are some of the results of this newly implemented traffic control. I sincerely hope that ADOT will reconsider!!

03/10/2008	enforce the carpool lane rules. Too many single occupant vehicles in carpool lanes.
03/13/2008	3 weeks ago 101-NB closed at guadalupe- hiwy patrol let cars & trucks make u-turn and exit off fwy on ramp.WHY DIDN'T THEY CLOSE FEEDER ON RAMP FOR 5-10 MILES SOUTH OF THE ACCIDENT & USE SIGN TO ALERT DRIVERS TO EXIT BEFORE THEY REACHED 1HR DELAY AT ACCIDENT
03/14/2008	Keep people out of theHOV lanes who are not supposed to be there. The HOV lane is not a fast lane alternate to get in front of a slow mover in the fast lane. Mor motorcycle cops please.
03/17/2008	Clearing of accident scenes is ridiculous. I spent 2 1/2 hrs on I-10 near Casa Grande (SB) on Sat 3/15 starting at 2PM. There are no by passes in that area and the police are too slow in processing the scene. More police patrols are needed between Tucson and PHX to slow people down to the posted speed limits.
03/24/2008	why in the world did you not put on the 101, 202 I10, Shea Blvd, etc. the fact that SR87 was closed?? My son finally saw a sign friday evening 1/2 mile from the bush highway.....you really lost the ball on this one.....just like before when you didn't take down the 1 lane traffic signs on labor day. really losing it.
03/24/2008	I would like to see a sign board at Payson on SR87. This way we don't have to go to SR188 and get turned around.
03/24/2008	Would like to see more of these with traffic conditions such as accidents
03/25/2008	I think it would have been wise for ADOT to construct the HOV lanes when the freeways were originally built. Aren't these lanes paid for by the federal government, so ideally no extra cost to the Az taxpayers. It seems to me that this "delayed" construction is adding time and inconvenience to the daily commute of all those that use the freeway system. The planning of this, and of the freeway system in general is probably why there is a budget shortfall, and why the "GOV" has said she would rely on the use of revenue generated by photo cameras.
03/27/2008	Need better updates on line of closures and re-opening due to crashes.
03/28/2008	I'm hoping they will bring the Metro Light Rail to the S. W. Valley. We really need a usable alternative. Laveen and other nearby areas are growing so fast.
03/28/2008	Would like to see more newspaper and other publicity about the significance of traffic cams. In particular, if they help to identify speeders, reckless drivers and shorten emergency response to accidents. If not, why not. Thanks.
04/15/2008	Please get sensors on the other highways - especially the Northeast (Scottsdale) segment of Loop 101 from the Loop 202 interchange to Highway 51. I always check az511 on the web before commuting, but can't see how that highway is doing to know if its a good option for me.
04/17/2008	On the webcams, would be cool if we could view the actual video stream (like the news does). Also - US-60 has has Crismon spelled as Crimson on your website under the webcams US-60 area...
04/30/2008	I cannot say that the times are acurate because the travel time segment extends beyond my exit.
05/02/2008	not much use. better information would be to know if accidents have occured on freeways before traveling on them, ie. via az511.com
05/07/2008	Turn off the ramp control lights when not needed (example SU Union Hills at 0600-traffic at that time this time of year doen not warrant the control-it is a gas waster.
05/19/2008	We need cameras on the Red Mountain Freeway from Cooper Rd East/West to Kyrene Blvd. Also, the Red Mountain has no traffic updates.
05/23/2008	It isn't obvious if it is the extra time or total time to get to some entry. Sometimes it takes some thinking to figure out where the other point is.
05/29/2008	I will Vote for the new sales tax when YOU (ADOT) do some thing with I-10 from CG to PX. You have had over 30 years to plan for it and don't blame it on the Indians.
05/31/2008	I use the freeways for my work as a courier only during off commute time. What copuld be better is more accuracy for notification of accidents and construction at off-ramp intersections.

06/03/2008	I absolutely try to avoid the freeways during the commute times and try to take the express bus as much as possible. Too bad it doesn't run later than 8am and only once after 5pm. It should run through 9am and 7pm, at least, because that's when real rush hour lasts. You should start promoting the express buses on your signs, i.e., saying things like, "If you're coming from Chandler, you might cut your commute in half if you're riding the Express Bus #xxx." You really have to sell the people on the Express bus because most people have no idea about them. I would be very impressed if ADOT partnered with Valley Metro. Just building freeways isn't going to cut it, it's just going to choke all of us out with more pollution.
06/03/2008	The ramp meters on the 101 are dangerous. Things were fine before. i have witness many close calls. i ignore them and merge when it is safe. Metered ramps do not prevent unsafe driving, they only add a component of distraction for all drivers. Get rid of them.
06/18/2008	start the morning carpool at 5AM!!!
07/05/2008	Their is a HUGE need for some sort of a sign that states traffic laws. Ignorance is no excuse. That is correct. But Ignorance causes accidents every day. You take a test when you are 16, get a license until you are 65. The typical person will make no effort to update them selves on new laws. And often forget current ones. My biggest thing is on people traveling 10 or more under the posted speed limit. They think that 45 on the 202 is going to be safe for them. I see it all the time. People from other countries just come here and drive. A simple sign to educate people would be great. "Slower traffic keep right" and the HOV times written bigger then the tiny font they currently are shown in. I'd pay for those myself. Thank you
07/13/2008	Get rid of the disappearing right lanes! Widen the roads!
07/13/2008	severe lack of info outside of Phoenix. no info on truck break down blocking 1 lane N. I 17 about Bumble Bee exit. ongoing condition since Thur. afternoon 7-10-08 till at least Sat. 7-13
07/14/2008	I would like to see maps of new construction.
07/20/2008	More cameras north of Ina Rd. Tucson to Picacho Peak
07/21/2008	The portion of freeway I've listed lies along my favorite inbound commute path. It is well travelled since it lies along a connection from loop 202 in the northeast phoenix area to loop 202 in the southeast phoenix area (with a US 60 connection in between)
07/30/2008	I'm not on the freeway long enough to see if the times are accurate. I get off I-10 at the 143 exit.
08/11/2008	Backup on 143 in afternoon
08/13/2008	I17 & Union Hills Road - The grate on the storm drain is collapsing causing a hazard for motorcycle operation in the center lane.
08/15/2008	I always check the traffic conditions and event listing to avoid potential tie-ups on my commute. I find it VERY useful.
08/22/2008	You need another response to "Do you find the travel time estimates to be accurate?" x I dont think about it again after I pass the sign.
08/28/2008	is the east bound traffic work complete from I10 west to shannon?
08/28/2008	Yes,can anthing be done about single drivers in the HOV lane sr 51 n&s! I drive a motorcycle and I'll see 5 or 6 single drivers on my morning & evening commute,please help!
09/04/2008	Please enforce the legal use of the HOV lanes.
09/05/2008	There should be more cams on the site to view in Scottsdale.
09/08/2008	Accuracy is a critical component of the freeway travel time information.
09/11/2008	LOCAL POLICE OR CITIES ARE NOT CHANGING TRAFFIC LIGHTS @ OFF RAMP TO RELEAVE FREEWAY BACK UP.AVONDALE BLVD,DYSART RD, LITCHFIELD RD. EVENING TRAFFIC WEST BOUND BACKS UP FOR MILES.TAKE 10 TO 15 LIGHT CHANGES TO GET ON SURFACE STREETS ??????????????????????
09/30/2008	yes, when will mesa residents get a lane on 202 red mountain that will not have them sitting in 101 south traffic. I stinks that I could be home 15 minutes sooner, but have to sit in that. And half the people are crossing five lanes near Priest then crossing back to get on the 101. That gumbs up the works.

10/14/2008	The last question is too vague. If there is an accident, yes i pick an alternate route. If it's just based on high volume, I usually don't have much choice.
10/14/2008	In my opinion the AZ511 web site needs a complete revamping and is currently useless. Get rid of the STUPID flash intro. Its a waste of time. Try using the web site on a 2-1/2" cellphone to get information - you can't. A complete redesign is necessary!!
10/24/2008	Work faster on ADOT construction projects especially the I-10 in the Goodyear area. Traffic is terrible and the construction seems to be a project that never ends. The freeway out west on I-10 stinks.
10/26/2008	commute clarification: I commute to downtown Phx starting @ 5 PM and leave for home in E Mesa at 2 AM
10/26/2008	our roads are the best! a phx resident.
10/28/2008	Cameras should not go off during RUSH hours where you can't drive with more than 60MPH and keep a distance of 3 dots!
11/03/2008	It`s not all about Phoenix
11/04/2008	If the tunnel was move well lit I think motorist would not slow to a crawl and cause a backup. This would greatly reduce travel times.
11/05/2008	You did a fantastic job on the Bob Martin aka Beeline. You took the dangerous curve our of the south bound new lane. You made the drive up to Payson wonderful. You did a fantastic job on the ecology. There is just one you did which I miss. You took the ROMANCE out of the drive to Payson. I guess that's the price of progress. I have driven the Phoenix Payson route for the past 41 years (this year it will be 41) and yes, I have suffered the changes. The Romance of it all is gone. However that doesn't mean I can't congratulate you on a job well done.
11/06/2008	You should state that this is a survey strictly for the PHX metro area and that you're not interested in the rest of the state.
11/19/2008	I am PISSED that I had a picture taken of me in a 65mph going 63! If you are going to charge me for going under the speed limit, then change the speed signs!
11/27/2008	one broken sign on the 10 needs to b fixed you just see random spots
12/04/2008	install cameras to catch the cheaters using the HOV lanes. Half the cars in that kane have only one occuapnt.
12/18/2008	I am in the 86301 prescott az and I tried to get the road conditons on this. How would I do this?
12/18/2008	You provide minimal information for anyone beyond Phoenix! We need road conditions on snowy days in Northern Arizona life does exist north of Anthem!
12/19/2008	Where do we locate how travel conditions will be on the Interstate in Arizona- I-17 for snow tires/chains?
12/27/2008	511 was wrong 12/26 for the 93 south of hoover dam. it said no delay but I waited 2 hours from the security checkpoint to the dam. really unacceptable.
12/28/2008	The information regarding road closures on the map is difficult to read and needs MORE WORK!!! I was unable to determine that SR 87 was closed on the stupid map & wasted my day finding out the hard way.
12/15/2008	I wanted information about getting from Show Low to Tucson because I heard there might be road closings on that route. This site was not helpful.
12/31/2008	It would be nice if they could update the signs more often. I find some of them stating problems long after the clean up.
01/06/2009	Too many people are illeagally using the HOV lanes duing commute times.
01/23/2009	No, but please do not remove the speed cameras. They are needed!

APPENDIX D – TRAVEL TIME VALIDATION RUN SUMMARY (JANUARY AND JULY 2008)

Wendesday, January 23, 2008

	DMS Location/Number	Destination									Time of Day	Travel Time Displayed	Actual Travel Time	Variance	Notes
		Tunnel	Airport	SR-143	83rd Ave (I-10)	Ray Rd (I-10)	Peoria Ave (I-17)	Val Vista (US-60)	Bell Rd (SR-51)	Loop 101					
INBOUND	I-10 EB 67th Ave (1)														
	Route 1	■									7:33 AM	20 min	15 min	-5 min	
	Route 2		■									20 min	19 min	-1 min	
	I-10 WB Guadalupe Rd (9)														
	Route 1			■							7:35 AM	15 min	10 min	-5 min	
	Route 2	■									7:47 AM	20 min	19:30 min	-30 sec	
	I-17 SB Northern Ave (27)	■									6:30 AM	20 min	19 min	-1 min	
	US-60 WB Extension (42)														
	Route 1 (via I-10)	■									7:24 AM	30 min	32:30 min	+2.5 min	
	Route 2 (via L-101)														**data collected on Thursday and Friday
	SR-51 SB Northern (58)	■									7:40 AM	15 min	19 min	+4 min	
	L-202 WB McClintock (47)														
	Route 1			■							6:55 AM	10 min	4 min	-6 min	
	Route 2	■										20 min	14 min	-6 min	
OUTBOUND	I-10 WB 7th Ave (13)														
	Route 1						■				6:30 PM	15 min	11 min	-4 min	
	Route 2				■						4:18 PM	15 min	15 min	even	
	I-10 EB 10th St (4)														
	Route 1								■		5:30 PM	20 min	23:30 min	+3.5 min	minor collision @ Colter/Bethany exits, no lanes blocked
	Route 2					■					5:00 PM	25 min	33 min	+8 min	
	I-17 SB Central Ave (32)														
	Route 1							■			5:42 PM	35 min	39 min	+4 min	
	Route 2					■					5:20 PM	25 min	32 min	+7 min	Accident at I-10/US 60 in HOV lane. Mostly cleared
	I-17 NB 4th Ave (17)														
	Route 1						■				5:00 PM	15 min	17 min	+2 min	
	Route 2				■						3:30 PM	15 min	12 min	-3 min	
	SR-51 NB Osborn Rd (55)								■		5:23 PM	15 min	16 min	+1 min	Accident on right shoulder south of Bethany home exit
	L-202 EB 24th St (50)									■	5:45 PM	20 min	17:30 min	-2.5 min	

Thursday, January 24, 2008

	DMS Location	Destination									Time of Day	Travel Time Displayed	Actual Travel Time	Variance	Notes
		Tunnel	Airport	SR-143	83rd Ave (I-10)	Ray Rd (I-10)	Peoria Ave (I-17)	Val Vista (US-60)	Bell Rd (SR-51)	Loop 101					
INBOUND	I-10 EB 67th Ave (1)														
	Route 1	■									8:10 AM	15 min	12 min	-3 min	Time changed from 15/15 to 15/20 on the DMS
	Route 2		■									20 min	16 min	-4 min	
	I-10 WB Guadalupe Rd (9)														
	Route 1			■							7:25 AM	15 min	11:30 min	-3.5 min	
	Route 2	■										20 min	21 min	+1 min	
	I-17 SB Northern Ave (27)	■									8:40 AM	20 min	13 min	-7 min	
	US-60 WB Extension (42)														
	Route 1 (via I-10)	■									7:26 AM	30 min	39 min	+9 min	
	Route 2a (via L-101)	■									6:50 AM	25 min	37 min	+12 min	Incident off right s/o University on L-101. Stop and go on L-101 b/w US 60 and L-202 transition. Approx 25 mph on L-202 b/w 44th St to I-10
	*Route 2b (via L-101)	■									7:25 AM	25 min	28 min	+3 min	**Data was collected on Friday AM (Jan 25)
	SR-51 SB Northern (58)	■									7:33 AM	15 min	19 min	+4 min	
	L-202 WB McClintock (47)														
	Route 1			■							7:26 AM	10 min	3 min	-7 min	
	Route 2	■										15 min	17 min	+2 min	
OUTBOUND	I-10 WB 7th Ave (13)														
	Route 1						■				4:50 PM	20 min	19 min	-1 min	very congested near 7th Ave lane drop
	Route 2				■						4:30 PM	15 min	18:30 min	+3.5 min	minor accident on I-17; very congested near 7th Ave
	I-10 EB 10th St (4)														
	Route 1								■		5:43 PM	25 min	31 min	+6 min	
	Route 2					■					5:00 PM	25 min	37 min	+12 min	
	I-17 SB Central Ave (32)														
	Route 1							■			6:00 PM	30 min	31:24 min	+1.5 min	
	Route 2					■					5:00 PM	25 min	33 min	+8 min	
	I-17 NB 4th Ave (17)														
	Route 1						■				5:35 PM	25 min	26 min	+1 min	
	Route 2				■						3:50 PM	15 min	22 min	+7 min	Continuous rain throughout travel time run
	SR-51 NB Osborn Rd (55)								■		5:25 PM	20 min	21:30	+1.5 min	
	L-202 EB 24th St (50)									■	5:30 PM	20 min	21 min	+1 min	

* Travel time data along Route 2b (via L-101) was collected on Friday, January 25, 2008

Wednesday, July 23, 2008

	DMS Location/DMS Number	Destination									Start Time	Travel Time Displayed	Actual Travel Time	Variance	Notes
		Tunnel	Airport	SR-143	83rd Ave (I-10)	Ray Rd (I-10)	Peoria Ave (I-17)	Val Vista (US-60)	Bell Rd (SR-51)	Loop 101					
INBOUND	I-10 EB 67th Ave (1)														
	Route 1	■									6:49 AM	12 min	8:30 min	-3:30 min	
	Route 2		■								6:49 AM	16 min	12:30 min	-3:30 min	
	I-10 WB Guadalupe Rd (9)														
	Route 1			■							7:40 AM	6 min	8 min	+2 min	
	Route 2	■									7:40 AM	17 min	16 min	-1 min	
	I-17 SB Northern Ave (27)	■									8:15 AM	14 min	8:30 min	-5:30 min	- Traffic moving at essentially free-flow speed +60 mph
	US-60 WB Extension (42)														
	Route 1 (via I-10)	■									7:30 AM	25 min	20:30 min	-4:30 min	
	*Route 2 (via L-101)	■									7:24 AM	23 min	20 min	-3 min	- Incident in EB 202 lanes caused minor slowing
	SR-51 SB Northern (58)	■									7:07 AM	13 min	11:30 min	-1:30 min	
	L-202 WB McClintock (47)														
	Route 1			■							7:14 AM	10 min	4 min	-6 min	
	Route 2	■									7:14 AM	16 min	11 min	-5 min	
OUTBOUND	I-10 WB 7th Ave (13)														
	Route 1						■				6:20 PM	14 min	10 min	-4 min	
	Route 2				■						4:21 PM	17 min	12 min	-5 min	
	I-10 EB 10th St (4)														
	Route 1								■		5:42 PM	20 min	18 min	-2 min	
	Route 2					■					5:31 PM	34 min	22 min	-12 min	- Sign displayed "29 minutes" 30 sec prior to arrival at sign
	I-17 SB Central Ave (32)														
	Route 1							■			5:59 PM	41 min	21 min	-20 min	
	Route 2					■					5:36 PM	30 min	21 min	-9 min	
	I-17 NB 4th Ave (17)														
	Route 1						■				5:14 PM	19 min	19 min	-	
	Route 2				■						5:46 PM	16 min	13 min	-3 min	
	SR-51 NB Osborn Rd (55)								■		5:47 PM	18 min	12 min	-6 min	
	L-202 EB 24th St (50)									■	5:32 PM	20 min	13 min	-7 min	

*This travel time run was conducted Wednesday, July 30, 2008

Thursday, July 24, 2008

	DMS Location/DMS Number	Destination									Start Time	Travel Time Displayed	Actual Travel Time	Variance	Notes
		Tunnel	Airport	SR-143	83rd Ave (I-10)	Ray Rd (I-10)	Peoria Ave (I-17)	Val Vista (US-60)	Bell Rd (SR-51)	Loop 101					
INBOUND	I-10 EB 67th Ave (1)														
	Route 1	■									6:48 AM	13 min	10:30 min	-2:30 min	
	Route 2		■								6:48 AM	17 min	14 min	-3 min	
	I-10 WB Guadalupe Rd (9)														
	Route 1			■							7:02 AM	6 min	6:30 min	-	
	Route 2	■									7:02 AM	16 min	14:30 min	-1:30 min	
	I-17 SB Northern Ave (27)	■									7:20 AM	14 min	10:30 min	-3:30 min	- Minor slowing @ Glendale Ave
	US-60 WB Extension (42)														
	Route 1 (via I-10)	■									7:44 AM	25 min	21 min	-4 min	
	*Route 2 (via L-101)	■													- No travel times posted due to L101 construction
	SR-51 SB Northern (58)	■									7:04 AM	13 min	10:30 min	-2:30 min	
	L-202 WB McClintock (47)														
	Route 1			■							7:28 AM	10 min	3 min	-7 min	
	Route 2	■									7:28 AM	16 min	12 min	-4 min	
OUTBOUND	I-10 WB 7th Ave (13)														
	Route 1						■				6:25 PM	14 min	10 min	-4 min	
	Route 2				■						5:37 PM	16 min	12 min	-4 min	
	I-10 EB 10th St (4)														
	Route 1								■		5:49 PM	20 min	17 min	-3 min	
	Route 2					■					5:16 PM	29 min	27:30 min	-1:30 min	- Semi broken down in lane 2 near 40th St
	I-17 SB Central Ave (32)														
	Route 1							■			6:22 PM	36 min	20 min	-16 min	
	Route 2					■					5:32 PM	31 min	26 min	-5 min	- Semi broken down in middle lanes at exit 153
	I-17 NB 4th Ave (17)														
	Route 1						■				5:43 PM	19 min	16 min	-3 min	
	Route 2				■						5:51 PM	16 min	13 min	-3 min	
	SR-51 NB Osborn Rd (55)								■		5:52 PM	17 min	14 min	-3 min	
	L-202 EB 24th St (50)									■	5:50 PM				- No travel times were posted

*This travel time run was conducted Thursday, July 31, 2008

APPENDIX E – SUMMARY OF MAINTENANCE COST ESTIMATES

The operations and maintenance costs used in this analysis are based on Washington State DOT's ITS Maintenance database of estimated annual costs for the variable message signs. These values are consistent with other state published state maintenance programs, but Washington's specifically is used in this analysis. ADOT's maintenance schedule is utilized in the calculations for the report as two minor checks and two major checks per year.

The following unit rates shown in **Table E1** were used for the various labor and equipment categories.

Table E1 – Unit Rates

Work Activity	Details	Costs
Labor	Maintenance Technicians for Traffic Control and Repair	$40 / hour / person
Equipment	Man Lift Truck	$16 / hour
	Pickup	$5 / hour
	Van	$4 / hour
	Truck-Mounted Impact Attenuator	$3 / hour
Materials	Varies	Varies

The recommended maintenance schedule for DMS signs is one major preventative maintenance per year plus monthly minor preventative maintenance checks. A major preventative maintenance on a sign over a traffic lane typically takes between six to eight hours (assume eight hours for the cost estimate). Traffic control requires two hours to set up and one hour to take down. **Table E2** summarizes the costs for the major preventative maintenance required on each DMS during the year.

Table E2 – Major Preventative DMS Maintenance

Work Activity	Qty	Details	Cost
Labor	6	Maintenance Technician	$1,920
Equipment	2	Man Lift Truck	$256
	1	Pickup	$40
	1	Van	$32
	2	Truck-Mounted Impact Attenuator	$48
Materials			$500
Total Cost Per Sign (Annually)			**$2,800**

A minor preventative maintenance check is recommended to be conducted on a monthly basis which requires one hour of labor, except for the month when the major preventative service is conducted. This translates into 11 preventative maintenance checks per year and the associated costs are included in **Table E3**.

Table E3 – Monthly Minor DMS Preventative Maintenance

Work Activity	Qty	Details	Cost
Labor	1	Maintenance Technician	$40

Equipment	0	Man Lift Truck	$0
	0	Pickup	$0
	1	Van	$4
	0	Truck-Mounted Impact Attenuator	$0
Materials			$0
Total Cost Per Sign (Per Visit)			**$44**
Total Cost Per Sign (Annually)			**$480**

Repair costs also need to be accounted for as some DMS will need repair over time. For a DMS sign over traffic, the cost includes traffic control set up and take down and is estimated at six hours per year per sign as shown in **Table E4**.

Table E4 – DMS Repair

Work Activity	Qty	Details	Cost
Labor	6	Maintenance Technician	$1,440
Equipment	2	Man Lift Truck	$192
	1	Pickup	$30
	1	Van	$24
	2	Truck-Mounted Impact Attenuator	$36
Materials – Repair parts and materials			$400
Total Cost Per Sign (Annually)			**$2,100**